DYED-IN-THE-WOOL: THE IMPACT OF OCCUPATIONAL BEHAVIOUR AND THE ENVIRONMENT ON SMALL URBAN AND RURAL COMMUNITIES IN FLANDERS, C. 1200-1860 AD

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ABSTRACT

This thesis presents a bioarchaeological study of six cemetery populations from Flanders (Belgium), dating from the medieval to early modern periods. The six sites represent populations from different regions/contexts (coastal, inland, small-urban and one high-status group), and through a multi-faceted study incorporating historical, archaeological and osteological evidence, provides the opportunity to explore the impact of socioeconomic and environmental conditions on the health status of individuals working within rural and small urban habitats between the late 12^{th} and 19^{th} centuries.

In order to interpret inter- and intra-population variability, patterns of mortality, stature, diseases and activity markers (entheseal changes or EC) were assessed to investigate the consequences of a physically active lifestyle in an economically important and dynamic period. Historical socioeconomic research detailed the significance of Flanders in the production and trade of wool, linen, cloth, and specified the labour-intensive cultivation of flax and other crops that instigated a major impact on the working lives of both citizens and peasants. The analysis of EC supports the regional and gender labour differentiation between coastal and inland Flanders, whilst the palaeopathological investigation further indicates the consequences of the environment on health, especially upon those residing in a riverine, coastal or polder area.

This research demonstrates the complementary and interdisciplinary nature of integrating a bioarchaeological study within a historical socio-economic framework, and elucidates, not only the impact of an arduous lifestyle on working individuals, but also the vulnerability of the people across status groups to the environment.

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'O felix nimium, sapiens et rusticus idem, qui terras animumque colens inpendit utrisque curam pervigilem'[1]

CHAPTER 1

INTRODUCTION

1.1. The Motivation for this Research Project

The study of human skeletal remains from archaeological collections provides a unique glimpse into the lives of past populations. Bioarchaeology or human osteoarchaeology should be approached as an interdisciplinary field of study that intersects with biological anthropology, archaeology and social theory to contextualize the lives of past individuals within their biological, cultural and environmental situations. Bioarchaeology should be considered as an integrative analysis since the physical remains of past human beings may reveal insight into health or traumatic injuries they survived or not, daily activities and more. Integrating these components rather than exploring only the human bones it will contribute to a more complete understanding of how people in the past may have experienced changes in socioeconomic, political, religious or environmental circumstances over time (Baker and Agarwal 2017). Zakrzewski (2015: 157) pointed out that for bioarchaeologists, each individual embodies multiple stories that 'exist as aspects of multiple identities, not only layered one on top of another, but also intercutting and transecting each other'.

This study aims to explore the impact of socioeconomic and environmental conditions on past communities between the late twelfth and mid-nineteenth centuries by analyzing the human remains from six archaeologically derived skeletal assemblages that were unearthed in Flanders (Belgium). Historical evidence indicated that, particularly from the High Middle Ages, Flanders witnessed a significant development in economic activities. The position of Flanders as a market leader, especially in the production of linen and woollen cloth, generated a fundamental shift in its society with the development of smaller cities (Stabel 2011: 123-124). The regional economic differentiation between town and countryside and between coastal and inland Flanders has also been widely illustrated by historical sources (e.g. Dejongh and Thoen 1999: 57; Thoen 2004: 52-53 and 61; Thoen and Soens 2015: 239; van Bavel 2003). For example, peasant households in the

[1] 'Truly blessed is he in whom philosopher and peasant both unite, cultivating his land and his mind, and who performs both tasks day and night'. Freely translated after: Prudentius, *Contra Symmachum 2*, 1020-1022.

countryside combined linen production with the exploitation of their small holdings which involved the cultivation and processing of flax, spinning and weaving, mostly within their own household which granted peasants a little security and independence (van Bavel 2003: 1145, 1150). In coastal Flanders, the situation was slightly different. Here, socioeconomic and environmental circumstances were associated with smallholdings until the late medieval period and larger holdings from 1500 AD, the cultivation of fodder crops, the reclamation of peat land and a vulnerability to the natural environment. Political and institutional conditions during the Middle Ages have been attributed to the divergence between the coastal area and inland Flanders which will be detailed in Chapter 2.

Divergences between socioeconomic activities in town and countryside in the Flemish region were further noticed in the organization of the textile industry. Merchants were in a strong position because of market privileges, and by controlling trade and production regulations. Bleaching of the linen, for example, was practiced in the towns under regulation by the merchants since it was restrained in the countryside (Stabel 2001). The finishing of the linen production was done within the cities enabling urban merchants to have charge of the 'final production stages and the marketing of the product' (van Bavel 2003: 1145-1146). van Bavel (2003: 1147) noted that 'typical of the Flemish linen sector was the existence of many intermediate wheels in the linen trade'. Both towns and countryside in Flanders were involved: e.g. the itinerant merchants in the countryside, urban markets, the merchant-bleachers, the wholesalers in larger towns such as Ghent, and foreign merchants who to a great extent contributed to the export of Flemish linen to Spain, France, Italy and England (van Bavel 2003: 1147). However, even until the late medieval period there was a strict separation between town and countryside which confined the possibilities of the rural labourers. Activities in other textile industries such as the production of wool were also regulated by the urban guilds. For example, weaving and fulling were mostly practiced in towns as well as dyeing and finishing of the cloths (Stabel 2001; van Bavel 2003: 1148). From the middle of the fifteenth century until the first decades of the nineteenth century, both the rural wool and linen industry experienced a large expansion (Thoen 2001: 121). Thoen (2001: 121-122) remarks that the 'slow movement of the textile industry to the countryside from the fourteenth century' is likely the result of the fragmentation of holdings in the rural hinterland as well as a changing character of the textile industry in towns which was now more focused on the production of fine linen and lighter cloths.

Although the urbanisation and the commercialisation of labour during the medieval period in Flanders has been extensively specified in historical studies, evidence of the impact of socioeconomic and environmental conditions on the people, and specifically on those individuals who were engaged in farming and textile related activities, by using bioarchaeological data is limited.

In Flanders, human osteological studies of medieval to early modern rural and small urban (as opposed to large) skeletal populations are scarce. This is certainly the case for low-status groups, which mainly consists of working individuals, since most human remains have been unearthed from monasteries and/or within churches in a rural and urban context, and hence represent high-status burials (Ervynck *et al.* 2008). Indeed, to illustrate this paucity, a summary of (previously) analysed skeletal individuals from medieval to early modern rural and small urban groups (inhumation graves) from Flemish sites is shown in table 1.1., including the six case studies of this thesis which are listed in bold:

Deinze, Moorsel, Oosterweel, Slijpe, Vichte and Zottegem.

SITE	**PERIOD (AD)**	**PUBLICATION/UNPUBLISHED REPORT**	**SKELETAL STUDY SAMPLE SIZE (n=)**	**REMARKS**
Asse-Kobbegem	1765-1912 (relative dating of inhumations)	Magermans and Saerens (2013: 10-11)	3	Analysed by Quintelier; micro-archaeological excavation; skeletons unearthed from the western part of trench of the churchyard *St. Goriks* and *Magdalene*
Boechout	Medieval	Vandenbruaene, M. (2007)	c. 13	Unpublished report; burials retrieved from *St. Bavo's Church*; poor surface preservation of bone; no detailed osteological study
Deinze	**13-19th C**		96	Analysed by Van Cant; part of this research project; small urban population
Hofstade	9-18th C	Moens and Quintelier (2010: 41-68)	12	High-status burials
Kontich	13-16th C	Janssens (1989: 41-45)	min. 12	*St. Martin's Church*; involves mainly osteometric descriptions
Kruishoutem	9-15th C	Lefever *et al.* (1993: 175-196)	83	Medieval cemetery (no church); focus on merely palaeodemographic data
Meldert	Post-medieval	Vander Ginst and Vandenbruaene (2006: 119-151)	20	High-status burials
Moorsel	**12-19th C**	Van Cant (2014); Van Cant (2012)	103	Unpublished Master's Dissertation (2012)
Oosterweel	**15-19th C**	Van Cant (2011)	68	Unpublished Bachelorpaper; High-status burials
Schriek	Unspecified	Quintelier (2011)	6	Unpublished report; inhumations from *St. John the Baptist church*
Slijpe	**12-15th**	Maesen (2012)	77	Re-analysed as part of this research project
Vichte	**19th C**	Maesen (*s.d.)*	62	Unpublished report; re-analysed as part of this research project
Zottegem	**14-19th C**		93	Part of this research project; analysed by Van Cant in 2016

Table 1.1: Overview of analysed skeletal remains from medieval to early modern rural and small urban populations in Flanders (Belgium) (Note: skeletal collections from monasteries (eg. Abbey of the Dunes in Koksijde and the Cistercian abbey in Herkenrode) are not included in this summary). Sites in bold are case studies in the current research.

The *status quaestionis* of bioarchaeological analyses on medieval and post-medieval rural and small urban working populations in Flanders indicates a dearth of publications. Therefore, this research project aims to explore the impact of socioeconomic developments and environmental conditions on the rural and small urban labourers between AD 1185-1860 by integrating the study of human skeletal remains in an interdisciplinary approach with historical and archaeological data. The inclusion of one rural high-status group (Oosterweel) may demonstrate social differentiation between status groups. It is suggested that low-status individuals may be more susceptible to malnourishment, unhealthy living circumstances, infections and physically demanding lifestyles compared to high-status individuals (Buzon 2012: 65).

1.2. A Brief Introduction to the Six Case Study Sites

To investigate how historical individuals may have been physically affected by socioeconomic developments and environmental conditions between AD 1100 and 1860 in Flanders, six archaeologically derived skeletal collections are applied in this study (also listed in bold in table 1.1) (fig. 1.1).

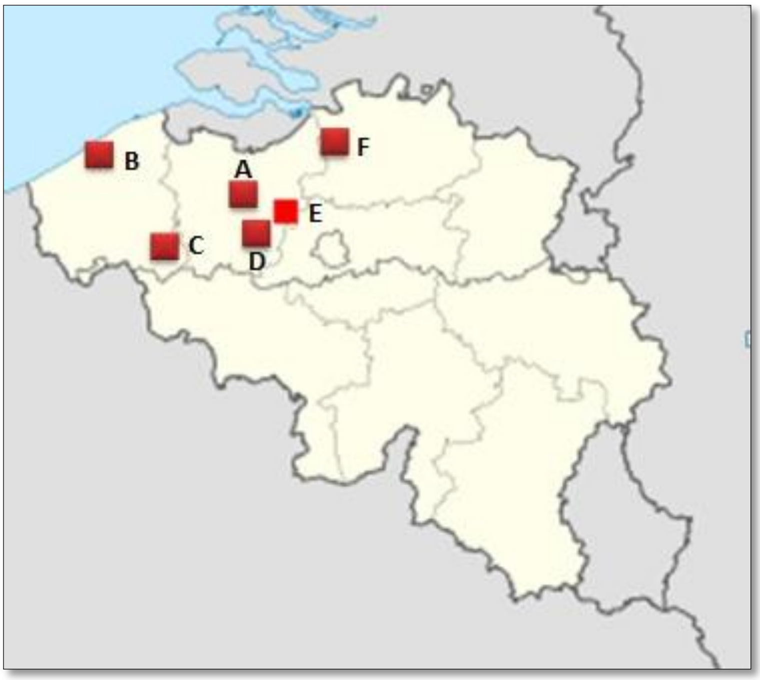

Fig. 1.1: Map of present-day Belgium with indication of the six case study sites in Flanders.

Deinze (prov. of East Flanders) (A)

Slijpe (prov. of West Flanders) (B)

Vichte (prov. of West Flanders) (C)

Zottegem (prov. of East Flanders) (D)

Moorsel (prov. of East Flanders) (E)

Oosterweel (prov. of Antwerp) (F)

Since the historical and archaeological context of the six case study sites will be detailed in Chapters 2 and 3, a brief introduction is presented here. The selection criteria of the sample sites were primarily based on the rich historical and archaeological data available to place each site in the integrative framework of bioarchaeology or human osteoarchaeology, archaeology and history in order to gain insight into socioeconomic and environmental circumstances and its impact on the physical condition observed in the human remains.

The case study of **Deinze**, the only small urban site in this study, provides a unique insight into the transition of a rural community to a small town during the thirteenth century. Located in the epicentre of the Flemish rural linen and flax production, Deinze functioned as a regional transit market for the rural linen industry. The production of textiles was thus an important activity for the Deinze citizens until the seventeenth century when the linen industry shifted from the urban center to the rural hinterland (Prevenier 2003a; Stabel 1985; Thoen 2006). By the end of the eighteenth century, a variety in occupations was demonstrated by census data that indicated that most people in Deinze were employed in retail business, or, for example, in the silk industry or local gin production (De Wilde 1997; Stabel and Dambruyne 2003).

Slijpe, situated in the North Sea area, is the only coastal site in this research. Its late medieval skeletal assemblage may illustrate how coastal populations were affected by their natural environment inherent to a higher risk of flood disasters and drainage problems, for example, during the fifteenth century, as indicated by historical sources (Soens 2013a; van Bavel and Thoen 2003). Dobson (1997) pointed out to an increased vulnerability to diseases when people are living in the proximity of marshlands. The moist weather and windy, cold climate of the North Sea region may indeed demonstrate a different disease pattern compared to inland Flanders with greater susceptibility to rheumatism, arthritis, colds, and endemic diseases such as malaria in the coastal wetlands (Knottnerus 2002: 346; Maes 1975: 44).

The skeletal collection of **Vichte** dates to the nineteenth century when the primary production of textiles was concentrated in the province of West-Flanders, and more specifically in the surroundings of Vichte. Although mechanisation of the linen production was not introduced before the end of the nineteenth century in Vichte, main economic activities of its villagers involved agriculture and household spinning (Blockeel 1975: 18). Many families owned a loom and spinning wheel as part of the home industry and 1 out of 3 labourers were reported to be engaged in textiles (Demasure 2012: 20 and 77; Soens *et al.* 2015: 47-48). During the 1840's, the agricultural crisis as a result of failed potato crops and the economic decline in the linen manufacturing lead to poor living standards in rural Flanders (Scholliers 1995: 67 and 75). Famine, poor sanitation, water pollution of the nearby located stream *Vichtebeek* as well as epidemics of typhoid and cholera were reported in Vichte, and affected nearly 1/3 of the villagers at the start of 1848 (Blockeel 1975: 19; Demasure 2012; Dewilde 1983: 22; De Wilde 1997: 155; Schrooten 2004: 85; Van Den Abeele 1941: 8).

Moorsel is situated in the region of Aalst in inland Flanders (also described as *Land of* Aalst) which experienced an increase in both population numbers and small peasant farms between 1650 and 1850 (Vermoesen 2010: 5-6). The case study site of post-medieval Moorsel is representative for both the cultivation of flax and linen weaving in the eighteenth century. In addition for being one of the main centres for the cultivation of hops and flax, linen manufacturing (spinning and weaving) was widely employed by c. half of the rural households in this area (Thoen 2001: 121; Vermoesen 2010: 6-8 and 22-23). The labour-intensive cultivation of flax involved the whole family who were preoccupied with, for example, digging the land with spades, weeding and sowing (Thoen and Soens 2015: 244-245, 249). The study of the skeletal remains of the post-medieval Moorsel population may demonstrate this high physical productivity across younger and older age groups in the Land of Aalst.

To explore social differentiation between status groups, one high-status skeletal sample is included in this study: **Oosterweel**. It has been hypothesized that privileged individuals were buffered against biological stresses such as malnutrition, a physically demanding workload and diseases because of their better access to medical care compared to low-status individuals (Buzon 2012: 65). Located in the polder region in the province of Antwerp, inundations and flood disasters were historically documented in Oosterweel such as the tidal surge which caused a flood also known as the St. Elizabeth's flood in 1421 (Asaert and Jamees 1995: 13). Other risks that may have affected the physical condition of the Oosterweel inhabitants is the presence of malaria or 'polder fever' which is, for example, indicated by a nearby seventeenth century chapel wherein apparently villagers beseeched protection from a certain fever, most likely polder fever (Kennes *et al.* 1992; Wagemans 2015). The osteological analysis of this high-status group may indicate if privileged individuals were indeed buffered from diseases, famine and/or physically demanding lives.

Villagers of the rural site of **Zottegem,** in the province of East Flanders, were mainly engaged with the cultivation of crops and cattle between the late medieval period and the eighteenth century. Even when labour was performed in other fields such as by carpenters, brewers and millers, historical data suggested that almost every villager was involved in farming in some way. The same period was characterised by several decades of turmoil, arsons, plundering, famine and epidemics (Lamarcq 1989). Thus, the skeletal collection of Zottegem may exhibit the vulnerability of villagers during turbulent times by the prevalence of traumatic injuries, stress markers or infectious disease.

The rural populations of both Vichte and Slijpe have been previously analysed by Maesen (2012; *s.d.*), and were re-examined by the author of this thesis for reassessment of age at death, stature, sex, pathologies, dental health and entheseal changes (EC) or the biomechanical stress markers that are visible on the entheses, or attachment sites of ligaments and muscles to bone, which might yield information on habitual behaviour of an individual (see 1.3.). The case study sites of Oosterweel and Moorsel were both the subject of previous works by the author, and a sub-sample of skeletal adult individuals from these two sites has also been re-analysed for EC and pathologies. For Oosterweel, this sub-sample involves eighteen adult individuals of known sex from different age groups and one juvenile of unknown sex. One of the main criteria for the selection of this sub-sample was the attribution of a sex category, preservation quality and completeness of the bones and/or the availibility of muscle attachment sites for the analysis of EC. The sub-sample of Moorsel involves the group of 41 post-medieval skeletons since the preservation of the bone surface was in a better condition compared to the bone material of the medieval cluster. This will allow a more accurate assessment of osteological data as well as this will allow contextualizing these data within a defined time period.

1.3. Research Aims

The principal aim of this research is to investigate differences in health and physiological stress of six rural and small urban communities from Flanders (Belgium) between the twelfth and nineteen centuries. The integration of historical data will allow exploring the effects of socioeconomic and environmental conditions by the bioarchaeological analysis of the six skeletal collections to identify inter- and intra-population variability in health patterns. To date, there have been limited bioarchaeological studies in investigating the impact of socioeconomic and environmental conditions or in interpreting socioeconomic differentiation between high- and low-status groups from rural and small urban sites in Flanders. Health studies drawing on comparisons between rural and (small) urban skeletal samples or on groups undergoing substantial societal and demographic transitions, however, have been applied on skeletal collections from different geographical locations and time periods. The impact of urbanisation and indrustrialisation, for example, has been explored in several ways: e.g. on child health in medieval and post-medieval UK (Lewis 2002a) and in medieval Denmark (Bennike *et al.* 2005), in a nineteenth-century Dutch town (Maat *et al.* 2005) and in two rural and one urban medieval populations from Holland and Zeeland focusing on joint disease, diet, environmental stress markers and infections (Schats 2017), while other studies demonstrated an association between poor environmental conditions such as contaminated water and poor sanitation and an increased risk in mortality (e.g. Connell *et al.* 2012; Cox and Roberts 2003; Hays 2000: 18; Roberts and Redfern 2005; Santos 1995). The location of settlements like coastal versus inland, humidity, elevation, temperature and access to water can indeed be considered as critical aspects in the acquisition of disease (Buzon 2012: 66). Moreover, van Oosten (2016: 723) combined archaeological data with historical documents referring to contaminated water and poor public hygiene in two pre-industrial towns in the Netherlands (Leiden and Haarlem), along with evidence for a dense population mainly engaged in textile manufacturing (Leiden), and suggested further osteological research. The effectiveness of using a multidisciplinary approach by the integration of historical data with osteoarchaeological analyses can certainly shape a nuanced picture of past people's lives (Schats 2017: 275).

A second aim of this study is to examine the impact of physical activities on the skeletal individuals by incorporating the analysis of entheseal changes (EC). Recording changes that occur at muscle attachment sites remains a widely used methodology for investigating activity patterns in past populations (Henderson *et al*. 2016a). The only study to date that has addressed EC in a skeletal collection from Flanders to demonstrate social differentiation was recently presented in the PhD thesis of Palmer (2019), who used three distinct socioeconomic groups from one spatio-temporal context: the post-medieval town of Aalst (province of East Flanders). Palmer (2019: 98) could not suggest that EC is a reliable proxy to demonstrate socioeconomic status, but noted sexual dimorphism in several entheses of the low-status individuals. Other studies that used EC to explore socioeconomic status did reveal differences between status groups (e.g. Havelková *et al.* 2013; Molnar 2010), or indicated a sexual division of labour (e.g. Havelková *et al.* 2011; Perry 2004;

Santana-Cabrera *et al.* 2015; Villotte and Knüsel 2014), thus showing the feasibility of using EC as an indicator for inter- and intrapopulation variability in habitual or occupational patterns of historical groups. However, other EC studies remarked its multifactorial aetiology since other factors such as age, body size, trauma and genetics may influence the morphology of entheses (e.g. Henderson *et al*. 2017; Jurmain *et al*. 2012; Weiss *et al.* 2012). Although the recognition of confounding factors inherent to EC research and the subsequent re-evaluation of exploring the relationship between habitual activities and EC by, for example, using identified skeletal collections (e.g. Alves-Cardoso and Henderson 2010, 2013; Milella *et al.* 2012, 2015), did not prevent other researchers to continue using EC as an activity marker (Palmer 2019: 16; Rojas-Sepúlveda and Dutour 2014). The methodology used in this study for the assessment of EC will be further detailed in 4.5 in Chapter 4.

Comparisons between the six case study sites might indeed reveal a sexual division in labour, differences in health status, and the potential impact of both occupational and environmental issues noticed in the skeletal remains. Furthermore, archaeological and historical data on contemporary socio-economic and demographic conditions will be juxtaposed with the bioarchaeological results of each case study in order to define a possible correlation between the observed health status and mortality patterns of the skeletal assemblages.

The collected data from this study intends to encourage both national and international comparative analyses. The data obtained in this research project will be supplementary to the current osteological database, and will enhance the development of a general overview of physical anthropological research in Flanders (and in Belgium more broadly). Seeing the interdisciplinary nature of osteological studies, it will further contribute to emphasising the importance of human bone studies from historical sites. For example, the integration of historical (medical) sources to understand the prevalence, frequency and evolution of diseases in the past was noted by Mitchell (2012: 320), who encouraged training in the use of historical texts to study ancient afflictions, and further stated that interaction between paleopathologists and historians should be stimulated, such as attending and presenting at each other's conferences. This multidisciplinary perspective will certainly allow for a broader understanding of past health and disease into related fields.

1.4. Research Questions

Tarlow (2015) has criticized that, in general, studies of churchyard burials are frequently explanatory rather than analytical, and often focused on the analysis one single site instead of integrating a comparative framework. The expansion in urban Europe, and hence the implementation of protective cultural heritage laws, however, has led to an increase in archaeological excavations in towns, whereby much attention is paid to the study of medieval to post-medieval cemeteries. Yet, other notable issues include the long-period of use of many churchyards, and publications of these sites may have been classified and 'marketed' under medieval studies instead of capturing the whole period of use of the cemetery (Tarlow 2015: 1-2 and 4). Tarlow (2015: 4) further remarked that the field has been mainly dominated by osteological, and particularly pathological, studies, and has thus often obscured a social and cultural approach of (post)medieval mortuary practices. Therefore, the archaeological evidence should instigate 'more ambitious' research questions regarding 'the nature of society, belief and cultural history' of the past (Tarlow 2015: 6). The bioarchaeological or osteoarchaeological perspective in this thesis means that beyond the focus on collecting osteological data, the historical, socioeconomic, environmental and archaeological context of each skeletal population will be integrated to assess research questions that aim to improve our knowledge on how multiple factors may have affected the lives of past individuals from distinct historical communities.

This research project can be summarized into the following two groups of research questions:

1. What can we learn about the rural and urban health status at both inter- and intra-population levels? Are there any specific demographic, pathological and dental lesions that reveal the consequences of a rural lifestyle compared to living in an urban environment in Flanders between the twelfth and nineteenth centuries?

2. Will the impact of occupational activities, the role of rural labour supply, the strong urban need, and the commercialisation of labour as illustrated by historical sources result in a regional economic differentiation between the skeletal assemblages, since the medieval era was essential for the formation of the rural market economy in the Low Countries? Could therefore the approach of entheseal changes (EC) reveal a sexual division of labour within each group and/or indicate variations between the groups? Will it enhance our understanding of inter- and intra-population variability if EC will relate to the different economic activities of the Flemish regions?

1.5. Thesis Outline

Chapter 2 considers the socioeconomic situation in the rural hinterland and its connection with towns in Flanders between the late medieval and early modern period, with a significant part dedicated to the importance of textile manufacturing in the provinces of East and West Flanders. Since the impact of the environment and occupational behaviour will be questioned by the osteological analysis in this study, the same chapter provides information on living conditions, and regional and gender related activities. Chapter 3 discusses the historical and archaeological context of the six skeletal collections, and is followed by an introduction to medieval to post-medieval Christian funerary traditions which will be illustrated through the mortuary topography and burial practices related to the six case studies. Chapter 4 specifies the bioarchaeological and statistical methodologies used to determine preservation and completeness of the skeletal collections, age at death, stature, sex, palaeopathologies examined in this study, dental health and the investigation of EC of the skeletal individuals retrieved from the six archaeological populations. Chapter 5 presents the results of the osteological and statistical analysis to point out the mortality profile, the distribution of age according to biological sex, average stature, palaeopathological lesions and the analysis of the twenty muscle attachment sites, or EC, within each skeletal collection. These data are discussed in chapter 6 to indicate inter- and intra-population variability, and to identify any relationships between various factors such as: diet, environment, occupational stress markers and sex, age and social status. The integration of historical documents will aid in the discussion regarding regional and social differentiation and sexual division of labour. One section is attributed to the history of occupational diseases among textile workers linked to present occupational risks in the same field. The final chapter 7 evaluates the main research questions that were introduced in the first chapter, and explores prospective opportunities in bioarchaeological research of past communities.

CHAPTER 2

COMMERCIAL SURVIVAL STRATEGIES IN THE RURAL HINTERLAND AND ITS URBAN CONNECTION IN FLANDERS BETWEEN THE LATE MEDIEVAL AND EARLY MODERN PERIOD

This chapter illustrates the economic role of the rural hinterland, the establishment of the 'social agrosystem' and its connection with towns since five skeletal collections studied in this thesis (Moorsel, Oosterweel, Slijpe, Vichte and Zottegem) were excavated from rural sites and one (Deinze) from a small-urban site in Flanders. It will further highlight the important economic industry of textiles in Flanders since the Middle Ages, with a focus on the provinces of East and West Flanders. The textile manufacturing in Flanders experienced a shift since the sixteenth century when the medieval cloth industry ceded its prominent position to the linen production, and when the centre of gravity of this Flemish linen production moved from the towns to the countryside (Stabel and Dambruyne 2003a: 149). The case study of Deinze, the only skeletal assemblage of a small town in this study, provides the opportunity to question, both archaeologically and historically, if its textile production was affected by these transformation processes. Comparative samples from other countries in the North Sea region are also illustrated throughout this chapter, since it experiences comparable geographic, economic and cultural characteristics, which have in turn provided the impetus for a (competitive) trade network that acted as a catalyst factor in the economic history of Europe (for example Flanders among the most developed regions in Europe in the middle ages) (Vanhaute *et al*. 2011: xiii-xiv). Since it is hypothesised that the impact of the environment and occupational activities will be evidence within the osteological data, the following chapter will explore the living conditions of the populations, regional variation in these conditions as well as activity-related differences on the basis of gender.

2.1. The Unique Development of the Flemish Social Agrosystem

The demarcation between the North Sea coastal plains and inland Flanders has been adopted by Thoen (2004, 2006) who developed the concept of a social agrosystem which he outlines as 'a rural regional production system based on region-specific, social relations involved in the economic production process of a given geographical area' (Thoen 2004: 47; Thoen 2006: 195). Thoen (2004: 47-49) argues that a social agrosystem is subject to change throughout time because of several reciprocally affecting primary and secondary key factors. These factors include, for example, social property structures, labour organisation, income policies and agricultural technologies (as primary), and further, soil, and the physical and cultural environment (as secondary). Further, Thoen and Soens (2015: 227) notably distinguish two 'most contrasting' systems in the Low Countries between 1000-1750, which are the commercial survival economy and the commercial business economies, and state that regional variations in rural production within one agrosystem do occur (Thoen and Soens 2015: 236). A differentiation in the social agrosystem between the coastal area and inland Flanders is outlined in, for instance, a majority of peasant smallholders engaged in a combination of farming and small-scale proto-industrial production such as textiles, sheep and cattle husbandry, a focus on the cultivation of fodder crops, fishing, an often anthropogenic intervention of peat land and a vulnerability to the natural environment involving drainage problems in coastal Flanders. From the sixteenth century, the situation in the latter region was characterised by larger holdings and by the disappearance of proto-industrial activities (Soens *et al.* 2014: 142-144; Soens *et al.* 2015; Thoen 2001; Tys 1997). Even more, in contrast to peasant landowners, tenant farmers were able to rely on financial resources from their landlord in case of disasters such as warfare, flooding or fire (Soens *et al.* 2014: 147). In inland Flanders, on the other hand, the differentiation is outlined by small peasant family holdings, a diversity of crops such as flax, hemp and dye plants (woad), sandy-loamy soils and a lesser 'burden of the physical environment', and the invention of the reaping hook as one of the labour-saving tools in the fourteenth century (Dejongh and Thoen 1999: 57; Thoen 2004: 52-53 and 61; Thoen and Soens 2015: 239). By the sixteenth century and in contrast to the coastal region, Soens *et al.* (2015: 45) state that, in inland Flanders, ‘proto-industrial activities had to compensate more than ever for the falling agricultural income’.

Political and institutional conditions during the Middle Ages have been attributed to the divergence between the coastal area and inland Flanders, with a dominance by the Counts of Flanders and more autonomy for peasant communities in the coastal region, whereas a presence of feudal lords and less autonomy for peasants characterised in interior Flanders (Soens *et al.* 2014; Tys 2004). From the twelfth-thirteenth centuries, changing power and property structures in both regions seemed to converge, which resulted in peasant smallholdings in inland Flanders, whilst peasant holdings in the coastal area were increasingly split up. The social-agro system in Flanders developed into a ‘commercial survival-economy’ with a dominance of peasant smallholders alongside a minority of larger holdings. As a result of this fragmentation, peasants were forced to seek alternative ways to guarantee their survival and basic needs. Other activities beyond agriculture such as peat digging, fishing, reed cutting and also textile production, offered an additional income to establish survival strategies (Soens *et al.* 2015: 45-46). However, a distinct discrepancy between the two regions was generated by the late medieval crisis, and more particularly in the coastal region, which experienced flood and drainage problems, and higher taxes forced the peasant landowners to sell (or they lost) their properties to 'mostly absentee bourgeois' strategies (Soens *et al.* 2015: 45-46). This eventually induced an increasing size of holdings, whilst proto-industrial and semi-agrarian activities disappeared and coastal Flanders made the transition to a capitalist rural economy while inland Flanders remained a peasant society with a dominance of small holdings and proto-industrial activities to compensate the agricultural income (Soens *et al.* 2015: 46 also citing Thoen 1988 and Thoen and Soens 2009).

Although Thoen and Soens (2015: 236-238) admit that 'many regions have not yet been studied in detail, sometimes because data is scarce', they could provide local data of crop yields before 1550, derived from probate inventories, which show higher yields on intensively cultivated peasant-holdings in inland Flanders (Oudenaarde) than yields on bigger farms (coastal Flanders). The authors suggest that this regional divergence might be due to the low fourteenth century yields from one study of a larger hospital farm in the coastal area (Thoen and Soens 2015: 236-238). Despite a distinction between the two areas in Flanders, the two social agrosystems were certainly interconnected by mutual mobility and seasonal labourers from inland Flanders to the coastal region who were needed during harvesting time (Thoen 2004: 62). More yield figures, based on probate inventories and tithe documents concern the labour-intensive cultivation of flax, which provided the raw material for the linen industry, and were, besides the yields of bread cereals, analysed by Dejongh and Thoen (1999). The flax data display an ample expansion after the fourteenth century, mainly in the rural hinterland of Ghent and Alost (Aalst) (Dejongh and Thoen (1999: 38). Even in later centuries, there is a consolidation of flax production in the same region as an interregional comparison of gross yields of industrial crops such as flax and coleseed in the eighteenth century indicates a high productivity of flax cultivation in the provinces of East and West Flanders (Dejongh and Thoen 1999: 53 and 55).

An example of a regional study about two cloth producing centres with the consideration of the social agrosystems is presented by Soens *et al.* (2015). Here, the social agrosystems were used as a framework to illustrate regional development and the significance of rural organisation for the late medieval cloth manufacturing in the western region of Flanders, and to point out the integrative aspects of urban and rural economies. Historical records such as economic output data and *penningkohieren* (property lists of villagers for tax purposes), including for example property structures, were applied for two test cases: the coastal cloth-town Hondschoote (at present situated on the French-Belgian border), and the village of Nieuwkerke (c. 50 km from our case study Vichte). This study reconsidered the common dichotomy between the commercial survival economy in inland Flanders and the commercial or capitalist economy in the coastal region. Along with impact factors such as mercantile capitalism and a flexible guild regulation and organisation, an expansion in late medieval rural and semi-urban textiles in Hondschoote and Nieuwkerke was suggested to be influenced by both urban and rural labour markets, and a regional and interregional network, however, political and institutional control in textile manufacturing should be definitely considered too seeing their location close to political boundaries (Soens *et al.* 2015: 41 and 57-58).

2.2. The Impact of the Environment

Understanding the connection between historic landscapes and diseases in an environmental framework was prompted by Ziegler (2016), who pointed out that, for instance, malarial landscapes were generated by human processes such as deforestation, the use of water mills, or the integration of 'stagnant water in urban landscapes'. Apart from the organisation of water, other agents that could modify the landscape of disease include agrarian activities and the handling of human and cattle debris (Ziegler 2016: 104-105). Infectious diseases such as cholera, typhoid and plague are usually disseminated by zoonoses (from animals to humans), or caused by consuming polluted water or food. Therefore, studying infectious diseases within landscapes, or landscape epidemiology, is certainly benefited by an interdisciplinary approach. The contribution from different fields like geology, landscape archaeology, zooarchaeology, cultural, medical and economic history, and ancient DNA applications to identify primary agents and disperse of epidemics, is certainly required to gain a holistic insight into the evolution of diseases in the past (Ziegler 2016: 99-100). The influences of landscapes on past population health was further discussed by Tesorieri (2016), who examined early medieval skeletal remains from three different regions in Ireland according to the political, cultural and physical landscape, and revealed regional differentiations, since more exposure to (physiological) stress was observed in the north, which might be caused by a nutritional deficiency, not only due to more severe climatic conditions, but also because viking invasions may have escalated levels of physiological stress. However, besides a dominant cultivation of oat in the northern region (Tesorieri 2016: 127), no further economic or cultural practices such as water management were specified, which could imply possible other causative agents of increasing stress levels in the north of Ireland, such as infectious diseases because of contaminated water.

Warfare, diseases, famine and climatic changes have undeniably determined mortality rates, as well as shaping regional identities across Europe in the medieval and early modern period. Consequently, how communities endured an agrarian crisis was also influenced by local resources and topographic variations (Dodds and Britnell 2008: 217-220; Lambrecht *et al.* 2011: 325). Relying on environmental resources was, for instance, observed in the coastal wetlands of the North Sea area, in which peasant small-holdings were involved in activities such as peat extraction for fuel, fishing and cultivation of salt marshes for sheep grazing. The provision of a surplus production of wool and grain contributed to the development of small towns and the rural textile manufacturing in the region of Bruges, until an increase in flood and inundation risk from the fourteenth century forced the small farmers to loose control over water management to absentee landowners (Soens 2013a; Thoen and Soens 2009: 20 and 30). de Kraker (2006) has described flood events that occurred in the southwestern Netherlands and coastal Belgium between 1400-1953 AD by using primary written sources such as dike and town accounts, and has detailed large-scale floods during the sixteenth century which affected most of the polder regions in Flanders, coastal Flanders and its inlets, including the coastal towns of, for example, Nieuwpoort and Oostende (de Kraker 2006: 918). He further remarks an increased risk for 'areas where intensive peat quarrying had taken place' (de Kraker 2006: 926). Flooding was, however, not always caused by natural phenomenona, but was sometimes the result of human intervention as this was the case during warfare to prevent enemy troops from taking territory control (de Kraker 2006: 915). Inundation as a military strategy was, for example, used during the battle of Oosterweel in 1567 on the eve of the Eighty Years' War (1568-1648) (Meys 1981).

An investigation on how past societies in fragile environments dealt with rural land use was undertaken by van Bavel and Thoen (2013) since environmental history is certainly related to economic history. To illustrate this, they argued that peat extraction in the North Sea area had caused 'a slow sinking' of the ground, and generated a decrease in peat land (van Bavel and Thoen 2013: 25). The fertile clay soils of the coastal region were, however, prone to high flood risk and investments in drainage projects to reclaim the land were not always successful, but could be even more detrimental than environmental aspects like the gradual sinking of the drained peat land (van Cruyningen 2013: 181-182). Political, social and economic decisions that included the management of property rights have consequently played a large role in maintaining the sustainability of the polder area in the wetlands, and financial shortcomings and taxation disputes for dike maintenance could lead to an imbalanced rural economy (van Cruyningen 2013).

Bad weather conditions such as harsh winters and heavy rain falls were reported in northern Europe in the fourteenth century, which likely harmed the economy (Dyer 2005: 31; Epstein 2009: 41). Even during the cold climate in the fourteenth century, the coastal area in Flanders was predisposed to floods or torrents (van Bavel 2010). Moreover, the climate and the coastal environment is suggested as exhibiting different diseases compared to the inland, and the winds, cold and wet weather in the North Sea region must have intensified afflictions such as rheumatism, arthritis, colds, and the endemic disease of malaria, the latter also depicted as, for example, 'Polder fever' or 'Zealand fever' (Knottnerus 2002: 346; Maes 1975: 44). Hence, it is suggested that mortality is more prevalent in the coastal area and marshlands because of malaria and the rather inferior water conditions (Lambrecht *et al.* 2011: 327).

The frailty of coastal locations to endemics is also pointed out by Dobson (1997: 483-484), who argued that, for example, the plague was recurrent during both medieval and post-medieval times because of overseas trade contacts. Nevertheless, she suggested by population studies, historical accounts and parish registers it had chiefly urban and locally specific and seasonal (with a noticed decline during the winter season) intensity. Endemic infectious diseases and epidemics were an important mortality factor for young people of both sexes in the late medieval era (Dobson 1997: 484; Dyer 2005: 243; Morgan 1999: 121). In the east of England, demographic fluctuations, with a high toll in working populations as suggested by economic historical evidence, were apart from the Black Death, again induced by other catastrophes such as famine and wars, and resulted in a failing wool export leading to pauperised ports (Britnell 2008; Byrne 2006; Dyer 2005: 29-30; Feller 2007: 219). But in the region of Flanders, Britnell (2008: 160-161) remarks that during the aftermath of the Black Death in 1350-1450 AD, a strong population resurgence was observed, and its socioeconomic consequences did not restrain the linen production, as in the castellany of Courtrai (Kortrijk), for instance, many small-holders were active in the manufacturing of textiles. However, Stabel and Dambruyne (2003: 191) argue that after an increased mortality in Flanders in the fourteenth century, a general resumption in the following century was often hampered by epidemics, famines and successive political and military operations.

Examining mortality rates during post-medieval epidemics in rural areas may be accomplished by examining historical sources such as parish registers (Souquet-Leroy *et al.* 2015: 81). For Slijpe, a historical study of parish registers, including death certificates between 1628 and 1800, was undertaken by Maes (1975: 12 and 55), and has indicated that four members of the same family died from the plague in 1632 within two months. Maes (1975: 28 and 30-31) further suggests that, despite a high infant mortality of 50/100 in Slijpe throughout the seventeenth century, neither baptisms nor interments were performed in Slijpe between September 1646 and July 1647, and that twenty-two villagers, from which several plague casualties, were alternatively buried in the towns of e.g. Bruges, Ostend and Nieuwpoort. However, Maes (1975: 28 and 30) indicates that at the start of 1647, a vicar named *Witvliet*, had organised the funerals of at least sixteen dwellers in the parish of Slijpe. General mortality rates indicate that in the last decade of the eighteenth century, an annual average of 35 burials was noted (Maes 1975: 36). These examples may indeed demonstrate mortality during both times of plague and beyond in Slijpe, but fail to address overall mortality rates within a conclusive interpretation, or does not specify the organisation of funerals in the parish during calamities.

In addition, to provide an example of funerary practices during epidemics, seventeenth-century French historical sources illustrate the organisation of burials in the countryside during the plague, when as soon as space in the parish cemetery became constrained, inhumations were carried out either near a barn, in a garden, or in outside fields, and the practise showed similarities with towns where 'new extra-muros burial grounds' were created (Souquet-Leroy *et al.* 2015: 81). The evidence suggests that individuals who died from infectious diseases were initially buried in the communal graveyard, and in a later stage to deal with an increasing number of deaths, were allocated to a burial space outside the community, in order to manage the limited burial space, rather than to deal with a fear of contamination as the latter has been proposed by Souquet-Leroy *et al.* (2015: 81-82).

2.3. The Rural Hinterland and its Urban Interaction

Dyer (2005: 13) remarks that the towns in late medieval England seem rather 'small and thinly distributed' if compared to, for example, 'heavily urbanized Flanders'. Indeed, although the region of Flanders was heavily urbanized since the twelfth centuries, the influence of the countryside and its impact on towns as for instance in its role as supplier has certainly gained more attention in the last few decades (e.g. Limberger 2000; 2009; Thoen 2006: 184 and 195; van Cruyningen and Thoen 2012).

Both rural and urban developments, socially, economic, political and demographic, were present across Europe between the ninth and thirteenth centuries, and involved alterations in the agricultural strategy (Jones and Page 2006: 79; Lewis *et al*. 1997: 239 and 242). A population increase in Western Europe during the Middle Ages resulted in smaller units of burgage plots in the region, and which in turn led to a deficiency in fertilizer which required a re-organisation of the landscape to create the so-called infield-outfield system before AD 1000 (Thoen 2007a: 67; Thoen and Soens 2015: 233). This method of agricultural management consisted of two parts: the infield area was regularly cultivated and manured whereas the outfield was mainly pasture with occasionally cropped segments, and less intensively manured (Rippon 2002: 54; van Bavel and Thoen 2013: 19). Thoen and Soens (2015: 233) specify that a village was organised following a 'patchwork of micro open-fields, each individually organised with a collective field system' as for instance in the late medieval area of Land of Aalst. Additional organisation of the arable field during the medieval period involved, for example, the establishment of the three-field system and the employment of different plough types by farmers, both on the continent and in the UK, such as a heavy mould board plough and a lighter non-wheeled mould board plough, along with a frequent use of oxen (Epstein 2009: 45; Roberts and Wrathmell 2002: 66 and 123; Verhulst 1992: 20-23).

Thoen (2001: 147) attributes the role of the countryside to the establishment of an urban network during the High Middle Ages by the increasing flows of capital from the countryside to the towns which stimulated urban consumption (Thoen 2001: 147). According to Britnell (2008: 150), the rural population in Europe was most likely c. 80% in the fourteenth century. He further notes that, what historians describe as small towns 'because of their occupational structure and marketing functions', 'that their urban status is questionable' since their reliance for supply on adjacent communities (Britnell 2008: 150). However, Britnell (2008) does not address the probability of small towns in the high densely populated region of the Low Countries. Indeed, in here, a demographic impulse in the late thirteenth and fourteenth centuries generated the establishment of urban centres that, despite being anchored in strong rural foundations, amalgamated certain non-agricultural functions, nevertheless that some of the new juridical towns were very small (Devos *et al.* 2011: 159). Notwithstanding a general population decline between AD 1650-1750 in the Low Countries, this was not the case for the inland agrarian demographic rates that showed a rapid progress in population numbers, and despite a strong urbanisation, most people were still living in rural areas (Devos *et al.* 2011: 162). A feature that may assist in looking at demographic growth and the prosperity of a community is the expansion of the nave of the village church, or other structural enlargements and renovations carried out in this house of worship, one of the few remaining medieval buildings of a village, although Jones and Hooke (2012: 35) propose religious customs as a motive for construction works (e.g. the employment of the West Tower for funerals). However, expansions of the church were noticed in the case studies of e.g. Vichte (sixteenth century) and Zottegem (eighteenth century), and are here associated with a population increase based on historical evidence such as census records (see also Chapter 3). For example, the census of 1766 of the castellany of Oudenaarde, illustrates an average of six residents that were accommodated in one dwelling (Vermaut 1974: 261). Although this evidence does not support a population increase, it may be indicative of a population density.

In order to understand discrepancies and similarities between rural and urban settlements, Dyer and Lilley (2012: 81-83 and 97) argue that 'we should be more fully aware of the contacts between town and country' as citizens and products circulate, and definitions distinguishing between towns and rural settlements should not result in building rigid dichotomies between the two settlement types. A synergy between town and countryside was indeed discerned in the Low Countries since, for instance, demographic growth in the sixteenth century undoubtedly stimulated an increase in linen manufacturing, while property listings of citizens from important market towns for rural linens, such as Oudenaarde, have shown their ownership of land parcels in the rural hinterland, and may indicate a combination of both urban and rural economic activities (Stabel 2001: 150).

Rural dwellers were definitely connected with the outside world by means of commercial exchange, the transmission of knowledge of new agrarian techniques and migration to stimulate economic growth (Dyer 2007: 22 and 141; Limberger 2009; van Cruyningen and Thoen 2012). Wool, for instance, is described by Epstein (2009: 47) as 'one example of the tight links between urban and rural economies'. Also, the provision of food, and especially the import of grain for bread for the urban citizens was economically significant for the connectivity between towns and the rural hinterland (with Ghent as an important transit port for the interregional grain trade in the Low Countries during the sixteenth century) (Dambruyne 2012). Cattle breeding in the proximity of bigger towns (as for instance the polder land of Oosterweel was mainly used for livestock cultivation) was the result of a growing meat consumption in cities from the late twelfth century (Verhulst 1992: 24).

An important aspect of the rural-urban interaction in Flanders is the proto-industry, defined by Soens *et. al* (2015: 39) as 'the massive production of cheaper products' that depended on a high input of cheap labour. The search for an additional income beyond agriculture, usually on smallholdings, was particularly noticed in the rural linen industry of inland Flanders (Devos et al. 2011: 160; Soens *et al.* 2015: 39; van Bavel 2010). Soens *et al.* (2015: 58) have demonstrated that the development in textile manufacturing in the countryside was 'certainly stimulated as much by the interaction of urban and rural labour markets, and a functional distribution of quality and skill across the textile landscape'. The significance of textile manufacturing in both urban centres and the countryside in Flanders will be further explained in 2.5.

2.3.1. Exploring Health between Town and Countryside

Previous studies of medieval and early-modern skeletal assemblages from the UK to explore health differences between towns and the countryside have indicated that individuals from early medieval rural sites exhibit a better health status than those living in the successive era when a transition towards urbanism occurred (e.g. Gilchrist 2012; Mays 1997; Roberts 2009b). However, it should be considered that diseases that affect the soft tissues will not be identifiable in the bone material (as discussed as an impediment to interpreting health of past populations in the 'osteological paradox' impact paper by Wood *et al.* 1992, and reviewed by DeWitte and Stojanowski in 2015, see also

Chapter 4). People living close to each other, poor hygiene and sanitation and contaminated water all contribute to the spread of infectious diseases. Moreover, peasants lived in the vicinity of their cattle, and shared characteristic illnesses with them such as influenza and smallpox, but, nevertheless, it is suggested that they were able to acquire a stronger immunity to these diseases that would normally affect those not living near animals (Epstein 2009: 47). An example of an infectious disease that may have first affected cattle before it was transmitted to humans as a result of domestication is considered the bovine form of tuberculosis, caused by the bovine strain through consumption of meat and milk (Ryan 1992: 6).

While attested as not being life-threatening for humans, a study, albeit unfinished, by government veterinarian Verwee (1941: 12) has shown that cattle-plague or rinderpest was reported in the eighteenth century in the adjacent villages of Deinze, but not in Deinze itself, and regulations were formed to restrain the spread of this contagious disease such as massive and preventive slaughter (Thoen and Soens 2015: 251; Vanhaute and Van Molle 2004: 22-23). Although Verwee (1941: 12, 18-19) details the archives referring to the stock-list of 1777 carried out in the neighbouring area of Deinze, *Deinze-buyten* and *Peteghem-buyten*, he states that the census of livestock in 1777 revealed 'many cows in inner-Deinze, fattened by gin distillers and starch manufacturers', nevertheless he lists only the inventory of cattle breeds from outer-Deinze.

An aspect that needs to be considered, however, when comparing rural with urban health or frailty is migration, since there is a probability that people from the rural hinterland might have spent many years in the nearby town, or vice versa (Mays 1997: 124). Poverty often instigated people to migrate to towns which offered charity, and charitable institutions concentrated their efforts on those who were not able to work (Dyer 2007: 20 and 240; French 2007: 83). Parish registers that listed the poor in both the rural areas and towns in the Low Countries were studied by Blockmans and Prevenier (1975: 519) to illustrate that in fifteenth-sixteenth century Brabant (in Flanders), which was according to Devos *et al*. (2011: 162) 'the heart of the urban system' before 1650, rural dwellers were motivated to move because of the care of the poor in towns, but they admit the limitations of poverty driven mobility studies between towns and the countryside due to its temporal situation. Blockmans and Prevenier (1975: 513) refer to archival sources (census) from 1469 to present an overview of the poor in small towns in the County of Flanders. From the seventeen sites in the list, the percentage of the poor in Deinze was estimated at 17.1%, and thus ranked number thirteen, which indicates fewer indigent households compared to for instance the highest 75% in Lombardsijde (prov. of West Flanders, coastal area). Detailed percentages of the poor in the countryside in 1469 were however not provided because several parish registers did not mention impoverished households which might indicate that not all the poor may have been recorded (Blockmans and Prevenier 1975: 513-515). Evidence of likely long-term migration, however, can be revealed by the surname of the person as noticed in fourteenth century tax records of Hertfordshire (UK) listing surnames such as 'de Aylesbury', referring to the person's origin (Dyer 2007: 11).

Urban capitalists in the late medieval period tried to benefit from an economic growth, and were therefore considering alternative ways to cheapen labor by subdividing the production process by, for example, the employment of rural women in the proto-industrial households (Gray 2003: 185; Howell 1986: 36). Evans (1985: 110-111) indicates, by, for example, probate inventories of poor people owning spinning wheels, that the linen industry often attracted those who were 'too old or weak or unskilled to find other work', which is corroborated by sixteenth-century records of the poor in Ipswich (UK), that listed a preponderance of both female spinners and weavers, and suggests that spinning was a common activity among both indigent urban and rural dwellers.

Further, textual sources from medieval towns in the north of England have described a preponderance of women which may be related to migrant female labour in crafts such as weaving. A preponderance of women was prompted by skeletal evidence from the churchyard of a poor area near York (St Helen-on-the-Walls, Aldwark, situated within medieval York, and described as a poor district of York by Mays (1997: 124), with many 'single women living in cheap tenements' (Mays 1997: 124). Although the osteological report of the cemetery of St Helen-on-the-Walls revealed less adult males (N=338) than adult females (N=394), the sex of 45 adult individuals could not be determined (Dawes 1980:27), and thus does not corroborate a significant predominance of women in the demographic profile.

Other economic motives that stimulated mostly young women to migrate involved opportunities such as working as a servant, or employment in textile manufacturing (Dyer 2007: 14 and 138-139). Smith (1999: 42), who has investigated female marriage in England between 1350 and 1800, demonstrates that most households including servants were to be found in towns, and that a significant proportion of these servants were unmarried women. Moreover, the surplus of females in cities in both the fourteenth and seventeenth centuries may be indicative of migration from the countryside to work in a broad scope of activities, or even to live in 'households made up solely of spinsters' (Smith 1999: 42). In addition, Dyer (2005: 215) states that servants could stem from (but supposedly are employed in) all social strata, from the most underprivileged peasant families to gentlemen servants in the nobility, and they were usually accommodated near their bosses. Further, migrants looking for employment were often the most healthy and active individuals of the community (Brown 2007: 119).

A study by De Langhe *et al.* (2013) of the census of 1814, that listed most official female occupations, investigated the work status of unmarried women in the hinterland of Bruges (here with a distinction between the polders and inland), when a crisis in both the rural and linen industry has clearly exacerbated living conditions, and showed that women older than 50 years were mainly engaged in spinning activities, and younger women above the age of 30 were involved in more demanding jobs such as in the inland linen production, but were also employed as servants or labourers in the polder area.

2.3.2. The Development of a Small Town: the Case Study of Deinze

Verhulst (1992: 21-22, 24) states that speaking of an agricultural revolution in the highly populated region of northwest Europe during the thirteenth century is certainly not misplaced, and consequently resulted in high land reclamation and soil productivity. Also Dyer (2005: 245) considers the thirteenth century as an evolutionary period, or 'an age of transition', with the rise of technical skills (e.g. the use of a two-wheeled plow with a coulter), commercial development, population movement and urbanization. This fundamental transformation seems to be supported by other authors, not only by historical evidence, but also by an archaeological approach, such as Astill (2010: 26-27), who states that the end of the twelfth century is regarded as a period wherein major changes occurred since for example dendrochronological analysis has shown that the use of pegged mortise benefitted the construction of fully framed timber buildings which favoured 'the development of multistoreyed structures that produced a distinctive form of urban architecture'.

Indeed, in the thirteenth century, a transition from a rural village towards a small town was archaeologically testified in Deinze, with the establishment of fortifications, town walls, gates, and canals (Stabel 1985: 1). However, it still remains unclear when exactly Deinze obtained its town charter, or how its transformation into an urban entity was perceived by its contemporaries (Prevenier 2003a: 10; Stabel 1985: 1). Remnants of the town gate *Brugse Poort* are depicted on cartographic material from the sixteenth century and later (fig. 2.1). They were uncovered during excavations in 2011 by KLAD, and have been dated to the fourteenth-fifteenth centuries by its brick type (Laisnez and Vandecatsye 2011: 256, *KLAD Archaeological Report 24*). Historical account books of Deinze, however, refer to the purchase of bricks in the fifteenth century, and mention that from 1479 the bricks intended for the fortification of the town, were used in public works projects such as the maintenance of the '*Brugsche Poort*', which was allegedly in need of recurrent reparations (Stabel 1985: 128, 133). This may indicate that another type of brick had been previously used to build the gate, and thus implying an earlier existence than the attested fifteenth century date of construction.

Fig. 2.1: Cartographic material from 1649 after J. Blaeu (first edition from 1641 by Sanderus, Flandria Illustrata), showing '*Deinse*', with indication of the *Brugse Poort* (*gate*) (Image courtesy of the National Maritime Museum, Amsterdam, inventory number S. 1034_(16) map 052).

Because of the limited extent of the trench, further evidence of the town wall was not exposed during the archaeological survey in 2011, except an extension of the gate to the south which is likely related to the enclosure of the town (Laisnez and Vandecatsye 2011: 257, *KLAD Archaeological Report 24*). Other archaeological evidence included ditches in the near vicinity of the *Brugse Poort*, which were dated to before the construction of this town gate. Furthermore, the minimal presence of artefacts including thirteenth-century greyware is suggested to indicate the use of the gate as a passageway between the town centre and its adjacent rural area (Laisnez and Vandecatsye 2011: 257-258, *KLAD Archaeological Report 24*). Although both ecological and archaeological analyses suggest pre-urban activities between the tenth and twelfth centuries in Deinze, the limited extent of the test pits during the excavations in 2011 at the *Markt*, hindered to draw conclusive interpretations on the identified structures such as postholes and ditches (Laisnez and Vandecatsye 2011: 38 and 72, *KLAD Archaeological Report 24*).

Most archaeological data of the twelfth century, apart from the few postholes that are indicative of building structures, are 'represented by pottery rather than structural evidence' (Astill 2010: 27-28). Although Astill (2010) does not refer to archaeological sciences such as soil micromorphology to provide information on cultural behaviour, in Deinze, nevertheless, the recovery of both a large quantity of potsherds and highly decorated ceramics dating from the thirteenth century (c. 800 potsherds according to the inventory list of ceramics), is suggested by Laisnez and Vandecatsye (2011: 29-31, *KLAD Archaeological Report 24*) to indicate an intense habitation, and hence implying a transition towards urbanization. However, the findings of a large number of ceramics does certainly not signify a strong occupation of a site. For example, Jones and Page (2006: 92-93) have shown that a much larger quantity of c. 2000 thirteenth-fourteenth-century pottery fragments have been identified in the rural area of Whittlewood (UK) with c. 40 households in 1279 according to tax records of the parish of Lillingstone Lovell in the same region (Jones and Page 2006: 207). Demographic figures for Deinze in the thirteenth century are not available, and the earliest census of 1469 indicates a population of c. 684 inhabitants (*Deinze-binnen*), which is lower compared to the nearby small towns of Eeklo (c. 2000 inhabitants) and Kaprijke (c. 1600 inhabitants) for the same year, suggesting a minimal difference between an agricultural and urban society when only using population numbers (Stabel 1985: 12 and 15). On the other hand, documentary evidence from 1220, records an itinerary across Flanders by the Count of Boulogne in 1213, and alludes to both Deinze as a town ('*une autre* ***ville*** *que on apiele* ***Donse***') and to its textile craftsmanship or linen manufacturing ('*il a souvent eu grand plente de toiles*') (Prevenier 2003a: 11). However, the use of villata or *vill* was applied by the state as a unit of government, or even as a unit of taxation, covering several villages (Dyer 2007: 3), thus the use of *ville* as an indication of a town is conjectural.

The evolution of Deinze into a larger unit might be related to the evolution of its textile production as also noticed in the enlargement of the early modern village of Haworth (UK) (Roberts and Wrathmell 2002: 93). More similarities with England are perceived in cloth-making places such as Pensford in Somerset that experienced a transformation into an urban centre between the fourteenth and sixteenth centuries (Dyer 2005: 228). Historical accounts involving taxes on linen manufacturing and trade illustrate a profit raise from 1427, and hence suggest its economic importance in Deinze in the fifteenth century, and its market position for linen production in the rural hinterland (Stabel 1985: 91-92). Textiles that are made from flax are, for instance, common linen (*lijnwaad*), and the official establishment of the *lijnwaadmarkt* (linen market) in Deinze took place in the sixteenth century (Coenen 2014; Stabel and Dambruyne 2003a: 145). Based on indirect economic factors such as the number of burgesses, Stabel and Dambruyne (2003b: 191) suggest that the population in Deinze flourished in the sixteenth century when the small town functioned as a regional transit market for the rural linen industry. The geographical position of Deinze between the larger towns of Ghent and Kortrijk (Courtrai) was a beneficial condition (Van der Wee and Van Cauwenberghe 1973: 1059). Despite the notion of the Deinze cloth industry in historical accounts, Stabel and Dambruyne (2003a: 144) agree little is known about its quality, price and yield, but mention two late medieval documents referring to the regulations of cloth-fullers (labourers who cleaned and thickened the woven cloth to eliminate impurities) indicate a local production of diverse cloths such as '*sticwerc*' (small, rough cloth), '*snidelakens*' and '*keurelakens*'. Stabel and Dambruyne (2003a: 149) conducted further research on socio-economic activities in seventeenth-eighteenth century Deinze, when the textile (linen) production shifted from towns to the countryside (see e.g. Thoen 2006), and remark by the censuses of 1695 that merely 4% of the working population in Deinze was employed in the linen industry. Whilst Deinze is situated in the epicentre of the Flemish rural linen and flax production, the census of 1739 which included the rural hinterland of Deinze, indicated that 59% was involved in spinning and weaving, the highest number noticed in the castellany of Kortrijk, and only 8.2% in the town itself. To illustrate, in 1739, *Deinze-binnen* included four master-weavers while sixteen master-weavers were engaged in the surrounding countryside of *Deinze-buiten* (Stabel and Dambruyne 2003a: 150-153). In the town of Deinze, by the end of the eighteenth century, census data indicate that most people were employed in retail business with a significant evolution in the number of local jenever (also known as Dutch gin) distilleries, from only seven in 1767 towards 45 gin kettles in 1795, proportionately the highest distribution in the province of East-Flanders. The economic impact of the jenever production in Deinze since 1790, even more important than the linen industry that time, is partly attributed to the role of Deinze as main gin supplier to the French military (Stabel and Dambruyne 2003a: 152).

2.3.3. The impact of Occupational Behaviour

Dyer (2005: 236-237) points out that 'medieval work could be arduous and repetitive', and that working days were long and structured. As Evans (1985: 3 citing Bridbury 1982) admits: 'writing about the difficulties of discovering evidence for the ordinary activities of ordinary people in the Middle Ages', reminiscing the routine daily lifes of peasants and labourers in absence of occupational archives and probate records is indeed constrained. Alongside iconographic sources, occupational historical evidence can be illustrative of the regular medieval activities undertaken in both urban and rural sites.

The regulation of labour time in the different stages of several important thirteenth-fourteenth centuries' Flemish cloth manufacturing centres (e.g. Bruges, Ghent, Ypres and Oudenaarde) was analysed through guild statutes by the medieval historian Peter Stabel. Stabel (2014: 36 and 50) indicated that working hours (and leisure time on Sundays and festive days) were regulated by the guilds, and working days were extremely long, coordinated by the bell, but regional differences in working time occur as well as divergences in the various stages of textile production. Although working time data for labour intensive wool preparation chores such as spinning and combing seem not to be present, the available records demonstrate that time regulation was mostly concerned for weaving activities (for instance, the political power of the weavers guild in Ghent must have influenced the regulation), in contrast to the finishing cloth stages with a male preponderance (e.g. shearers, dyers and fullers), where 'regulation of labour time was less ubiquitous' (Stabel 2014: 42 and 46).

Dyer and Lilley (2012: 83) propose that besides material features such as houses, streets and a marketplace, another method to distinguish the characteristics of towns in contrast to rural settlements is evidence for non-agricultural occupations. Regarding labour in Deinze, historical sources dated to the fifteenth century suggest that a part of the population worked in tapestry manufacturing (Stabel 1985: 97), but it is not clear what percentage of the inhabitants this comprised. A more detailed list of 41 craftsmen who were employed in the public sector between 1460-1480 AD, was nevertheless compiled by Stabel (1985: 145) based on historical data of wages of people engaged in public works, and lists for example stonemasons, carpenters, thatchers, smiths and one cobblestone paver.

Similar occupations were noticed in Zottegem and Slijpe in the eighteenth century, and are suggested in the former by Lamarcq (1989) to be related to the transition from an agrarian to an industrial society in the second half of the eighteenth century, driven by a population upsurge (Dewulf-Heus 1989). The polder region of Oosterweel to the north of Antwerp was mainly used for cattle fattening, and sixteenth-century leases even indicate that plots were owned by wealthy citizens to employ the polder land either for pasture or for the production of hay and oats (Limberger 2000: 192-194, 203 and 218). Besides the husbandry of horses in the coastal polder area of Slijpe, both fifteenth-century land books and archaeological excavations in 2002-2003 at the Knights Templar preceptory illustrate such activities as peat and clay extraction, probably for the fabrication of (roof) tiles and bricks. Moreover, the toponym *tegelrie* (*tegel* is Dutch for *tile*) in the vicinity of the preceptory supports the presence of a tile- or brickyard (Zeebroek *et al.* 2006: 161-162 and 168).

2.4. Inland versus Coastal Flanders: Regional Differentiation in Activities

Labour-intensive commercial crops such as flax, hop, and dye plants for textiles, were essential in areas dominated by small peasant farms and a plentiful labour supply such as in south-eastern Flanders where market specialization was labour-intensive (Dyer 2005: 235; Gray 2003: 182; Tits-Dieuaide 1984: 605; van Bavel 2001: 39-40). van Bavel (2001: 37) points out this regional diversity, even noticeable in sixteenth-century rural England, and agricultural specialisation varied between the regions. In the eighteenth century, the zone surrounding Ghent shows the flax cultivation in the north-eastern area that can be distinguished from the linen producing inland parts (Gray 2003: 183; Vandenbroeke 1987) (fig. 2.2).

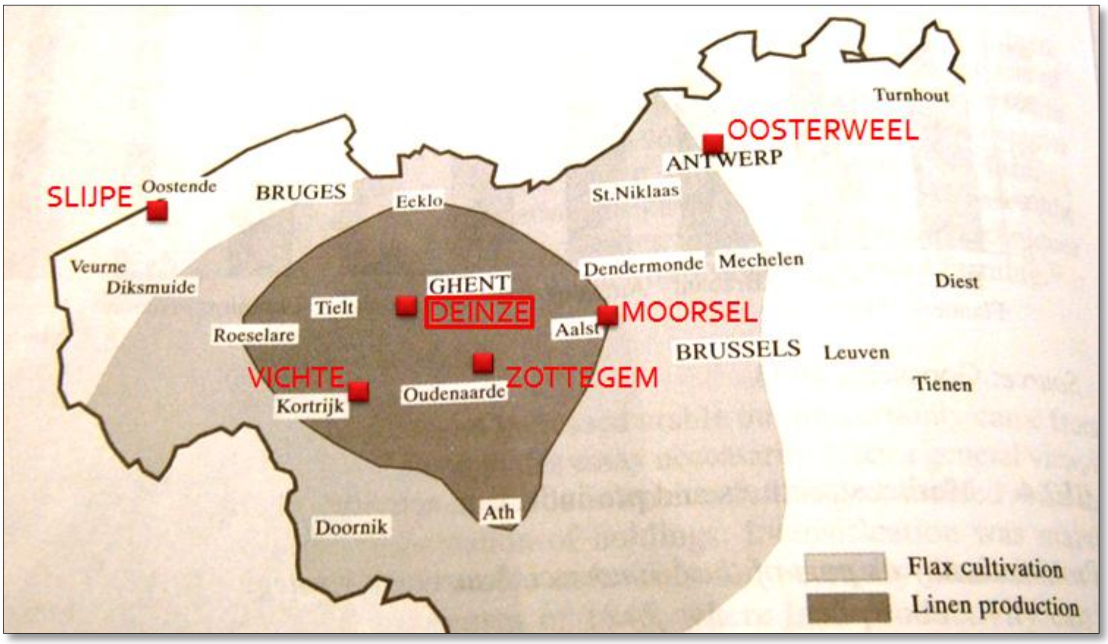

Fig. 2.2: This (partial) representation of present-day Belgium illustrates regional specialisation in flax cultivation and linen manufacturing in Flanders in the eighteenth century, with location of the 6 sites (Adapted from Thoen 2001: 120, figure 6.2, data source Vandenbroeke 1987, with permission).

Few individuals worked both in trades or crafts and agriculture, while those who did not possess farmland combined several trades, as seen in historical evidence from 1496 that illustrates a labourer who was 'a dealer in salt and iron as well as a clothier' (Dyer 2005: 118-119). Non-agrarian activities were thus integrated in the small-scale peasant holdings 'to obtain additional income' (van Bavel 2001: 40). Thoen (2001) applies the term 'commercial-survival economy' to indicate the commercial strategies from small landholdings in inland Flanders which produced labour-intensive crops along proto-industrial goods in order to yield this surplus income.

In his historical study of rural household inventories, Vermoesen (2010: 5-6) suggests that the rural household economy in the region of Aalst (which includes Moorsel), representative for the sandy-loam area of inland Flanders, is characterised by an increase in both population and small peasant farms between 1650 and 1850. In addition to one of the main centres for the cultivation of hops, linen manufacturing (flax, spinning and weaving) was extensively performed by around half of the rural households in this area, and weaving, in particular, was carried out by poor peasant families for whom it was not financially viable to keep livestock (Scott 2012: 134; Thoen 2001: 121; Vermoesen 2010: 6-8 and 22-23). Indeed, sixteenth-century household inventories from the Oudenaarde region (prov. of East Flanders, near Ghent) indicated that 'as much as 47% of the peasant population possessed a weaving loom' (Thoen 2001: 121). And numbers even increased as Castelain (1983: 220) notes that by 1767, 75% of the family units in the shire of Oudenaarde were the owner of a weaving-loom. The trend of owning a loom and spinning wheel as part of the home industry was continued in the nineteenth century when the dominant area of the linen production was situated in the province of West-Flanders, specifically in the villages near Kortrijk and the Leie river (which includes Vichte), with 1 out of 3 labourers reported as working in textiles (Demasure 2012: 20 and 77; Soens *et al.* 2015: 47-48).

After the flax was pulled by hand, other activities in flax processing in preparation for spinning included scutching and retting (Dewilde 1983; Collins and Ollerenshaw 2003; Impe 1937). Scutching involves separating the fibre from the retted stems of flax, usually by means of a wooden tool, although sometimes this process was undertaken in a scutch mill controlled by water power (Collins and Ollerenshaw 2003: xxiv). The use of a scutch mill was introduced in Flanders in the nineteenth century, rather late compared to Ireland and Scotland where these advanced techniques in flax handling were already applied in the beginning of the eighteenth century (Dewilde 1983: 332; Solar 2003: 251). A reason for the prior practice of a scutch mill in Ireland and Scotland may be that Irish and Scottish linens experienced a substantial increase on the English market as a consequence of protective regulations on continental (and thus Flemish) imports that were issued by England by the end of the seventeenth century (Gray 2003: 165). The watermill in Vichte, however, was apparently not used for scutching, as Dewilde (1983: 332) notes that the only known scutch mill in West-Flanders was built in the nearby village of *Bavikhove* in c. 1877.

2.5. The Importance of Textiles Manufacturing, and its Key Role for East and West Flanders

The cultivation of flax demands a mild climate and heavily manured land, and the most excellent soils for flax are those that are fertile and contain moisture such as loam, sandy loam and light clay soils (Dewilde 1983: 29). In Flanders, these soils are mainly situated in the provinces of East and West Flanders, and thus provide the most favourable circumstances for the production of flax. The seeds were sown during spring, and afterwards, when the crop was a few inches long, weeding the flax field was the next procedure, mostly undertaken by female workers (Impe 1937: 3). The production of flax in Flanders and its subsequent use for linen, as well as for consumption, must have most likely originated before the Roman era (Schrooten 2004: 84). Impe (1937: 1), in order to introduce a historical survey of the flax and linen industry in Belgium, cites the Roman playwright Titus Maccius Plautus (c. 254-184 BC), who according to Impe, wrote in 200 BC, *linnae cooperta est Gallia*, which he translates as 'Gaul is covered with flax-factories'. Other sources who refer to Plautus' verse, however, quote *linna(e) cooperta est **textrino** Gallia*, which is translated by Throop (2005) as *covered by the Gallic cloak, by the weaver's skill*.[2] Albeit both citations and translations of Plautus' verse slightly diverge, the text fragment alludes to at least a manufacturing of linen in the Gallic area. Indeed, the long history of the cultivation of flax and its use for linen (but also certainly for food) was not only indicated by documentary evidence, but as well by archaeological and human osteological research that even revealed a tradition that goes back to the Neolithic period (Collins and Ollerenshaw 2003: 1-2). This is shown by, for example, remains of flax seeds and a bone handle with linen residue in Neolithic sites in Switzerland, and evidence from later eras such as Viking Age and medieval flax processing wooden tools, and dental evidence of an early-medieval mature woman from an Irish burial who most likely may have 'pulled some kind of yarn through her teeth' (Epstein 2009: 97; Wincott Heckett 2003: 44, 56, 59). Archaeological evidence of flax processing (e.g. by wooden tools) was also attested in the Russian medieval town of Novgorod, which was as well an important center for the trade of fur (Epstein 2009: 97; Sherman 2015).

The cultivation of flax continues in the subsequent centuries, and as Collins and Ollerenshaw (2003: 3) suggest as trade horizons broadened, an 'increasing competition with other textiles' emerged in

[2]The complete source of the verse is unfortunately lost. The word *linna(e)* might indicate a cloak worn by Celts as suggested by Le Beau, M. (1777: 512). *Mémoire sur la légion Romaine. Habillement du fantassin légionaire*. *Mémoires de littérature* tirés des registres de l'Académie royale des inscriptions et belles-lettres. Volume 39.

northern Europe during the Middle Ages. Clothing was undeniably a substantial consumer good for all social groups: essential products such as wool, cotton, and linen were all part of a trading network (Epstein 2009: 96). Dyer (2005: 13) mentions this international trade such as the import of Flemish Ypres cloth to England, and even points out that 'the most advanced agricultural methods were to be found in the intensively cultivated fields of the Low Countries, with their early development of fodder crops'

Indeed, in Flanders, with the rise of towns in West and East Flanders such as Ypres and Ghent in the eleventh century, the wool production and the cultivation of dye plants, but also the availability of markets, have contributed to the importance of textile manufacturing in Flemish cities (Dewilde 1983; van Bavel 2010). The textile production in towns required an intensive input of the nutrient-rich loamy soils, mostly situated in the area south of the River Leie, where an increase in the cultivation of dye plants was noticed in the thirteenth century (Verhulst 1992: 24). Madder, for example, a dye plant that yields a reddish pigment, appeared only in the surroundings of Bruges (Slicher van Bath 1976: 297; Vanhaute and Van Molle 2004: 13).

From c 1150 reclamation of land and embankment in coastal Flanders led to the import of mainly English wool (van Bavel 2010). But not only was this highly prized English wool exported to Flanders, also wool from Castilia (from the Merino-sheep) reached the Low Countries to keep weavers busy in Bruges (Britnell 2008: 156; Epstein 2009: 96 and 193). The division of Flanders into several quarters in the fourteenth century coincided with the recession of the wool trade, and benefited the consolidation of the three urban estates of Bruges, Ypres and Ghent (Scott 2012: 131). In the late thirteenth and fourteenth centuries, the wool trade encountered rivalry between its different qualities, and innovations in iron shears and carding tools for the spinning process were developed, along with the introduction of the spinning wheel, which yielded a higher turnover compared to hand spinning (Devos *et al.* 2011: 160; Epstein 2009: 193-194). Epstein (2009: 196) further depicts by calculations of productivity rates - suggesting that 'a team of weavers, working 240 days a year' could yield 'ten broadcloths' - the weaving techniques in late medieval Flanders as being sophisticated. The competitive nature in the textile production in the fourteenth century was indeed noticed by Evans (1985: 54) who states that 'Edward III introduced into England linen-weavers as well as other Flemish textile workers in the second quarter of the fourteenth century, at which date Flanders was as much ahead in linen manufacture'. Evidence of immigrant workers is for instance observed in the English town of Beverley (East Riding of Yorkshire), where the place name *Flemingate* reminisces the small group of Flemish weavers that likely arrived before the fourteenth century (Bense 1924: 11). Other novelties included the use of the chemical compound *alum* as a dye fixative, and was shipped from

Genoa to cloth centres such as Bruges in the era before the population decline caused by the Black Death (Epstein 2009: 196). Competition with the English wool market led to a decline in the Flemish trade in the fourteenth century, but nevertheless, the consolidation of the flax and linen industry mainly in the provinces of East and West Flanders brought new economic perspectives, such as the development of small peasant holdings in inland Flanders which combined both agricultural and weaving activities (Dewilde 1983: 16; Vermaut 1974: 568).

Collins and Ollerenshaw (2003: 3) point out that there is a demarcation between wool-producing regions such as England and Spain and flax-yielding areas such as the Low Countries, Russia and north-west France, but there were nonetheless territories where both flax and wool were produced and competed with each other, like northern France and Flanders. Despite a predominance of the Flemish wool production in the twelfth-thirteenth centuries, regional specialisation from the thirteenth century resulted in an expanded trade involving other textiles such as cloth from Kortrijk (*napes* or tablecloth) and from Doornik (Dewilde 1983: 15). Stabel (2001: 143) distinguishes four types of rural textile production in Flanders, each with a different labour management: the production of linen in the areas of the rivers Leie, Scheldt and Dender, and to the north of Ghent; tapestries were mainly created in the region of Oudenaarde and Geraardsbergen; a scattered rural woollen industry, albeit with a cluster in the province of West-Flanders (near e.g. Ypres), and lastly, the light woollens industry in the coastal area and south-eastern Flanders. Since the late fourteenth century, the linen industry, much more than the woollen industry, experienced a strong production development in the regions of the river basin, along with a growth in flax cultivation, which peasants often engaged in alongside their weaving crafts (Castelain 1983: 90; Stabel 2001: 147). Although larger urban centres started to focus on high-quality and more expensive products, whereas smaller towns and the rural hinterland produced mass goods, Stabel (2001: 154) further argues that there is no segregation between urban and rural manufacturing, given the high (seasonal) mobility, and the fact that skilled labourers from smaller towns possessed farmland in the rural areas. In the Low Countries, citizens could therefore act as active investors in rural properties (Howell 2010: 37).

Nevertheless, while the cloth industry was particularly concentrated in the urban centres, the production of linen on the other hand was mainly organised in the rural hinterland of inland Flanders. For example, the region of 'Land van Aalst', where small peasant holdings combined flax production with spinning and weaving, noticed a strong growth in the sixteenth century due to the prosperous trade of Flemish linen to Spain and to the overseas colonies in the New World. Political turmoil such as the war with Spain (1568-1648) caused a decline in the rural linen production, but the establishment of an official linen market in Aalst in 1646 led to an increase again until c. 1850, although with temporary ups and downs (Van der Wee and D'Haeseleer 1996: 244, 247 and 259-260). An evolution in the linen industry in the region of Ghent in the province of East Flanders, for example, was noted from the seventeenth century (Deceulaer 2001: 221; Gray 2003: 163). But, in the eighteenth century, the Flemish linen production encountered English and Irish competitors in the overseas export to the new colonies (Dewilde 1983: 21). More competition on the linen market was the result of mechanisation in the nineteenth century which generated cheaper and less qualitative linen. This linen crisis, in coincidence with the agricultural crisis during the 1840's due to failed potato crops, instigated poor living standards in rural Flanders (Scholliers 1995: 67 and 75). Hence, textile manufacturing needed to reinvent itself by, for example, creating apprentice schools and specialised goods such as silk. In Deinze, it is suggested that the apprentice school which was founded in 1847 for weaving black silk stimulated the expansion of its silk industry (De Wilde 1997: 21).

In 1842, on the eve of the agricultural crisis and five years before the typhoid outbreak in Vichte, the governor of East- and West Flanders, M. Desmaisières, lauded the flax industry as 'the first of the Flemish, or rather national industries, (...), being significant for most of the population, and being a question of commerce and ethics as there is no trade which better preserves the family-spirit; and which provides for tender youth or advanced age an occupation so beneficial for everyone's character and mind' (Impe 1937: 37-40). Although the linen production had experienced critical situations, as for instance in Ghent in the 1830's due to for example a lack of investments in new technologies, mechanical improvements (and not to neglect low wages) afterwards in both Flanders and Wallonia, contributed to the fact that Belgium was able to maintain its international position in the flax and linen industry throughout the nineteenth century (Scholliers 1995: 63; Vannieuwenhuyse 1998: 61). In Vichte, mechanisation was not introduced before the end of the nineteenth century, and economic activities of its villagers were concentrated on agriculture and household spinning (Blockeel 1975: 18). The crisis in both agriculture and linen production in the 1840's was disastrous and resulted in unemployment, famine due to the aforementioned failed potato crops, and epidemics of typhoid and cholera, which for example affected nearly 1/3 of the population in Vichte at the start of 1848 (Blockeel 1975: 19; Demasure 2012; Dewilde 1983: 22; De Wilde 1997: 155; Schrooten 2004: 85; Van Den Abeele 1941: 8).

Textile production in East and West Flanders has been extensively discussed by historians, principally because it was regarded as a crucial element to the Flemish industrial development throughout the nineteenth and twentieth centuries, and many studies focused on socio-economic development, mechanisation processes or employment relationships (De Wilde 1997). Although textile studies have not only gained attention from historians, an integration of scientific analyses has also been undertaken. One example is a study that explored the technical and chemical processes of silk dyeing by Hofenk de Graaff (1992), who built a bridge between history and technology by reconstructing old textile procedures based on documentary records. She reveals the different dying components (such as the inclusion of lead) applied to silk in the Dutch city of 's- Hertogenbosch, an important linen trade center in the sixteenth and seventeenth centuries, and remarks unhealthy working conditions in the different stages of the silk industry where 'work at silk mills and in the production of dyestuffs (rasping of redwood!) were forms of forced labour for prisoners and poor or idle youths' (Hofenk de Graaff 1992: 237).

2.6. Gender Roles in Textile Production and Farming

Sexual division of labour was not always clearly demarcated in rural medieval households, and sometimes women adopted their husband's jobs in their absence, or, after they had passed away (Howell 1986: 10). Women were often needed for activities such as spinning, harvesting and weeding, and as dairymaids, but they usually did not work as shepherds (Dyer 2005: 221; Epstein 2009: 194). The textile industry demanded strong physical strength at every process from sheep shearing to cloth dyeing (Epstein 2009: 197). Hence, these activities are suggested to be gender determined as the heavy manual process of weaving was mainly carried out by men (apparently apart from in Sweden and Norway thus indicating this may occur elsewhere), and spinning was usually done by women, though children were needed to take charge of nimble-fingered tasks such as winding the bobbins (De Wilde 1997: 151-152; Evans 1985: 110; Lambrecht *et al.* 2011: 336). van Bavel (2010: 155) states that an innovation in weaving methods is rooted in the handling of the weaving loom by men: the primitive vertical loom that was mostly used by women was substituted by the heavier horizontal loom from 1100, which 'raised labour productivity, but it required more skill and specialization, making weaving a man's job to an increasing extent' (van Bavel 2010: 155) (fig. 2.3).

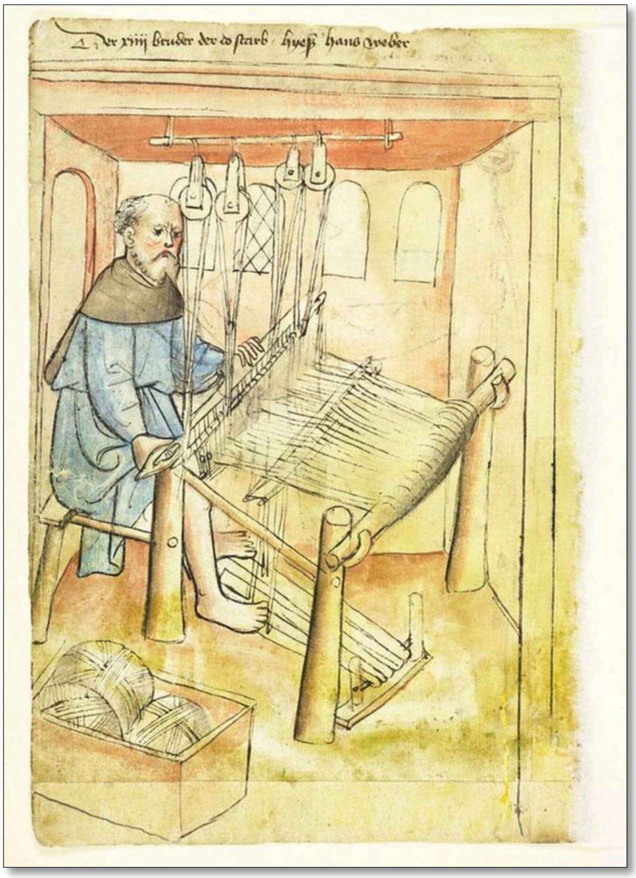

Fig. 2.3: Iconographic evidence from the fifteenth century of a male weaver handling the heavier horizontal loom by using four treadles (Illustration derived from Øye 2016: 42 citing Nuremberg Mendelsche Zwölfbrüderstiftung (1425), Mendelschen Stiftungsbuch. Stadtbibliothek Nürnberg, Amb. 317.2°, f. 4v, with permission).

By the mid-twelfth century, when the production of textiles became more organised along with these advanced techniques to reinforce such manufacturing, men started to participate in crafts such as embroidery and weaving that had been the traditional area of expertise of women. This shift in gender tasks started in major urban cloth centers like Bruges and Ghent, and took place over centuries while activities such as spinning, sewing and cutting, however, remained the primary domain of women (Wright 2006: 62-63).

Impe (1937: 38-39), in his work on the flax and linen industry in East and West Flanders, suggests indeed that, based on computed figures from 1825, children, women and old persons were mainly in charge of the preparation process, but does not specify further activities. Female chores of wool preparation were, however, demonstrated by Stabel (2014: 34) through thirteenth-fourteenth centuries guild statutes, which revealed that women were involved in low paid jobs of wool preparation such as spinning and combing. Iconographic material from the late nineteenth early twentieth century may further underpin these gender roles in home weaving (fig. 2.4).

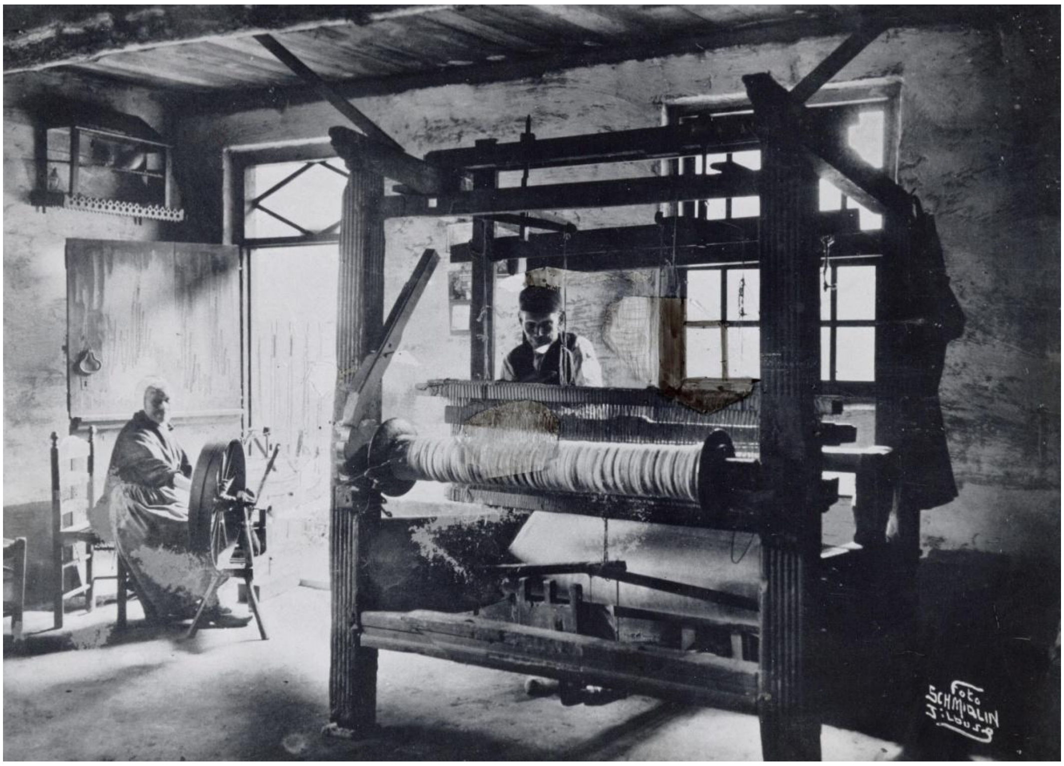

Fig. 2.4: Home weavers, a man weaving and a woman behind her spinning wheel in the late nineteenth early twentieth century in the Dutch city of Tilburg, known for its burgeoning production of woollen textiles until the 1960's (Photograph courtesy of Regional Archives Tilburg, inventory nr. 037455).

Although certain historical and iconographic evidence may be indicative of delineated gender roles in textile manufacturing, Øye (2016), however, queries this dichotomy by indicating the existence of female guilds in principal textile-producing cities such as Paris, London and Cologne during the Middle Ages, and argues that 'the conception of the medieval weaver as a male craftsman should be adjusted' (Øye 2016: 47). She further notes that women were mainly 'legally and economically subjected to the head of the household, normally a man', which illustrates 'why the written sources are usually quite tacit' about the participation of women in economic and juridical affairs (Øye 2016: 47). The role of women in textile family workshops, as, for example, illustrated below in the Dutch town of Leiden, should perhaps not be undervalued, since other mainly high- and late-medieval illustrations depict both men and women at the loom. This is, for instance, shown in the Ordinance book of Ypres (*Keurboek*) from 1366 AD, that shows a man and a woman at a broadloom, and another woman at a warping board, and hence may indicate the participation of both sexes in operating the horizontal treadle loom (Øye 2016: 36, 46) (fig. 2.5). Øye (2016: 46) further points out that similar illustrations of handling the horizontal loom by both men and women were also noticed in other European countries such as England, France and Germany.

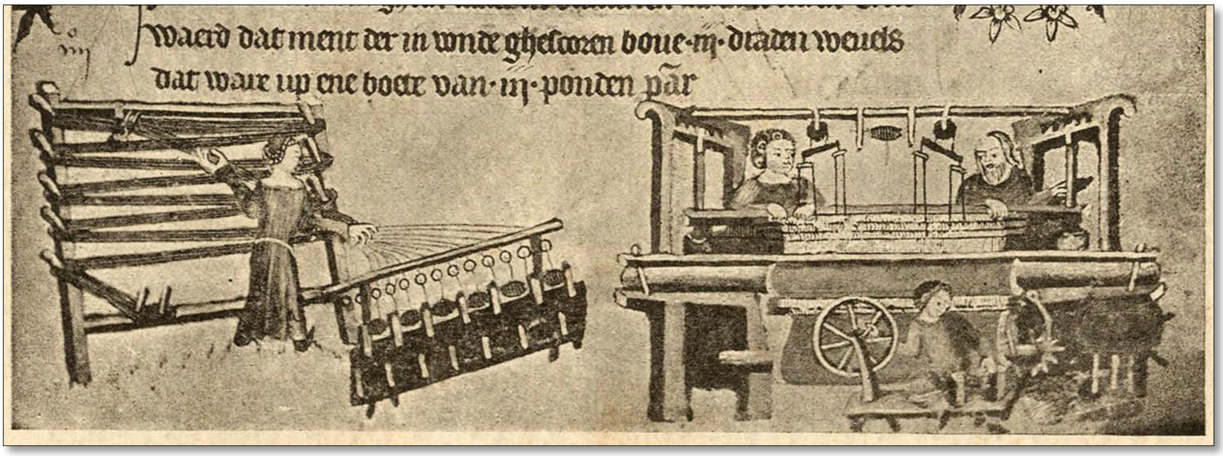

Fig. 2.5: 'The Weaver's Ordinance Book (*Keurboek*) from Ypres, Flanders, 1366'; one of the earliest depictions of the broadloom operated by a man and a woman, as well as a depiction of a child sitting near a new type of spinning wheel as suggested by Øye (2016: 36). On the left is a woman warping. The setting may represent a textile household workshop. The original illuminated manuscript was destroyed in 1914 (Illustration and information derived from Øye 2016: 36 citing the city of Ypres: City Archives, with permission).

Thus, female participation in handling the heavier horizontal loom should not be overlooked but would have certainly required physical strength. In Italy, for instance, Ramazzini (1777: chapter XLIV) (further discussed in Chapter 6, section 6.5. on Occupational Diseases) has examined the hazards of several occupations and demonstrated that weavers in Italy were both men and women, but, if they were not robust and muscular, they were reported to suffer exhaustion of the spine, arms and feet. Moreover, in the industry of silk weaving, Thackrah (1832: 37), a surgeon and physician from Leeds, distinguishes in his work on occupational diseases in England in the 1820's no particular evidence for a sexual division of labour, and notices that both women and men from all ages start working at a very young age until the age of 60, and even until 80 years old, for sixteen hours a day, despite his observation of their small height and starving appearance. Nevertheless, an activity in this industry which was exclusively undertaken by women was soaking the silkworms in boiling water in order to extract the silk threads (Ramazzini (1777: chapter XXVI). Children, however, other than being employed in textiles, often undertook work at the farm, especially when needed during harvest, and from the age of twelve, they were usually charged with even more household chores. Moreover, children from low-status households could also move in with upper-class families to work as servants (Lambrecht *et al.* 2011: 337).

As mentioned above and to illustrate with an example from the northern Low Countries, no clear sexual division of labour was noticed in Leiden during the fifteenth-sixteenth century when the town was the market leader for the production and international trade of drapery, a heavy cloth made of English wool; the supremacy of Flanders in the cloth industry was receding due to political turmoil in the fourteenth century. Fifteenth-century historical documents such as *Corrextieboeken* indicated that more than the half of the female working group of Leiden was engaged in the general cloth industry (Howell 1986: 85). More particularly, women were involved in dying cloth, weaving and finishing the linens until these trades received *ambacht* (craftsmanship) status, and female workers were excluded from high-status positions in linen manufacturing (Howell 1986: 49, 51 and 88). In contrast, in fourteenth-century Ghent, women were at least allowed into two dyer's guilds (Hutton 2011: 112). The participation of women in the late medieval textile trades in Leiden was iconographically examined by Broomhall and Spinks (2011), who focused on the series of paintings on the wool trade by the Dutch Renaissance and Mannerist painter Isaac Claesz. van Swanenburg (1537-1614). This collection of artworks, titled as 'The Old and New Trades' depicts both men and women working in the various stages of wool preparation such as spinning, combing, washing the skins and grading. Broomhall and Spinks (2011: 61-62) argue that the series was previously applied to study technical aspects of the late medieval textile manufacturing in Leiden, but that the participation of women in the cloth industry was unfortunately overlooked. Using historical sources alongside studies of cultural and social historians to investigate the role of women in textiles in early modern Leiden, Broomhall and Spinks (2011: 50-51) suggest that urban female participation during the Golden Age also took place outside the domestic setting. However, it could also be possible that the painter focused on the family workshops which were a crucial environment for textile production with daughters, wives and widows engaged in non-paid jobs (Broomhall and Spinks 2011: 69). Despite their important contribution to the medieval and early modern cloth industry in Leiden, women were, however, mainly employed in the lower-paid categories such as low-status wool preparation jobs, and most likely worked in sectors that exclude the '*ambacht* structure', although the 1581 source that was used registered only the heads of households, a category that excludes many women (Broomhall and Spinks 2011: 62-63). They conclude that women were active in all sectors of the cloth manufacturing, apart from wool combing, which became a male activity from the seventeenth century, but suggest to consider the symbolic value of women's active participation too since the paintings may embody a 'new moral possibility for female labour at the dawn of the Golden Age', or portray a moral household if they represent textile family workshops (Broomhall and Spinks 2011: 64 and 69).

In thirteenth-century northern Flanders, in the prevailing cloth producing cities such as Ghent, Bruges and Ypres, more than half of the population was employed in textiles (van Bavel 2010: 343). And even much later, at the beginning of the nineteenth century, up to half of the population of inland Flanders still worked in rural flax and linen manufacturing until a decline in the prices of cloth meant that in the 1830s, one out of every five Flemish families was enlisted as poor, and from the mid-nineteenth century, a process of de-ruralisation with fewer agricultural workers commenced (Karel *et al.* 2011: 201; Lambrecht *et al.* 2011: 324). To compare with the situation in the twenty-first century: Lambrecht *et al.* (2011: 324) state that (at the time of their study) nowadays 'less than 5 per cent of the active population in the North Sea area' is employed in agriculture opposed to 'more than 50 per cent around 1900'.

In addition to gendered divisions of labour in the textile industry, it was also apparent that gendered labour divisions occurred on rural farms which could be demonstrated by historical economic data. For example, high level of yields of rye and wheat were illustrated by Thoen and Soens (2015: 244-245, 249), who used probate inventories from the commercial survival area of the Land of Aalst between the seventeenth and nineteenth centuries, and suggest that 'a high physical productivity on small plots of land' was carried out by the whole family who 'worked in the fields in the most intensive way' by, for instance, digging the land with spades instead of ploughs, weeding, sowing and manuring. Although farming was usually a family orientated enterprise, Karel *et al.* (2011: 192-193) note in their study on rural economy from 1750 in the Low Countries, regional variations in gender activities, with a strict distinction in the coastal households. For example, housekeeping was regarded as a predominant activity for women, alongside milking, butter making, gardening, weeding during the spring (although they were not required to work on the field in the winter), and looking after smaller animals such as pigs, sheep and poultry. Men on the other hand were involved in most land activities, farm work with horses, grain threshing in the winter, hay cutting and dredging. In contrast, the small peasant households in the inland region demanded the work of women both on the field and in and around the farm (Karel *et al.* 2011: 193). However, Lambrecht *et al.* (2011: 336) argue that there is a definite sexual division of labour in the high medieval period, except 'in busy harvest times'. Devos *et al.* (2011: 157, 165) also draw a distinction between the rural households in the coastal and inland Flemish areas before 1750, built on the well-documented historiography of Flanders and Holland, where the commercial agricultural market economy in the North Sea region required a significant input of a young and male working population whereas with the small peasant families in the hinterland, there was a larger percentage of females and an older population. Thoen and Soens (2015: 250) suggest that the divergence from the sixteenth century between family labour in the commercial peasant system and the larger coastal farms lies within survival strategies, such as reducing labour costs by engaging women for harvesting in the coastal area since their wages were lower compared to the wages of men. Even more, they relate the high input of female labour to the prolonged use of the sickle as a harvesting tool in the coastal region until at least the nineteenth century, while adjacent smallholdings applied a small scythe which allowed one to work much faster and provided them additional time to work on the larger farms to gain an extra source of income (Thoen and Soens 2015: 250).

2.7. Summary

The six sites in this study testify to the geographical, topographical and regional differentiation in Flanders, and variations are not only observed between the coastal and inland areas, but also between the development of early medieval settlements in the countryside towards a transformation into small urban centres as seen in the case study of Deinze in the thirteenth century. The differentiation was further distinguished in economic strategies where the cultivation of labour-intensive crops such as flax and the production of linen dominated the inland region, owing to its sandy-loam soils, while activities such as the (light) wool trade and peat extraction were mainly concentrated in the North Sea marshlands. Environmental conditions have undoubtedly reinforced the organisation of occupational activities, whether or not gender related, which in turn may have led to diseases related to labour circumstances which will be discussed in Chapter 6, such as the retting of flax in the streaming water of the *Leie*-river, resulting in contaminated water, or a high exposure to dust during weaving or flax scutching causing pulmonary afflictions with the labourers.

A better understanding of settlements and its villagers in the countryside undoubtedly requires an interdisciplinary approach, integrating historical, geographical and archaeological data (Dyer 1997: 58; Dyer and Everson 2012: 24; Jones and Page 2006: 1). Dyer and Everson (2012: 26) do not only point out the effectiveness of environmental studies such as palynology and the suitability of toponyms to shed light on the origins of villages, but also illustrate how large-scale studies of rural skeletal collections can contribute to a comprehensive framework of health assessment to equate with better-studied medieval urban communities.

The next chapter will present the historical and archaeological context of the six study sites. A bioarchaeological study of the skeletal assemblages will be undertaken to elucidate diversities in the health and frailty of the populations, not only between those from small urban and rural communities but also between the coastal and inland areas. Also, gendered labour through the analysis of entheseal changes will be considered to demonstrate a sexual division of labour in the six case studies.

CHAPTER 3

AN INTRODUCTION TO THE SIX CASE STUDIES IN FLANDERS, BELGIUM

This chapter presents an introduction to the six sites of this thesis wherein the geographical and pedological situation will be discussed, alongside toponymic data of each place name to outline the historical landscape within the general landscape context. It will continue with both archaeological and historical evidence of each site with the main focus on the unearthing of the skeletal assemblages that have been analysed for this research project. Further, medieval and post-medieval Christian funerary customs will be illustrated through the mortuary topography, grave types and alignment, position of the arms and the identified artefacts of the six case studies.

3.1. Overview of the Six Sites: Landscape Context

The skeletal collections from the following six sites in Flanders, Belgium, (table 3.1), have been applied for this thesis (also listed in bold in table 1.1 on page 4), and are indicated on the map of Belgium (Chapter 1, fig. 1.1). The preservation criteria of 'poor', 'good' or 'excellent' applied in this study and presented in table 3.1 is based on the standard methods for recording surface condition of bone material (McKinley 2004: 15-16). A more detailed description of the completeness and the stage of cortical erosion of each skeletal individual from this study will be outlined and presented in Chapters 4 and 5.

Site (general location)	Province	General Soil Type	General Preservation of Bone Surface
Deinze	East Flanders	Sandy Loam	Good
Moorsel	East Flanders	Sandy Loam	Poor/Good
Oosterweel	Antwerp	Clay (polders)	Good
Slijpe	West Flanders	Clay (polders)	Excellent
Vichte	West Flanders	Sandy Loam	Good
Zottegem	East Flanders	Sandy Loam	Poor

Table 3.1: List of the skeletal assemblages analysed in this thesis and the location, geological condition and general surface condition of the human bones (Source: [Online]. Available from: https://dov.vlaanderen.be/dovweb/html/bodemloketten.html, and pers. comm. with Philippe Derynck, GIS-Expert and Application Manager at the Prov. of West Flanders for the data of Slijpe and Vichte).

Three skeletal assemblages were unearthed in the province of East Flanders (Deinze, Moorsel and Zottegem), two in the province of West Flanders (the coastal site of Slijpe and Vichte), and one in the province of Antwerp (Oosterweel). The reasons for the noticed high density of uncovered bone material in East and West Flanders might be related to geological conditions of the soil that may affect the preservation state of skeletal remains (Ervynck *et al.* 2008; Mays 2010: 28-29; Smits 2002: 55).

A study on the surface condition of archaeologically excavated bones from various soil types in Flanders was presented by Schotsmans (2007; 2008: 55-68). Schotsmans (2007: 109) concluded that sandy soils from such sites as the *Kempen* (in the eastern part of Belgium) imply a disintegration of organic tissues. Moreover, she states that aside from the soil type, the level of acidity or alkalinity in combination with the draining affects the condition of the osseous material as observed from case studies (e.g. *Lindel* and *Donk* in the prov. of Limburg and *Ouwen* in the *Kempen*-area in the prov. of Antwerp) where the sandy texture with a dry or complex drainage has resulted in a severe degradation of the human bones (Schotsmans 2007: 94-95, 127, 149 and 173). Skeletal remains from a sandy loam soil type, however, show a varied preservation which might be related to the presence of oxygen (Schotsmans 2007: 174). Poor preservation is, indeed, observed in both the skeletal collections of Zottegem, and partially in Moorsel, whereas the skeletal remains from other sites with a sandy loam soil, Deinze and Vichte, display better preservation. The archaeological report on Vichte, however, reveals the discovery of a clay texture in the natural soil in contrast to the data recorded on the soil map (Bot and Acke 2014: 7). Indeed, the presence of clay, and especially the clay soil from the coastal region, display an excellent preservation, as noticed in the site of Slijpe, and this is likely attributed to the dearth of oxygen and steady moisture profile which characterise this soil type (Schotsmans 2007: 175; Schotsmans 2008: 63). The rather poor preservation of the Zottegem skeletal collection might be due to a high oxygen level in the soil, or other factors such as the depth of the burials (in this case between 50 and 180 cm), although a similar depth of the graves was observed in the much better preserved Deinze-site (Klinkenborg 2014: 3; Laisnez and Vandecatsye 2011: 91-92*, KLAD Archaeological Report 24*). Unfortunately, to date, not a comprehensive, but only a first evaluation report on phase 1 of the *Zottegem-Markt* archaeological excavations is available due to time restrictions, which implies that only elemental information of the unearthing of this skeletal collection is available (Klinkenborg, *pers. comm.*).

One element that might explain the recovery of skeletal assemblages mainly in the provinces of East and West Flanders might be the direct consequences of the particularly humid sandy loam and clay soil. These nutrient-rich soil types are above all suitable for agricultural production (Pieters 1986: 42;

Wille 1985: 22), and when situated in alluvial lowland, it has been suggested that this location presents a favourable condition for the development of settlements (Antrop and Van Eetvelde 2007: 367; Bauters and De Dapper 2003: 5; De Dapper 2007: 22). The river areas of the *Schelde* and the *Leie*, and their affluents, with its sandy loam soil were favourable sites for occupation in the early-medieval period (van Bavel 2010: 32). An association between the soil category and a rural village type, such as a nucleated village where farms are clustered around a village green (Bolin 1966: 640), was observed by Lewis *et al.* (1997: 235) in their work on English rural settlements, who point out that sandy to heavy clay soil regions did not develop nucleated settlements. Thoen (2007a: 69) on the other hand used the English term 'green villages' to describe a common area surrounded by a cluster of farms, however, the Swedish historian Bolin (1966: 640) noted a difference between a 'village green' and 'green-village', with the former free of 'physico-geographical' obstructions, or without 'traffic between tillage and pasture', and thus resulting in a large village street or 'a village green'. Areas, in which nucleated sites were dominant, seemed to have had the highest amount of cultivated land (Lewis *et al.* 1997: 235). A discrepancy in population density between the regions of Flanders in c. 1450 AD was noted by Scott (2012: 133) with a population density of 70 inhabitants per square kilometre in Flanders 'though no more than 30 in the sandy district of Campine/Kempen' (i.e. central and eastern Flanders).

Deinze and Vichte are both situated in the region of the River *Leie* in a transitional alluvial environment (like Moorsel) which was hence crucial for the development of early-medieval settlements. Indeed, Thoen (2007a: 78) concludes in his paper on the landscape in medieval Deinze that the valleys of the *Leie* and its adjacent rivers were essential for livestock farming. However, his conclusion is based on the toponymic and historical evidence of earlier place names with the suffix -*sele* or -*sala*, which might indicate a temporary settlement used for cattle-breeding (Thoen 2007a: 63).

Textual sources on the early-medieval development of settlements and villages are scarce, which is, unfortunately, a general impediment when exploring early occupation of these sites and their evolution before the thirteenth century (Gardiner 1997: 64; Hamerow 2002).

Therefore, toponyms, or place names referring to topographical features, may elucidate specific environmental elements, and may be a pivotal tool to define the landscape, or even indicate early occupation and cultivation in a region before 1100 AD (Thoen 2007a: 60-61; Tys 2013: 205-206). The etymology of all site names incorporates a landscape feature (except for Zottegem although this has not been historically attested as stated by Debrabandere *et al.* 2010: 293), and they are listed in Table 3.2, including the earliest reference to each site according to documentary evidence.

Site	Toponyms/ Etymology	Date (AD)	Source	Etymological and textual reference
Deinze	*Dunsa*	c. 1050	Debrabandere *et al.* 2010: 60 citing Gysseling 1983; *Vita Popponis*	Possibly related to its location in a 'former meander of the River *Leie*', although uncertain etymological origin
Moorsel	*Morcella*	1114	Debrabandere *et al.* 2010: 173; Verleyen 1985: 41	Combination of *moor* or *mort* (mud) and *zele* (habitation)
Oosterweel	*Otserwele*	1210	Bredael 1984: 40; Prims and Timmermans 1943: 9-10 citing *Cartularium St Michiels Abbey*; Debrabandere *et al.* 2010: 190; Havermans 1956: 22	The suffix *weel* likely implies an elliptic pond caused by a flood after a dike burst, and the prefix *Otser/Ooster* might indicate a family name
Slijpe	*Slipae* *Slipan*	840 (?) 1116	Goetghebeur and Jansseune 1989: 31; Jansseune 1970: 8 (no historical source) Debrabandere *et al.* 2010: 239; Loontiens *s.d.*: 30	Either literally derived from the Germanic *slipo*, meaning a 'slippery locus', or from *slippe*, a small strip of land
	Haerlebouds cappelle	1172	Jansseune 1970: 5 citing *Actum Lefinges*; Goetghebeur and Jansseune 1989: 94	Alternative name of Slijpe; refers to the court and chapel of *Haerleboud(t)*
Vichte	*Fifta* *Vehta*	965 1119; 1187	Blockeel 1975: 9 citing *St Peter's Abbey Ghent*; Blockeel 1975: 9; Goeminne 2016: 14; *Gros Brief*	*Fluviolum Fifta* or *Vichtebeek* (now: *Kasselrijbeek, beek* is Dutch for *stream*) 'Viscount *Balduinus I de Vehta* who collected his rents in *Veurne* (prov. of West-Flanders)'
Zottegem	*Sottengem*	1088	Debrabandere *et al.* 2010: 293 (although not historically specified)	Prefix *Sotto* might refer to the name of landowner *Sutto* since the Germanic suffix –*ingaheim* commonly suggests

				a family property or residence

Table 3.2: A summary of the etymology of all site names, including the oldest spelling illustrated by historical evidence, and its likely related natural element or textual reference.

Other sources of toponymic evidence are testified in the Dutch *kouter*-suffix which is derived from the Latin substantive *cultura*, meaning an arable land (Thoen 2007a: 64), and likely originated in the Roman period (Verleyen 1985: 220). These *kouter*-toponyms are still identifiable in Deinze (e.g. *Oostkouter, Bachtekouter*), Moorsel (14 *kouter*-names such as *Rozen*- and *Molenkouter*), and Zottegem (e.g. *Letter*- and *Molenkouter*), and suggest the organisation of the farmland into segregated parcels (Pieters 1986: 52; Thoen 2007a: 67; Verleyen 1985: 220). This approach of field cultivation in Moorsel is corroborated by historical documents from 1636-1637 AD which Aelbrecht (2006) applied for a reconstruction of the rural village, and even demonstrates contemporary notations such as *Den Bruggen Cauter*. It could be thus argued that the coincidence of the relatively good bone survival in areas where population density was probably highest makes the samples in this study a strong dataset.

3.2. Historical-archaeological Research on the Six Sites

This section provides both a brief historical introduction to the case study sites, mostly related to the excavated churchyard and church, and an outline of the archaeological excavations that have been carried out in the six sites, with the emphasis on the unearthing of the human skeletal remains, along with previous excavations in the area if other skeletal collections were attested.

3.2.1. Deinze

In 2010, archaeological excavations were carried out by *Kale Leie Archeologische Dienst* (KLAD) at *Kerkplein*, and revealed the skeletal remains of 96 individuals from the churchyard of the *Onze-Lieve-Vrouwekerk* (Our Lady's Church) (fig 3.1). Although the archaeological report (KLAD 2011: 77) states the excavation of 100 inhumations, only 96 skeletal individuals were inventoried and stored in the former archaeological depository of KLAD in Aalter (Belgium), prior to the osteological analysis of the Deinze skeletal collection. Prior to the start of the archaeological survey, the site was in use as a parking-lot.

Fig. 3.1: Aerial view of the archaeological excavations at Our Lady's Church graveyard (circled), located at *Kerkplein* in Deinze, with the *Leie* river to the south (Photograph taken from KLAD 2011: 79, fig. 82, citing *GISOost*).

The excavated area is bounded by the streets *Kaaistraat* and *Leiedam* to the east, the River Leie to the south, the *Markt* to the west, and Our Lady's Church to the north. In the *Markt*, archaeological excavations were conducted by KLAD during the same year in order to reconstruct the occupation of the site from the prehistoric until the post-medieval era. Here, six test pits were excavated, and postholes and ditches were uncovered in test pits one and two, which indicated a pre-urban habitation of the *Markt*, dating back to AD 1000. Besides these structural remains, other findings such as animal bones, two lead loom weights, several fragments of leather shoes, and ceramics, dating to between AD 1000-1400, have been registered too (Laisnez and Vandecatsye 2011: 27-39). Moreover, even prehistoric evidence was observed near the *Brugse Poort* in test pit six, by which the filling of a prehistoric pit revealed modeled coarse-grained pottery with finger impressions (Laisnez and Vandecatsye 2011: 72).

Evidence of early settlement occupation can also be illustrated by geoarchaeological studies such as palynology, or pollen analysis, as suggested by Thoen (2007a: 61), and, in particular, it is a useful additional source when there is a dearth of documentary information (van Bavel 2010: 33-34). Unfortunately, a specific research question on remodeling habitation was not addressed in the pollen analysis of *Deinze Markt* that was conducted by BIAX in 2013, and data were focused on previous vegetation and human activities (van der Meer 2013: 2). Indeed, this ecological study of the thirteenth-century watering place, or pool, that was uncovered in test pit 2, suggested rural activities such as threshing waste of rye and flax processing since its pollen is solely dispersed by anthropogenic action (van der Meer 2013: 20 citing Hall 1988). Radiocarbon dating of five wood samples from the revetment of the medieval watering place provided a date range of c. 1035-1250 AD (KIA-46997; KIA-46998; KIA-46999; KIA-47000; KIA-47002), and were analysed by Mark Van Strydonck from the Royal Institute for Cultural Heritage, Radiocarbon and Stable Isotope Measurements, Brussels, Belgium. Laisnez and Vandecatsye (2011: 20), on the other hand, dated this watering place to the thirteenth century based on the findings of potsherds. Moreover, the reported large presence of heather is likely more related to an agrarian rather than an urban economy, however, transportation from the rural hinterland to the actual site could be an explanation (van der Meer 2013: 2 and 20). Otherwise, a higher than expected 45% of tree pollens (mainly oak, hazel and birch) does not generally correspond to a developed urban context, and should be regarded as deriving from a pre-urban environment. Furthermore, the large proportion of grassland suggested livestock breeding, while macro-remains of fibre plants and dyer's weed (used for dyeing) might imply textile-related activities (van der Meer 2013: 21-23). The evolution of Deinze from an agricultural settlement to an urban site and its related socio-economic activities has been discussed in Chapter 2.

Relative dating on the basis of artefacts recovered, such as ceramics from the ninth-twelfth centuries and a coin dating to 1741, combined with stratigraphic data, allow a possible dating of the inhumations to between the ninth century and the dissolution of the cemetery in c. 1860 AD. Radiocarbon dating of the human remains was requested by the archaeologists (Laisnez and Vandecatsye 2011: 92), and was carried out on bone samples of seven skeletal individuals in 2012 by Mark Van Strydonck from the Royal Institute for Cultural Heritage, Radiocarbon and Stable Isotope Measurements in Brussels (Radiocarbon Dating Report 2011.11374, 2012; Vandecatsye *pers. comm.*). Bone collagen samples from the first stratigraphic layer were not considered for radiocarbon dating since findings such as industrially manufactured wire nails and the excellent preservation of organic material like remnants of human hair and wood indicated inhumations dated to the late 18th-19th centuries (Vandecatsye *pers. comm.*). The C14-analysis of the aforementioned small sample provided a date range of between 1150 and 1700 AD, and is listed below in table 3.3 since it also incorporates the motivations stated by KLAD in their proposal for future interdisciplinary and biochemical analyses on the archaeological data of the Deinze excavations in 2010 and 2011.[3]

[3] Proposal for Continued Scientific Research (Vandecatsye *pers. comm.*).

Skeletal Individual Nr.	Data entry according to KIKIRPA	Motivation by KLAD for Radiocarbon Dating (based on stratigraphy)	Radiocarbon Date Range (AD) - results *(according to the highest probability % within a 95.4% confidence interval)*
L30 WP2 (female, 36-50 years)	KIA-47192	Suggested dating to the 17th century	1630-1690
L44 WP1 (male, 40-50 years)	KIA-47191	NW-SE orientation (in contrast to the common W-E alignment in this cemetery)	1260-1295
L58 WP2 (male, 40+)	KIA-47190	'Deviant' NW-SE alignment; beneath L30; assumption that it was one of the earliest burials	1220-1280
L59 WP2 (male, 60+)	KIA-47189	Common W-E orientation; assumption that it was one of the earliest burials	1640-1670
L71 WP2 (male, 36-50 years)	KIA-47193	Dense stratigraphic sequence; radiocarbon date intended to determine time interval within stratigraphic structure	1630-1670
L72 WP2 (female, 36-50 years)	KIA-47195	Beneath L71; dense stratigraphic sequence; radiocarbon date intended to determine time interval within stratigraphic structure	1150-1260
L165 WP12 (male, 36-50 years)	KIA-47194	Assumption of a priest's grave because of its E-W alignment; uncovered in the segregated section between the early and successive churchyard wall	1490-1650

Table 3.3: Results of the radiocarbon dating of 7 skeletal individuals from the Deinze-*Kerkplein* inhumations, along with the motivations for C14-bone collagen sampling issued by KLAD in their research proposal for continued data analysis.

Although the radiocarbon dating corroborated the general dating indicated by the stratigraphic sequence of the churchyard, they do not underpin a short time interval between the interments of L71 (seventeenth century) and L72 (twelfth-thirteenth century). Even though both sampled adult graves were located in the east part of the cemetery where a strong concentration of mainly infant burials was observed - with the suggestion of even more child burials located towards the eastern direction of the chancel since the extent of this trench was not fully excavated (Laisnez and Vandecatsye 2011: 101), the radiocarbon dating indicates an extended period of use of this cemetery, and in particular of this section WP2 (fig. 3.2). Unfortunately, no additional C14-data were acquired for the skeletal remains from nearby graves, or, at least from burials located in the far east of area WP2, to reveal the likelihood of inhumations in a short period of time.

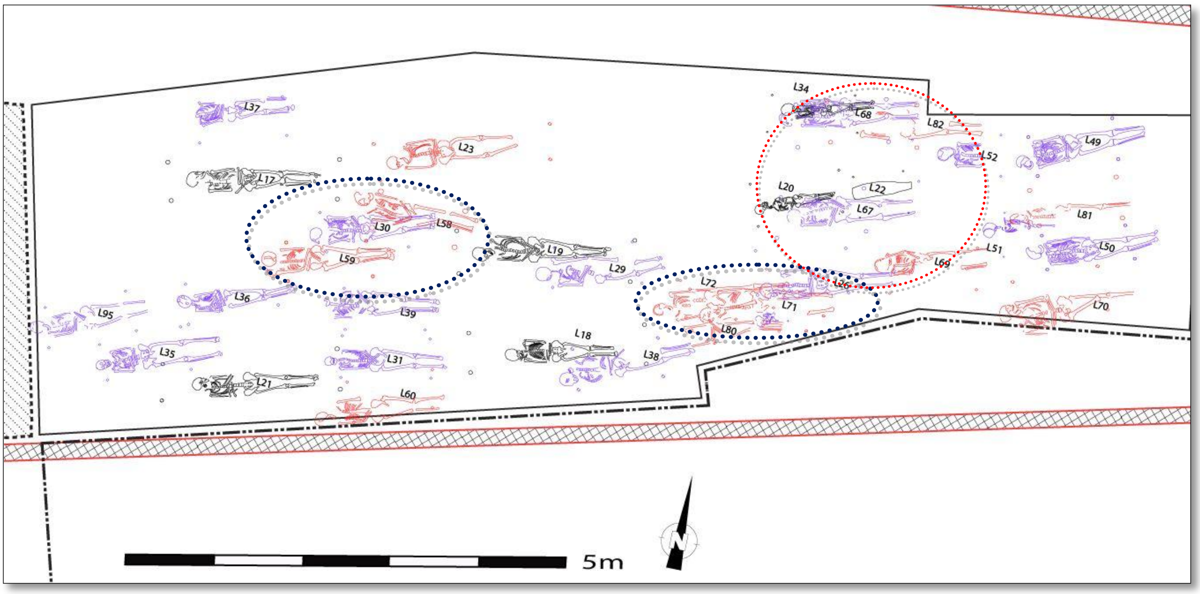

Fig. 3.2: Section WP2 of the churchyard in Deinze indicates a concentration of infant burials in the east part (red circle). Although the archaeological excavations revealed a density of burials in the same section in contrast to the west area, radiocarbon dating of several inhumations (blue circles), listed in table 3.3, demonstrated a long-time interval between the burials (figure from *Proposal for Continued Scientific Research, Deinze Kerkplein* DNZ.KRK 2010, 2014).

Further, a non-normative NW-SE alignment is noticed among the earliest thirteenth-century burials (L44 and L58), and is suggested to be linked with the construction of a predecessor of Our Lady's Church seeing that the church, according to ecclesial archives, had been rebuilt after several catastrophic fires in the fourteenth century (Laisnez and Vandecatsye 2011: 80). Grave alignment may indeed reflect the orientation of buildings (Daniels and Loveluck 2007), and a chronological change in orientation of burials has been identified at several medieval churchyards. For example, at Norton Bishopsmill (UK), an initial northwest-southeast orientation shifted to west-east in a later phase (Craig 2009: 130 citing Johnson 2005: 9). Archaeological investigation of the churchyard walls revealed also the remnants of several buildings of an unknown function dating from at least 1650 AD, which were clustered around a courtyard with a well next to the cemetery (Laisnez and Vandecatsye 2011: 80, 99 and 137). These findings illustrate how the churchyard and its extent have been modified over several decades until its abolition in the nineteenth century.

Historical research on Our Lady's Church was undertaken by Laisnez and Vandecatsye (2011: 80-81) prior to the unearthing of the skeletal remains of its churchyard. Written sources on land donations allude to a donation to the chapter of Doornik in 840 AD by *Lodewijk de Vrome* (Louis the Pious, 778-840 AD), and indicate the existence of a church in Deinze, although this has not been corroborated archaeologically (Laisnez and Vandecatsye 2011: 80). Nevertheless, despite the scarcity of historical documents, Declercq (2007: 251) suggests that the development of parish churches in Deinze and its surrounding villages likely occurred in the late eighth-ninth century, since the abbeys of St Pieters and St Baafs 'operated as mission posts for the Christianisation of the adjacent countryside'.

Trio (2003: 251 and 281) acknowledges the scarce archival evidence of the medieval church of Deinze, and the suggestion by other authors that the church had probably been destroyed by vikings before the tenth century and had been rebuilt afterwards, is therefore conjectural (Bogaert and Lanclus 1991; Laisnez and Vandecatsye 2011: 80 citing Trio 2003: 251, although Trio does not refer to viking raids). Historical archives illustrate devastations that most likely occurred afterwards in the course of the fourteenth century (several fires) and the sixteenth century (Iconoclasm), and restorations of the nave and southern aisle in the seventeenth and nineteenth centuries, respectively, might indicate a turbulent history of Our Lady's Church (Bogaert and Lanclus 1991).

A precise date for inauguration of burial in the churchyard is unknown, but the archaeological survey by KLAD in 2011 suggested an expansion in the extent of the cemetery from the findings of both the foundation of the successive churchyard walls, situated at a different location. This alteration in size of the graveyard was also supported by historical documents that allude to an (undated) extension beyond the west side of the church until the church council sold this section of the graveyard to the municipal authorities of Deinze in 1793 (Laisnez and Vandecatsye 2011: 81 and 143 citing Van Den Abeele 1865: 177). The churchyard had been in use for many decades until c. 1860 when a new cemetery outside the town was established (Laisnez and Vandecatsye 2011: 81).

3.2.1.1. Caring for the Sick and the Poor in Medieval Times: Evidence of a Hospital in Deinze

An urban characteristic that may distinguish villages from towns is a hospital, which is historically recorded in Deinze in 1232 as suggested by Prevenier (2003a: 12). Goeminne and De Clercq (2012a: 225) point out the dearth of historical research about this hospital in Deinze, and refer to previous concise studies by Cassiman (1935 and 1954) and Cloet (2003) who did not include complete property listings of the institution. Most historical sources were, according to Goeminne and De Clercq (2012a: 225), lost or abolished in 1794, and the scarce archival documents involve account books from 1361 and 1514 that revealed the ownership of arable land, farms, a fishery and a windmill (Goeminne and De Clercq 2012a and 2012b). This infirmary, first referred to as *O.-L.-*

Vrouwehospitaal in 1232, but in 1455 re-named after Saint Blasius, the patron saint of both wool combers (in the UK) and patients with throat ailments (in the Low Countries), was located in the proximity of the church (Bogaert and Lanclus 1991; Prevenier and Huys 2003: 232; Stabel 1985: 49) (fig. 3.3).

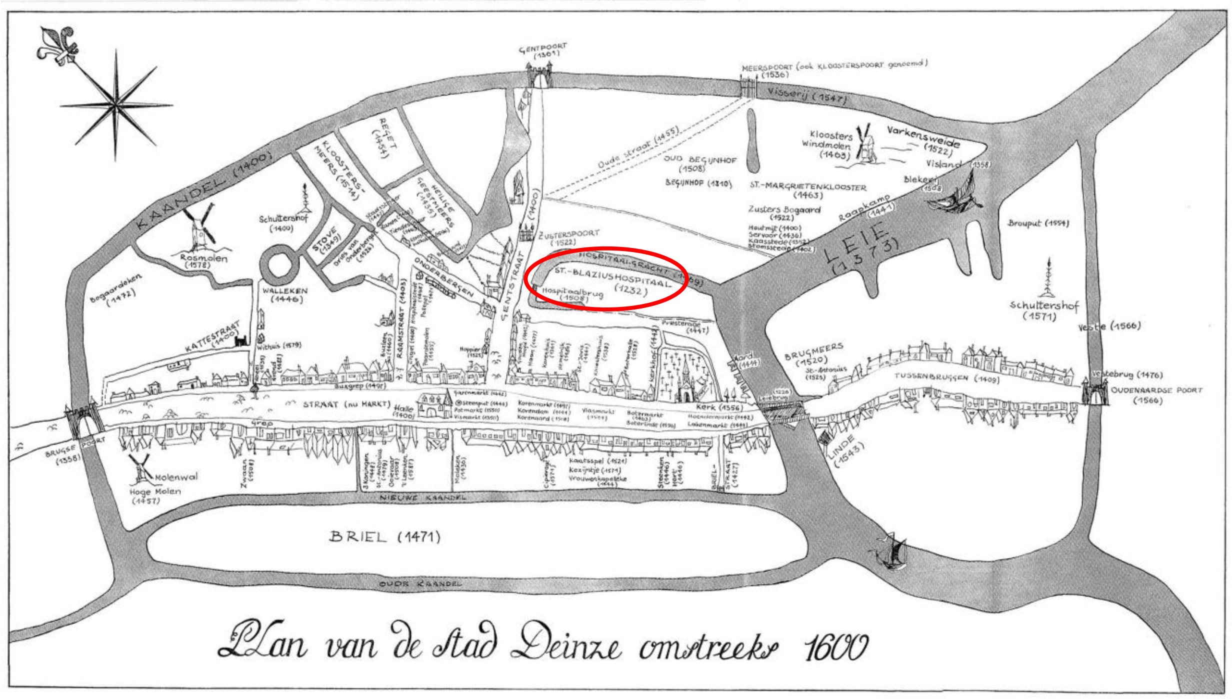

Fig. 3.3: Map of Deinze c. 1600 AD, with indication of the St Blasius hospital, north of the church (Image courtesy of Heritage Collection Leie-Schelde).

An undated seal of the St Blasius hospital depicts indeed a tool which shows similarities with a wool comb (as illustrated in Cassiman 1935 between p. 16-17) (fig. 3.4).

Zegel van het Hospitaal Deinze
(Bewaard in het Klooster der Zusters Maricolen, Deinze)

Fig. 3.4: Seal of the St Blasius hospital in Deinze, with a likely *terminus post quem* of 1455. The tool depicted between S and B most likely represents a wool comb as the hospital's name refers to St Blasius, the patron saint of the wool combers (Photograph courtesy of Cassiman 1935, between p. 16-17).

Town records indicate the destruction of the hospital in 1584, but it was rebuilt in the course of the seventeenth century, integrating both a chapel and a girls' school, until its abolition as an infirmary in 1796 (Bogaert and Lanclus 1991; Nuyttens 1998). Apart from the accommodation of pilgrims and paupers and carrying out religious services such as confession and anointing of the sick by the priest, the hospital was not only in charge of taking care of the ill, but also responsible for the burial of the deceased patients (Blockmans 2002: 10; Rawcliffe 2013: 317; Stabel 1985: 49 and 50). Since the initial name of the hospital is identical to the name of the church, being listed in the archives as an ecclesiastical charitable institution (Nuyttens 1998), the assumption could be made that the sick were buried at the nearby churchyard of the O.L.V.-church, as there is neither direct ample documentary nor archaeological evidence of a graveyard adjacent to the hospital in Deinze. Although Trio (2003: 273) alludes indeed to the paucity in historical records of this hospital, Cassiman (1935: 11 and 33-34), however, cites a sixteenth century Latin document (dated to July 3rd 1522) indicating that the poor and the ill were excluded from the churchyard, and were only permitted to be buried in the cemetery from which it was separated by a ditch:

> '*...et in eodem hospitali ultra fossatum iuxta ortum benedixit et consecravit cemiterium in quo pauperes et miserabiles persone in dicto hospitali confluentes et ab egritudine decedentea ab hoc seculo duntaxat sepelientur ecclesiastica sepultura ibidem aliis interdicta*'. ('State Archive. Bergen. Bisdom Doornik. Reg. 283, blz. 27ro -27vo)'.

Medieval hospitals, however, did include cemeteries, such as the larger hospital of St Jan in Bruges, which expanded in 1336 (Gilté *et al.* 2004). Similar examples are noticed in the UK, where excavations in High Wycombe revealed the presence of four hospitals, each with an adjacent burial ground, although all were situated outside the town (Farley and Manchester 1989). Moreover, two of these hospitals were considered as *leprosaria*, which likely explains its isolated location (Farley and Manchester 1989). The segregation of those afflicted with leprosy, however, was not always institutionalised, as seen in one leprosy hospital in late medieval Ireland that was built near the church of St Stephen's in Waterford, until its re-organisation as a regular hospital in the eighteenth century (Murphy and Manchester 2002: 194). Rawcliffe (2005; 2013: 318 and 323) suggests that, despite the long-lasting assumption of the ostracism of lepers, many of the leper houses were at least located in the near distance of a town, and that *leprosi* were not particularly impeded from access into towns to seek assistance or buy provisions.

The existence of a leper house outside Deinze has been suggested by textual sources, however, no further details about its capacity and function are known (Stabel 1985: 49). The absence of clear leprous diseases in the skeletal assemblage of Deinze may indicate that those infected might have been buried elsewhere, although the early stage of this disease might not have been identifiable in the human remains (e.g. Roberts and Manchester 2010). Additionally, the choices of patron saints may shed light on the identification of a hospital. Saint names associated with leprosy, for instance, include St Mary Magdalene, St Giles, St James, St Leonard, St Lazare, St Laurence, and St Nicholas (Demaitre 2007: 247; Farley and Manchester 1989:88; Rawcliffe 2006: 418-421), as for example noticed in the Flemish leprosoria of Bruges (*Magdalen*) and Ghent (*Our Lady of Lazerie*) (Boelaert 2011: 175; Demaitre 2007: 61).

3.2.2. Moorsel

Both toponymic and archaeological evidence may illustrate early habitation in the region of Moorsel. The suffix *-zele* (see table 3.2), for example, refers to a villa or farmstead, and thus may imply agricultural activities in the Gallo-Roman and early-medieval period (Verbesselt 1967: 141 and 145; Uyttersprot 1972). Evidence of probable early habitation in the region of Moorsel was also demonstrated by archaeological research undertaken by Pieters (1986: 42-43), who uncovered a dense concentration of artefacts such as *tegulae* and Roman pottery. Moreover, the recovery of supra-regional imported Roman ceramics such as potsherds of Gallic *terra sigillata* and likely Spanish amphora, and the attestation of a Gallo-Roman sanctuary and villa in the nearby *vici* of Hofstade and Asse may be suggestive of early trade relations (Pieters 1986: 43 citing De Laet 1950).

Archaeological research in Moorsel initiated in 1975, uncovered a *motte*, or a military fortification, located in the valley to the south, and dated to between the twelfth and fourteenth centuries by pottery sherds. The investigation revealed the evolution of the site from the twelfth-century *castrum* to the fifteenth-century bailey, and reflected the archaeological potential of this small rural village and its nearby surroundings (Callebaut 1979: 6, 32-33 and 35; Pieters and De Swaef 1997: 11 and 14).

The skeletal assemblage addressed in this doctoral study was unearthed by SOLVA in 2009-2010 at the site of the St Martin church and its adjacent St Gudula chapel. The parish churchyard revealed 103 skeletal individuals, all dating between the eighth century and 1923 AD, and which the author of this thesis analyzed in 2012 as the main subject of a Master's dissertation (Van Cant 2012). A long period of use of the cemetery was indicated by the truncation of earlier graves by later burials from the post-medieval era, resulting in a large quantity of intrusive bone material, and thus implying a high number of interments (Klinkenborg *et al.* 2012: 33).

The area of the village square between St Gudula's chapel and St Martin's church was also archaeologically investigated in 1987 by Pieters *et al*. (1999: 137-142), and in 2007 by De Groote and Moens (2008). The former survey revealed both early-medieval ceramics and two ditches, most likely encircling the church, and consisting of an internal ditch dated to the tenth-eleventh centuries, and a twelfth-early thirteenth century external circular ditch (Pieters *et al.* 1999: 154). The area enclosed by the ditches revealed five burials from which one has been radiocarbon dated to the second half of the twelfth century (Pieters *et al.* 1999: 145 citing Van Strydonck, Radiocarbon dating report of burial 2 from the medieval churchyard of Moorsel, UtC-5041, Moorsel-Dorp GR2, calibrated age(s) cal AD 1167, with a 95.4% probability interval between 'cal AD 1033-1230'). Only four graves contained human skeletal remains, but unfortunately, detailed osteological analysis was not undertaken since the overall poor preservation and limited completeness of the bone material hindered further research. A basic macroscopic examination of burials one and two, which included the best-preserved remains, revealed nevertheless two adult individuals (Pieters *et al.* 1999: 145-146 and 154). Since only the age at death of the individuals was determined, and neither sex assessment nor the identification of pathologies and dental health despite the assessment of pelvic and mandibular fragments (Pieters *et al.* 1999: 146 and 156 citing Herrmann *et al.* 1990), it may illustrate the paucity in guidelines and the use of standardized methodologies concerning human osteological analyses in Flanders at that time of the archaeological research in 1987.

The latter survey carried out by De Groote and Moens in 2007 was situated adjacent to the area excavated in 1987, within the circular zone but outside the post-medieval church wall, and it revealed, along with four postholes and a kiln, six graves. Both radiocarbon dating, carried out by Van

Strydonck in 2009, and ceramics, provided a date range for the burials between the seventh and fourteenth centuries (De Groote and Moens 2008). These data are inventoried as Moorsel-Aalst skeleton nr. S2, 07/MO.DO/60 (KIA-38064), skeleton nr. S3, 07/MO.DO/61 (KIA-37910) and skeleton nr. S5, 07/MO.DO/63 (KIA-38866). Burials S2 to S5 were W-E positioned. Skeleton nr. S1, which was found in a NW-SE alignment, is dated to the fourteenth century, or likely earlier, by ceramics. No dating analysis of skeleton nr. S4, however, was noticed. Further osteological analysis of these six skeletons, however, has never been undertaken (De Groote *pers. comm.*). Radiocarbon dating of eight human bone samples from the medieval and post-medieval cohorts from the current project was also undertaken by Van Strydonck, and supplied a date range between c. 700-1923 AD, for which the latter year reflects the dissolution of the churchyard (Klinkenborg *et al.* 2012: 23 and 26-31). These data are shown in table 3.4.

Skeletal Individual Nr.	**Data entry according to KIKIRPA**	**Radiocarbon Date Range (AD) - results** ***(according to the highest probability % within a 95.4% confidence interval)***
V/S1/8-299 (male, 40+)	KIA-43601	890-1030
IX/S1/1-302 (unknown sex, 40+)	KIA-43600	890-1030
XII/S1/6-356 (unknown sex, 18+)	KIA-43599	690-880
XII/S1/2-353 (female, 16-19 years)	KIA-43598	1660-1923
XII/S1/1-352 (unknown sex, 20-35 years)	KIA-43597	1180-1275
V/S1/1-292 (male, 20-35 years)	KIA-43596	1415-1450
III/S1/6-92 (unknown sex and age)	KIA-44330	780-990
IX/S1/4-304 (male, 20-35 years)	KIA-44329	1020-1160

Table 3.4: Radiocarbon dating analysis of 8 skeletal individuals from the Moorsel assemblage.

To shed light on the development of the rural parish, the three archaeological excavations undertaken between 1987 and 2010, were concentrated on the conjectural existence of an early-medieval convent in the village centre. Hagiographic sources such as the *Vita Gudula* and the *Vita*

Berlindis alluded to a seventh-century monastery situated at the village square, but all three surveys failed to find clear evidence for this convent (Pieters *et al.* 1999: 131-132, 152 and 154) (Klinkenborg *et al.* 2012: 9). Despite the aforementioned uncovering of the four postholes and the circular kiln, which was suggested to be linked to the convent, dating of the inhumations and the postholes within the sacred area around the chapel, however, revealed they were no earlier than at least the tenth century (De Groote and Moens 2008: 83-84) (Klinkenborg *et al.* 2012: 62 and 67). Later fieldwork by SOLVA indicated a likely remodelling of the churchyard during the fourteenth-fifteenth centuries, which involved relocation of the access to the passageway between the chapel and the church as it is known to date (Klinkenborg *et al.* 2012: 61).

Historical sources concerning the foundation of St Martin's church and St Gudula's chapel are scarce, and limited to the aforementioned hagiographies of the *Vita Gudula* and the *Vita Berlindis*, although they have to be taken cautiously as the hypothetical existence of the seventh-century convent in Moorsel was not testified by other written sources (Van de Perre 2005: 30). The presence of both a church and the adjoining chapel in the small parish may be illustrative of the governmental dichotomy of Moorsel since the Middle Ages (Pieters 1986: 47; Verbesselt 1967: 145). Indeed, Moorsel was initially divided into two manors: *Moorsel-propre* (*Moorsel-Land van Aalst*), and in the north *Moorsel-Kapittel* (*Land van Dendermonde*) until the parish became administered by the abbey of Affligem in the twelfth century, although the manorial lords could maintain the usufruct of their properties (Callebaut 1979: 28-29; Verbesselt 1967: 145 and 261-262). The broad outer circular ditch that was revealed by excavations in 1987 in the zone between the chapel and the church may be related to the acquisition by the abbey of Affligem to consolidate their ownership (Pieters *et al.* 1999: 152). The inner ditch is likely associated with the organisation of the medieval churchyard in the tenth or eleventh centuries (Pieter *et al.* 1999: 153). The extent of churchyards was regulated in 1058 AD to an area encircling a church at 60 steps, or at 30 steps from a chapel (Kenzler 2015: 149 citing Werner and Werner 1988). A distance of 30 steps between the ditch and the church was nevertheless ascertained by Pieters *et al.* (1999: 153), and is hence indicative of the organisation of the medieval churchyard.

Details of the construction of the church and possible amendments were not specified in the archaeological report by SOLVA (2012). The oldest structure within the current building is situated in the tower, and is dated to between 1250-1300 (Pieters 1986: 48; Verleyen 1985: 263). After arson in c. 1580, renovations were carried out at the beginning of the seventeenth century, and repeated in 1663 with a rebuilding of the chancel (Verleyen 1985: 263 and 265).

The relationship between the chapel and the church and whether or not they functioned as autonomous institutions simultaneously has been questioned, but was not elucidated by the archaeological study. Thus, it remains speculative which area evolved first (Klinkenborg *et al.* 2012: 17). The excavated site contained the zones surrounding both the chapel and the church wherein the earliest burials are to be located in these two sections. In contrast, 65 post-medieval inhumations were uncovered from the plot surrounding the church (Klinkenborg *et al.* 2012: 19 and 33). A cluster of seventeen medieval burials comprised six graves in the south and eleven to the west area of the chapel. The preservation of the skeletal remains from these burials was poor overall, particularly those located in the west of the chapel, and this might have been caused by the shallow depth (c. 30 to 50 cm) at which the burials were found (Klinkenborg *et al.* 2012: 20). According to the excavation report, nineteen medieval inhumations were found within both the north-west and south area of the church, and included two earth-cut graves (Klinkenborg *et al.* 2012: 27). The bone surface of these skeletal remains was recorded as being better preserved, and has provided possibilities to compare health between the medieval and post-medieval group.

3.2.3. Oosterweel

The earliest historical document concerning the parish of Oosterweel is a charter of the St Michiels abbey from 1283 AD, and refers to *'parochia de Outserwele*'. The name of the church, St John the Baptist, alludes to the patron saint of butchers and fishermen, who is also considered to be a protector of cattle and pasture fattening (De Mets and Pottier 1987: 10; Vandeweert 1986). Moreover, it has been suggested that parishes located in the vicinity of water, like Oosterweel and the nearby community of Oorderen, often employ the name of John the Baptist for their village church. Oorderen, indeed, possesses a church with an identical name (Havermans 1973: 6; Vandeweert 1986). Meys (1981: 44) argues that a chapel named after St John was originally built at the same location of the church in Oosterweel. The excavations in 1985, however, did not identify any foundations of this plausible sanctuary of St John (De Mets and Pottier 1987: 47).

Oosterweel, its buildings, and its dwellers have been exposed to several calamities throughout many decades: e.g. inundations such as the St Elizabeth's flood caused by a disastrous tidal surge in the region of Zeeland in 1421 (Asaert and Jamees 1995: 13), the battle of Oosterweel on March 13th, 1567 (Meys 1981), a devastating explosion on September 6th, 1889 in an adjacent ammunition warehouse that severely damaged several houses and the church and which has been vividly reported by Winkeler (1889: 16). Consequently, Oosterweel and its church of St John the Baptist (both with and without its church tower) have been frequently portrayed in iconographic sources, such as an engraving by Frans Hogenberg (1535-1590) of the battle of Oosterweel in 1567 (fig. 3.5).

Fig. 3.5: The battle of Oosterweel on 13 March 1567 (*Bataille d'Oestervel*), after an engraving by Frans Hogenberg (1535-1590), which depicts the defeat of the Calvinists by the Spanish troops near the village. The St John the Baptist church is portrayed in the background (Royal Library of Belgium, Prints Collection, Inventory Nr. S.II 143291).

The several demolitions of the church building resulted in repeated restoration works from the beginning of the seventeenth century until bombing in WW2 led to a temporarily dissolution of the church. After several post-war renovations of the chancel, the last service in the church was organised in 1971 (Meys 1981: 42). Since 1994, the St John the Baptist church has been acknowledged as a protected heritage monument by the Flemish Government (Kennes *et al.* 1992).

Archaeological excavations in and outside the St John the Baptist church in Oosterweel were carried out in 1985 on behalf of the provincial government of Antwerp. The purpose of the archaeological survey was to clarify the construction history of the church, one of the last testimonials of this dissolved polder village in 1958 due to the expansion of the port of Antwerp in the 1950's and 1960's (Meys 1981: 16-17). The excavations revealed the skeletal remains of 68 individuals from burials inside the church. The excavation map (fig. 3.6) shows the ten trenches that have been unearthed (four inside and six outside the church), and are numbered from I to X, along with the location of most human skeletal remains, albeit these are illustrated without any inventory reference. This skeletal collection, however, was not analysed at the time of the excavation until 2011 in the context of the bachelor's dissertation by the author of this doctoral thesis (Van Cant 2011).

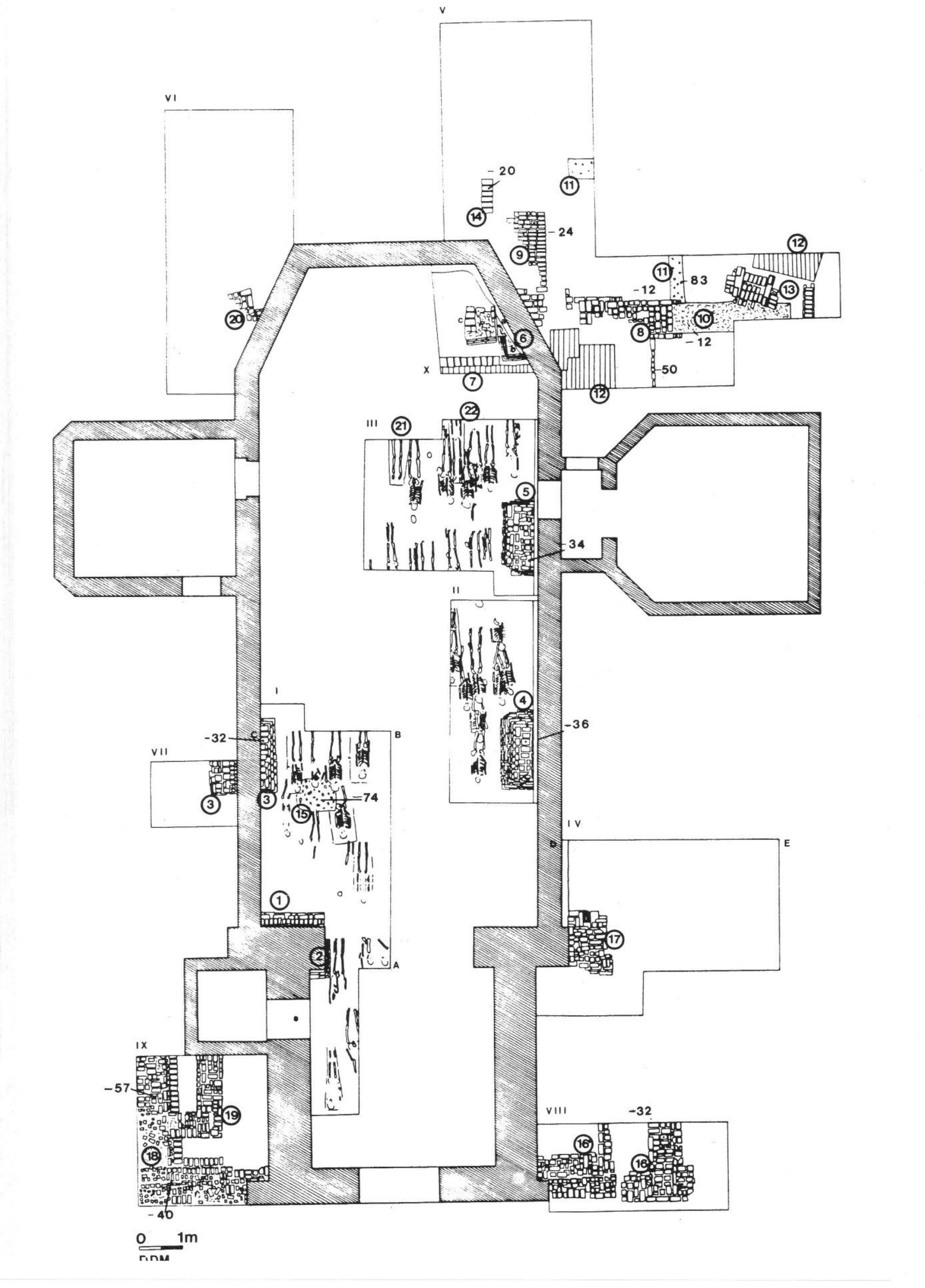

Fig. 3.6: An illustration of the excavated area in and outside the *St John the Baptist church* in Oosterweel depicting the four trenches (numbers I, II, III and X) inside and six trenches (numbers IV to IX) outside that were uncovered in 1985. The inventory number of each human skeleton, however, is not shown (Source map: De Mets and Pottier 1987: 26, fig. nr. 34). A detailed plan including all skeletal inventory numbers was created according to Dirk De Mets (pers. comm.), but is not archived at the S.A.A.A. (City of Antwerp Archaeological Department, Oosterweel: Church and Environment Archives, *s.d.*), and thus unfortunately abolished or misplaced (Johan Veeckman, Deputy Archaeology and Heritage, City of Antwerp, pers. comm.).

Foundations of aisles discovered in both the north and south parts of the church tower indicate that the initial church was likely divided into three aisles, and the two small side aisles plausibly included a groin vault as suggested by the recovery of vault fragments from the staircase tower (De Mets and Pottier 1987: 34 and 47). Other recovered artefacts were scarce and contained pottery dated to the twelfth century and a fifteenth-century seal stamp made of bronze, which is a rare find since seal stamps were usually demolished after the owner's (generally peasants, merchants or priests) death (De Mets and Pottier 1987: 42-44). According to the archives of the City of Antwerp Archaeological Department (S.A.A.A.), a few burials included some 'butcher's knives', although these interments were not specified by the archaeologists. However, these metal items might be related to an unspecified number of iron shears, dated to the seventeenth century, that were identified in two graves from trench I (De Mets and Pottier 1987: 38).

Two skeletal individuals that were unearthed from trench III were buried near the chancel on an E-W alignment, and hence suggested to be the graves of priests. This is also corroborated by textile fragments of their liturgical garments that were observed on the pelvic area and upper legs, along with remnants of shoes (De Mets and Pottier 1987: 37-38). Following the Christian tradition, it was common that the clergy were interred in their ecclesiastical robes (Bungeneers 1987: 6; Veeckman 1997: 73; Veeckman *et al.* 2003). Analysis of the recovered textile fibers revealed a probable woollen cloth, combined with an outer chasuble which was ornamented with copper-wire woven embroidered borders. This type of vestment is suggested to predate the eighteenth century. However, Veeckman (1997: 73) argues that the vestments of priests were usually passed on to the next generation, and hence remained in use for long periods, and so it is difficult to attribute a more accurate date to the burials on the basis of the traces of vestments.

Radiocarbon dating of the skeletal remains has, unfortunately, never been undertaken, and an absolute dating of the inhumations is therefore unclear. Moreover, De Mets and Pottier (1987: 38) state that 'a horizontal and vertical stratigraphic association between the graves and structures could not be determined'. Nonetheless, relative dating from material and iconographic evidence, and historical sources have suggested a date range of the burials between 1450-1850 AD.

3.2.4. Slijpe

Historical reconstruction of the coastal landscape in the North Sea region has been widely undertaken, but a recent interdisciplinary approach has fostered the debate on the interaction between environmental and socio-economic/historical conditions, and the impact of its aftermath on human activities (Thoen *et al.* 2013). For example, Thoen *et al.* (2013: 4) note the significance of 'peat compaction as a result of peoples' activities. The extraction of peat for fuel was indeed of importance in the polder land of the North Sea region until the fifteenth century, and even in the post-medieval era as shown by archaeological excavations in the 1990's in the fishing village of Walraversijde (Ostend) that revealed several pits for the extraction of peat (Pieters 2013a: 102; Pieters 2013b: 544). At the the site of Slijpe, archaeologists identified as well a pit for peat extraction during the excavations in 2011 (cf. *infra*), which further testifies to the reclamation of peat-land in the North Sea region before the fifteenth century (Pieters 2013b: 544; Smet *et al.* 2012: 144).

The emergence of Christianity coincides with the foundation of chapels and parishes, usually by local lords, whose names are represented in the topographic evidence of community names with the suffix *-kapelle* (-chapel) or *-kerke* (-church). This was indeed recorded in several historical sources such as charters dating to e.g. 1288 and 1419 for the parish of Slijpe, which was, besides *Slipen*, described as *(H)Aerleboud(t)s cappelle* (or chapel/church of (H)Aerleboud(t)), alluding to the founder of the sanctuary (Goetghebeur and Jansseune 1989: 31; Jansseune 1970: 5; Loontiens *s.d.* 29). A charter dated to 1450 illustrates the cession of land in Slijpe including both place names: *'(...) binnen der prochie van Haerlebouds cappelle diemen heet Slipen (...)'* (Goetghebeur and Jansseune 1989: 94). Loontiens (*s.d.*: 30), however, argues that a charter from 1141 alludes to *Arleboutskapelle* (*or Erlebaldi capella*) as a hamlet within Slijpe, and are thus considered as two independent entities.

In his research on the medieval embankment of the coastal plains in Flanders, Tys (2013: 213-215) refers to the fifteenth-century land books of the *Brevia Camera* and *Magna Brevia* of Bruges, which indicate that the medieval parish of Slijpe was altered into a comital estate, representing a 'topographical unity' under the control of the Counts of Flanders (Tys 2013: 215). In the twelfth century, the residing Count of Flanders, Willem II, attributed the mother parish of Leffinge and its annexes to the Knights Templar, who founded a preceptory in Slijpe to manage the tithes, mainly involving the organisation of granary and cattle (Zeebroek *et al* 2006: 159). The Knights Templar preceptory was not only of economic importance for the region, but also occupied a religious function with a small monastery including a chapel and hospital on the premises (Zeebroek *et al.* 2006: 176). After the dissolution of the Knights Templar in 1312, their properties were assigned to the Order of St John (Maes 1975: 5). The chancel in the parish church in Slijpe contained several burials from men of the religious military orders, but a fire in 1822 has unfortunately destroyed the graves of the commanders in the chancel and the original stained-glass windows depicting the weapons of the Order of Malta (Demerre, I. 2005: 5, *unpublished internal report*; Maes 1975: 9). The church, and many other buildings in Slijpe, were almost completely destroyed in 1915, and successive restorations were undertaken between 1922-1925, although the remnants of the substructure were retained (Demerre, I. 2005: 5, *unpublished internal report*).

During November and December 2011, 106 skeletal individuals were unearthed from the west section of the late-medieval parish churchyard in Slijpe by Ruben Willaert Ltd. The motivations for this archaeological project included dating of the archaeological remnants, revealing stratigraphic relationships within the graveyard, providing demographic insights into the population, and demonstrating the complementary value of the archaeological data and historical sources (Smet *et al.* 2012: 7-8 and 135, *Report 7*). In 2005, a previous excavation was carried out in the same St Nicholas church, and uncovered the skeletal remains of at least 38 individuals, however, osteological analysis has not been carried out to date (Demerre, I. 2005: 14, *unpublished internal report*, and Demerre and Pieters *pers. comm*.). Other archaeological excavations in Slijpe involving human skeletal remains were undertaken between 1971-2003 at the medieval site of *Groot-Tempelhof* (Knights Templar preceptory), and revealed a minimum of ten burials in a W-E alignment. Only one likely coffin burial was noticed. Elemental osteological analysis, yet unpublished, was carried out by Vandenbruaene, and indicated the inhumations of mostly children and adult males aged 25-40 years (Zeebroek *et al.* 2006: 165, 174-175).

A ditch, which had likely enclosed the church, was observed extending from the north to the south. At the northern end of the trench, a pit for peat extraction was cut by the ditch. When the ditch was constructed could not be determined, but pottery sherds from its fill suggest it dates to between the twelfth-fourteenth centuries, and predates the excavated churchyard wall that was built at the same location (Smet *et al.* 2012: 135 and 144). Post-medieval evidence from the excavated site was only recorded in the foundations of a basement and floor, and this is interpreted as the structures of the historically and cartographically attested inn '*'t Wapen van't Vrije*' that was located to the north of the church (Smet *et al*. 2012: 14-15, 37 and 143). Ceramics datable to at least the sixteenth century indicate that this area of the churchyard was probably abandoned in favour of the tavern, likely resulting in the removal of burials, which is corroborated by the excavation of an ossuary pit in the same trench (nr. 6) (Smet *et al.* 2012: 32 and 145).

Spatial analysis of the graves revealed a clear distinction between a dense concentration of burials in trenches 2, 5 and 6, compared to fewer inhumations in trenches 7 and 10. The observation of four organised rows in trench 12 indicates a variation within the structure of the cemetery. Furthermore, the truncation of the burials in the highly concentrated zones situated at the churchyard boundary, may suggest a less widespread use of grave markers on the periphery of the cemetery, although no other evidence for use of grave markers elsewhere in the cemetery has been specified (Smet *et al.* 2012: 139). Smet *et al.* (2012: 139) argue for a social differentiation in the burials in the churchyard based on this lack of evidence for commemorative stones, although it should be noted that grave markers are not always observable in the archaeological record. Infant burials were particularly concentrated in the north area of the cemetery, and only two of the twelve unearthed subadult graves were located in the south (Smet *et al.* 2012: 140).

Bone samples from nineteen skeletons were submitted for radiocarbon dating, and provided a date range between the ninth and beginning of the fifteenth centuries. An overview of the radiocarbon data is listed in Smet *et al.* (2012: 151-152). Here, bone collagen was taken from the following trenches listed below in table 3.5, and represents a 95.4% confidence interval.

Trench+Skeletal Individual Nr.	**Data entry according to KIKIRPA**	**Radiocarbon Date Range (AD) - results *(according to the highest probability % within a 95.4% confidence interval)***
10-27 (unknown)	KIA-47735	810-990
10-17 (likely male, 18+)	KIA-47740	890-1020
2-67 (likely male, 18+)	KIA-47742	890-1020
2-37 (female, 20-35 years)	KIA-47741	890-1030
10-30 (female, 50+)	KIA-47728	890-1020
2-25 (unknown sex and age)	KIA-47734	980-1160
9-46 (unknown)	KIA-47738	990-1160
12-16 (child, c. 4-5 years)	KIA-47726	1020-1160
5-39 & 6-68 (male, 20-35 years)	KIA-47733	1020-1190
12-9 (female, 50+)	KIA-47730	1030-1220
2-55	KIA-47731	1040-1260

(likely female, 36-50 years)		
7-10 (female, 40+)	KIA-47725	1160-1280
2-13 (female, 40+)	KIA-47729	1185-1285
5-21 & 6-56 (female, 20-35 years)	KIA-47739	1215-1280
9-29 (male, 60+)	KIA-47737	1220-1390
7-12 (child, c. 4 years)	KIA-47724	1260-1390
2-9 (likely male, 18+)	KIA-47727	1260-1390
2-38 (likely female, 20-35 years)	KIA-47736	1260-1400
6-38 (unknown sex and age)	KIA-47732	1280-1400

Table 3.5: Radiocarbon dating analysis of 19 skeletal individuals from the Slijpe assemblage.

3.2.5. Vichte

Vichte is situated on the border between the castellanies (shires) of Oudenaarde and Kortrijk, and this border is demarcated by the small stream *Vichtebeek* or *Kasselrijbeek* (Despriet 2004: 9). The presence of a castle, which may have originated from a motte, its outer and inner bailey, and a church, mirrors the once feudal structure of the manor of Vichte (Despriet 2004). For example, an unspecified source dating to 1685 depicts the castle as '*een fraii kasteel staende op een **mote***' ('*an appealing castle on a **mote***') (De Gryse and Boncquet 2011: 10).

The oldest historical attestation of the name Vichte is as *Vehta* in the cartularium of the *St Diederik* abbey in Reims when the parish was founded in 1119 (Blockeel 1975: 9 and 79). Blockeel (1975: 100), however, suggests that the church was erected shortly before 1114 by the first local lord of Vichte, and likely the first owner of the nearby castle, *knight Goswin van Nieuwerkerke ('de nova ecclesia')*, later referred to as *Goswin van Vichte* (Blockeel 1975: 79; Despriet 2004). Remnants of the original structure of the church indicate a single nave and west aisle which was extended with two transepts to the north and south before 1363, presumably commissioned by the resident lord *Jan van der Vichte (†1363)* (Blockeel 1975: 100-102). Successive renovations of the church building were carried out in the sixteenth century, including an expansion of the southern aisle, which may be related to the demographic increase in the castellany of Oudenaarde (Blockeel 1975: 106). Blockeel (1975: 15-17) postulates that the population of Vichte consisted of c. 200 inhabitants in the sixteenth century, based on the historical records from the castellany of Oudenaarde, but also states that an estimation of the population size before this period is conjectural. Documentary evidence of the subsequent centuries indicate a demographic increase leading to 1327 dwellers in 1846, until a typhus outbreak between 1845-1850 provoked population decline with only 1054 villagers being recorded in the census of 1866. A modest population growth was recorded again after 1866 (Blockeel 1975: 17).

Apart from a castle with inner and outer bailey and the church, the manor of Vichte comprised a corn watermill and a windmill before 1918. The water from the *Vichtebeek* or *Kasselrijbeek* was applied as driving force for the mill, and became an open sewer in the landscape. As a result, the pollution of this water was extremely high (Blockeel 1975). Iconographic and textual evidence of the fifteenth and seventeenth centuries illustrate the ownership of the mills by the feudal lords who imposed banalities (e.g. fees) for its use by the parishioners in order to obtain additional resources (Despriet 2004: 82). Another feudal right was the jurisdiction by the lord in his manor, and the authorisation of capital punishment. Historical and pictorial sources from the seventeenth century indicate that death sentences in Vichte were executed at the *Galgeveld* (field of gallows), situated in the north of the manor (Despriet 2004: 89-90). A common practice in northern Europe at this time was to bury criminals beneath the gallows (Tarlow 2015: 9).

Further restorations of the church were undertaken after destruction during WWI, and the old parish church remained accessible for liturgical services until a new designed religious building was inaugurated nearby in 1962 (Blockeel 1975: 112-113; Despriet 2004).

Archaeological research on the south-west site of the *Oude Kerk* (Old Church), situated in the village centre at the *Kerkdreef*, and adjacent to the moat and courtyard of the castle, was undertaken by Monument Vandekerckhove NV in 2012 after the excavation of four trial trenches in 2011 (De Gryse and Boncquet 2011). The area to the south of the church, which was divided into five zones/levels during the successive fieldwork, revealed 66 skeletal remains that have been dated mainly to the nineteenth century by several artefacts found with the burials, such as a coin from 1862, depicting King Leopold I (1790-1865) (Bot and Acke 2014: 5, 47 and 57). The human skeletal remains from level 1, 2, 3 are most likely dated to the ninetheenth century, and the same period is, although undetermined, likely for level 4 and 5 (Bot and Acke 2014: 73). The churchyard was in use until its dissolution in 1930 (Blockeel 1975: 110).

Other archaeological observations included a ditch which was located below a stone wall dated to the seventeenth century. The ditch was either connected to the moat of the courtyard, or linked to the *Kasselrijbeek* as proposed by Bot and Acke (2014: 46). No datable artefacts were observed in the lowest layers of the ditch, while the ceramics uncovered from the upper stratigraphic levels indicate a *terminus ante quem* of 1600 AD for the ditch. Iconographic sources such as *Flandria Illustrata* (1641-1644 AD) (fig 3.7), although they should be considered critically, notably illustrate a building in the location of the ditch that might have been used to control the water supply (Bot and Acke: 2014: 33 and 46).

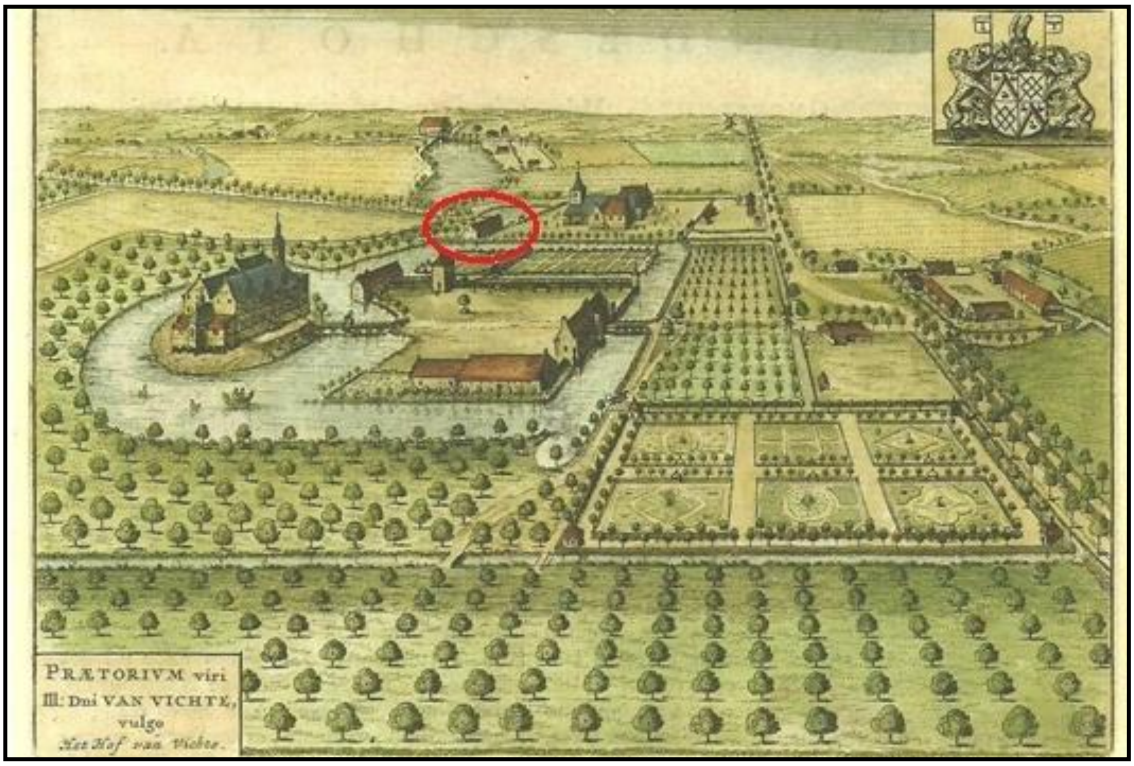

Fig. 3.7: The castle, church, and courtyard in Vichte as depicted on cartographic material from 1641-1644 AD. The encircled building connects with the moat, and might have functioned to manage the water supply (Iconographic source: Bot and Acke (2014: 34, fig. nr. 31) citing © Despriet, Ph., 2004, front page).

Hence, Bot and Acke (2014: 46) hypothesize that either the ditch had a short time span and that a subsequent one was established nearby, or that the ditch was cleared out regularly through which datable older material had been discarded and thus suggesting a possible longer period of utilization. Nevertheless, a simultaneous use of this smaller ditch and the brick construction could not be confirmed (Bot and Acke 2014: 75).

The unearthing and categorising of the 66 skeletal remains were based on the TAW-value (*Tweede Algemene Waterpassing*, or Second General Water Level, is a reference height that is applied for altimetry in Belgium) of the five excavated levels and is represented in table 3.6 (data derived from Bot and Acke 2014: 47-68). However, 59 instead of 66 skeletons were listed, and by inspecting all five tables in the report, the following seven skeletal individuals were not recorded in the overview: 14, 15, 16, 17, 18, 22 and 31. Therefore, the spreadsheet database of the Vichte skeletal collection that was applied during the osteological analysis by the author of this thesis was verified in order to attribute the level to the excluded skeletons.

Level	**TAW-value between**	**Number of skeletons** (based on Bot and Acke 2014: 47-68)	**Remarks**
1	+18.75 and +18.90 m	10	Excludes skeleton nr. 17
2	+18.58 and +18.70 m	17	18 according to the report (Bot and Acke 2014: 51); excludes skeleton nrs. 14, 15, 16 and 18
3	+18.45 and +18.55 m	15	14 according to the report (Bot and Acke 2014: 56); excludes skeleton nrs. 22 and 31
4	+18.29 and +18.44 m	14	/
5	+18.19 and +18.30 m	3	/

Table 3.6: Summary of the 5 levels with the TAW-value and total number of skeletal individuals from Vichte, based on the archaeological report. Additional comments on missing/incorrect data are listed in the last column.

The bone surface and overall preservation of skeleton nr. 62 in level 2 was identified to be in an excellent condition, which might have been the result of the burial that was uncovered in a wooden coffin with a well-preserved lead lid. Because of the identification of soft tissue, and the ensuing health and safety issues, it was decided to leave the skeleton in-situ (Bot and Acke 2014: 51).

Spatial analysis of graves within the graveyard was not recorded. The only evidence of cemetery topography was noticed in level 1 (skeleton nrs. 9 and 10) and level 2 (skeleton nrs. 11 and 12) where the coffins of graves 9 and 10 were placed on top of 11 and 12. Moreover, the precise position of the recorded bone material and the absence of linings of the grave may indicate that the burials took place within a short time interval in one grave and might imply that the deceased were relatives (Bot and Acke 2014: 70). A plan of the cemetery, however, was not included in the internal archaeological report provided by Bot and Acke (2014).

3.2.6. Zottegem

Renovations in the centre of Zottegem necessitated an archaeological survey in the area north of the *OLV-Hemelvaart* (Our Lady of Ascension) church situated at the *Markt*. The research was carried out by SOLVA in the autumn of 2014 and revealed 94 primary interments as well an ossuary pit. As indicated previously in section 2.1., no comprehensive excavation report has been produced to date by SOLVA, and the archaeological data used in this research project are based on the evaluation report on phase 1 that involved the unearthing of the skeletons (Klinkenborg 2014: 1-8). Additional context information comprehends an inventory list of e.g. photos, grave alignment, body positioning, preservation and completeness of the burials (SOLVA 2014).

The first historical indication of a parish church in Zottegem is dated to 1162 AD, although its exact location is questionable since the earliest evidence of Our Lady of Ascension church has been dated only to the fourteenth century (Lamarcq 2013a). Previous archaeological excavations at the site of the nearby Egmont castle in 1993-1994 revealed the foundations of a twelfth-century Romanesque hall church with a surface of 7x13m, and it has been suggested that this 'castral chapel' might have served as the first church in Zottegem (Lamarcq 2016; Van Eenhooge 1995). This was not only underpinned by its dimension, but also by its adjacent cemetery that was partially excavated to the north, and revealed the skeletal remains from c. ten children and one adult individual (Lamarcq 2016). Moreover, a tentative similar case was demonstrated in Pevensey (UK), where the inner bailey of the castle uncovered stone foundations of a thirteenth-century chapel, used until the village was relocated outside the walls, where a new parish church was built (Van Eenhooge 1995). Thus, Van Eenhooge (1995) suggests by extrapolating from the archaeological data that the initial village of Zottegem was relocated by the end of the thirteenth century to its current topographical situation to the south-east of the Egmont castle, and coincided with the erection of Our Lady of Ascension church.

The church consisted originally of a single nave, and was expanded by transepts in the course of the eighteenth century (d'Huyvetter *et al.* 1978). Between the fifteenth and the eighteenth centuries both the church and the village of Zottegem endured several decades of turmoil, arsons and plundering, along with famine and epidemics, culminating in demographic fluctuations (Lamarcq 1989).

The parish churchyard was most likely in use since the fourteenth century, until it was discarded in 1824, when a new cemetery was installed outside the village with a separate smaller zone for non-Catholic inhabitants 'in the north and un-consecrated' area (Lamarcq 2003: 19-20 and 25).

Apart from the uncovering of the inhumations in 2014, remnants of the previous church wall were observed in the north-east corner of the excavated area. However, due to recent construction works, parts of this wall were demolished and a possible entrance to the churchyard could not be identified. Moreover, the previous installation of sewer pipes had disturbed several burials located between this wall and the church. Although no datable artefacts have been reported, and radiocarbon dating of the skeletal remains is scheduled but not yet undertaken, the dating of the burials relies solely on historical sources which suggest that the churchyard has been in use for at least five centuries. This prolonged period of use is also suggested by the truncation of graves and the excavation of an ossuary pit (SOLVA 2014, following data along with photographs were recorded of the ossuary pit: context/feature nr. I-36; plan nr. 1, 3, 2, inventory nr. 59).

No evidence of grave markers was reported. Although the churchyard was demarcated by a wall, historical documents from the seventeenth century illustrate that the area was sometimes used as a marketplace, even until the nineteenth century (Lamarcq 2003: 16). The organisation of a market on the churchyard was a regular practice in medieval Europe (Howell 2010: 30).

Previous surveys in Zottegem that involved recording of human skeletal remains from the church, concerned the crypt of the decapitated Lamoral, Count of Egmont (1522-1568) and his family (Lamarcq 2013b). Osteological analysis was carried out by Twiesselmann and Orban, and was published in 2007 (Twiesselmann and Orban 2007). Another unusual find in the village centre was a neonate found in a late-medieval pot (Deschieter and Dewandel 2009: 453). This phenomenon, illustrated as *limbo puerorum* or *limbus infantium* (purgatory) was introduced in the twelfth century, and referred to a place for the souls of the un-baptised infants until their union with the soul of a new child of the mother. The foetal or neonate skeletal remains found in ceramics at the periphery of other churchyards, such as Kruishoutem and Klein-Sinaai, may be further examples of this custom (Deschieter and De Wandel 2009: 459; Smet *et al.* 2012: 140 citing Deschieter 2009 and Vermeulen 2010). A globular pot was also found at the churchyard in Slijpe, but did not contain foetal or neonatal bones (Smet *et al.* 2012: 140). Other burials were recovered from the Egmont castle site in 1993-1994, and may shed light on the initial location of the church.

As illustrated in 3.2.1.1., Deinze is the only site in this study with both historical and iconographic evidence of a medieval hospital, although toponymic data as seen in the street named *Hospitaalstraat* allude to the conjectural existence of an infirmary close to the central market in Zottegem too. Van Durme (1999: 89-90 citing Watté 1986: 39 and 298) suggests that a hospital in Zottegem located at the *Markt* might have existed before 1412, based on a historical text fragment '*waer plocht het hospitael te syn*' (translated as '*where the hospital was located*'), though unfortunately this antiquarian source is irretrievable at present.

Rescue excavations near the putative location of this hospital in the *Hospitaalstraat* in 2001 uncovered a density of seventeenth-eighteenth-century ceramics (e.g. red ware, slipware and tin-glazed pottery) and one knife with wooden handle and remnants of its leather holder, but time restrictions hindered a more in-depth analysis of the hypothetical infirmary (Deschieter and De Mulder 2001; Deschieter and De Mulder 2003). A study by Egan (2007) on excavated material from English medieval hospitals has shown that, apart from medical tools such as knives with wooden handles (in this study in a medicinal context and thus not to be regarded as everyday objects when uncovered in a different setting), specific vessels may be exemplary of equipment for medical care. However, Egan (2007: 76) underlines that the archaeological information to determine the tools of the doctor is generally elusive, and suggests that burials from both hospital sites and perhaps even more from religious institutions provide 'slightly firmer ground' to reveal medical interventions such as the use of copper-alloy plates as a treatment for knee injuries. The ceramics unearthed from the Zottegem site, however, do not reveal distinct similarities with those discussed in Egan's paper, hence a medical or household purpose of the material remains uncertain.

3.3. Burial Practices in the Case Studies

Daniell (1997: vii) states that religion was deemed to be ubiquitous in daily medieval life, and its associated beliefs about death and burial was not exclusively restricted to one privileged group, but was embedded in all social classes. Gilchrist (2012: 200) remarks that medieval churchyards may elucidate a variation in local customs such as the use of grave goods, coffins, clothed burial or grave markers. In order to demonstrate local burial practices within the six case study sites, this section will present a brief summary of the funerary rites, which involves the archaeological data of mortuary topography, grave types, alignment, body positioning and the visibility of artefacts or grave goods in their funerary record.

3.3.1. Mortuary Topography

Being interred in the proximity of the church was regulated by Pope Gregory I (590 to 604 AD) with the motivation that 'the souls of the dead might benefit from the prayers’ (Houlbrooke 1998: 331). What about less fortunate individuals buried in the periphery of the churchyard? Perhaps spatial analysis of the graves within the cemetery might elucidate social differentiation since the social status of the interred individual was commonly reflected by its burial location. High-status inhumations were usually located inside the parish church, whereas the majority of lay members of the community, mainly children and lower-status adults, were usually buried in the churchyard (Horrox 1999: 103-104; Houlbrooke 1998: 331). However, the (under)representation of infant skeletal remains in churchyards, and even in churches, has been regularly tackled, and shows variety in the archaeological dataset. Firstly, it is widely assumed that the scarcity of infant bones is caused by their porous structure, which makes them less visible in the archaeological record (e.g. Lewis 2000: 40; Mays 2010: 28). However, De Groote *et al*. (2011: 171) argue that the unearthing of smaller adult bones, such as hand and foot phalanges, is frequently recorded during fieldwork, suggesting that the archaeological recovery of immature bones should not be underestimated, and indicate that children were likely buried elsewhere within the cemetery.

Secondly, an alternative explanation to the underrepresentation of immature bones could be indeed associated with cultural practices (Halcrow and Tayles 2011: 340). Newborns, for instance, were possibly excluded from the collective burial ground as they were not baptised (Meier & Graham-Campbell 2007: 434). Gittings (1999: 150) even postulates that stillborn babies who had passed away before birth were considered as ‘less than human’, and ought to be buried in a hidden location. Moreover, historical evidence from England from the fifteenth century illustrates that women who lost their lives while giving birth were banned from interment in the churchyard (Daniell 1997: 103). This may indicate that deceased mothers were buried together with their stillborn babies outside the cemetery.

The plausibility of there being a specific assigned area for immature individuals was also suggested by Hadley (2004: 308-309) in a study on burial practices in later Anglo-Saxon England. In addition, a bio-cultural analysis of the later Anglo-Saxon cemetery of Black Gate in Newcastle- upon-Tyne by Swales (2012: 195-197) revealed more evidence regarding the underrepresentation of immature skeletons as both a total of 22.2% of young children (from birth to five years old) was recorded, along with a preservation of the bone surface documented as 'good' or 'excellent'. However, there has been no discussion about whether the soil type of the burial ground in Newcastle-upon-Tyne has affected the preservation of this sub-adult bone material, although Swales (2012: 105-106 citing Buckberry 2000) does refer to Buckberry's taphonomical study of Anglo-Saxon sites that has indicated better preservation of immature remains recovered from clay soils unlike those from sandy areas. Nevertheless, a cluster of both foetal, neonatal and infant burials was recovered near the church, likely ruling out the segregation of an inhumation area for only newborns (Swales 2012: 197).

Despite this group of children's burials outside the church, in Flanders, excavations during the 1980's revealed a concentration of medieval and post-medieval immature inhumations near the chancel of the cathedral in Antwerp (five children) (Bungeneers 1987: 6). A similarly located cluster was noticed at the case study site of Oosterweel, including three neonates and two children aged less than nine years. Burial in the proximity of the chancel was certainly one of the most favored final medieval resting places (Daniell 1997: 95).

Table 3.7 summarises the total number of subadults recovered from the six sites according to their age group, following the standard methods for defining age classes applied by the Flanders Heritage Agency (Quintelier *et al.* 2012: 278): Neonatus (neonate), 0-12 months; Infans I (young child), 1-6 years; Infans II (older child), 7-12 years, and Juvenis (adolescent/juvenile), 13-19 years. Further, the finds location within the excavated area of the church(yard) is specified, according to the archaeological reports and detailed plans with allocated reference numbers of the skeletal individuals if provided.

Age category	**Deinze (n=96)**	**Oosterweel (n=68)**	**Moorsel (n=103)**	**Slijpe (n=77)**	**Vichte (n=62)**	**Zottegem (n=93)**
Neonatus (0-12 M)	2 (2%)	3 (4%)	0 (0%)	1 (1%)	0 (0%)	3 (3%)
Location (excavated area)	east and central (south of church)	unspecified, likely near chancel	-	north	-	north; near church wall
Infans I (1-6 Y)	4 (4%)	1 (1%)	1 (1%)	8 (10%)	2 (3%)	3 (3%)
Location (excavated area)	mainly east (south of church)	near chancel	north	north (west of church)	west zone (south of church)	north of church; west zone
Infans II (7-12 Y)	5 (5%)	1 (1%)	3 (3%)	6 (8%)	1 (2%)	0 (0%)
Location (excavated area)	mainly east (south of church)	near chancel	north	north (west of church)	west zone (south of church)	-
Juvenis (13-19 Y)	12 (13%)	3 (4%)	7 (7%)	3 (4%)	1 (2%)	5 (5%)
Location (excavated area)	mainly east (south of church)	unknown	central	dispersed (west of church)	west zone (south of church)	north of church; dispersed
TOTAL	23 (24%)	8 (12%)	11 (11%)	18 (23%)	4 (6%)	11 (12%)

Table 3.7: Representation of subadults aged less than nineteen years in the six case studies, with the number of skeletal individuals along with the percentage within the total population (%) and geographical position in the excavated area.

All of the case study cemeteries include a small number of neonates, with the highest presence among the high-status burials at Oosterweel and Zottegem, and none observed at Moorsel or the nineteenth-century parish churchyard of Vichte. Considering the general poor preservation of the bone surface recorded in Zottegem, and the overall good bone preservation in Vichte, one would expect the impact of the soil type to be represented in the frequency of immature burials. One explanation for the inverse situation could be the extent of the excavated area. This might especially be the case for Vichte since the archaeological survey was carried out to the west and south area of the church, with all skeletal remains unearthed from the southern section. In Zottegem, however, the remains of three neonates were uncovered alongside the wall to the northern area of the church, within close distance of the three other young children excavated in the cemetery. At the cemetery of Rivenhall (Essex, UK), medieval burials of young infants were also situated close to the church wall (Houlbrooke 1998: 332). It has been suggested that the north side of the church was deemed as inferior (as for example suggested by the separate zone for non-Catholics in the north of the new cemetery in Zottegem), and was reserved for persons who committed suicide, or even as a burial location for women, while men would have been allocated a southern plot (Gittings 1999: 150; Meier and Graham-Campbell 2007: 432 and 434). This predilection for being interred on the south side of the church may be because it is adjacent to the church entrance (Houlbrooke 1998: 331). However, the five low-status case studies did not reveal any particular distinction in mortuary organisation between male and female burials.

The eastern part (south of trench 2) of the churchyard in Deinze included most subadult burials, and is situated closer to the chancel as opposed to the burial location of the other graves, and this might imply a preferred location in which to inter children, although this cluster was nonetheless surrounded by the graves of adults (Laisnez and Vandecatsye 2011: 101*, KLAD Archaeological Report 24*). Four children aged less than 13 years were also buried near to the chancel at Moorsel, and were all unearthed in the north part of the church. All rural case studies, and even the small urban settlement of Deinze, show a distinction between the locations of the burial of neonates and older children (see table 3.7), with the exception of the high-status group of Oosterweel, where the remains of neonates were clustered near the chancel. The only site where excavations were carried out inside the church was Slijpe, excavated in 2005 (Demerre, I. 2005, *unpublished internal report*; see also 3.2.4.), and they revealed the graves of at least two children in the aisles. However, the archaeologists suggest that the stone structure that included these burials might have been part of the external foundations of the original singular nave church in the Middle Ages, suggesting that the children were buried at that time in the cemetery adjacent to the initial smaller church (Demerre, I. 2005: 15, *unpublished internal report*). The immature burials from Slijpe examined in this study were mainly clustered to the north of the church. For Deinze, as discussed before, since the trench with the most child burials was not completely excavated, it was conjectured that there may have been more immature graves in the east zone towards the chancel (Laisnez and Vandecatsye 2011: 101, *KLAD Archaeological Report 24*). Yet it has been suggested that the mortality in towns was higher in contrast to the countryside, and thus reuse of the burial grounds was required because of the restricted burial space (Houlbrooke 1998: 332). However, an intensification of post-medieval burials was also indicated in rural Moorsel by the intercutting of the graves and a large amount of intrusive bone material, which implies a higher quantity of skeletal individuals (Klinkenborg *et al.* 2012: 33). The truncation of earlier graves by later burials is a phenomenon that has been testified in many medieval graveyards, since they were in use for many decades, if not centuries, and may illustrate an over-representation of later eras (Gilchrist 2012: 46).

3.3.2. Grave Types and Markers

The widespread use of coffins at all sites was noted, and they may be interpreted as a measure to prevent the corpse from being intermingled with other burials and polluted or dirty soil (Tagesson 2015: 27). Horrox (1999: 104) suggests that coffin burials may display a distinction in status, since most people were generally buried without a coffin in the churchyard between the twelfth and fourteenth centuries, unless outbursts of plague required the use of a coffin to impede the evaporation of contaminated air. From 1550 AD, a coffin burial was much regarded as a 'decent' burial, and historical sources indicate that even the ultimate wish of plague-victims was to be buried in a coffin (Houlbrooke 1999: 339). However, the aforementioned documented radiocarbon dating of several coffin burials from the coastal site of Slijpe indicates that this form of burial was adopted earlier, as they date to between the ninth and thirteenth centuries (Smet *et al.* 2012: 151-152). The data analysis includes the following inventoried coffin burials: 2-67; 10-17; 10-27 and 10-30 (ninth-eleventh centuries), and 7-10 (twelfth-thirteenth centuries). Here, other burial customs were noticed, as there were ten earth-cut graves which were scattered through the cemetery, which are suggested to have been common between the tenth-twelfth centuries (Bru *et al.* 2010; Smet *et al*. 2012: 141). This was supported by the c14-analysis of one earth-cut burial (inventoried as nr. 2-37) dating to between the ninth-eleventh centuries (Smet *et al*. 2012: 142). Moreover, similar earth-cut graves were found at Moorsel among the medieval group of burials, along with coffin burials, which c14-analysis has shown were simultaneous, albeit that radiocarbon dating of the latter grave type has revealed that coffins were used as early as the seventh century (Klinkenborg *et al.* 2012: 65). The 26 medieval burials of Moorsel also included the only example in this study of an apparent tree-trunk coffin, found near to the chapel, which was radiocarbon dated between the eighth and tenth centuries (fig. 3.8). A tree-trunk coffin is made by splitting the trunk of a tree into two parts: one part is hollowed out while the other part is used as a lid.

Despite the paucity of studies of early-medieval cemeteries in Flanders according to Ervynck *et al.* (2008), excavations in 2010 at the graveyard of the abbey in Munsterbilzen (prov. of Limburg) have revealed evidence of nine tree-trunk coffins dated by stratigraphic data and c14-analysis to the eighth-tenth centuries and were the oldest burials at the site (Sevenants *et al*. 2010: 81). Sevenants *et al.* (2010: 91) conclude that the presence of tree-trunk coffins from this era is rather uncommon in the archaeological record in Flanders. In contrast, less diversity in grave types was seen within the post-medieval group at Moorsel, from which all inhumations were uncovered in the zone near the church, and which comprised only coffin burials, albeit a precise grave lining could not be determined for each interment (Klinkenborg *et al.* 2012: 33-34).

Fig. 3.8: A possible tree-trunk coffin with a *tegula* fragment below the cranium unearthed in Moorsel. Radiocarbon dating provided a date range of 780-990 AD, within the 95.4% probability range (calibrated date) (inventory nr. KIA-44330).

Evidence of coffin burials in the six case study cemeteries was identified from elements such as wooden coffin fragments and nails. Burials from the late eighteenth and nineteenth centuries show a transition in grave furnishings: iron binding with angelic decoration was recovered at Vichte (Bot and

Acke 2014: 47), and at Moorsel with comparable coffin ornamentations. At Deinze, this change was demonstrated by the finds of industrial wire nails as replacement of earlier wrought iron nails (Klinkenborg *et al.* 2012: 34; Vandecatsye *pers. comm*.).

Tagesson (2015: 24) suggests that cemeteries from rural and low-status urban contexts have fewer burial variations such as grave markers, in contrast to high-status graves until the Early Modern period when the 'social topography' of the graveyard develops into 'wholly egalitarian', and 'high and low status' burials are intermingled. The only socially higher-ranked individuals in this study, from Oosterweel, were however not recovered with any evidence of grave markers, and the gravestones have most likely been destroyed due to vandalism at the abandoned church as was reported in a newspaper article dated before the start of the excavations in January 1985 (S.A.A.A., Oosterweel). Fortunately, Meys' work on the abandoned polder village of Oosterweel (Austruweel) (1981: 48) portrays the commemorative stone of a priest in *Austerweel* named *Guielmus Van Baclegem*, who died on May 19th, 1705. A study of the parish registers of Oosterweel by D'hooge (2004: 2) unveiled the name of the same vicar who was baptised in 1664, and a similar date of death, indicating he passed away at the age of 41 years. Despite the lack of a detailed inventory of the Oosterweel skeletal assemblage, the only allocated numbers of the priest's graves pictured on the excavation map, nrs. 21 and 22, might be associated with skeleton nrs. 85.OA.21 and 85.OA.22. The osteological analysis carried out in 2010 determined the latter individual as a male, between the age of 40-60 years. The circular green oxidation stain that was observed on the left pelvic bone is likely the result of copper-alloy jewellery or textiles such as the copper wire ornamented pre-eighteenth century liturgical robes in which the priest was buried (Van Cant 2011: 24, *unpublished bachelorpaper*). Grave markers, although not always identifiable in the archaeological record, were not reported at the low-status sites and this absence of commemorative monuments was only suggested at Slijpe as a likely consequence of intercutting burials (cf. *supra*) (Smet *et al.* 2012: 139). A dearth of grave markers does not signify they were not employed as Renshaw and Powers (2016: 163) mention the uncovering of at least 21 wooden grave markers in Ives's study (2015) of the nineteenth-century cemetery of the impoverished parish of Bethnal Green in East End (London) (Ives 2015: 150-154).

3.3.3. Grave Orientation

The orientation of the grave is usually integrated within the Christian ideology that Christ will arise in the east on Judgment's Day and the corpse was thus positioned with the head in the west and the feet in the east to look at Christ in the 'region of goodness and light'. Other influences on the alignment, however, could be the construction of walls and passages in the churchyard (Daniell 1997: 148).

Table 3.8 outlines the grave alignment of the burials at the six sites along with the number of each observed oriented burials within the sites, according to the data provided in the archaeological reports and the in-situ skeletal recording sheets. For Zottegem, alignment data are based on the in-situ archaeological 'context and feature list' as reported in the context data report of Zottegem by SOLVA (2014).

Orientation	Deinze (N=96)	Moorsel (N=103)	Oosterweel (N=ND)	Slijpe (N=41)	Vichte (N=62)	Zottegem (N=93)
W-E	88 (92%)	21 (20%)	mainly	39 (95%)	62(100%)	64 (69%)
E-W	1 (1%)	0	2	0	0	1 (1%)
NW-SE	7 (7%)	54 (52%)	unknown	0	0	29 (31%)
SW-NE	0	20 (19%)	unknown	2 (5%)	0	0
NE-SW	0	5 (5%)	unknown	0	0	0

Table 3.8: Grave alignment of each case study with total numbers of known orientation and percentage within the population (%). For Oosterweel, detailed information of grave orientation for each skeleton has not been reported.

The grave of all of the case studies, with the exception of Moorsel, have a predominantly W-E orientation. In Moorsel, a NW-SE orientation was mainly identified for most of the post-medieval burials in the zone surrounding the church, and might be due to the construction of the churchyard wall nearby (Klinkenborg *et al.* 2012: 33-34). Similar practical factors may account for the NW-SE burials in Deinze and Zottegem (Laisnez and Vandecatsye 2011: 99). The medieval inhumations in the south area of the chapel in Moorsel, nevertheless, demonstrate a more common W-E alignment for both the earth-cut and coffin burials (Klinkenborg *et al.* 2012: 21-23). The reverse position of E-W, which implies the head towards the west, is usually associated with the graves of priests, who thus look over the parishioners, and is suggested to be a post-medieval tradition (Daniell 1997: 149).

The E-W orientation for priests was certainly observed at Oosterweel (as previously illustrated in 2.2.3), where two clerics were facing their community members who were mostly buried in the opposite direction. Only one further E-W inhumation was observed at both Deinze and Zottegem, and although both have been determined as adult males, the burial in Deinze has been ascribed as the one of a priest by Laisnez and Vandecatsye (2011: 99*)* on the basis of its reversed alignment (skeletal individual nr. WP12 165). His burial, however, was located at the most distant place from the church in contrast to the other inhumations, and was alongside only one other grave, that of an older child (skeletal individual nr. WP12 164), in a zone demarcated by the old churchyard wall, and thus it seems questionable to attribute this grave to a priest. A hypothesis for the one E-W grave in Zottegem remains tentative since its central position was enclosed by other burials, but considering that only the cranium had been uncovered, an incorrect data entry of the orientation may be possible (skeletal individual nr. 119).

3.3.4. Position of the Arms

The habit of praying played a significant role in the daily life of the medieval and post-medieval communities in central and northern Europe as it is widely testified by both iconographic and historical evidence (Atzbach 2016: 28-29). To question archaeological evidence of prayer as a chronological tool, however, has been investigated by Atzbach (2016), who analysed the position of the arms of buried individuals in four Danish Christian graves. Dating burials through the position of the arms has been used in Scandinavian archaeology based on a model developed by Redin in 1976, and adapted later by Kieffer-Olsen (1993), but the associated date ranges are still debatable (Jensen 2017: 208). The way arms were positioned is thought to be related to the Christian expectations of the afterlife: from an open, optimistic view of placing both arms alongside the corpse towards a more anxious one from the fifteenth century when ‘admission to Paradise involved a prior ordeal’ expressed by folding the arms across the chest (Kieffer-Olsen 1993; Lynnerup 1998: 55). Atzbach’s (2016) statistical study of the four medieval parish graveyards in Denmark elucidated no chronology of arm positions, and even a subsequent investigation revealed no statistical difference between female and male hand placements. Furthermore, the parallel arm position is most likely overrepresented in the archaeological record because the process of putrefaction can stimulate enlargement of the corpse's midriff, and hands that were originally placed on the abdomen could hence fall besides the body. Therefore, the position of the arms in burials must be interpreted as a regional or 'socially determined custom', and not as an indicator of a 'chronological sequence' (Atzbach 2016: 35 and 37).

Although the suggestion of a chronological evolution, with the arms extended as the earliest practice, was also proposed by De Groote *et al.* (2011: 203), this study revealed that the former arm position was indeed only noticed among the oldest burials dating before 1500 AD at both Moorsel and Slijpe, but, the shallow depth of the earth-cut graves at Moorsel might have necessitated an extended arm position too. In this thesis, the placement of the arms was mostly recorded for all skeletal individuals from the six sites, and all variations are listed in table 3.9 if both left and right arm were documented in situ. For Oosterweel and Vichte general observations were described consistent with the data provided in the archaeological reports.

Arm position	**Deinze (N=82)**	**Moorsel (N=60)**	**Oosterweel (N=ND)**	**Slijpe (N=41)**	**Vichte (N=ND)**	**Zottegem (N=29)**
Both arms extended	8 (10%)	13 (22%)	predominant	33 (80%)	predominant	2 (7%)
Crossed on abdomen	65 (79%)	11 (18%)	predominant	4 (10%)	predominant	23 (79%)
Crossed on pelvis	1 (1%)	10 (17%)	unknown	2 (5%)	predominant	1 (3%)
Crossed on chest	3 (4%)	7 (12%)	unknown	0	to a smaller extent	2 (7%)
Right arm on pelvis; left arm extended; and inversed	0	6 (10%)	unknown	0	to a smaller extent	0
Right arm on abdomen; left arm extended; and inversed	3 (4%)	3 (5%)	unknown	2 (5%)	to a smaller extent	0
Right arm on chest; left arm extended; and inversed	0	4 (7%)	unknown	0	0	0
Right arm on chest; left arm on abdomen	1 (1%)	1 (2%)	unknown	0	0	1 (3%)
Right arm flexed 90°; left arm on pelvis	0	5 (8%)	unknown	0	0	0
Right arm on upper leg; left arm on abdomen	0	0	unknown	0	1	0
Both arms on upper legs	1 (1%)	0	unknown	0	0	0

Table 3.9: Positions of the arms recorded in the six sites.

Two arm placements were significantly identified in all sites: the extension of both arms alongside the body (particularly in the aforementioned medieval burials of Moorsel and Slijpe), and both arms crossed over the abdomen (in Deinze and Zottegem). At Oosterweel and Vichte, these two arm placements were also predominant. In contrast, skeletons from the post-medieval graves had their arms crossed over the pelvis or the chest. However, at the site of Deinze, the placement of the arms crossed over the abdomen was common in both the medieval and post-medieval graves, and there seems not to have been any development over time. Furthermore, only at Moorsel was there a slight relationship between the arm position and sex of the skeleton: no males were found with the arms crossed on the chest and no females had their arms extended, but mainly had the arms crossed on the pelvis, abdomen, or chest as were the infants from the site. A consistency in arm placement with respect to sex and age was not observed for the other sites, which may indeed indicate regional customs rather than a chronological evolution as suggested by Atzbach (2016: 37).

3.3.5. Grave Goods

Houlbrooke (1998: 343) believes it is challenging to expect a homogenous concept behind the heterogeneous array of small objects that have been uncovered in post-medieval graves, and suggests that the relatives wanted to give the deceased an identity by the provision of these small gifts, rather than to convey protection in the afterlife. However, an illustration of religious objects that might have served as protection or for healing purposes are scapulars or amulets (Gilchrist 2012: 215). These objects are usually small metal pendants, but variations such as textile ones do occur, and those were found in two post-medieval burials at Deinze. Here, both metal pendants or amulets containing remnants of textile and paper were recovered from the adjoining graves of a biological adolescent, probable female, aged 16-18 years, and one undetermined adult of 30-40 years (skeletal individuals nr. WP2 L54 and WP2 L55). Subsequent microscopic analysis of the text fragment and the metal pendant of the former individual revealed respectively an extract from the gospel according to John, and the inscription 'Holy blood of Jesus Christ'. This investigation was carried out by Restaura in 2013 (and published in Report EC 2013-1tm4), after lyophilization (freeze drying) of the paper fragment from the metal pendant of WP2 L54 and not of WP2 L55, as stated inversely by Laisnez and Vandecatsye (2011: 104). The burial of WP2 L54 is likely dated to between the seventeenth and nineteenth centuries based on stratigraphy (Vandecatsye, *pers. comm*.). The text fragment of burial WP2 L55, unfortunately, could not be retrieved due to its poor state.

An unspecified number of metal scapulars were also recovered from the post-medieval high-status burials of the Cathedral of Our Lady in Antwerp (Veeckman 1997: 74), but a more detailed description of the pendants was not supplied in the site report. Across borders, similar devotional objects, but in a myriad of materials, were found in two eighteenth-century graves of different social status in Prague, and the medals from these burials depicting Jesus or the Virgin Mary are suggested to have been believed to provide protection (Blažková *et al*. 2015: 214-215). Moreover, social differentiation was not testified by the quantity of grave provisions, but rather by the quality and finesse of the material from which they were made (Blažková *et al*. 2015: 217-218). Since the two skeletal individuals from Deinze were diagnosed with the non-specific infectious disease *periosteal reaction* (i.e. inflammation of the *periosteum*, or connective bone tissue) (see Chapter 4 and Chapter 6), the provision of the scapular holding the Bible citation in the two graves might have embodied a protective motive for interring them with these particular individuals. This could also imply a notion of anxiety among the living of revenants, as Härke (2014: 51 citing Zender 1959) alludes to early modern Slavic burials wherein finds also included Bible fragments for 'keeping the dead body in its grave'. The only metal scapular that was discovered in Vichte was dated to 1854 by an inscription depicting the fraternity of Franciscus Xaverius along with the initials of Jesus Christ ('IHS'). This brotherhood was founded in France in 1840, and was aimed to convert labourers to pursue an honorable and respectable life path. Attending the funeral of a fellow friar was deemed highly important (Bot and Acke 2014: 71-72).

Other common religious finds in the post-medieval burials of this study involve rosaries, crucifixes, and small jewellery items such as rings, and show a contrast with the elaborate funerary furnishings of the early medieval period. Härke (2014) has alluded to the gradual transition from pagan practices to the introduction of Christian mortuary customs, but admits the constraints in identifying the motives behind the supply of objects, which have plausibly changed over time.

In the medieval burials of Moorsel and Slijpe, grave goods only included the remains of coat pins, in bone (Moorsel) and metal (Moorsel and Slijpe), with the latter found in the grave of a young child according to the description of a 'metal pin' in the in-situ archaeological report (skeletal individual nr. 6-54). It is uncertain whether the fragments of late medieval ceramics recovered within the three earth-cut burials of Slijpe were intentional. The red tegula-fragment that was found below the cranium of an unsexed individual in the possible tree-trunk coffin near the chapel was suggested to be associated with a high-status person. This was based on comparable (although not pictured) stone fragments that were discovered under the head in earth-cut graves from two abbeys in Ghent, and on which inscriptions revealed the names of eleventh-century abbots (Klinkenborg *et al.* 2012: 25 citing Bru *et al.* 2010: 101-102). However, no name could be identified on the tegula from Moorsel (Klinkenborg *et al.* 2012: 25). In addition, Bru *et al.* (2010: 103) report the use of mortar from red tiles on the sides and bottom of the earth-cut graves in Ghent, and although the grave type in Moorsel has not been ascertained, the red tile or tegula, if intentionally deposited, may have been applied for other reasons.

Although the archaeological report does not specify the location of the skeletal individual numbers, the iron shears that were uncovered with two burials in Oosterweel might be explained by the suggestion that 'scissors are often a typical grave good for women who died in childbirth', even though the symbolization behind this custom is not specified (Kenzler 2015: 162). Osteological evidence of foetal skeletal remains in at least one female's grave could have illustrated this custom if the exact burial position of these iron shears would have indeed been detailed during the archaeological excavation in 1985, although whether she died during late pregnancy or during labour could not be determined by the study of the foetal bones (skeletal ind. nr. 85.OA.59) because their position was not recorded. On the other hand, similar iron shears were discovered at the medieval rural settlement of Eldbotle (UK), and are suggested to belong to a high-status man for 'hair or beard trimming' (John Gray Centre 2017). At the end, the final decision to provide items, whether religious or not, with the deceased, lay with the mourners, and it is most likely to happen that the surviving relatives have the last word on how the departed will be immortalised (Härke 2014: 54; Renshaw and Powers 2016: 160). Table 3.10 summarises the grave goods by type that were uncovered in the six sites of this study.

	Grave Goods/Material by Type							
Site	**Textile/ Garments**	**Coins**	**Rosaries/Crucifix**	**Jewellery**	**Scapular**	**Iron Shears**	**Fibula**	**Pottery Sherds**
Deinze	x	1 1 likely	1 small crucifix	x	x			
Moorsel								
Medieval							2 (metal+bone)	tegula
Post-medieval	x		x	x				
Oosterweel	x					x		
Slijpe							1 metal pin	within 3 earth-cut graves
Vichte	x	x	x	x	x			
Zottegem								

Table 3.10: Summary of the most common grave goods by type within the 6 sites.

3.3.6. Discussion and Summary

Archaeological (rescue) excavations at the churchyards of the six sites were undertaken to reveal, for example, the development of the parish church and churchyard (Moorsel, Oosterweel, Vichte, Zottegem), stratigraphic relationships within the graveyard (Slijpe), or to demonstrate pre-urban occupation at the site (Deinze, including excavations in the Market Place).

Tarlow (2015: 2-3) sought to explore mortuary practices across Europe, and to look for similarities and differences in mainly post-medieval burial customs in the various regions. One of these observations includes the ongoing tendency for a W-E alignment until a more thoughtful organisation of urban cemeteries occurred in the nineteenth century. Not restricted to towns in this study, the dominant W-E orientation was clearly observed in nearly all case study cemeteries; only Moorsel involved a preponderant variation in the NW-SE burials enclosing the church, but this might be due to practical factors. Alternatively, the nineteenth-century rural churchyard of Vichte did not reveal any structural mortuary topography which may be related to the smaller size of the community in a non-urban environment. In addition, a burial might embody the social identity and status of the dead, but moreover, it is often the decision of the mourning community members on how to commemorate the deceased (Tagesson 2015: 20).

Many burials in rural Moorsel and Vichte included Catholic (Christian) objects such as rosaries and small crucifixes, which contrast with the paucity of similar grave goods in the small urban site of Deinze, apart from the two scapulars that might have epitomised protection. This may reflect the prevailing influence of the Church in the countryside, perhaps more than in towns. For example, textual evidence notably illustrates that in Moorsel during the first half of the seventeenth century, the Counter-Reformation was strengthened by a vicar named *Grevens* (Verleyen 1985: 379). Furthermore, Verleyen (1985: 380) depicts Moorsel as a 'traditional exemplary Catholic parish'. On the other hand, discrepancies in mortuary practices may be representative of regional customs such as the position of the arms which again, differed in Deinze with no chronological preference apparent. The personal objects, such as iron shears that were noticed with two burials of the high-status group of Ooserweel might exhibit a social identity, rather than staying within the fine line of Christian beliefs.

The skeletal collections of the six sites, both rural and small-urban, and encapsulating medieval to early modern church(yard) burials from different social status groups, provide a unique opportunity to address osteological questions, with a focus on the socioeconomic, historical, environmental and cultural character of each community.The research intends to illustrate how the archaeological and osteological evidence could be integrated into a collaborative and interpretative framework and will further explore how socioeconomic activities, environmental and living conditions may have affected the health of the inhabitants to allow comparison between the sexes, age and status groups. For example, since the effects of a population increase and impoverished living conditions have been indicated in the Netherlands (e.g. Maat *et al.* 2005 on the skeletal collection of the nineteenth-century city of ‘s-Hertogenbosch), similar consequences of rapid industrialisation, as listed by Boyle (2015: 56) such as detrimental environmental conditions, insufficient public health regulations, poor sanitation, polluted air and water, and hazardous working circumstances occurred as well in pre-industrial rural and small-urban societies as illustrated in the previous chapter.

CHAPTER 4

THE SIX HUMAN SKELETAL COLLECTIONS: METHODOLOGY OF THE OSTEOLOGICAL ANALYSIS

The bioarchaeological analysis of human skeletal remains is an essential complementary source to attain a more comprehensive picture of the lives of past individuals since it can provide information that is lacking from written records or archaeological data (DeWitte 2015: 10-11). Therefore, alongside the historical and archaeological evidence to demonstrate the socioeconomic and environmental impact on the six case study sites, this study focuses on differences in lifestyle, occupation and health arising from environmental and cultural factors by integrating bioarchaeological data of the six skeletal populations. This chapter outlines the methodologies used to determine the preservation, completeness, age at death, sex, stature, palaeopathologies, dental health and entheseal changes (EC) of the human skeletal individuals from the six case studies. The data allow a demographic, pathological and mortality profile of each skeletal assemblage from which to indicate inter- and intra-population variability in health status in order to have a detailed discussion in Chapter 6. Pathological findings such as trauma, infectious disease, metabolic disease and occupational stress markers may yield information on aspects of lifestyle, health or activity in each case study and may demonstrate differences in the prevalence rates of certain pathological conditions between the sexes and different age categories. Dental lesions, skeletal stress markers and a reduced adult stature may indicate limited access to nutritional resources during childhood and may expose patterns of skeletal health within and between these archaeological populations from different geographic areas (Marklein *et al*. 2016). The socioeconomic developments that occurred in Flanders between c. 1200 and 1860 AD including the intensification and commercialisation of both urban and rural industries must have impacted male and female working populations, both young and old, which may be inferred by integrating skeletal data alongside the historical evidence.

Limitations, however, occur in the preservation and completeness of the bone material due to taphonomic processes or burial customs which may result in skewed data distributions. Inferring health from past populations by analysing human skeletal remains does indeed involve challenges which are outlined in section 4.3.1. on ‘the osteological paradox’. The various degrees of preservation of human bones will be described in this chapter to identify and discuss prevalence rates of pathologies and EC.

4.1. Completeness and Preservation of Skeletal Collections

The degree of preservation and completeness of a skeletal collection is an important factor to obtain data on sex, age and pathologies since taphonomic processes such as soil and climate conditions, and burial practices, are all factors that influence reconstructing a demographic profile of a skeletal population (Mays 2010: 28-29; Smits 2002; Waldron 1994). In this study, the stage of preservation and completeness was determined for each skeletal individual, and the methods are outlined below in 4.1.1. The results are presented in Chapter 5.

4.1.1. Degree of Completeness and Preservation: Methodologies

The completeness of a skeletal individual refers to the present bone elements of an excavated skeleton, and is expressed as a percentage. This percentage is categorised in four groups: 0-24%; 25-49%; 50-74%; 75-100% (Buikstra and Ubelaker 1994).

Assessment of the macroscopically observable surface preservation of the human remains in this research was undertaken by applying a grading system, based on the BABAO standard methodology, from 0 until 5+, with 0 indicating a clearly visible surface morphology and no modifications, and a score of 5+ implying heavy erosion masking the whole bone surface (McKinley 2004: 16). The detailed descriptions of the seven different preservation levels from grade 0 to 5+ are listed below and shown in fig. 4.1:

grade 0: Surface morphology is clearly visible with fresh appearance to bone and no modifications.

grade 1: Slight and patchy surface erosion (for instance by root action).

grade 2: More extensive surface erosion (e.g. through root action) than grade 1, with deeper surface penetration.

grade 3: Most of bone surface affected by some degree of erosion (by root action); general morphology maintained but detail of parts of surface masked by erosive action.

grade 4: All of bone surface affected by erosive action; general profile maintained and depth of modification not uniform across whole surface.

grade 5: Heavy erosion across whole surface, completely masking normal surface morphology, with some modification of profile.

grade 5+: As grade 5, but with extensive penetrating erosion resulting in modification of profile.

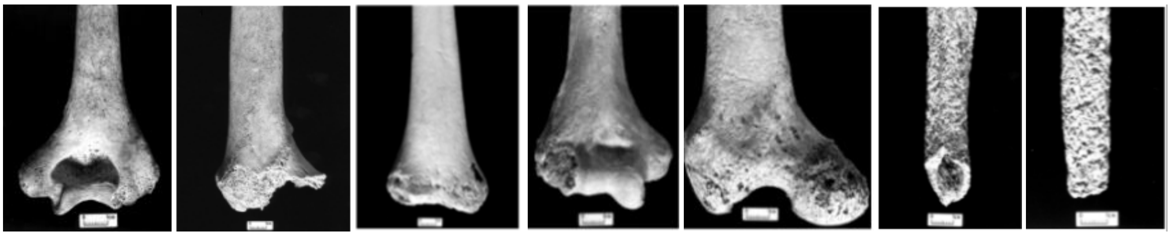

Fig. 4.1: Various stages of bone surface morphology for recording erosion (Adapted from McKinley 2004: 16).

Present and missing skeletal fragments were recorded for the cranial and post-cranial skeleton on the skeletal recording sheets that were used during the osteological analysis. These standard skeletal recording forms were created by Maat and Mastwijk (2009) and include an outline drawing of a skeleton on which present and or absent bones can be shaded, a dental inventory scheme, and forms to complete the morphological sex determination, the skeletal age at death, and to calculate the stature of adults. Also, observed pathologies and dental lesions and present non-metric traits were recorded. Other conditions such as post-mortem fractures, staining, intrusive human bones, or factors such as scavenging that affect the bone material were recorded on these reports too. The available *in situ* skeletal reports that were drafted during the archaeological excavations of the skeletal collections were used to verify the preservation, completeness and other variables such as grave alignment and artifacts associated with each skeleton.

The gathered data on the skeletal recording sheets were extrapolated to a specifically created database in Microsoft Word and Excel in order to have an overview of each skeletal individual with principal assessments of completeness, degree of preservation, age at death, sex, average stature, dental lesions, pathologies and EC (see Appendices A-F).

The data in the Excel spreadsheets including a detailed skeletal inventory and frequencies of pathologies and EC were used to enable statistical analysis, and will be further detailed in 4.6.

4.2. Determination of Sex, Age and Stature

The estimation of biological sex of adult skeletal individuals was accomplished by observing morphological traits on both the skull and the os coxae or pelvis, according to the methodology of Acsádi and Neméskeri (1970: 75-79 and 87-91) and to the criteria described by the Workshop of European Anthropologists (WEA 1980: 518-525), by giving priority to the pelvis since this is considered as the most reliable bone for sex estimation (Mays 2010: 40). If possible, each skeleton was attributed a sex classification: 'male' (M), 'possible male' (M?), 'female' (F), 'possible female' (F?). When male or female traits were not significant enough to assign an appropriate biological sex category, the skeletal individual was recorded as 'indeterminate' (ND).

Sex determination of immature remains is complicated since their bones are not fully developed which is necessary for the assessment of morphological traits (Roberts 2009a: 124). Although several methods have been established to assign sex to immature individuals (see for example Schutkowski 1993), such methods, however, have been shown unreliable (Scheuer 2002). Therefore, the estimation of sex of non-adults is not integrated in this study.

Assessment of age was undertaken by using methods that involve recording of the following: the symphyseal phase of the pubic symphysis (Acsádi and Neméskeri 1970: 113; Brooks and Suchey 1990: 227-238), the stage of the auricular surface (Buckberry and Chamberlain 2002: 233-235; Lovejoy *et al*. 1985: 27), the sternal ends of ribs (Işcan *et al*. 1984) and the obliteration stage of the endocranial and ectocranial sutures (Meindl and Lovejoy 1985: 60-64; Nemeskéri *et al*. 1960: 89-90) and are further detailed by Boldsen *et al.* (2002), SjØvold (1975: 10-22), Ubelaker (1999: 89) and WEA (1980: 533-534).

Determination of age was also applied through occlusal dental wear by using the occlusal attrition scheme of the permanent molars by Miles (1962: 881-886), and the occlusal surfaces of all dental elements by Lovejoy (1985). However, the use of dental attrition as an ageing method has a few possible limitations, as different factors such as diet and cultural practices may affect the stage of dental wear (Mays 2010: 73). Moreover, Mays (2002: 869) also suggested that post-medieval skeletons demonstrate less dental attrition, but admitted that some European populations continued to display heavy dental wear during the same era. Therefore, considering the limitations when using dental attrition for age estimation alone, it is primarily used in this study in combination with the aforementioned ageing techniques.

The adult age categories applied in this thesis are suggested by Buikstra and Ubelaker (1994), and are presented below:

- Young adult: 20-35 years
- Middle adult: 36-50 years
- Old adult: 50+

The use of broad age categories will allow enlarging the sample size to obtain a statistically significant difference. When a skeleton was incomplete, or too poorly preserved to attribute a specific age category, the adult individual was assigned to the 18+ group.

To determine the age of subadults below the age of nineteen, the dental eruption scheme by Ubelaker (1999) and Moorrees *et al*. (1963: 205-213) was applied. Dental development is considered as the most accurate technique for ageing immature remains since the growth of teeth is less affected by extrinsic factors such as disease and malnutrion compared to the growth of bones (Hillson 2008; Mays 2010: 51). In addition, other methods that were employed for age assessment of subadults include the ossification of the axial skeleton, the epiphyseal fusion of the diaphyses of the long bones and measurements of the diaphyses of the long bones (Hoppa 1992: 280-282; Meschan 1975: 47-56; Schaefer *et al.* 2009: 340-355; Scheuer and Black 2000; WEA 1980: 531).

The following age categories devised by Buikstra and Ubelaker (1994) for subadults were employed:

- Foetal: <0
- Neonate: 0-12 months
- Infans I (young child): 1-6 years
- Infans II (older child): 7-12 years
- Juvenis (adolescent): 13-19 years

The average adult stature was calculated by the measurements of the complete long bones of the lower and upper extremities, followed by the commonly used equations of Trotter (1970) for males, and Trotter and Gleser (1958) for females. Furthermore, all stature estimations have been registered with a standard deviation (s.d.), or the variation of values since 'stature predictions are only estimates of stature and as such have errors associated with them' (Brothwell and Zakrzewski 2004: 33). Measurements of the lower limb bones are preferred as they provide smaller or lower associated errors than the upper limbs (Maat 2005: 278). When the sex of the individual was undetermined, both male and female calculations were applied.

4.3. Assessment of Pathology

Palaeopathology is the study of diseases in past populations, and the skeletal remains of an individual are the primary source to investigate its health status. The bones and teeth of a skeletal individual represent an accumulation of diseases that a person has experienced throughout his or her life. Although bioarchaeologists investigate and record the human bones of a person at the point of their death, it is usually not possible to assign a cause of death (Roberts 2017: 46). However, unlike chronic conditions, acute diseases, which mostly affect the soft tissues do not manifest on the skeleton (Aufderheide and Rodríguez-Martin 2008: 118; Roberts and Manchester 2010: 13; Waldron 2009: 1-5).

4.3.1. 'The Osteological Paradox'

As briefly touched upon in section 2.7.2, studying the prevalence of diseases in skeletal collections indeed raises challenges, described by Wood *et al.* (1992) as 'the osteological paradox'. Here, Wood *et al.* (1992: 344-345) argue to consider three major problems that are inherent when inferring health status from archaeologically derived human skeletal remains, which are:

1. selective mortality: individuals who die at a certain age are unlikely to represent the complete living population at risk of death at that age.
2. hidden heterogeneity in frailty: every individual from a living population at a certain age responds differently to diseases, and thus showing a variation in risk of dying at that age. This variation may be the result of various factors such as a susceptibility to acquire diseases because of differences in socioeconomic or cultural behaviour, divergences in nutrition or environmental conditions, or genetic predisposition.
3. demographic nonstationarity: a growth or decline of population numbers may have been caused by fluctuations in mortality, fertility or by migration.

The first two concepts demand cautiousness in the interpretation of skeletal lesions: individuals with visible stress markers such as periosteal new bone formation are not necessarily unhealthier than those without them as lesions require time to manifest on the bones, and this indicates a strong immune system of people who were able to survive trauma or diseases long enough before the development of morphological changes in the skeleton (Wood *et al*. 1992: 345). Individuals showing no skeletal lesions may not have been sick, or it may be suggestive of a weak immunity, and they might have died before the formation of bony changes became visible (DeWitte and Stojanowski 2015: 407; Wood *et al.* 1992).

The publication of the seminal paper by Wood *et al.* in 1992 sparked an intense discussion among bioarchaeologists. Goodman (1993), for example, proposed to overcome these issues of 'the osteological paradox' by looking at multiple stress indicators, and by integrating a more holistic approach by using archaeological and/or historical sources next to the osteological evidence in order to reconstruct health patterns within past populations. In addition, Goodman (1993: 282) states that 'the bones and teeth of the dead reflect conditions at death *and* conditions during life', but admits limitations in the field by adding 'They (bones and teeth) do tell tales about life processes, albeit ones that can be difficult to interpret'.

Even a decade later, 'the osteological paradox' has not lost its significance and the paper by Wood *et al.* (1992) has been often cited in bioarchaeological studies. Most papers address the limitations of the field and its theoretical contribution, but it seems there was less consideration for frailty and selectivity in the biorchaeological record (DeWitte and Stojanowski 2015: 412). To assess these concepts of heterogeneous frailty and selective mortality, DeWitte and Stojanowski (2015: 429) state to consider these at the beginning stage of the research design. Another response to the 'osteological paradox' was issued by Wright and Yoder (2003) who noted the progress in the field of bioarchaeology, such as in epigenetics and in biomolecular analysis, and the importance of the cultural context within the interpretation of diseases in skeletal collections.

To minimize the effects of heterogeneous frailty, Wood *et al.* (1992) suggest focusing on short-term cemeteries to reduce the issues associated with demographic nonstationarity. The underlying idea here is that they represent generations, cohorts or populations, and 'not time-averaged lineages', however, a bibliometric survey by DeWitte and Stojanowski (2015: 414) of nearly 300 publications revealed an average site duration of 552 years. As outlined in Chapter 3, the churchyards of the sites addressed in this research were indeed in use for several centuries. However, the integration of the archaeological and historical context of each case study next to the bioarchaeological information derived from the human bones will contribute to examine inter- and intra-population variability in health status. Moreover, as previously argued by Goodman (1993) and reiterated by DeWitte and Stojanowski (2015: 409), the employment of multiple stress indicators of health and nutrition rather than a single indicator in this study, can help to overcome the problems of the 'osteological paradox' since different indicators reflect various aspects of the health of an individual. In addition, in order to deal with the challenges described in the 'osteological paradox', this study intends to gain a better understanding of frailty by focusing on the site specific nature of each skeletal assemblage (such as environment, socioeconomic and cultural aspects). Also, each skeletal population shows similarities in social status and socioeconomic background to minimise the effects of variation in socioeconomic status in each group (i.e. the possibility of socially meaningful subgroups, especially within larger burial sites). This approach will assist to provide a more accurate, nuanced interpretation of health status and the implications of socioeconomic activities and the environment on the skeletal assemblages of this research.

4.3.2. Identifying and Recording Pathological Lesions

An assessment of the frequency of pathological lesions that are observed in a skeletal population is a common procedure within osteoarchaeological analysis (Mays *et al.* 2014: 6). Buikstra and Roberts (2012: 685) state that the identification of pathological lesions in the archaeological skeletal record relies on the medical knowledge that nowadays converges with a continuous development of new methodologies, and which is in conjunction with a growing understanding of bone reaction to disease. The use of clinical data may assist in understanding bone reaction to diseases as advocated by Roberts (2017: 44), however, she further states that clinical radiographic criteria may not always be useful for the diagnosis of diseases in dry bone specimens. This issue was also shown by Mays (2012: 287) who notes that, for example, the loss of articular cartilage is considered as an important indicator of osteoarthritis (OA) in clinical studies, but cannot be assessed in bone material, while other criteria for the palaeopathological diagnosis of OA such as marginal osteophytes can be recorded visually and makes radiography 'redundant'. Roberts (2016: 7), in another study, remarks that radiographs may not detect the subtle bone changes on the ribs and in the sinuses that might be associated with respiratory diseases in skeletal remains. Nevertheless, integrating contemporary clinical data may yield insights in the interpretation of diseases such as the impact of femoral neck fractures by Ives *et al.* (2017: 271-272), who revealed that more males survived hip fractures than females by analysing eight urban post-medieval skeletal collections in England and by comparing with contemporary clinical records.

The practise of palaeopathology as an 'investigative tool' has expanded since the late twentieth century, and a myriad of new studies are published each year tackling a broader comprehension of past human populations within a cultural and socioeconomic context (Ostendorf Smith 2013: 181 and 182). Many pathologies embody an economic or occupational 'dimension' in past populations as argued by Robb (2000: 487), who further states that 'particularly in economic studies, it has rarely been appreciated that skeletal studies are almost unique in their ability to provide information on actual patterns of behaviour and consumption and their effects upon specific individuals of known age and sex'. In this study, the prevalence of pathological lesions and its comparison, both between the six sites and between males and females from each site, may reveal information concerning environment, lifestyle and activities, and the impact of socioeconomic developments on these historical communities.

The macroscopic identification of pathological lesions on the skeleton is supported by reference to the standard works of Aufderheide and Rodríguez-Martin (1998), Ortner (2003), Ortner and Putschar (1985), Roberts and Manchester (2010) and Waldron (2009). To record pathological lesions on the skeleton, a classification of diseases and injuries was formulated according to their aetiology, and consists of the following diseases analysed in this study: joint disease, trauma, infectious disease and metabolic disease alongside the observation of enthesopathies of the hand phalanges. Pathologies were recorded using diagnostic features described under each category. The identified pathologies are recorded in the Excel-database as 'present' (2), 'absent' (1), or as 'not-observable' (0) if the bone element is missing to enable statistical analysis of the data. Specific lesions were further described (size, structure) and registered by photographs. Recording the presence/absence of a disease in an individual skeleton will allow calculating the percentage of individuals affected within a skeletal population in order to demonstrate distribution patterns within distinct groups (Robb 2000: 486). Prevalence rates of bioarchaeological data are usually presented as crude prevalence rates (CPR's) (the number of individuals affected by a pathological lesion within the study sample) or true prevalence rates (TPR's) (the number of affected bone elements from the number of elements observable) (Bourbou 2009: 224; Roberts and Cox 2003).

Although CPR is a less accurate representation of disease prevalence than TPR, because it may be skewed by differential skeletal preservation, it has certain value for providing an overall impression of the disease burden within a skeletal sample (Shields Wilford and Gowland 2019: 228). In addition, data on joint diseases and trauma may yield insight on the effects of the increased manual labour on the bodies of the working individuals as demonstrated in a study by Shields Wilford and Gowland (2019) on low-status inhabitants in post-medieval London. Prevalence data of pathological conditions in this thesis will be presented as CPR since this will facilitate comparative analyses, and where possible, TPR is also presented to provide a more accurate representation of the number of cases. The classification and a concise description of the palaeopathologies analysed in this thesis is outlined below.

4.3.3. Joint Disease

Joint disease is one of the most prevalent pathological lesions observed in human skeletal remains, and is mostly noticed in old adult individuals (Ortner 2003: 545; Waldron 2012: 513). Joint diseases can be classified into two categories, based on proliferative (bone growth) and erosive (bone destruction) arthropathies, with (primary) osteoarthritis (OA) or degenerative joint disease (DJD) as an archetype of the first group, and rheumatoid (secondary) arthritis (RA) considered as the 'most characteristic of the erosive joint diseases' (Waldron 2009: 46). OA affects the synovial joints, and this is indicated by morphological characteristics such as eburnation, marginal osteophytes, new bone and pitting on the joint surface, and a modification of the joint contour (Waldron 2012: 514). Being an 'age-progressive and without gender predilection' disease, OA is usually common from the age of 40+ (Aufderheide and Rodríguez-Martin 2008: 93).

In this study, the presence of OA was recorded according to the operational definition of Waldron (2009: 34), and is recorded by the presence of eburnation, or by at least two of the following alterations of the joint: marginal osteophytes, new bone on the joint surface, pitting on the joint surface and alteration in the joint contour. Eburnation is indeed the main factor for the diagnosis of OA, and if not present, two other bone alterations such as osteophytes and porosity should be recorded since osteophytes alone may be an indicator of the ageing process (Roberts 2017: 45; Roberts and Connell 2004: 38). The diagnosis of RA can only be done if bones of the hands and/or feet are present, and in this study, was recorded following the operational definition of Waldron (2009: 52), which involves symmetrical marginal erosion of the small joints of the hands and/or feet bones, and sparing of sacroiliac joints, minimal new bone formation and absence of spinal fusion. In archaeological skeletal assemblages, however, erosive arthropathies are less encountered than proliferative joint diseases due to, for example, the misinterpretation of post-mortem damage of a joint. The diagnosis of osteoarthritis at individual sites (both spinal and extraspinal) is detailed below.

Degenerative Disc Disease (DDD) or *Vertebral Osteophytosis* affects the spine and concerns a deterioration of the intervertebral disc, mainly caused by the ageing process and non-ergonomic body postures (Maat and Mastwijk 2009: 15). Other influential components are sex, genetic predisposition, trauma and biomechanical stress (Ortner 2003; Roberts and Manchester 2010; Waldron 2009).

Another type of spinal OA is *Vertebral Osteoarthritis* (vOA). vOA affects the articular facets of the lower cervical, upper thoracic and lower lumbar vertebrae (Aufderheide and Rodríguez-Martin 2008: 96). It is suggested that this degenerative disease of the apophyseal joints is caused by a chronic mechanical loading, and thus instigates joint pain and limited mobility (Maat and Mastwijk 2009: 16).

A type of arthritis that mainly affects the spine is *Diffuse Idiopathic Skeletal Hyperostosis* (DISH). In contrast to vOA, DISH or Forestier's Disease, does not affect the cartilage or synovial joints, but can be distinguished by the ossification of the anterior longitudinal ligaments of the spine (Aufderheide and Rodríguez-Martin 2008: 97; Roberts and Manchester 2010: 159). However, despite its aetiology remaining unknown, a relationship with obesity and Type 2 diabetes may be prevalent. Since DISH is commonly observed in skeletal adult males from monastic sites or high-status groups, it is therefore suggested that it is related to their abundant diet and sedentary lifestyle (Maat and Mastwijk 2009: 16; Rogers and Waldron 2001). Diagnostic criteria to identify DISH were used according to Rogers and Waldron (2001: 362-363), and involve hyperostosis or ossification of at least three vertebrae of the right side of the thoracic region in combination with calcification of extra-spinal ligaments. When fewer than four vertebrae were fused, the diagnosis of early DISH was recorded.

Notwithstanding a high prevalence of DISH among monks, interpretations that link DISH with high-status individuals must be carefully considered since more scientific research regarding its aetiology is needed (De Groote *et al*. 2011: 181; Rogers and Waldron 2001: 363; Waldron 2009: 76). For example, stable isotopic analysis was applied with burials from the post-medieval Carmelite friary of Aalst (Belgium) (as mentioned in Chapter 1) in order to test the association of DISH with a high protein intake (Quintelier *et al.* 2014). Their study did not reveal statistically significant differences between DISH and increased nitrogen values, suggesting similarities in the diet of both monastic and non-monastic males. In addition, the authors postulate that these results are likely due to the small sample size which included ten males with DISH and fifteen males without DISH (Quintelier *et al.* 2014: 208, 211). Although the results are suggestive of a similar protein diet between the two groups, and considering the lack of stastically significant differences, their analysis, however, demonstrated similar stable isotope values in DISH affected males compared to other monastic samples in the United Kingdom (Quintelier *et al.* 2014: 211). The only difference in the UK study revealed a greater consumption of omnivore protein observed in monastic DISH compared to monastic non-DISH (Spencer 2008: 253).

Further, *Schmorl's nodes* or *Schmörls noduli* (SN) are related to the degeneration of the intervertebral discs. These lesions are protrusions of the cartilage of the intervertebral disc into the bony tissue of the adjacent vertebra, and are principally situated in the middle and lower spine (Maat and Mastwijk 2009: 15; Roberts and Manchester 2010: 140). Since they are highly common in individuals over the age of 45 and several causes are suggested for its prevalence (Aufderheide and Rodríguez-Martin 2008: 97; Waldron 2009: 45), Schmorl's nodes are excluded from this study.

Apart from spinal OA, *Peripheral Osteoarthritis* (pOA) involves the appendicular skeleton with, in general, the knee the most affected joint, followed by the first metatarsophalangeal joint, hip, shoulder, elbow, acromioclavicular and sternoclavicular joints, and with an increase in severity after the age of 40 years (Ortner 2003: 547). This degeneration of the joint cartilage can be identified by the eburnation of the articular surface and the presence of marginal osteophytes (Maat and Mastwijk 2009: 16). Furthermore, it is suggested that OA of the hand affects more females than males, and that this principally involves the distal interphalangeal joints (Ortner 2003: 549).

An erosive arthropathy such as rheumatoid arthritis (RA) is a chronic inflammatory joint disease with a higher prevalence in females than in males, and which predominantly affects bilaterally the synovial joints of the hands and feet, wrist, elbow, knee, shoulder and cervical vertebrae (Roberts and Manchester 2010: 155; Waldron 2012: 523). This pathology, however, is seldom recognized in the archaeological record, and might be misinterpreted as another joint lesion (Roberts and Manchester 2010: 155). In addition, a possible indication of osteoarthritis located in the lower back is identified as inflammation of the sacroiliac joint (Aufderheide and Rodríguez-Martin 2008: 95). This tendon is situated between the spine and the pelvis, and sacroiliac joint pain is attributed to twisting or bending the back, pregnancy, falling, incorrect lifting, or to an occurrence with ankylosing spondylitis (Hansen and Helm 2003: 181). A final erosive arthropathy to be assessed is gouty arthritis, and is mainly observed in the first metatarsal or big toe. The basis of this disease lies in an increase in uric acid and an unbalanced excretion by the kidneys (Aufderheide and Rodríguez-Martin 2008: 108). Males, especially with an age of 50+, are more affected than females, and it seems there is an association with abundant alcohol consumption, a high protein diet, diabetes and heart disease (Roberts and Manchester 20140: 162). Although gout has been widely described in historical sources such as medical writings and journals since its first identification by the Egyptians in the third millennium BC, and has even been metaphorically described by Porter and Rousseau (2000: 285) as 'an eligible malady par excellence' and as 'the sign of distinction', archaeological evidence, however, observed in the asymmetric erosive lesions of the joint surface and overhanging hook shaped margins of the affected bone, is scarce (Waldron 2009: 67-70).

The data of the joint diseases that are observed in the skeletal collections of this study will be presented as crude prevalence rates (CPR's) (number of affected individuals within the total population) and as true prevalence rates (TPR's) by looking at the number of the affected elements of both upper and lower limbs in relation to the total number of observable joints. Seeing the inherent challenges of recording the frequency of OA in skeletal collections because of the 'inevitable absence of some joints due to poor preservation' (Waldron 2012: 516), this thesis maintains the following method to analyse the distribution pattern of OA of the different affected parts such as knee, elbow and shoulder since these data will show the prevalence of the affected sites to determine which joint in a population is most commonly affected by OA, which side (left or right) and sex related differences of the affected joints.

The following sites of the appendicular skeleton are included in this study to record the presence of pOA within males, females and adult individuals from unknown sex: acromio-clavicular joint (ACJ), sterno-clavicular joint (SCJ), shoulder, elbow, wrist+carpal bones, hand, hip and knee. When the joint involves two compartments such as the gleno-humeral joint of the shoulder, one element needs to be discernible to be recorded as present. Since the knee joint consists of three compartments: the patellofemoral, the medial and the lateral tibiofemoral (Waldron 2009: 37), the knee joint is considered present when at least two of the following bone elements were recorded: patella, distal end of the femur and/or proximal part of the tibia. The wrist joint or radiocarpal joint is recorded as present when at least the distal end of the radius and one of the three carpals (scaphoid, lunate and triquetrum) are registered since they are commonly affected by OA (Waldron 2009: 36). However, other carpal bones such as trapezium may display signs of OA as well, and therefore all recorded carpal bones are included in this study. If only one element of the wrist joint and carpal bones with OA was recorded, it was included in the sample of present wrists. The hand involves recorded metacarpals and phalanges and will be regarded as a unity in the overview of pOA, and is thus in this section not subdivided into carpo-metacarpal, meta-carpophalangeal, and proximal and distal interphalangeal joints. Also, other studies have shown a predilection for hand OA in the joints of the thumb and the thumb base for both sexes (Waldron 1991: 304). The spine is considered present when at least one cervical, thoracic and lumbar vertebra or at least seven vertebrae of an individual were available to record osteoarthritis of the spine (vOA). When an individual exhibited vOA or DDD on one spinal element available for analysis, the spine was included in the sample. TPR’s for vOA and DDD are calculated by the number of present cervical, thoracic and lumbar vertebrae. For Vichte, however, it was not possible to present the exact number of each vertebrae type due to loss of data. Therefore, to provide comparable data with the five others sites of this study, the number of affected male and female spines in all skeletal collections is presented.

Joint diseases may illustrate rural-urban discrepancies or differences between status groups and sex, and may demonstrate a variation in activity levels in past populations as a result of socioeconomic strategies.

4.3.4. Trauma

In the archaeological record, evidence of antemortem trauma is easily recognised macroscopically because of the dislocation of the bone and the healing process afterwards, which is dependent on the type of the fracture and the health status and medical care received by the injured individual (Ortner 2003: 119; Roberts and Manchester 2010: 91). However, one must be aware of certain limitations when interpreting trauma as it can be difficult to distinguish perimortem fractures from post-mortem fragmentation, and it must be borne in mind that indications of soft-tissue injuries are rare (Roberts and Manchester 2010: 85 and 94-95). Nevertheless, analysis of trauma could shed light on human behaviour, labour division, the possible impact of occupational activities, cultural practices, warfare and many facets concerning the daily life of past populations (Aufderheide and Rodríguez-Martin 2008: 19; Roberts 2000: 338). For example, Judd and Roberts (1999) investigated the distribution of fractures at rural medieval British sites, and revealed a majority of injuries to the forearm with females, whereas males were observed with a more diverse trauma pattern. This variation in trauma is ascribed to the hazardous environment of the farm, especially when working with animals is involved such as dairying, and the use of horses for ploughing (Judd and Roberts 1999:237-240).

Other studies of skeletal trauma have focused on factors, asides from sex-specific patterns of trauma, such as rural-urban discrepancies, social status, subadult trauma, interpersonal violence between different cultural groups, or have addressed individual case studies versus a population approach (e.g. Brickley 2006; Ives *et al.* 2017; Judd 2006; Judd and Roberts 1999; Lewis 2007; for a concise overview of traumatic research in the palaeopathological record see Judd and Redfern 2012 and authors listed therein, and Lovell 2008: 341).

Bennike (2008: 210) notes the different types of trauma that are common in the palaeopathological record including fractures, crushing, sharp force injuries, trepanation, dislocation, deformation, mutilation, spinal fractures like spondylolysis and dental trauma, whether intentional or accidental. Another type of trauma is o*steochondritis dissecans* (OCD), a traumatic injury of the joint which is caused by a loss of blood circulation, and is mostly observed in the knee of young males often in the form of a circular and porous lesion in the articular cartilage and bone (Roberts and Manchester 2010: 121). Halcrow and Tayles (2011: 343 citing Lewis 1997) indicate that trauma is seldom diagnosed in subadults in the archaeological record, and the reason for its underestimation may be due to the bone remodelling of immature bones which can obscure previous injuries. However, the type and occurrence of fractures are informative evidence that could shed light on the age at which children started to work (Lewis 2007: 169).

In this study, evidence of trauma is recorded by the number of affected bones, and if possible, types of fractures were specified on the individual skeletal forms as suggested by Roberts and Connell (2004: 37 and 39) and summarized in Chapter 5 per site. Table 4.1 describes fracture types and mechanisms of injury. The data collected on the spreadsheets (see Appendices) include the skeletal individuals observed with trauma and the affected bone element, and are presented by age and sex (if biological sex of an adult individual could be assigned). Because of the limitation of fragmentary or incomplete bones when analysing skeletal remains, a long bone is recorded as present when at least two-thirds is available for analysis. The trauma data will be first presented according to the number of individuals affected (CPR) in Chapter 5 since this presentation of data is commonly accepted (Roberts and Connell 2004: 39). In addition, to calculate frequency rates according to the present bones available for trauma analysis, prevalence rates of traumatic injuries were calculated following Lovell (2008), whose analysis of skeletal trauma specifies the different types of fractures, and the method of recording and interpreting in order to demonstrate inter- and intra-site variation, and are further specified and presented in percentages of the observed left and right bone elements of each sex in Chapter 5, and discussed in Chapter 6.

To have a better understanding of intra-population trauma distribution, Lovell (2008: 349) states that the prevalence rates in percentages of fracture types should be calculated as:

$$n / N \times 100$$

where n stands for the affected bone elements or individuals, and N for the total number of observed bone elements or individuals, with a preference for the 'bone count' or 'element count' rate, especially if elements are complete, or 'equally observable for fractures' (Lovell 2008: 349). To demonstrate sex specific differences for traumatic injuries within the six sites, prevalence rates in percentages of the observed left and right bone elements of each sex are shown. Because of the often fragmentary preservation of rib bones, only the percentage rates for rib fractures represent the affected individuals, or the individual count rate, and thus not the bone element count rate.

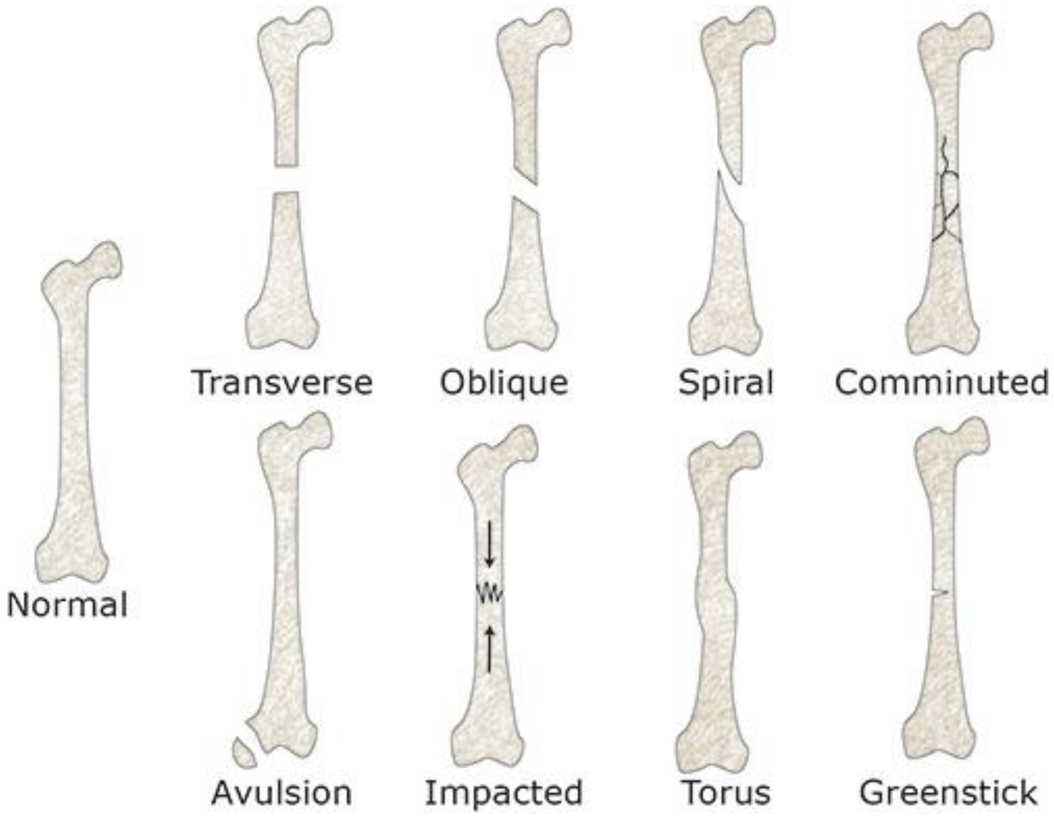

Fig. 4.2: Various fracture types (here shown by using the right femur) (illustration adapted from [Online]. Available from: http://www.startradiology.com/the-basics/fracture-general-principles/).

Fracture Type	**Details**
Penetrating	Partial or complete penetration of bone cortex
Comminuted	Bone is broken into more than two pieces (affects usually shafts of long bones)
Crush 1. Depression 2. Compression 3. Pressure	 Crushing force on one side of the bone Crushing force on both sides Force applied to growing bone
Transverse	Force applied perpendicular to the long axis of a bone
Spiral	Rotational stress on long axis
Oblique	Angular stress on long axis
Torus	Bulging of bone cortex. Buckling of the bone from longitudinal impaction; common in children
Greenstick	Incomplete fracture from rotational or angular stress; common in children

Impacted	Bone ends are driven into each other
Burst	Spinal injury from vertical compression
Avulsion	Fracture from tension at tendon or ligament attachment
Stress/fatigue	Due to repetitive force or stress; usually perpendicular to long axis
Secondary/pathological	Secondary to localized or systemic disease that has caused weakening of the bone (e.g. osteoporosis, infection or metabolic disorders)

Table 4.1: Fracture types and their mechanisms of injury. Penetrating, comminuted, crush and transverse fractures are caused by direct trauma, all other listed fractures by indirect trauma (adapted from Lovell 2008: 346).

4.3.5. Infectious Disease

Infectious diseases may elucidate living conditions and sanitary circumstances of a cultural group, however, infections affecting the soft-tissue are not always skeletally identifiable because they are often fatal before bone formation or bone destruction occurs, or because the affected individual recovers within a short time span (Aufderheide and Rodríguez-Martin 2008: 117; Roberts and Manchester 2010: 167). Hence, the frequency of infectious diseases observed in a past community is most likely a mere reflection of the minimum of its actual ubiquity (De Groote *et al*. 2011: 177; Ortner 2003: 42).

Four groups can be distinguished based on its infectious agent: bacterial, viral, fungal and parasitic (Aufderheide and Rodríguez-Martin 2008: 118). A non-specific bacterial infection such as *periosteal reaction* is probably caused by injury, and is observed by the formation of striated new bone on the cortical surface, mainly on the tibiae (Roberts and Manchester 2010: 172). Another non-specific inflammatory infectious disease is *osteomyelitis* at which the formation of pus results in the enlargement and deformation of the bone (Roberts and Manchester 2010: 168-169; Waldron 2009). Specific bacterial infectious diseases on the other hand, do have a known causative agent and a few of them, such as leprosy, tuberculosis (TB), and treponemal diseases (e.g. syphilis) have caused a demographic impact throughout history (Roberts and Manchester 2010: 182). However, Waldron (2009: 91) states that a minority of individuals infected with TB develop skeletal lesions, thus resulting in an underestimation of the prevalence of the disease in the osteoarchaeological record.

Skeletal lesions that are associated with TB mainly manifest in the spine, especially in the vertebral bodies of the lumbar area, which may eventually lead to collapse and ankylosis of the spine, also known as Pott's disease (Aufderheide and Rodríguez-Martin 2008: 133-136; Waldron 2009: 93-94). Extra-spinal manifestation of TB occurs in the joints of the hip, knee and wrist characterised by lytic lesions with little or no new bone formation (Waldron 2009: 94). However, several studies have demonstrated the involvement of rib lesions in TB-affected individuals (Gernaey *et al.* 2001), or that the formation of new bone on the visceral surface of the ribs was significantly more common in individuals who died from TB (e.g. Roberts *et al.* 1998; Santos and Roberts 2006 and authors therein). Although not pathognomonic for TB, these findings indicate the importance of the ribs for the diagnosis of TB, and moreover, for its most common form i.e. pulmonary TB (Santos and Roberts 2006: 47). Moreover, the use of biomolecular methods such as ancient DNA (aDNA) to identify the presence of *Mycobacterium tuberculosis* in skeletal remains showing new bone formation on visceral surfaces of ribs has positively demonstrated to incorporate rib fragments into molecular analyses of ancient TB (Müller *et al*. 2014). Mays *et al.* (2002) applied aDNA too, but here on a small sample of seven medieval skeletons from the rural English site of Wharram Percy, and their study did not reveal an association between the presence of *M. Tuberculosis* DNA and the proliferative visceral rib lesions that were observed in these individuals. However, the possibility of poor DNA survival which may have affected the results can not be completely ruled out (Mays *et al.* 2002: 31). Also, the integration of larger skeletal samples with documented causes of death may contribute to a more successful detection and interpretation of the role of rib lesions in the diagnosis of TB. Santos and Roberts (2006), for example, employed an identified twentieth century skeletal collection of 263 adult individuals with TB and pulmonary nontuberculosis as a cause of death and found that lesions on the visceral surface of the ribs are suggestive of pulmonary tuberculosis. They further recommend to observe all ribs and/or fragments from archaeologically derived skeletons for periosteal reaction, with indication of location and area of the rib involved, which 'may be relevant to a diagnosis of pulmonary TB' (Santos and Roberts 2006: 47). It is worth noting that morphological changes on the ribs are, unfortunately, not confined to the diagnosis of TB only, but they should be considered within the wide range of chronic respiratory diseases to which that particular population was exposed (Mays *et al.* 2002: 34; Waldron 2009: 95).

Roberts (2012: 443) acknowledges the irrefutable link between TB and specific occupations that involve a higher risk of being infected with TB bacilli such as food-handlers, people who work in an environment with an increased susceptibility to TB (e.g. in hospitals, farmsteads and prisons), and lastly, occupations with a high vulnerability to acquire the TB bacilli such as during the production of ceramics. Moreover, it has been suggested that TB was a common infectious disease among miners, weavers, glassworkers, silk carders and stonecutters (Roberts 2012). Indeed, other studies regarding labourers in the field of e.g. meatpacking, leather tanning, baking and textiles, and especially when the work is done in an insufficient ventilated area, indicated a higher risk of being predisposed to TB (Roberts and Buikstra 2008: 69-73).

The diagnostic features of the infectious diseases that are analysed in this study are described below in table 4.2, following the operational definition as described by Waldron (2009), Roberts and Connell (2004) and Santos and Roberts (2006). In this study, lesions suggestive of pulmonary TB are categorised under respiratory infections.

Infectious disease	**Operational definition**
TB/Respiratory Infections	Spinal: lytic lesions observed in the vertebral bodies with sparing of posterior elements; And/or: no new bone formation, possibility of ankylosis, kyphosis, spinal collapse, extra-spinal unifocal lytic lesions without the formation of new bone In addition: new bone formation on the visceral surface of the ribs seems to suggest pulmonary TB
Periosteal Reaction (non-specific infection)	Formation of new bone; although there are many causes (as a result of e.g. inflammation in response to an infection, trauma, rickets, tumours), periosteal reaction or periosteal new bone (PNB) is classified under infectious diseases (see Roberts and Connell 2004: 37; Waldron 2009: 115)
Osteomyelitis (non-specific infection)	Inflammatory destruction of bone; production of pus may increase the bone in size; formation of cloaca; periosteal new bone on the diaphysis; often observed in the proximal tibia
Syphilis	Caries sicca (cranial lesions demonstrating erosion, remodelling and scarring) OR sabre tibia without bowing; congenital: Hutchinson's teeth and/or Mulberry molars OR sabre tibia with bowing

Table 4.2: Operational definition for the infectious diseases analysed in this study.

The category 'other infections' refers to contagious diseases such as middle-ear and mastoid infection and is manifested by respectively inflammatory changes in the walls of the middle-ear cavity and in the auditory ossicles, and by destructive lesions of the mastoid process. Causative agents may be genetic factors or environmental aspects such as impoverished sanitation, climate and severe living circumstances (Roberts and Manchester 2010: 176-178).

The crude prevalence (CPR) of infectious diseases such as chronic respiratory infections or evidence of pulmonary TB, non-specific infections like osteomyelitis and periosteal reaction, and other infections identified in the six skeletal collections of this study will be analysed. The frequency of infectious diseases in the six case study sites may demonstrate if different living and working conditions affected the historical populations. The prevalence data may shed light on variations between males and females, age categories, social status groups and on the impact of the environment as a result of socioeconomic developments when living in a coastal, rural or small urban area.

4.3.6. Metabolic Disease

The aetiology of metabolic diseases such as *rickets* (term used for children) or *osteomalacia* (term used for adults) is usually attributed to an insufficient absorption of vitamin D because of a poor diet and/or lack of sunlight. Vitamin D is a crucial element for the mineralization of bone and an inadequate intake may lead to deformation of the long bones (Brickley 2000; Brickley and Ives 2008; Lewis 2000; Maat and Mastwijk 2009: 15; Ortner and Mays 1998). Since the bones of children are still growing, the condition is mainly observed in young individuals (Ortner 2003). Although rickets has the same aetiology as osteomalacia, the skeletal manifestation of rickets in children and of osteomalacia in adults slightly differs (Brickley 2000: 189). With adults, osteomalacia occurs after the cessation of bone growth, leaving them vulnerable to fractures of the ribs, pelvis and femur (Brickley and Ives 2008; Nikita 2017: 305-307; Ortner 2003). The skeletal manifestation of rickets in children is observable by several deformities, such as the bending of the long bones, forward bending of the sternum, flattening of the ribs, and by porous changes in the epiphyses and metaphyses of the long bones (Brickley and Ives 2008; Ortner 2003). Bowing deformities that occurred in childhood may prevail in adulthood (also known as residual rickets) and indicates the recovery of adult individuals from vitamin D deficiency at a young age (Brickley and Ives 2008; Brickley *et al*. 2010). The consequences of a vitamin D deficiency have been further explored by Snoddy *et al.* (2016) whose review of the clinical literature led them to conclude that there is an association between low level vitamin D and a susceptibility to infectious disease such as TB which may enhance our understanding of the coexistence of these conditions in skeletal collections. Although rickets has been widely described in the osteoarchaeological record, Waldron (2009: 128) remarks that its prevalence is likely underestimated since recovery of the disease is possible through sufficient exposure to sunlight.

Anaemia or iron deficiency can manifest in skeletal elements such as the orbital roofs and/or the cranial vault, resulting in *cribra orbitalia* (CO) (porosity in the surface of the orbits) and porotic hyperostosis (porous lesions on the cranial vault bones) (Roberts and Manchester 2010: 231; Stuart-Macadam 1985). The widely accepted relationship between iron deficiency anaemia and the latter conditions has been debated suggesting that vitamin B12 deficiency, genetic anaemia or a parasitic infection could be a likely explanation for CO and porotic hyperostosis (Walker *et al*. 2009). However, it seems plausible that a nutritional deficiency is responsible for porous lesions upon the orbital and cranial vault bones. Parasitic infections, for example, may activate the immune system 'to withhold iron from invading microorganisms as a defense mechanism' (Bennike *et al*. 2005: 737-738; Walker *et al.* 2009). Ortner *et al.* (2001), on the other hand, suggested that the appearance of CO may be related to vitamin C deficiency.

Another metabolic disease is scurvy which is caused by a lack of vitamin C. Many foods such as citrus fruits and fresh vegetables contain vitamin C, however, during periods of famine or winter months when there is less availability of these food products, levels of vitamin C may decline (Brickley 2000: 184-185). Vitamin C is important for the production of collagen, which is a main protein in connective bone tissue (Ortner 2012: 258). Skeletal lesions associated with scurvy are more noticed in non-adult remains than in adults since 'the most rapid proportionate growth occurs in infancy and early childhood' (Brickley and Ives 2006: 164). Macroscopic bone alterations which can be linked to scurvy are often observed by porotic changes in the cranium as a result of an inflammatory response to extravascular bleeding (Ortner 2012: 258; Snoddy *et al.* 2018: 878). Other bony changes that manifest in infantile scurvy are located near the epiphyses of bones and can result in trauma at the metaphysis, which may fuse or re-unite with the epiphysis in an 'abnormal' state (Brickley 2000: 185). New bone formation as a reaction to chronic bleeding is often found as an isolated area of porous bone, mostly affecting scapulae, lower limbs and cranial bones (Brickley and Ives 2006; Ortner 2003). Further, it is possible that scurvy occurs with anaemia and therefore the likelihood that an individual may have suffered from multiple conditions should be considered (Brickley and Ives 2006: 170).

The identification of scurvy in adult remains is more complicated. Clinical radiographic data of adults with scurvy showed subperiosteal formation of new bone on the shafts of long bones, however, these lesions may also be related to other pathological conditions such as trauma or infectious disease (Snoddy *et al*. 2018: 882). Succesful methods to demonstrate the presence of adult scurvy in skeletal remains were demonstrated by Maat (2004) and Van der Merwe *et al.* (2010) who employed biomolecular and histological analysis. Maat (2004) who applied immunoenzymatic staining of microscopic sections found that the presence of haematomas as a black staining at the tips of dental roots and bilaterally black stains on joint surfaces may be suggestive of haemarthroses, and therefore can be used in the identification of active scurvy. Histological investigation by Van der Merwe *et al.* (2010) on skeletal remains of a nineteenth century mining population from Kimberley (South Africa) confirmed the presence of ossified haematomas, widespread bilateral subperiosteal bone, mostly on the shafts of the tibiae and fibulae, and periodontal disease as an indicator of adult scurvy which was also supported by hospital records and historical documents that described the occurrence of scurvy among the mine labourers.

In this study, the presence or absence of metabolic diseases is recorded, and its frequency is reported per individual (CPR) and per observable bone element (TPR). For cribra orbitalia, the grading system described by Stuart-Macadam (1991) to classify severity is not applied since the prevalence of the lesions on the analysed orbits will allow to calculate the TPR's (number of individuals with observable orbits) for comparative purposes. Also for porotic hyperostosis, the TPR's are calculated by applying the number of individuals with observable cranial bones.

In sum, the prevalence of metabolic diseases in the six human skeletal collections will increase our understanding towards nutritional deficiencies and the lack of sunlight as a possible cause of indoor activities such as weaving at home. Also, differences between males and females may assist in the interpretation of differential access to certain food products within the context of a population. For example, a lack of vitamin C was reported to be more common in males than in females since men were more away from home because of warfare and long journeys, making them more susceptible to a deficiency in fresh foods (Brickley 2000: 185). The frequency of metabolic diseases within the six sites will be further discussed in Chapter 6.

4.3.7. Enthesopathies of the Hand Bones

In general, enthesopathies (EP) involve lesions of muscular attachments, or insertions, due to mechanical stress, and are observed by the presence of exostosis or erosion at entheses (Mariotti *et al.* 2004). This inflammatory disorder of the entheses shows an increase with age, and enthesophytic development is, according to Maat and Mastwijk (2009: 14), generally more common in males than females. Besides the sex and age of an individual, other factors that influence osteolytic lesions (e.g. pitting) and osteophytic formation (bone exostosis) include genetics, diseases or activities (Quintelier *et al.* 2012: 271). Since variation in muscle attachment sites of twenty upper and lower limb entheses will be further detailed in the section on entheseal changes (EC), the presence of osteophytic formation in the hand bones was recorded separately, and will be shown as crude prevalence rates (the number of affected individuals with observable hand bones). The frequency of hand bone enthesopathies within the six skeletal collections can reveal sex and age-related differences between the past populations, and can provide information on the frequent use of the hands, or even indicate differences between the younger age categories of all status groups as a result of socioeconomic activities.

4.4. Dental Pathologies

Dental health may be a valuable source of information to shed light on diet, oral hygiene, age, pathologic conditions, and even smoking habits of an individual (Garcin *et al.* 2010: 422; Waldron 2009). Mandibular and maxillary dental elements were inspected in this research, and the cause of the missing elements was defined as follows: post-mortem tooth loss (PM), antemortem tooth loss (AMTL), missing (M), unerupted (U) or congenitally absent (C) (Maat and Mastwijk 2009). Determination of the occlusal surface wear was recorded using a grading system by Smith (1984: 39-56) to score all premolars and upper canines and incisors from 1 (no dentin exposure) to 8 (severe dental wear affecting whole crown), and another similar grading system by Brothwell (1981: 176) for the molar teeth. Further, the stage of periodontal disease was investigated during the osteological analysis by marking 0 (no periodontal disease), slight (+), moderate (++) or severe (+++), based on the diagrams shown in Maat and Mastwijk (2009: 35, modified from Brothwell 1981), and present the degree of periodontal disease, defined by Maat and Mastwijk (2009: 6), as ‘interalveolar atrophy with pitting and reactive bone/crest formation’). Periodontal disease can be skeletally recognized by the alveolar bone resorption as it may result in destruction of the horizontal and vertical alveolar bone (Nikita 2017: 329). In this study, data of periodontal disease will be analysed and presented by number of affected individuals with available dentition.

Caries, linear enamel hypoplasia (in this study abbreviated as EH) (a developmental defect in the tooth enamel characterised by linear grooves and pitting), and tooth abscesses were recorded too on the dental scheme of the individual skeletal file. Although in this and the following chapter categorised under dental pathologies, the prevalence of EH, however, may indicate a non-specific environmental stress factor (such as seen by disruption to growth and reduced adult stature, or by the prevalence of porotic hyperostosis and cribra orbitalia), and may illustrate if an individual was susceptible to nutritional deficiencies or disease during childhood since the enamel of the tooth will show these disruptions during the development of the crown (Hillson 1996; Mays 1998: 156). Thus the prevalence of hypoplastic lesions or defects on the permanent teeth of adults suggests that they have been prone to periods of disease and/or nutritional stress between the age of one and seven years, or up to c. thirteen years if the third molar is involved (Mays 1998: 156). EH will be further discussed in the section on environmental stress markers in Chapter 6.

Goodman and Armelagos (1985) state that EH is mainly macroscopically observable on the anterior teeth, particularly in the middle of the tooth crown, and mostly noticed on the maxillary central incisors and mandibular canines. Disruptions in the enamel are likely to affect multiple teeth, and its prevalence is often applied in studies to indicate a relationship between childhood stresses and health and mortality patterns in later life, or to illustrate differences in social status and biological sex (see e.g. Goodman and Armelagos 1989; Lewis 2002a).

In this study, the prevalence of EH on the available anterior teeth (presented by pits or grooves) is recorded on the dental diagram of the skeletal individuals and will be calculated per individual and population. EH was recorded as present if one or more hypoplastic lesions on the tooth surface were macroscopically visible. Teeth that are covered by calculus (mineralised plaque) or showing worn enamel surface are excluded from this analysis since this will obscure hypoplastic defects. Since several studies mainly focus on the presence and absence of EH within skeletal collections (see e.g. King *et al.* 2005; Palubeckaite *et al.* 2002; Primeau 2014; Yaussy *et al.* 2016, and further discussed in Chapter 6), rather than on the description of severity or location of hypoplastic lesions only, recording its prevalence will allow for comparative analysis with other studies of EH. Also for caries, its prevalence will be presented as a percentage of the teeth affected within each skeletal collection to allow inter- and intra-site comparison, which is a commonly used technique for analysis of dental disease in human skeletal studies (Robb 2000: 486). Thus, the TPR's represent the percentage of teeth affected from the number of teeth observable per individual by the following dental pathologies: caries, abscess, AMTL and EH. For periodontal disease, the CPR was calculated per dentition, and represents the percentage of individuals affected within each population with dental elements available for analysis.

Finally, the diagnosis of dental anomalies, as, for instance, identified in the *cementum*, a tissue that is a part of the root, was reported. In a developmental stage of the tooth, nutritional components such as calcium, trace elements, phosphate, protein and vitamins A, C and D are necessary, and deficiencies of these fundamental components may culminate in deviant teeth (Ortner and Putschar 1985: 28).

In order to interpret the data of the six case studies to explain disease frequencies, it is essential to integrate the socio-cultural context of each historical population and to consider multiple factors, i.e. if the site is rural-urban, their social status and their living environment (Roberts and Connell 2004: 39). This study will consider the socioeconomic and environmental factors of each skeletal collection to illustrate disease patterns observed in the human remains alongside the integration of historical sources. The data will demonstrate if variation exists between males and females and between the age categories, next to variation between the rural and urban environment and social context to shed light on disease exposure due to environmental, behavioural and/or socioeconomic conditions.

4.5. Entheseal Changes (EC)

The reconstruction of life trajectories of past populations is a major research focus in both physical anthropology and osteoarchaeology (Yonemoto 2016: 267), and the study of skeletal markers to demonstrate physical activities of past individuals has been widely adopted since the 1980's (Dutour 1986; Larsen 1997; Mariotti *et al.* 1997). Bone changes that occur at tendon and ligament insertions may indicate an intense use of certain muscles because of repetitive movements caused by a specific occupation or activity (Roberts and Manchester 2010: 143-147).

Since the last decade, many studies have been published on the pitfalls of using bone changes as markers of activity (as they are for instance critically listed by Jurmain *et al.* 2012). Initially, the term *musculoskeletal stress marker* was widely used after Hawkey and Merbs (1995) published their 'influential' paper as stated by Jurmain *et al*. (2012: 535) on activity-induced stress lesions by analysing twenty-three ligament sites (Hawkey and Merbs 1995: 330), but came under criticism as their methodology neglected a myriad of aetiologies that might have caused these changes (Villotte *et al.* 2010b). Indeed, Villotte *et al.* (2010b: 224) point out the importance of incorporating recent clinical knowledge on entheses, since the integration of clinical research by Hawkey and Merbs (1995: 324-325) was limited only to studies on the impact of sports activities. It has been demonstrated that participants in high-risk sports activities such as soccer players nevertheless exhibit a high prevalence of degeneration of the joint (Jurmain *et al.* 2012: 534). Weiss and Jurmain (2007: 442-443) have for example listed studies from which 67% revealed a positive correlation between the prevalence of OA and specific occupational and sports activities, but, as it is remarked by Jurmain *et al.* (2012: 534), this pattern would be supposed since these individuals participated in intense and repetitive activities. Hence, the shift in the use of the terminology *musculoskeletal stress marker* to *entheseal changes* is now widely adopted in many studies, although Weiss (2015: 281) states that some scholars prefer to use the former to describe its association with activities.

A critical aspect of the study of EC as illustrated by Villotte *et al.* (2010b: 224) is not to overlook the difference between the two enthesis types: fibrous (located on the shaft of the long bone) and fibrocartilaginous (located near the joint). This was a second criticism towards the study of EC as some papers (e.g. Weiss *et* al. 2012; Wilczak 1998) did not integrate the distinction between these two entheses in order to comprehend the relationship between entheseal changes and activities (Weiss 2015: 281 and authors therein).

An overview of studies that tackle EC in association with their occurrence and severity, and linked to sexual division of labour or skilled labour (e.g. weavers, blacksmiths, archers) was presented by Ostendorf Smith (2013: 188) who demonstrated that, apart from age and body size, also trauma, genetic predisposition and ergonomically incorrect positions of joints and muscles (e.g. 'heavy lifting with the spine and not the legs') may have an impact on the prevalence and intensity of EC. The causative agent of EC may be idiopathic or unknown (Ostendorf Smith 2013: 188). The impact of age as a dominant factor of EC rather than occupational behaviour was indicated by the use of identified skeletal collections (i.e. individuals of known age and occupation) (e.g. Alves-Cardoso and Henderson 2010, 2013; Milella *et al*. 2012), however, other analyses have associated EC with activities (e.g. Capasso *et al.* 1999; Milella *et al.* 2014; Niinimäki 2012; Niinimäki *et al*. 2013; Palmer 2012; Villotte *et al*. 2010a, and also listed in Henderson and Nikita 2016: 806).

Although the acknowledgement of this multifactorial aetiology only occurred over the last few years, Jurmain *et al.* (2012: 537) argue that 'EC research has been the most plagued by poorly conceived and poorly executed studies', and notice at the same time a reappearance of a tendentious approach, but fail to illustrate accurately the flaws of these analyses. Additionally, Jurmain *et al.* (2012: 537-538) emphasise the importance of bone histology, and the influences of bone remodeling, as well as the inclusion of large population samples that need to be statistically analyzed to explore the several confounding factors. Certainly, the use of large archaeological samples was supported by Henderson and Nikita (2016) who implemented the statistical method of Generalised Linear Models (GLM) to investigate the multifactorial aetiology of EC, based on the study by Villotte *et al.* (2010b) who used an identified skeletal collection of 367 males from the eighteenth and twentieth centuries. The latter study showed higher stress patterns amongst heavy manual workers (e.g. soldiers, carpenters and farmers) compared to non- and light-manual workers in the fibrocartilaginous entheses of the upper limbs. However, although Henderson and Nikita (2016: 813) aimed to test a model developed using GLM on identified skeletal samples with a sample size approximately typical of archaeological assemblages, they concluded that their model was not effective for all age groups because the sample sizes affected a normal distribution of EC. Indeed, Henderson and Nikita's (2016) test did not involve a large archaeological skeletal assemblage (here 58 identified British post-medieval male skeletons), and they admit the effects of a small sample size on the outcome of the utilised GLM's, especially when applying 10-year age groups instead of larger age categories (Henderson and Nikita 2016: 816). Further, the new model indicated that there is 'no clear pattern of interaction between EC presence, activity pattern, age, and body size', and therefore

Henderson and Nikita (2016: 816) propose that studying more skeletal individuals when applying GLM's is needed in order to develop a model to test on 'archaeological sample sizes and on individuals whose age at death and occupation are not documented'. Although Villotte *et al.* (2010b: 231) demonstrated both a higher frequency of EC within the manual labourers engaged in strenuous activities and a correlation with an increase in age, they do acknowledge restrictions in their analysis such as the determination of a detailed activity reconstruction, which would be better supported by modern clinical research in sport or occupational medicine. Also, the four categories of occupational groups, from non-manual workers to manual workers carrying out 'forceful tasks' which were listed by Villotte *et al.* (2010b: 225) included weavers along with barbers, tailors, home servants and shoemakers in group B, who 'did not perform forceful tasks'. However, historical observations by Ramazzini (1777) reported heavy muscular activities in the spine and arms among weavers (as also described in Chapter 2, section 2.7.6.) in order to handle the weaving loom. The inclusion of weavers in group B might therefore be inaccurate since one age group (50-59 years) in Villotte's *et al*. (2010b: 229-230) data analysis show a higher frequency of EC in the left upper limbs within the workers of the 'less active group' compared to those involved in heavier labour such as carpenters, rural workers, masons and soldiers. That occupational grouping in such studies is 'a source of bias' was concluded by Alves-Cardoso and Henderson (2013: 194), who listed one weaver in their light manual group, and questioned concepts of physical efforts in labour as it depends on the social, economic and cultural context. Generally, an accumulation of other non-reported activities besides the known occupation of an individual may also influence the dataset since only the ultimate work a person had carried out before his death was recorded, and thus EC studies of identified skeletal assemblages that do not represent a complete life trajectory (Alves-Cardoso and Henderson 2013: 194).

Efforts to initiate a standardization in recording and describing EC were undertaken by an international group of scholars in order to avoid false presuppositions and to enhance comparative studies (Villotte *et al.* 2016). The first workshop to discuss methodologies and definitions of EC was organised in Coimbra (Portugal) in 2009, and resulted in three working groups, with follow-up meetings in 2013 and 2016. Since more involvement in EC-studies was undertaken, the need for consistent terminology and standardization stimulated the establishment of the 'Coimbra'-working group to foster the debate on EC among 'bioarchaeologists and paleopathologists' (Villotte *et al*. 2016: 49 and 54).

The resulting methodology, thus named the Coimbra method, was developed by Henderson *et al.* (2013), and revised in 2016 by Henderson *et al.* (2016b), and focuses on morphological changes recorded in two zones of the fibrocartilaginous entheses such as bone formation, textural change, fine porosity and erosion. Two entheses, the *subscapularis* insertion and the *biceps brachii* insertion have been tested by using the new Coimbra method (see Henderson *et al.* 2016a; Michopoulou *et al*. 2016), and were further instructed by the Coimbra Methodology Working Group during the workshops in Sheffield (2015) and Coimbra (2016). Michopoulou *et al.* (2016), for example, tested the efficacy of the Coimbra method on 78 age identified twentieth-century male skeletons, and revealed the primary impact of age on EC, although the statistically significant differences appear to be notably rather small, seeing that the largest group involved individuals of at least 60 years old. This minor association may be related to a decrease of muscle strength after the age of 50 as suggested in other studies (e.g. Milella *et al.* 2012; Niinimäki 2011; Robb 1998), since, for example, entheses may not be susceptible to bone alterations after a certain age.

However, an update for recording and defining textural change was published in 2016 by Henderson *et al.* (2016b), and illustrates that the methodology to employ a standardized system is still being tested and in development (Henderson *et al.* 2016a, 2016b, 2017). Even years after the introduction of the Coimbra method, this study is in agreement with Palmer *et al.* (2016: 85), who argued that 'a more standardized recording procedure must be established for EC to become more useful activity markers'.

Therefore, in this study, the methods established by Mariotti *et al.* (2004; 2007) and Villotte (2006), which are considered as a revised update based on the widely adopted methodologies of Hawkey and Merbs (1995) and Robb (1998), have been used for the analysis of both upper and lower limb EC. Yet since a combination of the two joint types (fibrous and fibrocartilaginous) was successfully shown by Palmer *et al.* (2016) and Niinimäki *et al.* (2013), the aforementioned methods were applied to score robusticity (swelling, ridging or cresting of bone at attachment site), cortical defect (pit-or furrow-like depression of bone cortex) or ossification exostosis (bony spur at ligament attachment site) of both fibrous and fibrocartilaginous muscle attachment sites observed in the upper and lower limbs. Figures 4.3 to 4.6 represent photographic standards for scoring the developmental stages of robusticity or the formation of enthesophytes of four entheses (derived from Mariotti *et al*. 2007, see the same paper for a detailed description and reference photographs of the morphological alterations of twenty-three entheses).

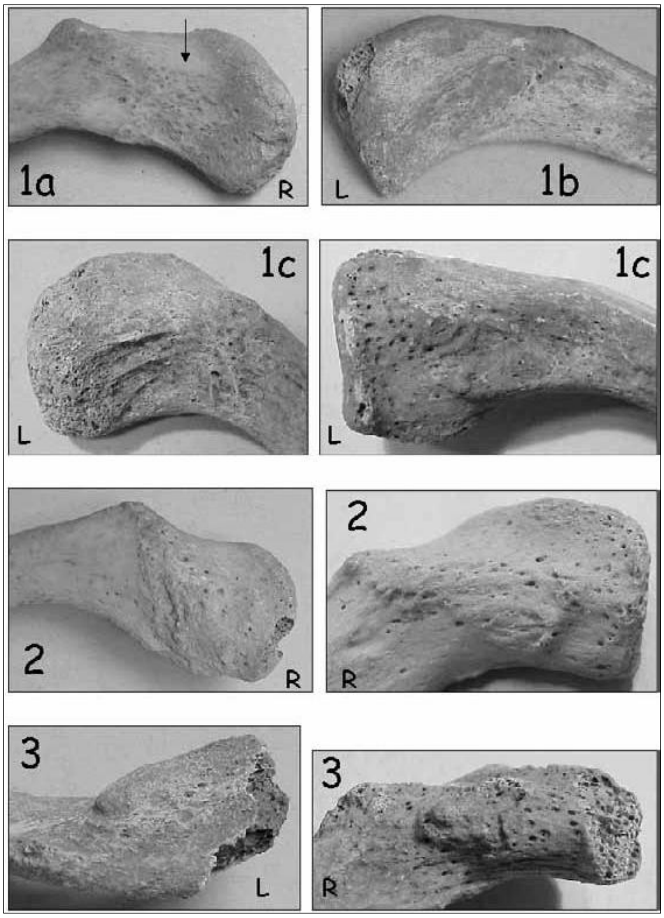

Fig. 4.3: Scoring standards for robusticity of the trapezoid ligament of the clavicula, showing hardly distinguishable to faint (1a, b and c), moderate (2) and strong (3) development of the insertion area (Photograph from Mariotti *et al.* 2007: 303, figure 5).

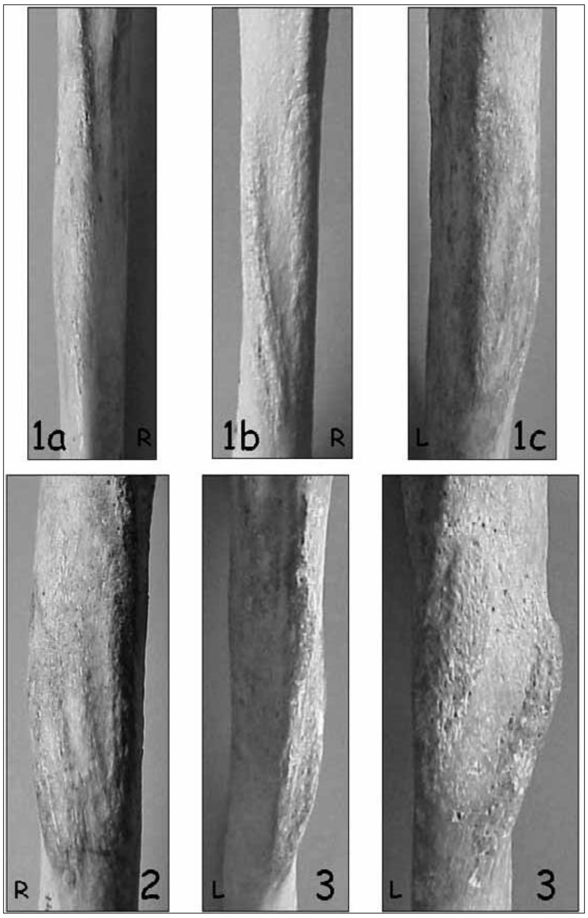

Fig. 4.4: Scoring standards for robusticity of the deltoideus of the humerus, showing hardly distinguishable to faint (1a, b and c), moderate (2) and strong (3) development of the insertion area (Photograph from Mariotti *et al.* 2007: 305, figure 10).

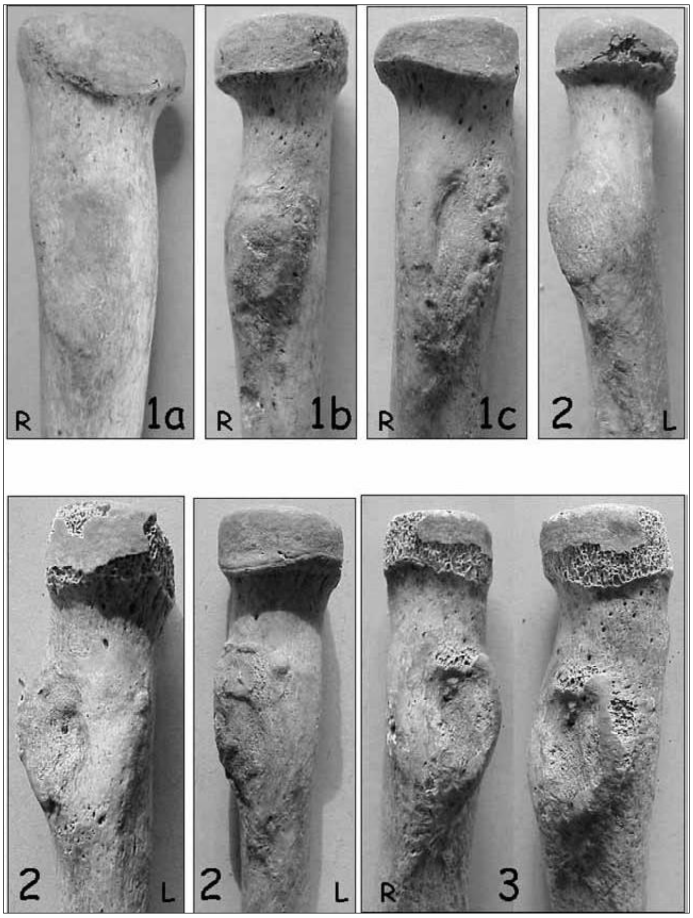

Fig. 4.5: Scoring standards for robusticity of the biceps brachii of the radius, showing hardly distinguishable to faint (1a, b and c), moderate (2) and strong (3) development of the insertion area (Photograph from Mariotti *et al.* 2007: 306, figure 12).

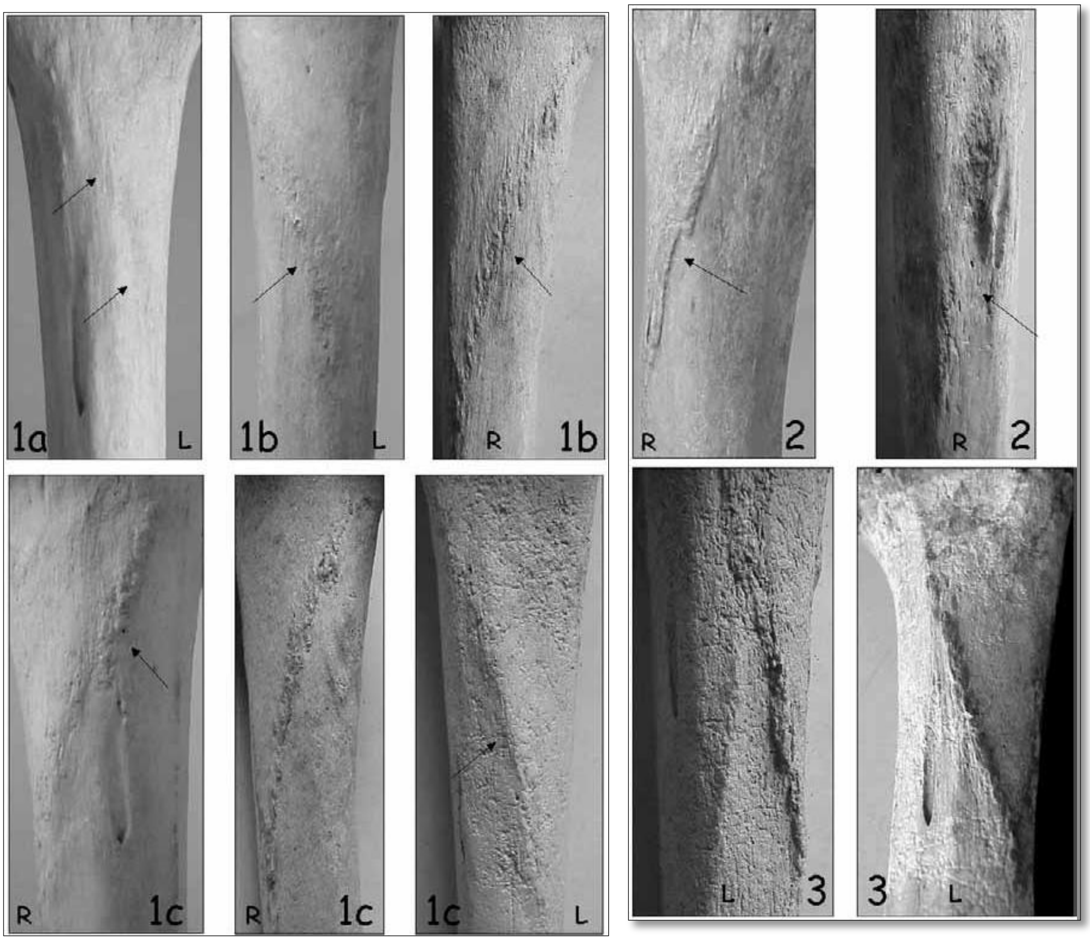

Fig. 4.6: Scoring standards for robusticity of the popliteal line (or *m. soleus*) of the tibia, showing a smooth surface to faint (1a, b and c), moderate (2) and strong (3) development of the insertion area (Photograph from Mariotti *et al.* 2007: 311, figure 23).

Twenty muscle attachment sites (fibrous and fibrocartilaginous) of the upper and lower limbs were given a score: 1 (no modification), 2 (faint alteration), 3 (moderate modification) and 4 (strong modification or irregularity). When the bone was registered as absent, 0 was entered in the database spreadsheet. These muscle attachment sites (presented below) have been selected as most of them have been applied in other EC studies and will therefore allow for comparative analyses, while other entheses such as the insertion of the *triceps brachii* located on the ulna are not included since nearby muscle attachment sites which are part of this study, like the *anconeus*, are responsible for similar movements and assist the triceps (Perry 2004). Muscle markings will be analysed by the percentages of adult individuals affected within the skeletal assemblages and by significance testing using ordinal statistics as suggested by Robb (2000: 486). The TPR data represent the number of observable EC of skeletal individuals with bone elements available for analysis. Differences between left and right entheses were tested on statistical significance by using the Mann-Whitney U test to demonstrate preferential arm use, but are only included in the charts in Chapter 5 when a statistically significant difference was observed.

Clavicula (fig. 4.7)**:**

Trapezoid (TRZ) (fibrocartilaginous)

Conoid (CO) (fibrocartilaginous)

Subclavius (SC) (no information)

Costoclavicular (CC) (fibrocartilaginous)

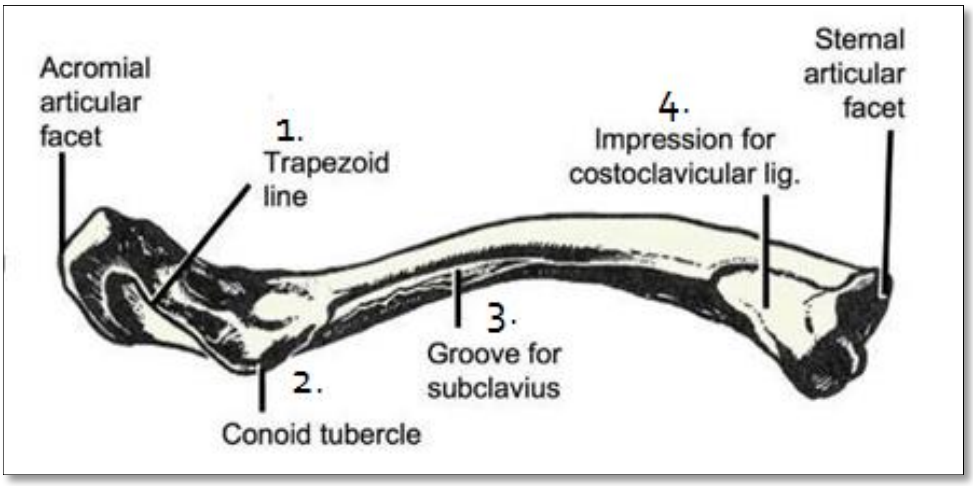

Fig. 4.7: Inferior part of the right clavicula with indication of the analysed entheses and ligaments.

Radius (fig. 4.8):

5. Biceps Brachii Insertion (BBI) (fibrocartilaginous)
6. Supinator (SU_RA) (no information)
7. Pronator Teres (PT) (fibrous)
8. Flexor Pollicis Longus (FPL) (fibrous)

Ulna:

9. Brachialis (BA) (fibrocartilaginous)

10. Anconeus (AN) (no information)

11. Supinator (SU_UL) (no information)

Humerus:

12. Deltoideus (DT) (fibrous)

13. Teres Major (TM) (fibrous)

14. Pectoralis Major (PM) (fibrous)

15. Latissimus Dorsi (LD) (fibrous)

16. Brachioradialis (BR) (origo) (fibrous)

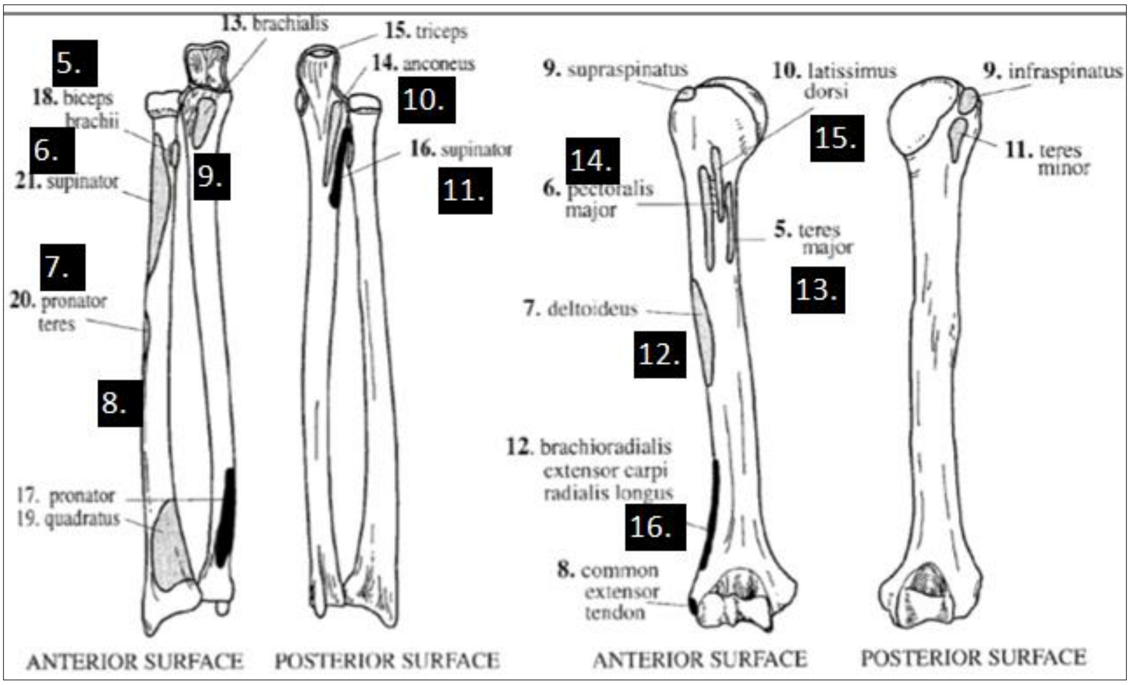

Fig. 4.8: Anterior and posterior surface of the right radius, right ulna (pictured left) and right humerus (pictured right) with indication of the analysed entheses (Figure adapted from Eshed *et al.* 2004: 305).

Femur (fig. 4.9):

17. Linea Aspera (LA) (fibrous)

18. Gluteus Maximus (GM) (fibrous)

19. Vastus Intermedius (VI) (no information)

Tibia:

20. Popliteal Line (PL) (fibrocartilaginous)

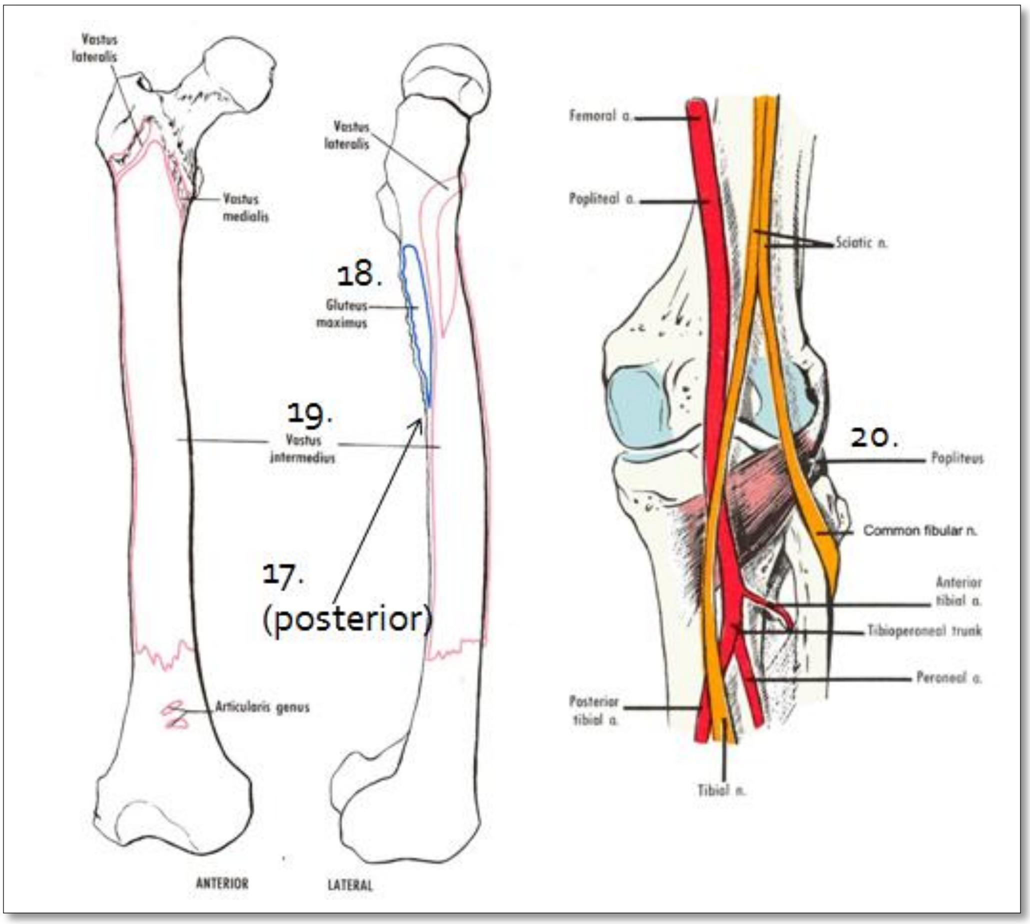

Fig. 4.9: Anterior and lateral side of the right femur (pictured left) and posterior side of the right tibia (pictured right, lowest bone) with indication of the analysed entheses (Image courtesy of © O'Rahilly 2004. Basic Human Anatomy: A Regional Study of Human Structure).

4.6. Data Analysis

All obtained data were inputted and analysed afterwards using the statistical software package SPSS Statistics v.24 after entry of demographic, pathological and EC data into a Microsoft Excel spreadsheet. In addition, statistical calculations of TPR data were enabled by the utilization of two-by-two tables provided by the statistical software of OpenEpi (Sullivan *et al.* 2009).

The use of statistical tests in this study will demonstrate the probability of the null hypothesis being true or false. The null hypothesis (H0) that was employed in this thesis implied that there were no significant differences in associations, means or distributions between the pattern of entheses and pathological or demographic variables.

There are three types of biological variables: measurement variables which are usually presented as numbers, nominal variables such as the sex of an individual and ranked or ordinal variables such as the age categories, which are defined by order from young to old. To perform statistical analysis of ordinal and nominal variables, non-parametric tests are used (McDonald 2014). Non-parametric tests are also applied when the sample size is small, which is often the case in archaeologically derived skeletal populations, and when there is a non-normal distribution.

The probability value which is expressed as p-value indicates if statistical significant results are obtained (McDonald 2014). In this study, a significance value of 0.05 ($P \leq 0.05$) was employed for rejection of the null hypothesis. When the significance value is less than 0.05, it means that the distribution of the data differs significantly from the normal distribution.

Seeing the small sample size of the skeletal collections in this study, the following non-parametric tests have been used (Field 2009) to examine correlations between sex, age, pathologies and EC. These tests are commonly used when analyzing bioarchaeological data (Robb 2000: 483-484):

1. the Chi-Square test of independence or association: to test two or more categories such as biological sex, and to demonstrate an association between two nominal or ordinal variables (i.e. categorical data)
2. Fisher's exact test: to overcome the problem of small sample sizes this test was additionally employed. This method is commonly used on two-by-two contingency tables (two variables with two options, however, it can be used on larger contingency tables too (Field 2009: 690). As mentioned above, the calculations of TPR data by single two-by-two tables provided by OpenEpi yields estimates for e.g. 'calculations of rate ratios and rate differences with confidence intervals and statistical tests', for 'Mid-p, exact p-values, and confidence limits for the odds ratio' and for 'precision-based estimates of the risk ratio and odds ratio'. Here,

both crude and adjusted estimates are given so that the assessment of confounding can be made as well as adjusted rate ratios and rate differences, and tests for interaction (Sullivan *et al.* 2009: 472-473). Routledge (2014, para. 1) states that by integrating the Mid-p value 'the power can be increased considerably'. Therefore, when the difference by using a one tailed Fisher's exact test was reported as statistically significant, the p-value was verified by the p-value of Mid-p exact tests to ensure that the statistically significant difference was justified.

3. Mann-Whitney U test: to enable comparison between two independent groups when the dependent variable is ordinal or continuous, and the independent variable is for example biological sex
4. Kruskal-Wallis test: considered as an extension of the aforementioned test to enable comparison between three or more groups when the nature of the dependent variable is ordinal or continuous and the nature of the independent variable, for example, involves more than two categories such as comparing three sites

CHAPTER 5

BIOARCHAEOLOGICAL RESULTS OF THE SIX CASE STUDIES

This chapter presents the results of the osteological analysis of the six skeletal assemblages included in this study. This discussion focuses on the preservation and completeness, mortality profile, average stature, palaeopathological conditions and the analysis of entheseal changes (EC) of each skeletal collection. The data will be compared on both an intra- and inter-population level to determine discrepancies in health status between males and females within each community, and between the six study populations. The lesions observed will illustrate if the skeletal individuals show similar or different patterns of stress which may indicate either whether or not sexual dimorphism in labour can be identified, or whether or not differences in activities between the communities can be assessed.

5.1. Preservation and Completeness of the Six Skeletal Assemblages

The methodologies used in this study for recording the degree of preservation and completeness of the six skeletal collections are explained in 4.1. in Chapter 4, and the results are presented in tables 5.1 to 5.5.

The diagnostic criteria to determine the degree of cortical erosion was not applied during the analysis of the 68 skeletons from Oosterweel in 2011, but was instead recorded as ‘very poor’ (one individual), ‘poor’ (eleven individuals), moderate’ (fourteen individuals), ‘good’ (36 individuals) or ‘very good’ (six individuals) (Van Cant 2011).

Degree of Surface Preservation	**Completeness 0-24%**		**Completeness 25-49%**		**Completeness 50-74%**		**Completeness 75-100%**		**Total**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Grade 0	1	1.04	1	1.04	8	8.33	10	10.42	20	20.83
Grade 1	1	1.04	3	3.12	9	9.37	14	14.58	27	28.12
Grade 2			6	6.25	10	10.42	7	7.29	23	23.96
Grade 3			5	5.21	8	8.33	6	6.25	19	19.79
Grade 4			1	1.04	3	3.12	3	3.12	7	7.29
Grade 5										
Grade 5+										
Total	**2**	**2.08**	**16**	**16.66**	**38**	**39.57**	**40**	**41.66**	96	99.99

Table 5.1: Degree of preservation and completeness of the Deinze skeletal assemblage (N=number of individuals; total group: N=96); grades of surface erosion are described in 4.1. in Chapter 4.

Degree of Surface Preservation	Completeness 0-24%		Completeness 25-49%		Completeness 50-74%		Completeness 75-100%		Total	
	N	%	N	%	N	%	N	%	N	%
Grade 0			7	9.09	7	9.09	10	12.99	24	31.17
Grade 1	1	1.30	10	12.99	12	15.58	5	6.49	28	36.36
Grade 2			6	7.79	6	7.79	1	1.30	13	16.88
Grade 3			4	5.19	5	6.49	2	2.60	11	14.28
Grade 4					1	1.30			1	1.30
Grade 5										
Grade 5+										
Total	**1**	**1.30**	**27**	**35.06**	**31**	**40.25**	**18**	**23.38**	77	99.99

Table 5.2: Degree of preservation and completeness of the Slijpe skeletal assemblage (N=number of individuals; total group: N=77); grades of surface erosion are described in 4.1. in Chapter 4.

Degree of Preservation	Completeness 0-24%		Completeness 25-49%		Completeness 50-74%		Completeness 75-100%		Total	
	N	%	N	%	N	%	N	%	N	%
Grade 0	5	8.06					3	4.84	8	12.90
Grade 1	2	3.22	1	1.61	5	8.06	16	25.81	24	38.71
Grade 2					5	8.06	15	24.20	20	32.25
Grade 3					1	1.61	8	12.90	9	14.52
Grade 4							1	1.61	1	1.61
Grade 5										
Grade 5+										
Total	**7**	**11.28**	**1**	**1.61**	**11**	**17.73**	**43**	**69.36**	62	99.99

Table 5.3: Degree of preservation and completeness of the Vichte skeletal assemblage (N=number of individuals; total group: N=62); grades of surface erosion are described in 4.1. in Chapter 4.

Degree of Surface Preservation	Completeness 0-24%		Completeness 25-49%		Completeness 50-74%		Completeness 75-100%		Total	
	N	%	N	%	N	%	N	%	N	%
Grade 0										
Grade 1	3	3.22			2	2.15	1	1.07	7	7.53
Grade 2	7	7.53	7	7.53	3	3.22	4	4.30	20	21.50
Grade 3	13	13.98	9	9.68	5	5.49	3	3.22	30	32.26
Grade 4	13	13.98	14	15.05	3	3.22			30	32.26
Grade 5	6	6.45							6	6.45
Grade 5+										
Total	**42**	**45.16**	**30**	**32.26**	**13**	**14.08**	**8**	**8.59**	93	100.00

Table 5.4: Degree of preservation and completeness of the Zottegem skeletal assemblage (N=number of individuals; total group: N=93); grades of surface erosion are described in 4.1. in Chapter 4.

Degree of Surface Preservation	Completeness 0-24%		Completeness 25-49%		Completeness 50-74%		Completeness 75-100%		Total	
	N	%	N	%	N	%	N	%	N	%
Grade 0					1	0.97			1	0.97
Grade 1	8	7.77	7	6.80	3	2.91	4	3.88	22	21.36
Grade 2	4	3.88	6	5.82	11	10.68	7	6.80	28	27.18
Grade 3	3	2.91	11	10.68	7	6.80	6	5.82	27	26.21
Grade 4	2	1.94	7	6.80	5	4.85			14	13.59
Grade 5	8	7.77	1	0.97	2	1.94			11	10.68
Grade 5+										
Total	**25**	**24.27**	**32**	**31.07**	**29**	**28.15**	**17**	**16.50**	103	99.99

Table 5.5: Degree of preservation and completeness of the Moorsel skeletal assemblage (N=number of individuals; total group: N=103); grades of surface erosion are described in 4.1. in Chapter 4.

Within the sites of Deinze, Vichte and Slijpe, most skeletons show a completeness of at least 50%, and display a high degree of surface preservation between grade 0 and grade 2, indicating that there is no severe cortical erosion of the human bones within the three skeletal assemblages. For Zottegem, most recorded skeletons for preservation and completeness (42/93; 45.2%) display a completeness of less than 24% (table 5.4), but more than half of the skeletal collection (57/93; 61.3%) is recorded with good to moderate destruction of the cortical bone (grade 1 to grade 3). In general, the overall condition of the bone material of the six skeletal collections was not hampered by strong erosive action or destruction represented by grade 5 and grade 5+. This is fundamental to provide osteological data and to minimize the risks of underrepresentation of palaeopathological information.

5.2. Mortality Profile of the Six Skeletal Collections

An overview of the total number of analysed and inventoried skeletons of each skeletal assemblage is presented in table 5.6.

Site	Total number of osteologically analysed skeletons
Deinze	96
Moorsel (total assemblage) Moorsel (post-medieval group)	103 41
Oosterweel (total assemblage) Oosterweel (sub-sample)	68 19
Slijpe	77
Vichte	62
Zottegem	93

Table 5.6: Total number of the osteologically analysed and inventoried skeletal individuals of each case study - skeletal assemblage.

The mortality profile of the six sites is shown in figure 5.1, including the skeletal individuals that were attributed a specific age category, and hence excluding adults of unknown age.

The demographic composition (age and sex) of each site is presented in figures 5.3 to 5.9, and includes the assessed minimum age group of 18+ as well as the age groups of the individuals of unknown sex (ND). Individuals that were determined as probable female (F?) and probable male (M?) during the osteological analysis are incorporated in the female and male categories. The distribution of adult males and females is represented in table 5.2. For Moorsel, since the pathological analysis and analysis of EC concerns the post-medieval group only due to the general poor preservation state and completeness of the skeletons of the medieval group, the demographic composition of the post-medieval group is presented separately in fig. 5.2.

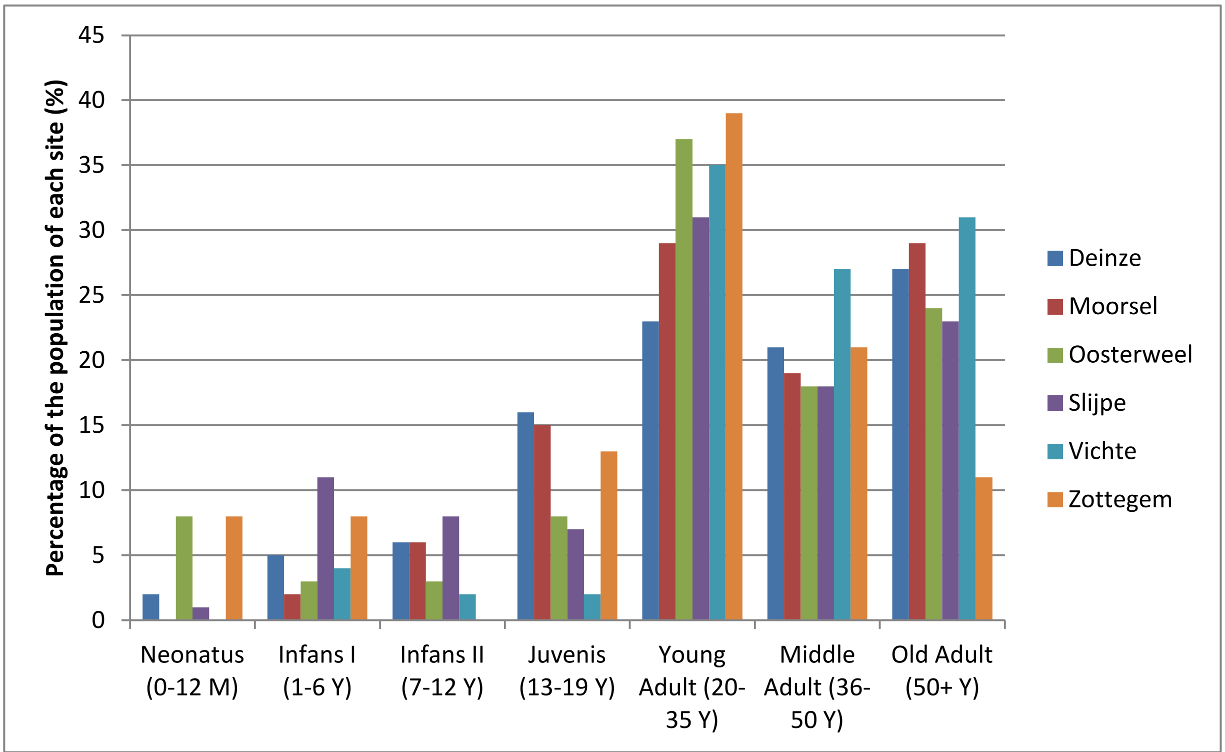

Fig. 5.1: Mortality profile of the skeletal assemblages of Deinze, Moorsel, Oosterweel, Slijpe, Vichte and Zottegem, showing age groups represented by percentages of the individuals of each population with determined age at death (Deinze: N=85; Moorsel: N=48; Oosterweel: N=38; Slijpe: N=73; Vichte: N=49; Zottegem: N=38).

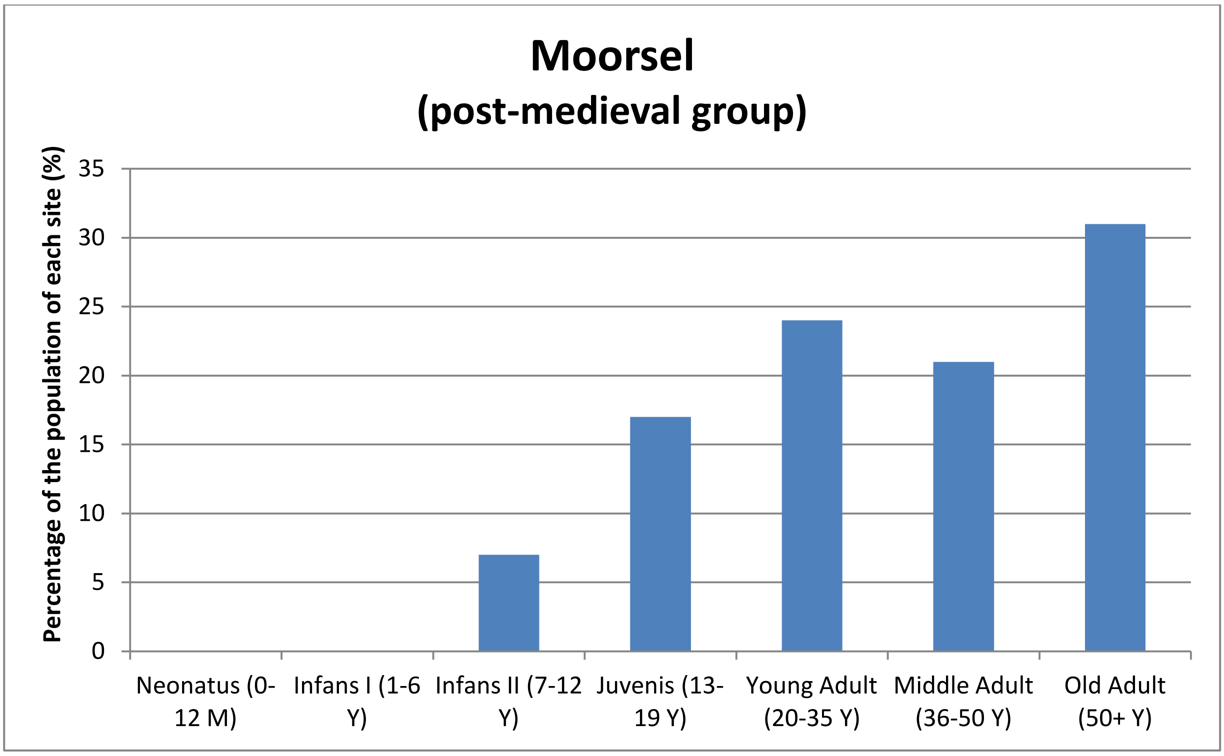

Fig. 5.2: Mortality profile of the post-medieval skeletal collection of Moorsel showing age groups represented by percentages of the individuals with determined age at death (N=29).

The mortality profile of the six sites (fig. 5.1) demonstrates that most newborns were found in Oosterweel (8%) and in Zotttegem (8%), but none were identified in Moorsel and Vichte. In Slijpe, both young (between 1 and 6 years) (11%) and older (between 7 and 12 years) (8%) children were mainly observed. Only Zottegem did not include older children. The low numbers of neonates and children in the six sites have been illustrated in section 3.3. of Chapter 3. Most juveniles were recorded in Deinze (16%).The latter site displays the third highest prevalence of old adults (27%) after Vichte (31%) and Moorsel (29%). Young adults (aged 20-35 years) represent the age group with the most recorded deceased individuals in all rural sites: Oosterweel (37%), Vichte (35%), Slijpe (31%) and the most in Zottegem (39%).

For the total group of Moorsel including medieval and post-medieval burials, both young and old adult age categories show a similar highest mortality percentage of 29%. When considering the post-medieval group of Moorsel, however, most recorded deaths are observed in the old adult age category (31%) (fig. 5.2). Old adults of at least 50 years of age were the least noticed in Zottegem (11%) and in Slijpe (23%).

When looking at the intra-site demographic profiles (figures 5.3 to 5.9 representing individuals for which an age estimation was possible including the age category of 18+), mortality numbers (%)

demonstrate an increase in cases starting from none (Moorsel) or less cases (Deinze and Zottegem) in newborn mortality to a peak in the juvenile age group for Deinze, Moorsel and Zottegem. Slijpe and Vichte, on the other hand, demonstrate another profile, although with similar percentage rates of few or no newborns, but starting from a peak in the Infans I age category to fewer cases of mortality in the juvenile group. Oosterweel shows more cases of neonate mortality, followed by fewer cases in the two childhood categories until adolescence. When sex determination could be accomplished from early adulthood, the data display that for all sites, apart from Zottegem where there is an equal proportion, more males than females are observed in the category of old adults (50+). When comparing female mortality within the adult age categories of young, middle and old adult, it seems that most female deaths were recorded in the young adult group (20-35 years) in all sites: Deinze (11/96) and Zottegem (9/81) (both 11%), Moorsel (7/87) (8%), Oosterweel (7/54) and Vichte (8/61) (both 13%) and Slijpe (18/67) (27%). For the post-medieval group of Moorsel (fig. 5.5), female deaths were particularly recorded in both groups of juvenis (4/41) and young adults (4/41) (both 10%), but also in the age category of old adults (5/41) (12%). An identical distribution between males and females within the young adult group was only noticed in Vichte. All sites, apart from Zottegem and post-medieval old adult group of Moorsel, show further a male preponderance in the middle and old adult age groups, and with an equal proportion between male and female mortality only in the old adult category of Zottegem (2/81) (2%). The latter site is the only site with a higher percentage of female deaths from the middle adult age group (5/81) (6%) than males from the same age category (3/81) (4%). It should be noted that the sites of Oosterweel (7/54) (13%), Moorsel (18/87) (21%) and Zottegem (22/81) (27%), involve a large group of skeletons in the age category of 18+ for which biological sex could not be attributed. The mortality data will be further illustrated in the historical context of the six case study sites in 6.1. of Chapter 6.

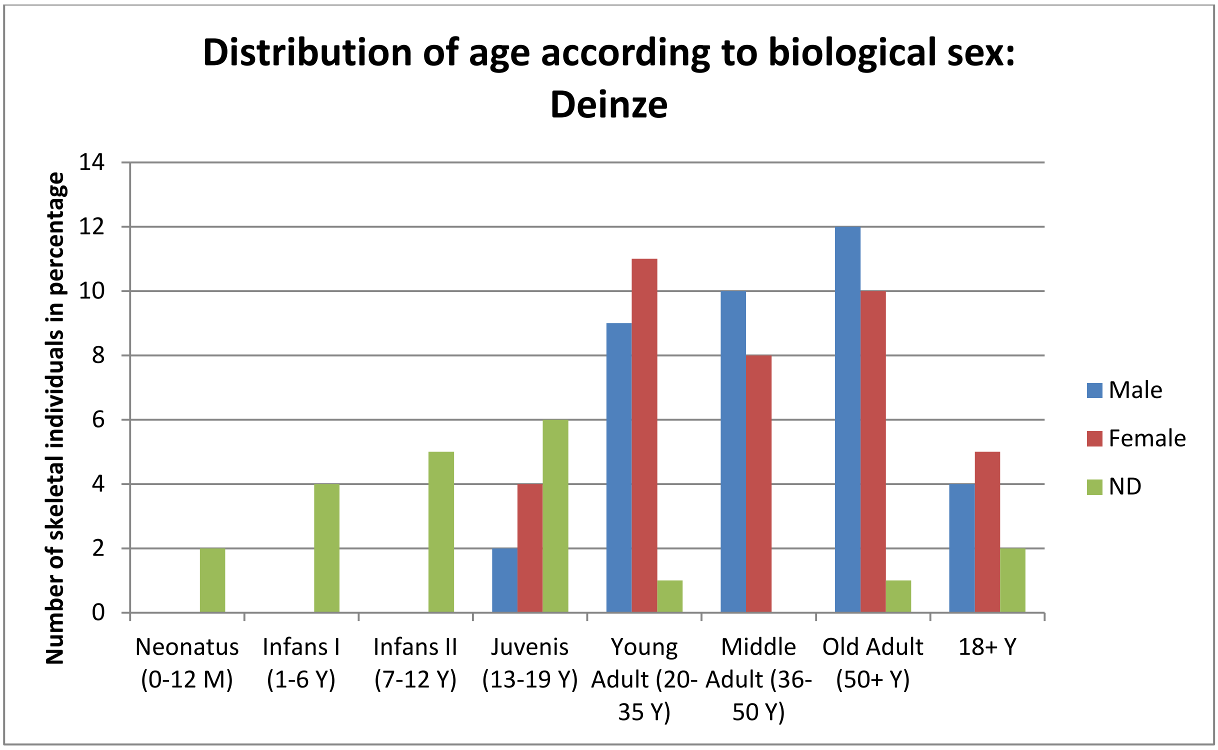

Fig. 5.3: Distribution of age within the Deinze skeletal collection (N=96).

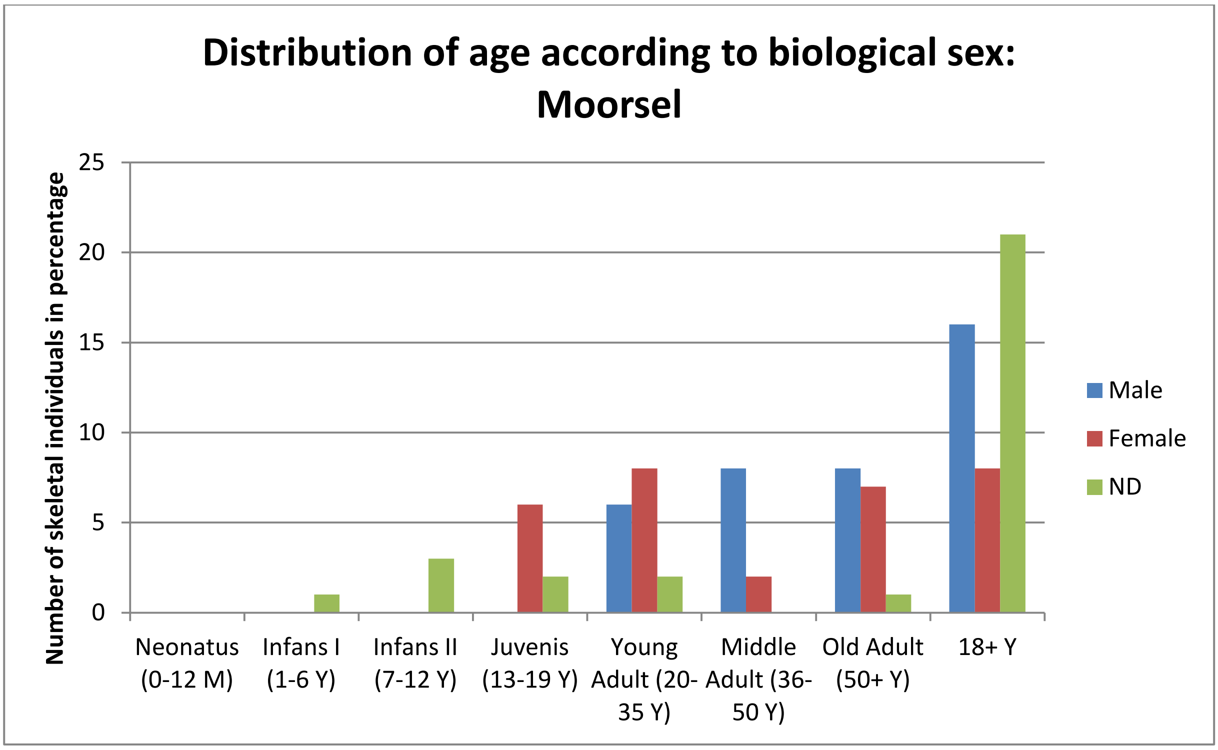

Fig. 5.4: Distribution of age within the medieval and post-medieval Moorsel skeletal collection (N=87).

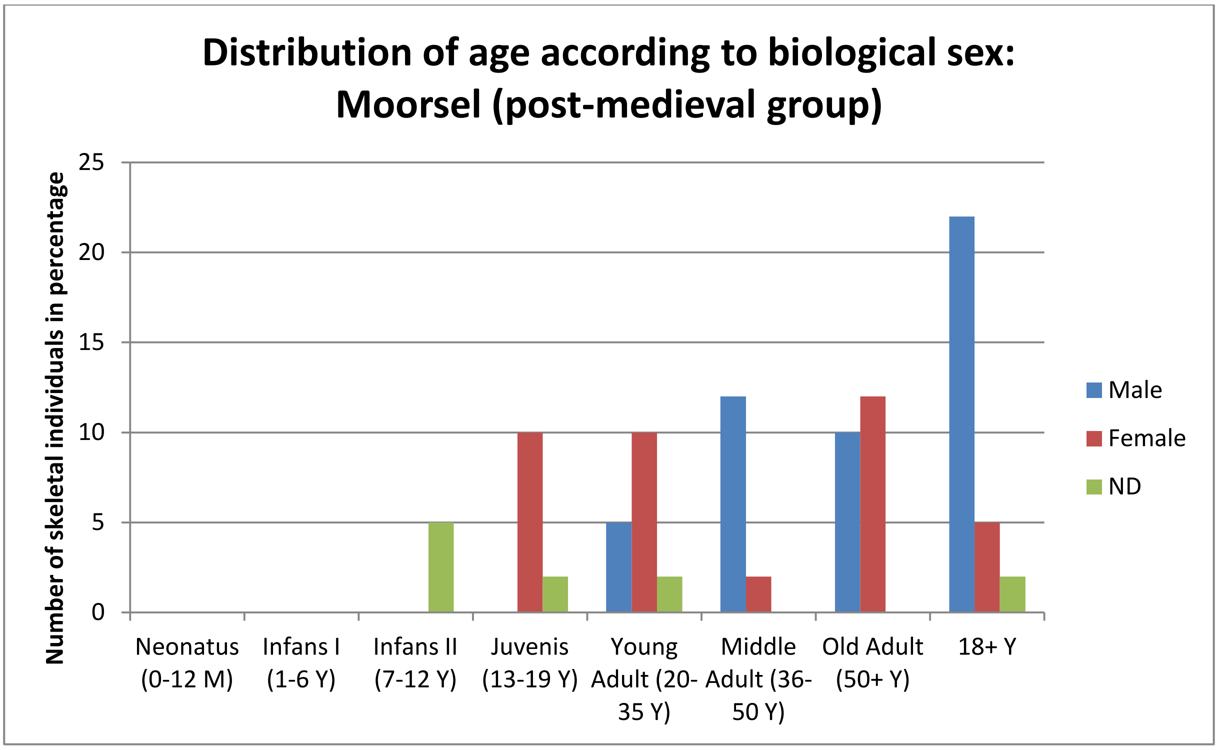

Fig. 5.5: Distribution of age within the Moorsel post-medieval skeletal collection (N=41).

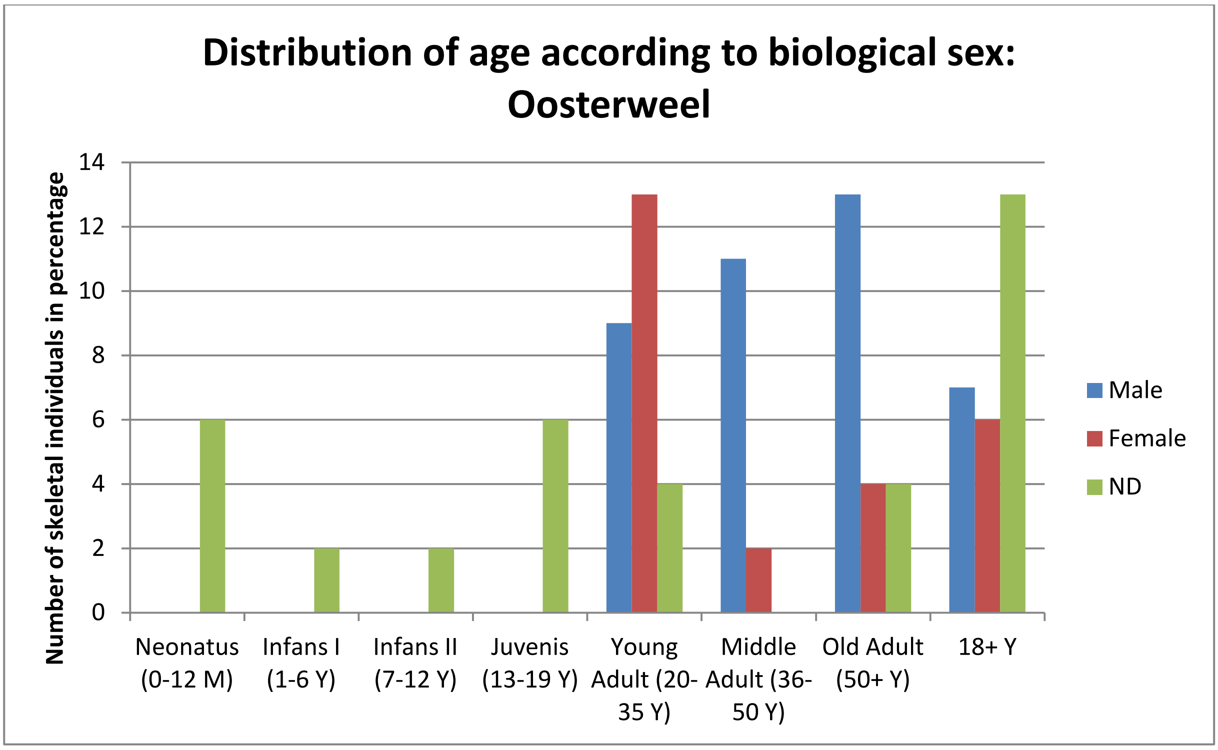

Fig. 5.6: Distribution of age within the Oosterweel skeletal collection (N=54).

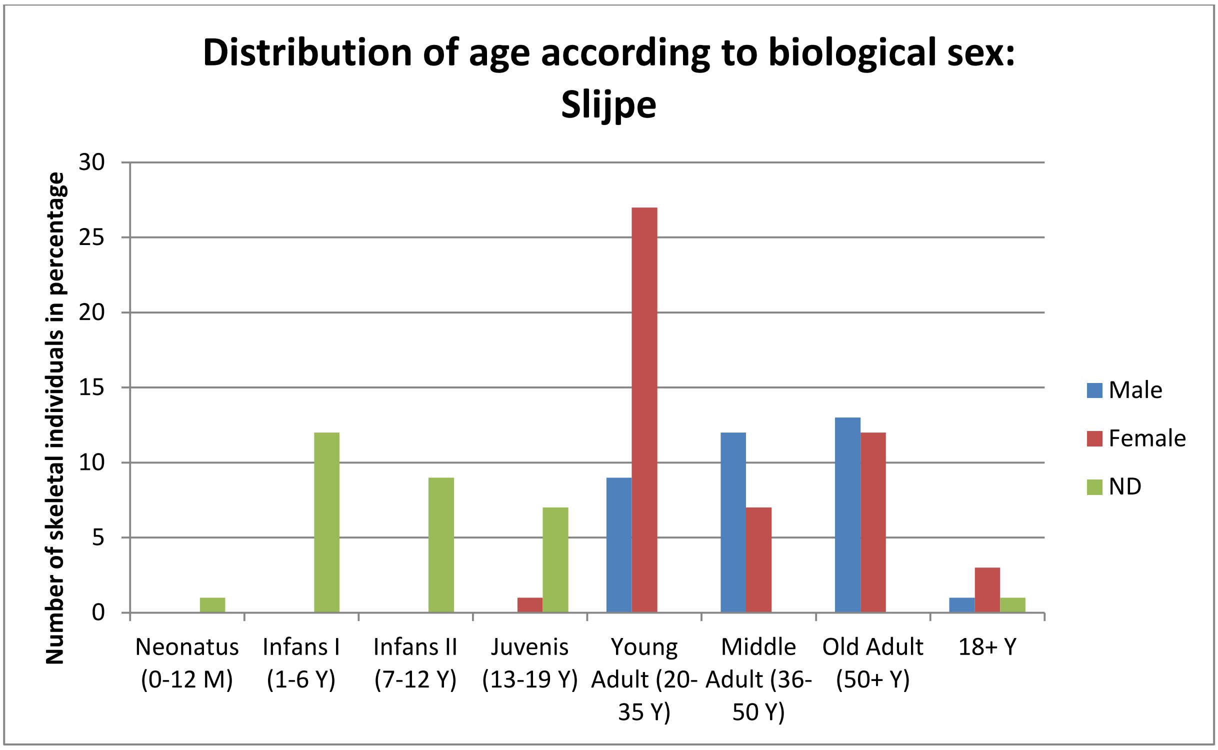

Fig. 5.7: Distribution of age within the Slijpe skeletal collection (N=67).

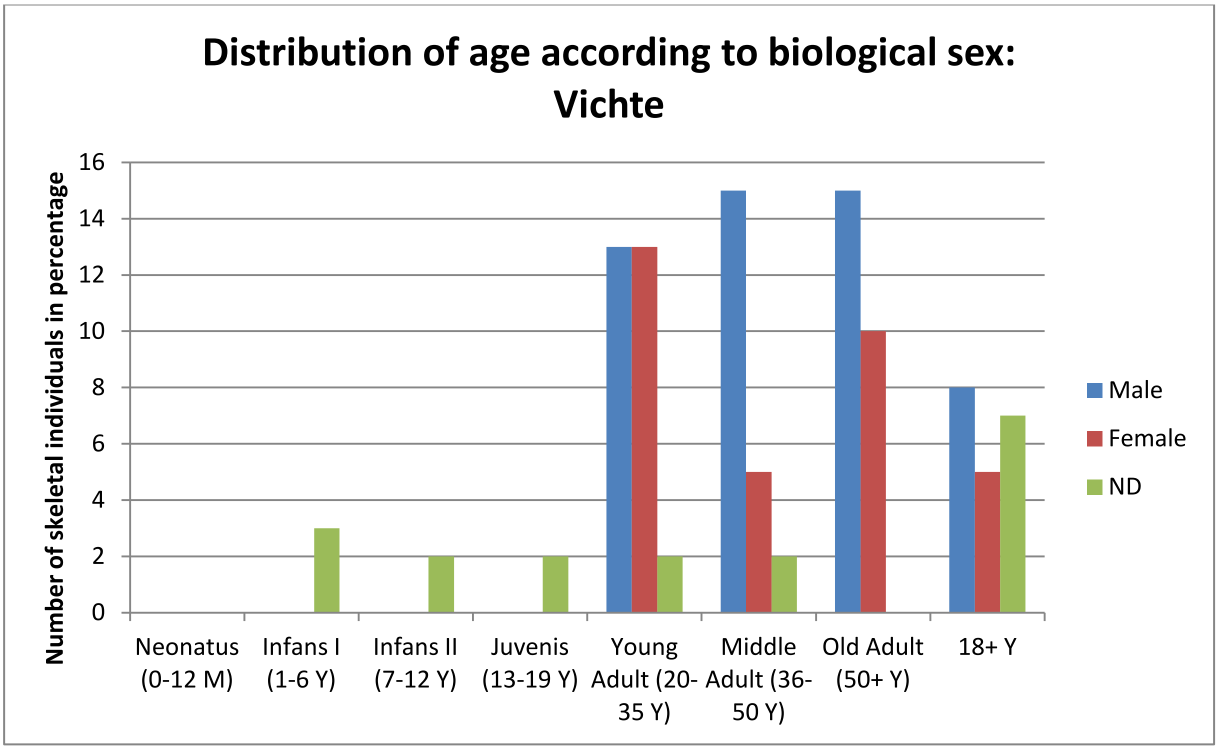

Fig. 5.8: Distribution of age within the Vichte skeletal collection (N=61).

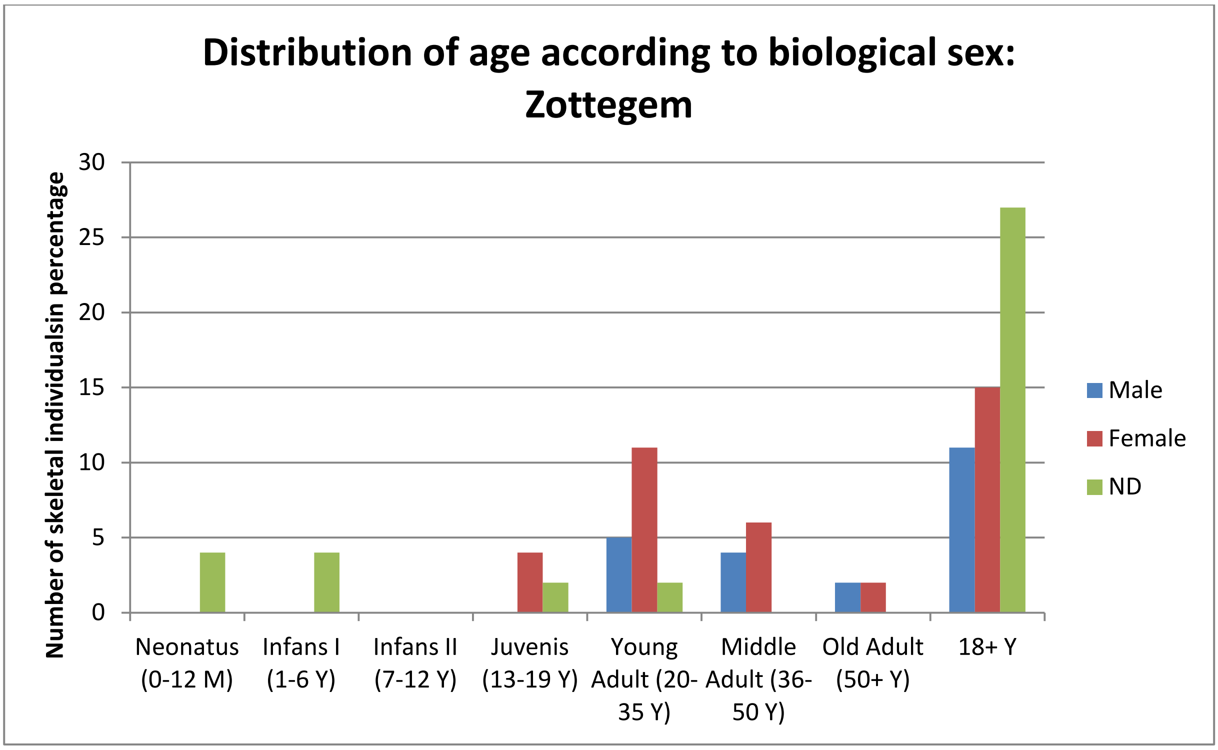

Fig. 5.9: Distribution of age within the Zottegem skeletal collection (N=81).

Site	Males (%)	Females (%)	ND (%)
Deinze (N=96)	35 (36%)	34 (35%)	27 (28%)
Moorsel (N=103)	36 (35%)	27 (26%)	40 (39%)
Moorsel (post-medieval) (N=41)	20 (49%)	16 (39%)	5 (12%)
Oosterweel (N=68)	30 (44%)	14 (21%)	24 (35%)
Slijpe (N=77)	24 (31%)	34 (44%)	19 (25%)
Vichte (N=62)	31 (50%)	20 (32%)	11 (18%)
Zottegem (N=93)	18 (19%)	31 (33%)	44 (47%)

Table 5.7: Proportion of males, females and individuals of unknown sex (ND) at the six sites shown by numbers and percentages.

When considering the assessment of biological sex, only Deinze and Moorsel show an equal proportion of males and females (less than 10% difference between males and females) (table 5.7 representing all individuals). The highest discrepancy in proportion was noticed in Oosterweel (44% males compared to 21% females), followed by Vichte (50% males compared to 32% females). The sites with a higher proportion of female burials are Zottegem (33%; 19% males) and Slijpe (44% females compared to 31% males). Individuals of unknown sex (ND) were mostly discerned in

Zottegem (47%), Moorsel (39%) and Oosterweel (35%), and will be only considered in the data analysis of age, stature and pathologies.

5.3. Adult Average Stature

Table 5.8 presents the mean average adult stature for each population, including the range for males and females and individuals of undetermined sex (ND). For Moorsel, the average adult stature was estimated from the post-medieval cohort only.

Site	Mean Average Male Stature	Mean Average Female Stature	Range Males	Range Females	Range ND
Deinze	169.0 (N=32)	158.0 (N=28)	161.5-179.0	147.0-181.4	155.5-175.5 (N=4)
Moorsel	169.0 (N=16)	161.8 (N=16)	157.0-181.0	153.0-179.0	168.5-172.5 (N=2)
Oosterweel	169.6 (N=18)	161.1 (N=9)	164.0-178.0	152.0-165.0	154.0-178.0 (N=7)
Slijpe	168.3 (N=23)	161.3 (N=28)	158.0-177.0	149.0-169.0	166.5-176.0 (N=1)
Vichte	170.2 (N=27)	158.2 (N=19)	146.5-184.3	151.0-164.4	168.0-172.0 (N=2)
Zottegem	171.8 (N=7)	157.5 (N=13)	169.0-176.0	144.0-171.0	159.0-167.5 (N=2)

Table 5.8: Mean male and female average stature of each site (in cm), including the range for males, females and individuals of unknown sex (ND).

The shortest average female stature was noticed in the sites of Deinze, Vichte and Zottegem (respectively 158.0, 158.2 and 157.5 cm) while males from Vichte and Zottegem did exhibit the highest average stature compared to males from the other sites (respectively 170.2 and 171.8 cm).

The influence of health, infectious diseases, socio-economic conditions, nutritional deficiencies and environmental stress on the stature of an individual will be further discussed in 6.3.5. in Chapter 6.

5.4. Palaeopathologies

Statistics of the prevalence of palaeopathological lesions identified in the six case studies are included in Appendices A-F. The statistical analysis of pathologies of the Moorsel group was carried out on 38 skeletal individuals from the post-medieval cluster because of the larger sample size and better preservation and completeness than those from the medieval burial group.

5.4.1. Joint Disease

5.4.1.1. OA of the Appendicular Skeleton in the Six Sites

* Deinze

Twenty out of 85 skeletal individuals were observed with OA of the peripheral joints (23.5%); from the 75 adult individuals with attributed biological sex: 7/38 (18.4%) were females and 12/37 (32.4%) were males affected with peripheral osteoarthritis (pOA). Biological sex of one individual with pOA could not be assigned.

Table 5.9 lists the TPR's and frequency rates of the affected joints.

Joint type/site	**Total number of observable sites**	**Male**	**Female**	**Total affected (including individuals of unknown sex)**
Sterno-clavicular				
Right	83	6/34 (17.6%)	3/34 (8.8%)	9 (10.8%)
Left	79	4/31 (12.9%)	2/33 (6.1%)	6 (7.6%)
Total	162	10/65 (15.4%)	5/67 (7.5%)	15 (9.2%)
Acromio-clavicular				
Right	82	3/35 (8.6%)	2/32 (6.2%)	5 (6.1%)
Left	79	2/30 (6.7%)	1/31 (3.2%)	3 (3.8%)
Total	161	5/65 (7.7%)	3/63 (4.8%)	8 (4.5%)
Shoulder				
Right	82	4/33 (12.1%)	0/30 (0.0%)	4 (4.9%)
Left	81	2/34 (5.9%)	0/34 (0.0%)	2 (2.5%)
Total	163	6/67 (8.9%)	0/64 (0.0%)	6 (3.7%)
Elbow				
Right	77	2/27 (7.4%)	1/28 (3.6%)	4 (5.2%)
Left	80	0/31 (0.0%)	1/30 (3.3%)	1 (1.2%)
Total	157	2/58 (3.4%)	2/58 (3.4%)	5 (3.2%)
Wrist+carpal bones				
Right	334	2/169 (1.2%)	1/119 (0.8%)	3 (0.9%)
Left	315	2/140 (1.4%)	1/141 (0.7%)	3 (0.9%)
Total	649	4/309 (1.3%)	2/260 (0.8%)	6 (0.9%)
Hand (metacarpals)				
Right	340	11/132 (8.3%)	3/126 (3.8%)	15 (4.4%)
Left	299	8/132 (6.1%)	3/116 (2.6%)	12 (4%)

Total	639	19/264 (7.2%)	6/242 (2.5%)	27 (4.2%)
Hand (phalanges)				
Right	461	1/206 (0.5%)	0/162 (0.0%)	1 (0.2%)
Left	445	1/205 (0.5%)	1/151 (0.7%)	2 (0.4%)
Total	906	2/411 (0.5%)	1/313 (0.3%)	3 (0.3%)
Hip				
Right	77	1/29 (3.4%)	1/31 (3.2%)	2 (2.6%)
Left	83	1/32 (3.1%)	0/33 (0.0%)	1 (1.2%)
Total	160	2/61 (3.3%)	1/64 (1.6%)	3 (1.9%)
Knee				
Right	62	3/26 (11.5%)	0/21 (0.0%)	3 (4.8%)
Left	64	1/27 (3.7%)	1/28 (3.6%)	2 (3.1%)
Total	126	4/53 (7.5%)	1/49 (2.0%)	5 (4.0%)

Table 5.9: Frequency rates for affected joints by osteoarthritis in the Deinze skeletal assemblage.

The CPR of pOA within the skeletal collection of known age and sex of Deinze is shown in fig. 5.10. The CPR for pOA of the total adult assemblage was 25.3% (19/75).

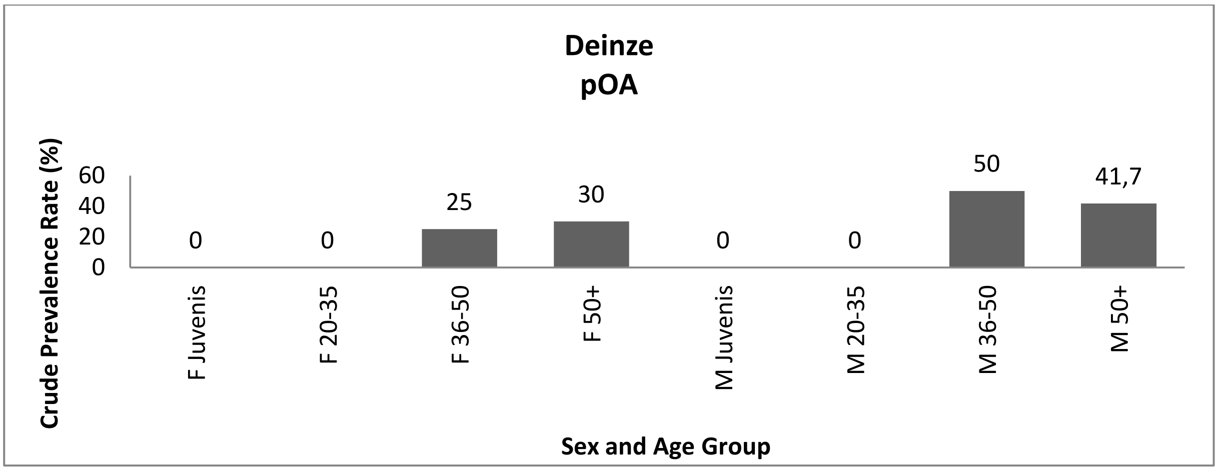

Fig. 5.10: CPR (Crude Prevalence Rate) in percentages for peripheral osteoarthritis (pOA) for each sex and age group within the Deinze skeletal assemblage.

There was a statistically significant difference for the prevalence of pOA between the groups of known age and sex ($p=0.028$, Fisher's exact test 2-sided, $n=66$), and between all age groups ($p=0.001$, Fisher's exact test 2-sided, $n=93$). There was no statistically significant difference between males (32.4%; 12/37) and females (18.4%; 7/38) for pOA ($x^2=1.946$, $df=1$, $p=0.163$, $n=75$).

* Slijpe

Sixteen individuals were observed with pOA (16/61; 26.2%) from Slijpe. From the 58 individuals with assigned biological sex: 8/34 (23.5%) were females and 7/24 (29.2%) were males. One individual affected with pOA is of unknown sex.

Table 5.10 lists the TPR's and frequency rates of the affected joints.

Joint type/site	Total number of observable sites	Male	Female	Total (including individuals of unknown sex)
Sterno-clavicular				
Right	53	1/20 (5.0%)	1/31 (3.2%)	2 (3.8%)
Left	46	2/14 (14.3%)	1/32 (3.1%)	3 (6.5%)
Total	99	3/34 (8.8%)	2/63 (3.2%)	5 (5.0%)
Acromio-clavicular				
Right	53	2/20 (10%)	1/31 (3.2%)	3 (5.7%)
Left	45	1/14 (7.1%)	1/31 (3.2%)	2 (4.4%)
Total	98	3/34 (8.8%)	2/62 (3.2%)	5 (5.1%)
Shoulder				
Right	59	1/26 (3.8%)	2/30 (6.7%)	3 (5.1%)
Left	47	0/19 (0.0%)	1/26 (3.8%)	1 (2.1%)
Total	106	1/45 (2.2%)	3/56 (5.3%)	4 (3.8%)
Elbow				
Right	52	0/22 (0.0%)	1/27 (3.7%)	1 (1.9%)
Left	49	0/19 (0.0%)	1/28 (3.6%)	1 (2.0%)
Total	101	0/41 (0.0%)	2/55 (3.6%)	2 (2.0%)
Wrist+carpal bones				
Right	206	1/99 (1.0%)	5/101 (4.9%)	6 (2.9%)
Left	148	0/67 (0.0%)	2/77 (2.6%)	2 (1.3%)
Total	354	1/166 (0.6%)	7/178 (3.9%)	8 (2.2%)
Hand (metacarpals)				
Right	182	2/90 (2.2%)	3/87 (3.4%)	5 (2.7%)
Left	151	1/72 (1.4%)	3/76 (3.9%)	4 (2.6%)
Total	333	3/162 (1.8%)	6/163 (3.7%)	9 (2.7%)
Hand (phalanges)				
Right	303	0/133 (0.0%)	0/159 (0.0%)	0 (0.0%)
Left	237	0/110 (0.0%)	0/120 (0.0%)	0 (0.0%)
Total	540	0/243 (0.0%)	0/279 (0.0%)	0 (0.0%)
Hip				
Right	48	0/20 (0.0%)	0/26 (0.0%)	0 (0.0%)
Left	47	1/21 (4.8%)	0/24 (0.0%)	1 (2.1%)
Total	95	1/41 (2.4%)	0/50 (0.0%)	1 (1.0%)
Knee				
Right	26	0/13 (0.0%)	0/12 (0.0%)	0 (0.0%)
Left	22	0/12 (0.0%)	0/9 (0.0%)	0 (0.0%)
Total	48	0/25 (0.0%)	0/21 (0.0%)	1 (0.0%)

Table 5.10: Frequency rates for affected joints by osteoarthritis in the Slijpe skeletal assemblage.

The CPR of pOA within the skeletal collection of known age and sex of Slijpe is shown in fig 5.11. The CPR for pOA for the adult assemblage of Slijpe was 25.9% (15/58) (fig. 5.39). The CPR of the complete collection for the prevalence of pOA including subadults and adult individuals of unknown sex is 22.2% (16/72). Peripheral OA was not observed in subadults. There was a statistically significant difference between all age categories (p=0.011, Fisher's exact test 2-sided, n=72), but not between the age groups of known sex (p=0.178, Fisher's exact test 2-sided, n=54). There was no statistically significant difference between adult males and females for pOA (x^2=0.233, df=1, p=0.629, n=58).

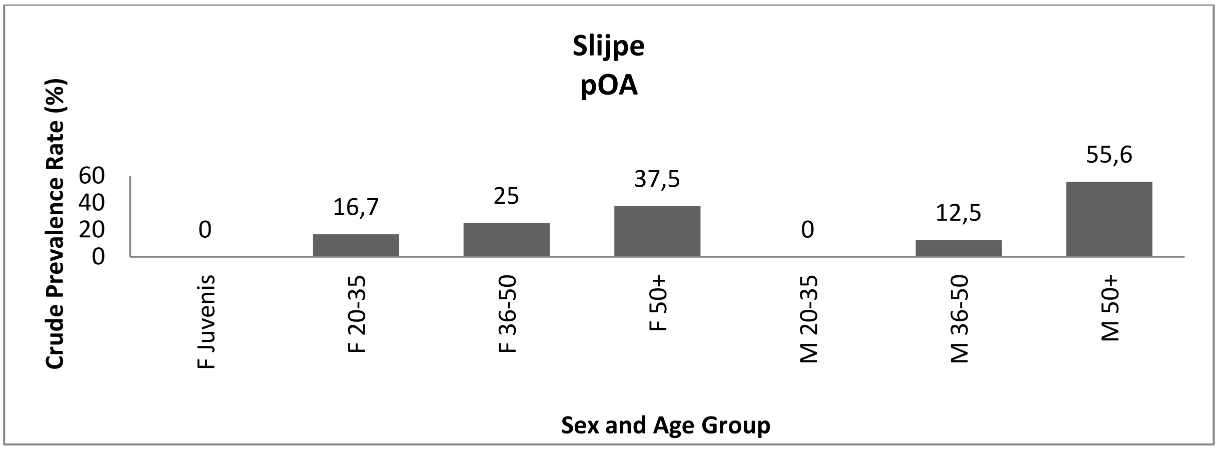

Fig. 5.11: CPR (Crude Prevalence Rate) in percentages for peripheral osteoarthritis (pOA) for each sex and age group within the Slijpe skeletal assemblage.

* Vichte

Seventeen individuals were observed with pOA (17/44; 38.6%). From the 42 individuals with assigned biological sex: 5/18 (27.8%) were females and 12/24 (50.0%) were males.

Table 5.11 lists the TPR's and frequency rates of the affected joints. The total count of hand bones (carpals, metacarpals and phalanges) could not be provided, therefore the number of affected individuals with OA of the hand bones is presented. Osteoarthritis of the hand and wrist was observed in six males only.

Joint type/site	Total number of observable sites	Male	Female	Total (including individuals of unknown sex)
Sterno-clavicular				
Right	43	0/25 (0.0%)	0/16 (0.0%)	0 (0.0%)
Left	39	1/22 (4.5%)	0/14 (0.0%)	1 (2.6%)
Total	82	1/47 (2.1%)	0/30 (0.0%)	1 (1.2%)
Acromio-clavicular				
Right	40	5/24 (20.8%)	4/15 (26.7%)	9 (22.5%)
Left	37	7/21 (33.3%)	2/13 (15.4%)	9 (24.3%)
Total	77	12/45 (26.7%)	6/28 (21.4%)	18 (23.4%)
Shoulder				
Right	39	1/20 (5.0%)	1/17 (5.9%)	2 (5.1%)
Left	33	1/21 (4.8%)	0/10 (0.0%)	1 (3.0%)
Total	72	2/41 (4.9%)	1/27 (3.7%)	3 (4.2%)
Elbow				
Right	40	1/20 (5.0%)	1/16 (6.2%)	2 (5.0%)
Left	38	0/18 (0.0%)	1/16 (6.2%)	1 (2.6%)
Total	78	1/38 (2.6%)	2/32 (6.2%)	3 (3.8%)
Wrist+carpal bones				
Right	N/A	3	0/3 (0.0%)	3
Left	N/A	1	0/4 (0.0%)	1
Total	N/A	4	0/? (0.0%)	4
Hand (metacarpals)				
Right	N/A	1	0/? (0.0%)	1
Left	N/A	3	0/? (0.0%)	3
Total	N/A	4	0/? (0.0%)	4
Hand (phalanges)				
Right	N/A	1	0/? (0.0%)	1
Left	N/A	1	0/? (0.0%)	1
Total	N/A	1	0/? (0.0%)	1
Hip				
Right	36	0/16 (0.0%)	0/17 (0.0%)	0 (0.0%)
Left	38	0/21 (0.0%)	0/12 (0.0%)	0 (0.0%)
Total	74	0/37 (0.0%)	0/29 (0.0%)	0 (0.0%)
Knee				
Right	41	1/22 (4.5%)	0/17 (0.0%)	1 (2.4%)
Left	40	1/20 (5.0%)	0/15 (0.0%)	1 (2.5%)
Total	81	2/42 (4.8%)	0/32 (0.0%)	2 (2.5%)

Table 5.11: Frequency rates for affected joints by osteoarthritis in the Vichte skeletal assemblage. The total count of hand bones (carpals, metacarpals and phalanges) could not be provided.

The CPR of pOA within the skeletal collection of known age and sex of Vichte is shown in fig. 5.12. There was a statistically significant difference between all age categories (p=0.009, Fisher's exact test 2-sided, n=44) and between the adult age groups of known sex (p=0.018, Fisher's exact test 2-sided, n=38). There was no statistically significant difference between males and females for pOA (x^2=2.108, df=1, p=0.147, n=42).

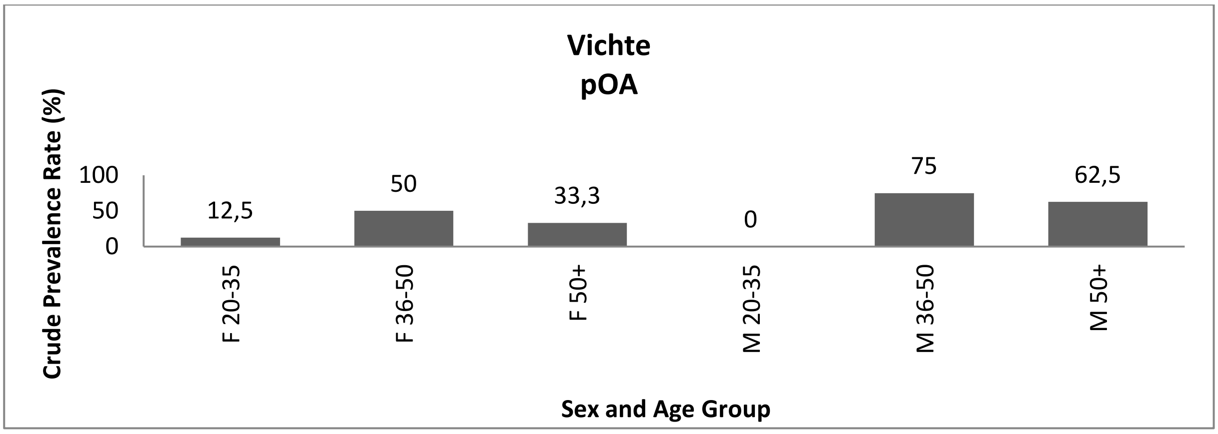

Fig. 5.12: CPR (Crude Prevalence Rate) in percentages for peripheral osteoarthritis (pOA) for each sex and age group within the Vichte skeletal assemblage.

* Zottegem

Eleven individuals were observed with pOA (11/37; 29.7%). From the 35 individuals with assigned biological sex: 6/21 (28.6%) were females and 5/14 (35.7%) were males.

Table 5.12 lists the TPR's and frequency rates of the affected joints.

Joint type/site	Total number of observable sites	Male	Female	Total (including individuals of unknown sex)
Sterno-clavicular				
Right	20	0/8 (0.0%)	1/11 (9.1%)	1 (5.0%)
Left	28	0/10 (0.0%)	3/17 (17.6%)	3 (10.7%)
Total	48	0/18 (0.0%)	4/28 (14.3%)	4 (8.3%)
Acromio-clavicular				
Right	23	1/9 (11.1%)	3/13 (23.1%)	4 (17.4%)
Left	28	0/10 (0.0%)	3/17 (17.6%)	3 (10.7%)
Total	51	1/19 (5.3%)	6/30 (20%)	7 (13.7%)
Shoulder				
Right	27	0/8 (0.0%)	0/18 (0.0%)	0 (0.0%)
Left	27	0/10 (0.0%)	0/16 (0.0%)	0 (0.0%)
Total	54	0/18 (0.0%)	0/34 (0.0%)	0 (0.0%)
Elbow				

Right	26	0/11 (0.0%)	0/14 (0.0%)	0 (0.0%)
Left	28	0/11 (0.0%)	0/16 (0.0%)	0 (0.0%)
Total	54	0/22 (0.0%)	0/30 (0.0%)	0 (0.0%)
Wrist+carpal bones				
Right	87	4/37 (10.8%)	0/49 (0.0%)	4 (4.6%)
Left	88	0/35 (0.0%)	1/51 (2.0%)	1 (1.1%)
Total	175	4/72 (5.5%)	1/100 (1.0%)	5 (2.8%)
Hand (metacarpals)				
Right	87	0/35 (0.0%)	1/50 (2.0%)	1 (1.1%)
Left	83	0/36 (0.0%)	2/45 (4.4%)	2 (2.4%)
Total	170	0/71 (0.0%)	3/95 (3.2%)	3 (1.8%)
Hand (phalanges)				
Right	124	0/54 (0.0%)	0/64 (0.0%)	0 (0.0%)
Left	127	0/54 (0.0%)	0/69 (0.0%)	0 (0.0%)
Total	251	0/108 (0.0%)	0/133 (0.0%)	0 (0.0%)
Hip				
Right	34	0/12 (0.0%)	1/21 (4.8%)	1 (2.9%)
Left	31	0/12 (0.0%)	1/18 (5.5%)	1 (3.2%)
Total	65	0/24 (0.0%)	2/39 (5.1%)	2 (3.1%)
Knee				
Right	22	0/7 (0.0%)	1/15 (6.7%)	1 (4.5%)
Left	21	0/8 (0.0%)	1/12 (8.3%)	1 (4.8%)
Total	43	0/15 (0.0%)	2/27 (7.4%)	2 (4.6%)

Table 5.12: Frequency rates for affected joints by osteoarthritis in the Zottegem skeletal assemblage.

The CPR of pOA within the skeletal collection of known age and sex of Zottegem is shown in fig. 5.13. There was no statistically significant difference between all age categories ($p=0.134$, Fisher's exact test 2-sided, $n=40$) and between the age groups of known sex ($p=0.178$, Fisher's exact test 2-sided, $n=24$). There was no statistically significant difference between males and females for pOA ($x^2=0.199$, $df=1$, $p=0.656$, $n=35$).

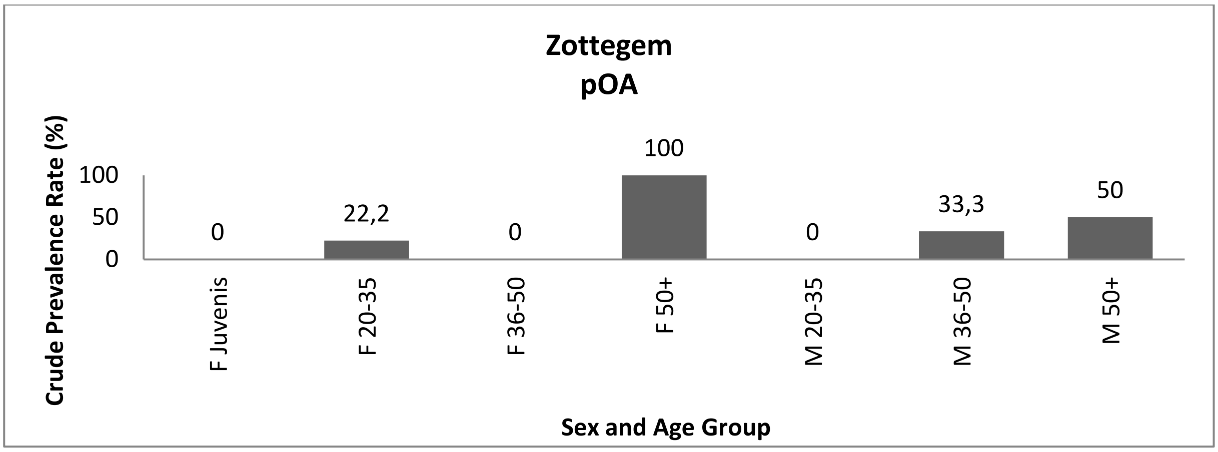

Fig. 5.13: CPR (Crude Prevalence Rate) in percentages for peripheral osteoarthritis (pOA) for each sex and age group within the Zottegem skeletal assemblage.

* Moorsel

Sixteen individuals from the complete collection were observed with pOA (42.1%; 16/38). From the 34 individuals with assigned biological sex: 6/16 (37.5%) were females and 9/18 (50.0%) were males.

Table 5.13 lists the TPR's and frequency rates of the affected joints.

Joint type/site	Total number of observable sites	Male	Female	Total (including individuals of unknown sex)
Sterno-clavicular				
Right	19	0/8 (0.0%)	0/10 (0.0%)	0 (0.0%)
Left	18	0/7 (0.0%)	0/11 (0.0%)	0 (0.0%)
Total	37	0/15 (0.0%)	0/21 (0.0%)	0 (0.0%)
Acromio-clavicular				
Right	19	0/8 (0.0%)	0/10 (0.0%)	0 (0.0%)
Left	19	0/7 (0.0%)	0/12 (0.0%)	0 (0.0%)
Total	38	0/15 (0.0%)	0/22 (0.0%)	0 (0.0%)
Shoulder				
Right	18	2/8 (25.0%)	0/9 (0.0%)	2 (11.1%)
Left	18	0/8 (0.0%)	0/9 (0.0%)	0 (0.0%)
Total	36	2/16 (12.5%)	0/18 (0.0%)	2 (5.5%)
Elbow				
Right	29	1/14 (7.1%)	2/12 (16.7%)	4 (13.8%)
Left	30	2/14 (14.3%)	2/13 (15.4%)	5 (16.7%)
Total	59	3/28 (10.7%)	4/25 (16.0%)	9 (15.2%)
Wrist+carpal bones				
Right	139	2/67 (3.0%)	2/59 (3.4%)	4 (2.9%)
Left	160	3/76 (3.9%)	1/69 (1.4%)	4 (2.5%)
Total	299	5/143 (3.5%)	3/128 (2.3%)	8 (2.7%)

Hand (metacarpals)				
Right	133	1/71 (1.4%)	1/53 (1.9%)	2 (1.5%)
Left	130	3/69 (4.3%)	0/47 (0.0%)	3 (2.3%)
Total	263	4/140 (2.8%)	1/100 (1.0%)	5 (1.9%)
Hand (phalanges)				
Right	225	0/122 (0.0%)	0/85 (0.0%)	0 (0.0%)
Left	256	15/145 (10.3%)	0/98 (0.0%)	15 (5.8%)
Total	481	15/267 (5.6%)	0/183 (0.0%)	15 (3.1%)
Hip				
Right	29	0/13 (0.0%)	1/14 (7.1%)	1 (7.1%)
Left	28	0/12 (0.0%)	1/14 (7.1%)	1 (7.1%)
Total	57	0/25 (0.0%)	2/28 (7.1%)	2 (3.5%)
Knee				
Right	30	4/16 (25.0%)	2/12 (16.7%)	6 (20.0%)
Left	27	4/14 (28.6%)	1/11 (9.1%)	5 (18.5%)
Total	57	8/30 (26.7%)	3/23 (13.0%)	11 (19.3%)

Table 5.13: Frequency rates for affected joints by osteoarthritis in the Moorsel skeletal assemblage.

The CPR of pOA within the skeletal collection of known age and sex of Moorsel is shown in fig. 5.14. The CPR for pOA for the adult assemblage of known sex and age of Moorsel was 37.5% (9/24). Subadults were not identified with pOA. There was no statistically significant difference between all age categories ($p=0.208$, Fisher's exact test 2-sided, $n=38$) and between the age groups of known sex ($p=0.497$, Fisher's exact test 2-sided, $n=24$). There was no statistically significant difference between adult males and females for pOA ($x^2=0.537$, $df=1$, $p=0.464$, $n=34$).

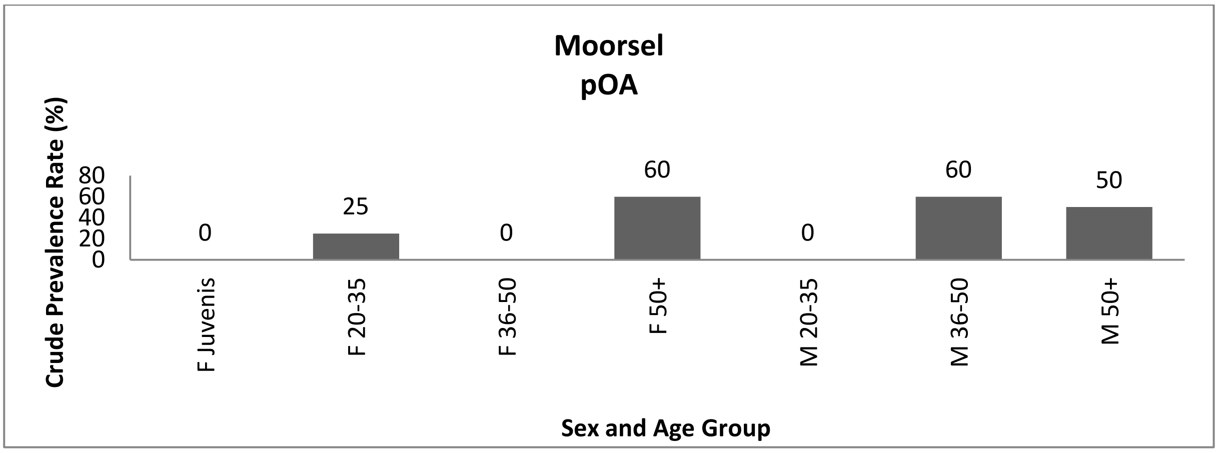

Fig. 5.14: CPR (Crude Prevalence Rate) in percentages for peripheral osteoarthritis (pOA) for each sex and age group within the Moorsel skeletal assemblage.

* Oosterweel

Three individuals of the total collection were observed with pOA (3/18; 16.7%). From the seventeen individuals with assigned biological sex: 1/8 (12.5%) was female and 2/9 (22.2%) were males.

Table 5.14 lists the TPR's and frequency rates of the affected joints.

Joint type/site	Total number of observable sites	Male	Female	Total (including individuals of unknown sex)
Sterno-clavicular				
Right	14	0/7 (0.0%)	0/7 (0.0%)	0 (0.0%)
Left	16	1/9 (11.1%)	0/7 (0.0%)	1 (6.2%)
Total	30	1/16 (6.2%)	0/14 (0.0%)	1 (3.3%)
Acromio-clavicular				
Right	14	0/7 (0.0%)	0/7 (0.0%)	0 (0.0%)
Left	15	0/9 (0.0%)	0/6 (0.0%)	0 (0.0%)
Total	29	0/16 (0.0%)	0/13 (0.0%)	0 (0.0%)
Shoulder				
Right	11	0/5 (0.0%)	0/6 (0.0%)	0 (0.0%)
Left	16	0/8 (0.0%)	0/7 (0.0%)	0 (0.0%)
Total	27	0/13 (0.0%)	0/13 (0.0%)	0 (0.0%)
Elbow				
Right	15	0/6 (0.0%)	0/8 (0.0%)	0 (0.0%)
Left	18	0/9 (0.0%)	0/8 (0.0%)	0 (0.0%)
Total	33	0/15 (0.0%)	0/16 (0.0%)	0 (0.0%)
Wrist+carpal bones				
Right	46	0/22 (0.0%)	0/24 (0.0%)	0 (0.0%)
Left	59	0/34 (0.0%)	0/25 (0.0%)	0 (0.0%)
Total	105	0/56 (0.0%)	0/49 (0.0%)	0 (0.0%)
Hand (metacarpals)				
Right	25	0/15 (0.0%)	0/10 (0.0%)	0 (0.0%)
Left	30	0/16 (0.0%)	0/14 (0.0%)	0 (0.0%)
Total	55	0/31 (0.0%)	0/24 (0.0%)	0 (0.0%)
Hand (phalanges)				
Right	28	0/17 (0.0%)	0/11 (0.0%)	0 (0.0%)
Left	42	0/20 (0.0%)	0/22 (0.0%)	0 (0.0%)
Total	70	0/37 (0.0%)	0/33 (0.0%)	0 (0.0%)
Hip				
Right	13	0/5 (0.0%)	0/7 (0.0%)	0 (0.0%)
Left	19	1/10 (10.0%)	0/8 (0.0%)	1 (5.3%)
Total	32	1/15 (6.7%)	0/15 (0.0%)	1 (3.1%)
Knee				
Right	14	2/6 (33.3%)	1/7 (14.3%)	3 (21.4%)
Left	15	2/7 (28.6%)	1/7 (14.3%)	3 (20.0%)
Total	29	4/13 (30.8%)	2/14 (14.3%)	6 (20.7%)

Table 5.14: Frequency rates for affected joints by osteoarthritis in the Oosterweel skeletal assemblage.

The CPR of pOA within the skeletal collection of known age and sex of Oosterweel is shown in fig. 5.15. pOA was not present in subadults and in young adults. There was no statistically significant difference between all age categories (p=0.206, Fisher's exact test 2-sided, n=18) and between the age groups of known sex (p=0.103, Fisher's exact test 2-sided, n=15). There was no statistically significant difference between adult males and females for pOA (x^2=0.275, df=1, p=0.600, n=17).

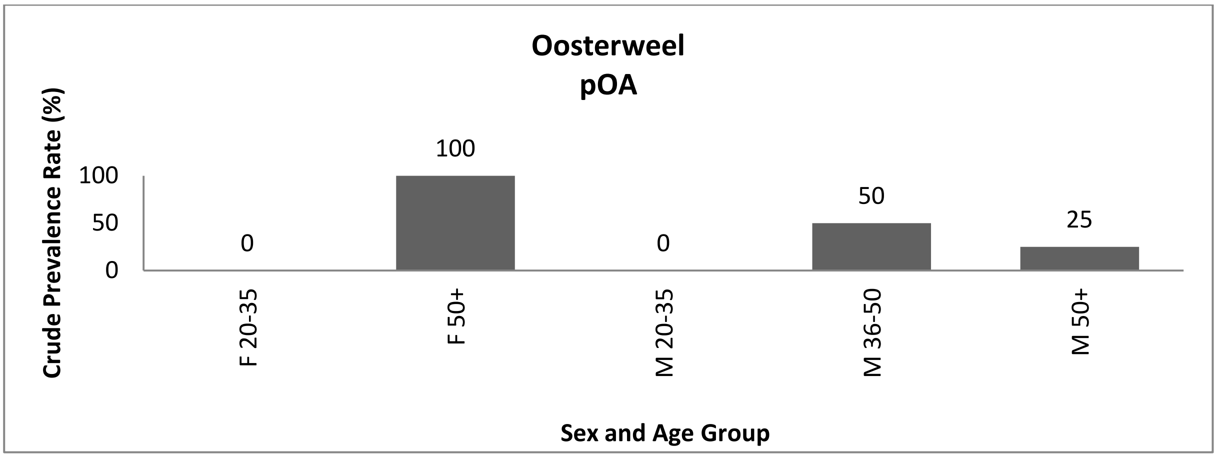

Fig. 5.15: CPR (Crude Prevalence Rate) in percentages for peripheral osteoarthritis (pOA) for each sex and age group within the Oosterweel skeletal assemblage.

Table 5.15 lists the number of young, middle and old adult individuals of known sex observed with OA in the six sites by age, sex and affected joint. OA was not observed within the juvenile age category.

Joint	Age	Deinze				Oosterweel				Moorsel				Slijpe				Vichte				Zottegem			
		M	F	Total %		M	F	Total %		M	F	Total %		M	F	Total %		M	F	Total %		M	F	Total %	
		n/N		M	F	n/N		M	F	n/N		M	F	n/N		M	F	n/N		M	F	n/N		M	F
SCJ																									
	YA	0/10	0/11	0.0	0.0	0/4	0/5	0.0	0.0	0/1	0/4	0.0	0.0	0/6	0/18	0.0	0.0	0/6	0/8	0.0	0.0	0/4	1/9	0.0	11.1
	MA	3/8	0/8	37.5	0.0	0/2	0/0	0.0	0.0	0/5	0/1	0.0	0.0	0/8	0/5	0.0	0.0	1/9	0/2	11.1	0.0	0/3	0/3	0.0	0.0
	OA	3/12	2/10	25.0	20.0	1/4	0/1	25.0	0.0	0/3	0/2	0.0	0.0	2/9	1/8	22.2	12.5	0/9	0/6	0.0	0.0	0/2	1/2	0.0	50.0
ACJ												0.0	0.0												
	YA	0/10	0/11	0.0	0.0	0/4	0/5	0.0	0.0	0/1	0/4	0.0	0.0	0/6	0/18	0.0	0.0	0/6	0/8	0.0	0.0	0/4	1/9	0.0	11.1
	MA	1/8	0/8	12.5	0.0	0/2	0/0	0.0	0.0	0/5	0/1	0.0	0.0	0/8	1/5	0.0	20.0	4/9	1/2	44.4	50.0	0/3	0/3	0.0	0.0
	OA	2/12	1/10	16.7	10.0	0/4	0/1	0.0	0.0	0/3	0/2	0.0	0.0	2/9	0/8	22.2	0.0	4/9	2/6	44.4	33.3	0/2	1/2	0.0	50.0
Shoulder												0.0	0.0												
	YA	0/10	0/11	0.0	0.0	0/4	0/5	0.0	0.0	0/1	0/4	0.0	0.0	0/6	1/18	0.0	5.5	0/6	0/8	0.0	0.0	0/4	0/9	0.0	0.0
	MA	2/8	0/8	25.0	0.0	0/2	0/0	0.0	0.0	1/5	0/1	20.0	0.0	0/8	1/5	0.0 -	20.0	0/9	0/2	0.0	0.0	0/3	0/3	0.0	0.0
	OA	2/12	0/10	16.7	0.0	0/4	0/1	0.0	0.0	0/3	0/2	0.0	0.0	0/9	0/8	0.0	0.0	1/9	0/6	11.1	0.0	0/2	0/2	0.0	0.0
Elbow								0.0	0.0															0.0	0.0
	YA	0/10	0/11	0.0	0.0	0/4	0/5	0.0	0.0	0/1	1/4	0.0	25.0	0/6	1/18	0.0	5.5	0/6	1/8	0.0	12.5	0/4	0/9	0.0	0.0
	MA	0/8	0/8	0.0	0.0	0/2	0/0	0.0	0.0	0/5	0/1	0.0	0.0	0/8	0/5	0.0	0.0	0/9	0/2	0.0	0.0	0/3	0/3	0.0	0.0
	OA	2/12	1/10	16.7	10.0	0/4	0/1	0.0	0.0	1/3	1/2	33.3	50.0	0/9	0/8	0.0	0.0	0/9	0/6	0.0	0.0	0/2	0/2	0.0	0.0
Wrist								0.0	0.0															0.0	0.0
	YA	0/10	0/11	0.0	0.0	0/4	0/5	0.0	0.0	0/1	0/4	0.0	0.0	0/6	0/18	0.0	0.0	0/6	0/8	0.0	0.0	0/4	0/9	0.0	0.0
	MA	1/8	2/8	12.5	25.0	0/2	0/0	0.0	0.0	1/5	0/1	20.0	0.0	0/8	0/5	0.0	0.0	2/9	0/2	22.2	0.0	1/3	0/3	33.3	0.0
	OA	2/12	0/10	16.7	0.0	0/4	0/1	0.0	0.0	1/3	1/2	33.3	50.0	0/9	2/8	0.0	25.0	2/9	0/6	22.2	0.0	1/2	0/2	50.0	0.0
Hand								0.0	0.0																
	YA	0/10	0/11	0.0	0.0	0/4	0/5	0.0	0.0	0/1	0/4	0.0	0.0	0/6	1/18	0.0	5.5	0/6	0/8	0.0	0.0	0/4	0/9	0.0	0.0
	MA	1/8	1/8	12.5	12.5	0/2	0/0	0.0	0.0	1/5	0/1	20.0	0.0	0/8	0/5	16.7	0.0	1/9	0/2	11.1	0.0	0/3	0/3	0.0	0.0
	OA	4/12	1/10	33.3	10.0	0/4	0/1	0.0	0.0	1/3	1/2	33.3	50.0	1/9	2/8	11.1	25.0	3/9	0/6	33.3	0.0	0/2	1/2	0.0	50.0
Hip								0.0	0.0																
	YA	0/10	0/11	0.0	0.0	0/4	0/5	0.0	0.0	0/1	0/4	0.0	0.0	0/6	0/18	0.0	0.0	0/6	0/8	0.0	0.0	0/4	0/9	0.0	0.0
	MA	2/8	1/8	25.0	12.5	0/2	0/0	0.0	0.0	0/5	0/1	0.0	0.0	0/8	0/5	0.0	0.0	0/9	0/2	0.0	0.0	0/3	0/3	0.0	0.0
	OA	1/12	0/10	8.3	0.0	0/4	0/1	0.0	0.0	0/3	1/2	0.0	50.0	1/9	0/8	11.1	0.0	0/9	0/6	0.0	0.0	0/2	1/2	0.0	0.0
Knee								0.0	0.0											0.0	0.0			0.0	0.0
	YA	0/10	0/11	0.0	0.0	0/4	0/5	0.0	0.0	0/1	0/4	0.0	0.0	0/6	0/18	0.0	0.0	0/6	0/8	0.0	0.0	0/4	0/9	0.0	0.0
	MA	0/8	1/8	0.0	12.5	1/2	0/0	50.0	0.0	2/5	0/1	40.0	0.0	0/8	0/5	0.0	0.0	0/9	0/2	0.0	0.0	0/3	0/3	0.0	0.0
	OA	1/12	0/10	8.3	0.0	0/4	1/1	0.0	100.0	0/3	1/2	0.0	50.0	0/9	0/8	0.0	0.0	2/9	0/6	22.2	0.0	0/2	1/2	0.0	50.0

Table 5.15: Number of adult individuals of known sex observed with OA in the six sites by age, sex and affected joint. YA=young adult; MA=middle adult; OA=old adult; SCJ=sterno-clavicular joint; ACJ=acromio-clavicular joint; n=count of affected joint sites, N=count of total number of individuals.

5.4.1.2. OA of the Spine in the Six Sites

* Deinze

For Deinze, 14/85 (16.5%) individuals (adult+juvenis) were observed with vOA: 5/38 (13.2%) were female individuals and 9/37 (24.3%) were males affected (fig. 5.). There was no statistically significant difference between males and females for vOA (x^2=1.540, df=1, p=0.215, n=75). There was a statistically significant difference between the age groups of known sex (p=0.038, Fisher's exact test 2-sided, n=66) (fig. 5.16). Vertebral OA was mostly observed with old adult males (54.5%; 6/11) and old adult females (20%; 2/10).

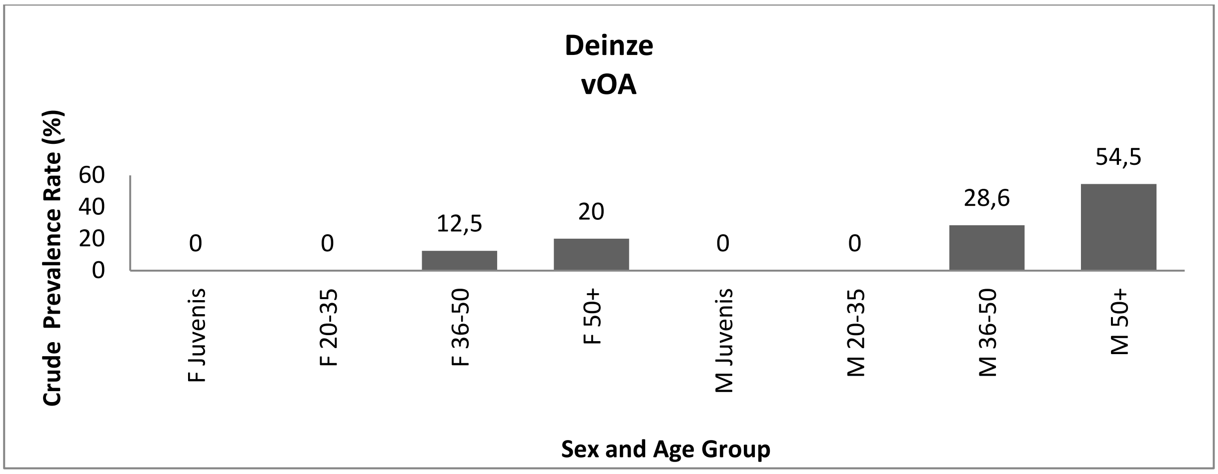

Fig. 5.16: CPR (Crude Prevalence Rate) in percentages for individuals affected with vertebral osteoarthritis (vOA) for each sex and age group within the Deinze skeletal assemblage.

* Slijpe

For Slijpe, 19/61 (31.1%) individuals (all adults+juvenis) were observed with vOA: 8/34 (23.5%) were female individuals and 11/24 (45.8%) were males affected (fig. 5.17). Three unaffected adults were of unknown sex.

There was no statistically significant difference between males and females for vOA (x^2=3.177, df=1, p=0.075, n=58). There was a statistically significant difference between all age groups (p=0.002, Fisher's exact test 2-sided, n=72), and between the age groups of known sex (p=0.012, Fisher's exact test 2-sided, n=54). vOA was mostly observed with old adult males (66.7%; 6/9) and old adult females (50%; 4/8).

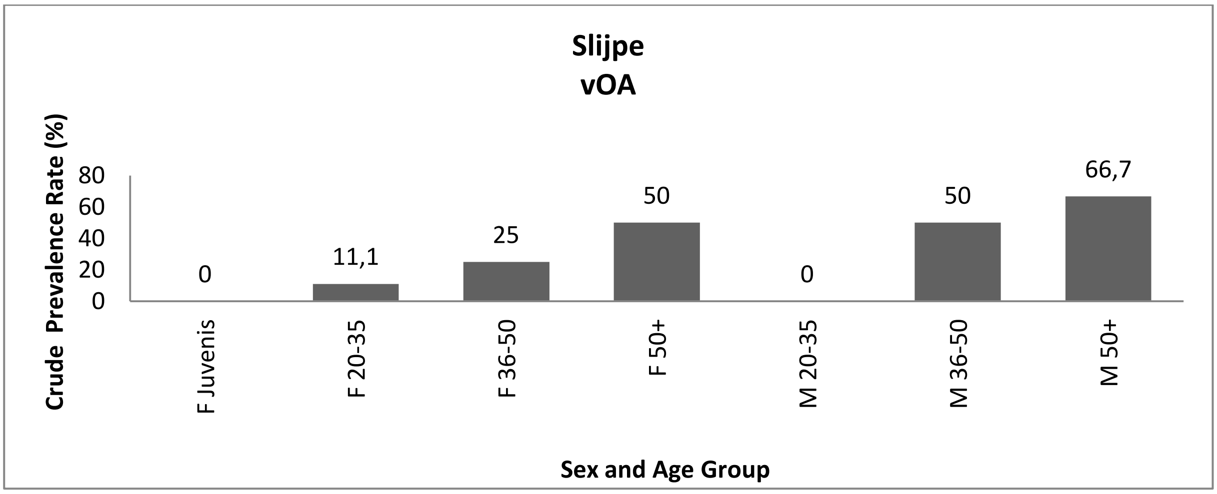

Fig. 5.17: CPR (Crude Prevalence Rate) in percentages for individuals affected with vertebral osteoarthritis (vOA) for each sex and age group within the Slijpe skeletal assemblage.

* Vichte

For Vichte, 15/46 (32.6%) individuals (adults+juvenis) were observed with vOA: 5/16 (31.3%) were female individuals and 10/23 (43.5%) were males affected (fig. 5.18). There was no statistically significant difference between males and females for vOA (x^2=0.596, df=1, p=0.440, n=39). There was a statistically significant difference between all age groups (p<0.001, Fisher's exact test 2-sided, n=41), and between the age groups of known sex (p=0.003, Fisher's exact test 2-sided, n=37). vOA was mostly observed in both old adult males (75%; 6/8) and females (60%; 3/5).

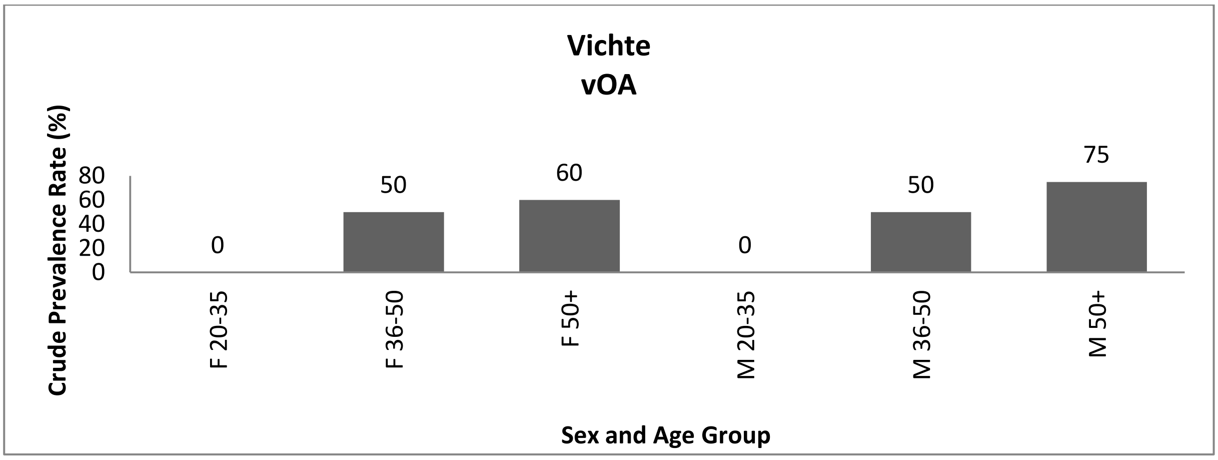

Fig. 5.18: CPR (Crude Prevalence Rate) in percentages for individuals affected with vertebral osteoarthritis (vOA) for each sex and age group within the Vichte skeletal assemblage.

* Zottegem

For Zottegem, 10/42 (23.8%) individuals (adults+juvenis) were observed with vOA: 4/21 (19%) were female individuals and 6/12 (50%) were males affected (fig. 5.19).
There was no statistically significant difference between males and females for vOA (x^2=3.464, df=1, p=0.063, n=33). There was a statistically significant difference between all age groups (p=0.003, Fisher's exact test 2-sided, n=35) and between the age groups of known sex (p=0.034, Fisher's exact test 2-sided n=22). vOA was mostly observed in old adult males and females.

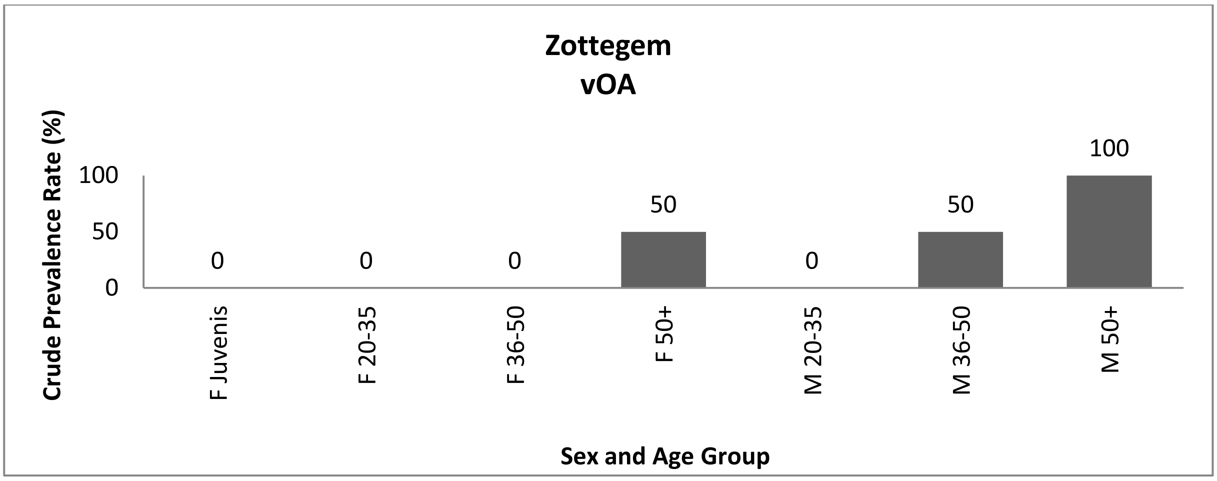

Fig. 5.19: CPR (Crude Prevalence Rate) in percentages for individuals affected with vertebral osteoarthritis (vOA) for each sex and age group within the Zottegem skeletal assemblage.

* Moorsel

For Moorsel, 6/36 (16.7%) individuals (adults+juvenis) were observed with vOA: 2/13 (15.4%) were female individuals and 4/16 (25%) were males affected (fig. 5.20).

There was no statistically significant difference between males and females for vOA (x^2=0.404, df=1, p=0.525, n=29). There was no statistically significant difference between all age groups (p=0.287, Fisher's exact test 2-sided, n=33) and between the age groups of known sex (p=0.839, Fisher's exact test 2-sided, n=22). vOA was mostly observed in old adult males and females.

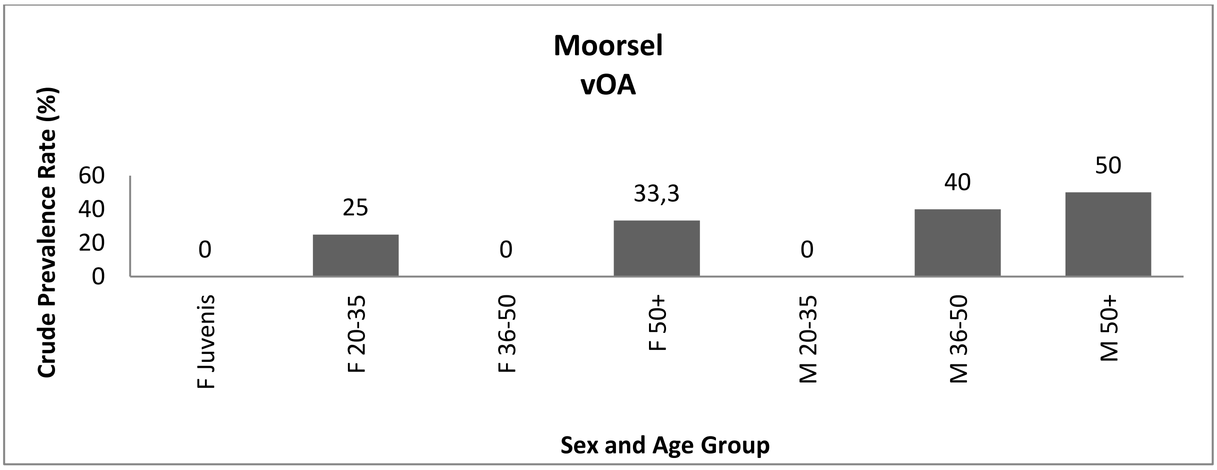

Fig. 5.20: CPR (Crude Prevalence Rate) in percentages for individuals affected with vertebral osteoarthritis (vOA) for each sex and age group within the Moorsel skeletal assemblage.

* Oosterweel

For Oosterweel, 2/19 (10.5%) individuals (adults+juvenis) were observed with vOA: none were female individuals (0.0%; 0/8) and 2/8 (25.0%) were males affected (fig. 5.21).
There was no statistically significant difference between males and females for vOA (x^2=2.286, df=1, p=0.131, n=16). There was no statistically significant difference between all age groups (p=0.324, Fisher's exact test 2-sided, n=17) and between the age groups of known sex (p=0.352, Fisher's exact test 2-sided, n=14). vOA was only observed in middle and old adult males.

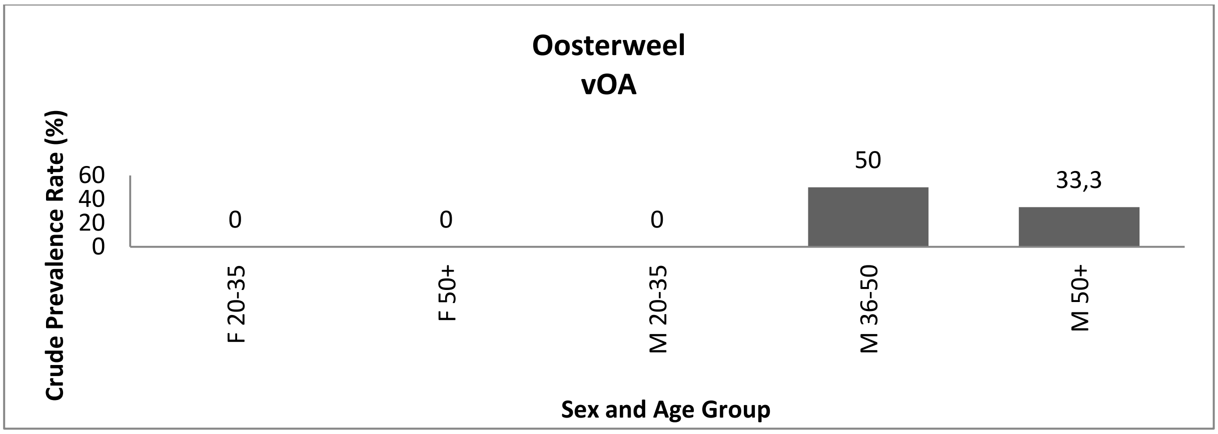

Fig. 5.21: CPR (Crude Prevalence Rate) in percentages for individuals affected with vertebral osteoarthritis (vOA) for each sex and age group within the Oosterweel skeletal assemblage.

Table 5.16 presents the TPR's of affected vertebrae of the total count diagnosed in individuals with observable elements within the male and female skeletal collections. Table 5.18 shows the frequency rates of vOA in the adult age categories. For Vichte, it was not possible to provide the total count of cervical, thoracic and lumbar vertebrae due to loss of data, therefore to present comparative data with the five other skeletal collections, the total count of male and female spines available for analysis is shown in tables, including the number of affected male and female spines.

Vertebra type		Deinze			Oosterweel			Moorsel			Slijpe			Zottegem		
		M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total
		n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N
Cervical		36/216	10/199	46/415	2/21	0/47	2/68	17/49	12/54	29/103	53/144	37/205	90/349	13/35	15/82	28/117
	%	16.7	5.02	11.1	9.5	0.0	2.9	34.7	22.2	28.1	36.8	18.0	25.8	37.1	18.3	23.9
Thoracic		0/392	6/374	6/766	1/59	0/71	1/130	0/89	0/81	0/170	0/271	4/368	4/639	0/64	0/134	0/198
	%	0.0	1.6	0.8	1.7	0.0	0.8	0.0	0.0	0.0	0.0	1.1	0.6	0.0	0.0	0.0
Lumbar		0/159	0/142	0/301	0/27	0/35	0/62	0/48	0/37	0/85	0/120	0/135	0/255	0/34	0/57	0/91
	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total		36/767	16/715	52/1482	3/107	0/153	3/260	17/186	12/172	29/358	53/535	41/708	94/1243	13/133	15/273	28/406
	%	4.7	2.2	0.03	2.8	0.0	1.1	9.1	7.0	8.1	9.9	5.8	7.6	9.8	5.5	6.7

Table 5.16: TPR's of vertebral osteoarthritis (vOA) in the adult skeletal collections of known sex. n=number of affected vertebra type; N=total count of vertebra type.

Table 5.17 presents the p-values of the TPR's for vOA between males and females of the six sites (using the raw data of table 5.16). Statistically significant differences are listed in bold.

Site	p-value
Deinze	**0.002**
Oosterweel	0.068
Moorsel	0.227
Slijpe	**0.003**
Zottegem	0.055

Table 5.17: P-values for TPR's of vOA between males and females. One tailed Fisher's exact test was applied for Oosterweel; Chi-Square test of independence for the other case studies. Statistically significant results are shown in bold.

Age	Deinze				Oosterweel				Moorsel				Slijpe				Vichte				Zottegem			
	M	F	Total %		M	F	Total %		M	F	Total %		M	F	Total %		M	F	Total %		M	F	Total %	
	n/N		M	F	n/N		M	F	n/N		M	F	n/N		M	F	n/N		M	F	n/N		M	F
YA	0/8	0/10	0.0	0.0	0/2	0/4	0.0	0.0	0/1	1/4	0.0	25.0	1/6	2/17	16.7	11.8	0/6	0/7	0.0	0.0	0/3	0/9	0.0	0.0
MA	2/7	1/8	28.6	12.5	1/2	0/0	50.0	0.0	1/4	0/1	25.0	0.0	3/8	1/5	37.5	20.0	4/8	1/1	50.0	100.0	1/1	0/3	100.0	0.0
OA	6/11	2/10	54.5	20.0	1/3	0/1	33.3	0.0	3/4	0/3	75.0	0.0	6/9	4/8	66.7	50.0	6/7	3/5	85.7	60.0	1/1	1/2	100.0	50.0

Table 5.18: Frequency rates of vertebral osteoarthritis (vOA) in the male and female adult age groups considering skeletal individuals with spinal elements available for analysis. n=number of affected individuals; N=total count of individuals with spinal elements available for analysis. YA=young adult; MA=middle adult; OA=old adult.

When considering males and females of the adult groups of known age only (young, middle and old adults) of all sites: the difference between the Deinze male and female adults for vOA was statistically significant (x^2=3.343, p=0.034). For Oosterweel, the difference between males and females was not statistically significant (p=0.067, one tailed Fisher's exact test). Also for Moorsel, the difference between male and female adults for vOA was not statistically significant (p=0.318, one tailed Fisher's exact test) as well as for Slijpe: p=0.183, one tailed Fisher's exact test; Vichte: x^2=2.425; p=0.060; Zottegem: p=0.272, one tailed Fisher's exact test).

Deinze			Oosterweel			Moorsel			Slijpe			Vichte			Zottegem		
M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total
n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N
Spine	**Spine**	**Spine**	**Spine**	**Spine**	**Spine**	**Spine**	**Spine**	**Spine**	**Spine**	**Spine**	**Spine**	**Spine**	**Spine**	**Spine**	**Spine**	**Spine**	**Spine**
9/33	4/35	13/68	2/7	0/7	2/14	4/13	2/10	6/23	11/24	8/33	19/57	10/23	5/13	15/36	6/7	4/15	10/22
27.3%	11.4%	19.1%	28.6%	0.0%	14.3%	30.8%	20.0%	26.1%	45.9%	24.2%	33.3%	43.5%	38.5%	41.7%	85.7%	26.7%	45.4%

Table 5.19: Frequency rates in percentages of vertebral osteoarthritis (vOA) in the skeletal individuals of known sex considering skeletal individuals with spinal elements available for analysis. n=number of spines affected; N=total count of spines.

Table 5.18 presents the number of male and female spines affected with vOA in the six sites. For Deinze, there was a statistically significant difference between males and females (x^2=2.758, p=0.048) as well as for Slijpe (x^2=2.915, p=0.043) and Zottegem (p=0.015, one tailed Fisher's exact test). For Oosterweel, the difference between males and females was not statistically significant (p=0.231, one tailed Fisher's exact test). Also for Moorsel, the difference between male and female spines affected with vOA was not statistically significant (p=0.463, one tailed Fisher's exact test) as well as for Vichte: x^2=0.086; p=0.385.

Tables 5.20 to 5.23 present the TPR's and frequency rates of degenerative disc disease (DDD) in the adult skeletal collections of known sex and age.

DDD		Deinze			Oosterweel			Moorsel			Slijpe			Zottegem		
		M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total
		n/N	n/N	n/N	n/N		n/N	n/N		n/N	n/N		n/N	n/N		n/N
Cervical		17/216	10/199	27/415	0/21	0/47	0/68	2/49	3/54	5/103	34/144	17/205	51/349	9/35	3/82	12/117
	%	7.9	5.0	6.5	0.0	0.0	0.0	4.1	5.6	4.8	23.6	8.3	14.6	25.7	3.6	10.2
Thoracic		57/392	50/374	107/766	13/59	4/71	17/130	26/89	4/81	30/170	99/271	68/368	167/639	12/64	16/134	28/198
	%	14.5	13.4	14.0	22.0	5.6	13.1	29.2	4.9	17.6	36.5	18.5	26.1	18.7	11.9	14.1
Lumbar		60/159	27/142	87/301	6/27	6/35	12/62	26/48	3/37	29/85	76/120	56/135	132/255	17/34	13/57	30/91
	%	37.7	19.0	28.9	22.2	17.1	19.3	54.2	8.1	34.1	63.3	41.5	51.8	50.0	22.8	33.0
Total		134/767	87/715	221/1482	19/107	10/153	29/260	54/186	10/172	64/358	209/535	141/708	350/1243	38/133	32/273	70/406
	%	17.5	12.2	14.9	17.8	6.5	11.1	29.0	5.8	17.9	39.1	19.9	28.1	28.6	11.7	17.2

Table 5.20: TPR's of degenerative disc disease (DDD) in the adult skeletal collections of known sex. n=number of affected vertebra type; N=total count of vertebra type.

Table 5.21 shows p-values of the TPR's for DDD between males and females of the six sites (using the raw data of table 5.20). Statistically significant differences are listed in bold.

Site	p-value
Deinze	**0.002**
Oosterweel	**0.002**
Moorsel	**<0.001**
Slijpe	**<0.001**
Zottegem	**<0.001**

Table 5.21: P-values for TPR's of DDD between males and females. Chi-Square test of independence was applied for all sites. Statistically significant results are shown in bold.

Age	Deinze				Oosterweel				Moorsel				Slijpe				Vichte				Zottegem			
	M	F	Total %		M	F	Total %		M	F	Total %		M	F	Total %		M	F	Total %		M	F	Total %	
	n/N		M	F	n/N		M	F	n/N		M	F	n/N		M	F	n/N		M	F	n/N		M	F
YA	1/11	1/10	9.1	10.0	1/2	1/4	50.0	25.0	0/1	2/4	0.0	50.0	5/6	8/17	83.3	47.0	0/6	1/7	0.0	14.3	0/3	1/9	0.0	11.1
MA	6/7	4/8	85.7	50.0	2/2	0/0	100.0	0.0	4/4	0/1	100.0	0.0	6/8	5/5	75.0	100.0	8/8	1/1	100.0	100.0	2/2	2/3	100.0	66.7
OA	9/11	6/10	81.9	60.0	3/3	0/1	100.0	0.0	3/4	1/1	75.0	100.0	9/9	8/8	100.0	100.0	8/8	6/6	100.0	100.0	1/1	2/2	100.0	100.0

Table 5.22: Frequency rates of degenerative disc disease (DDD) in the male and female adult age groups considering skeletal individuals with spinal elements available for analysis. n=number of affected individuals; N=total count of individuals with spinal elements available for analysis. YA=young adult; MA=middle adult; OA=old adult.

When considering males and females from the adult groups of known age only (young, middle and old adults) of all sites: the difference between the Deinze male and female adults for DDD was not statistically significant (x^2=1.442, p=0.115). For Oosterweel, the difference between males and females was statistically significant (p=0.045, one tailed Fisher's exact test). For Moorsel, the difference between male and female adults for DDD was not statistically significant (p=0.287, one tailed Fisher's exact test) as well for Slijpe: x^2=2.137, p=0.072; Vichte: p=0.271, one tailed Fisher's exact test; Zottegem: p=0.455, one tailed Fisher's exact test).

Deinze			Oosterweel			Moorsel			Slijpe			Vichte			Zottegem		
M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total
n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N
Spine	Spine	Spine	Spine	Spine	Spine	Spine	Spine	Spine	Spine	Spine	Spine	Spine	Spine	Spine	Spine	Spine	Spine
18/33	12/35	30/68	6/7	2/7	8/14	9/13	3/10	12/23	21/24	23/33	44/57	17/23	8/13	25/36	6/7	5/15	11/22
54.5%	34.3%	44.1%	85.7	28.6	57.1	69.2%	30.0%	52.2%	87.5%	69.7%	77.2%	73.9%	61.5	69.4%	85.7%	33.3%	50.0%

Table 5.23: Frequency rates in percentages of degenerative disc disease (DDD) in the skeletal individuals of known sex considering skeletal individuals with spinal elements available for analysis. n=number of spines affected; N=total count of spines.

Table 5.23 presents the number of male and female spines affected with DDD in the six sites. For Deinze, there was a statistically significant difference between males and females (x^2=2.828, p=0.046) as well as for Oosterweel (p=0.020, one tailed Fisher's exact test), Slijpe (x^2=1.463, p<0.001) and Zottegem (p=0.032, one tailed Fisher's exact test). For Moorsel, the difference between male and female spines affected with DDD was not statistically significant (p=0.073, one tailed Fisher's exact test) as well as for Vichte: p=0.342, one tailed Fisher's exact test).

* Deinze

For Deinze, 31/85 (36.5%) individuals (adult+juvenis) were observed with DDD: 12/38 (31.6%) were female individuals and 19/37 (51.4%) were males affected (fig. 5.22). One individual is of unknown sex. The difference for DDD between males and females was not statistically significant (x^2=3.022, df=1, p=0.082, n=75). There was a statistically significant difference for DDD between the age groups of known sex (p=0.001, Fisher's exact test 2-sided, n=66) and between all age groups (p<0.001, Fisher's exact test 2-sided, n=93). DDD was mostly observed with middle adult males (85.7%; 6/7) and old adult females (60%; 6/10).

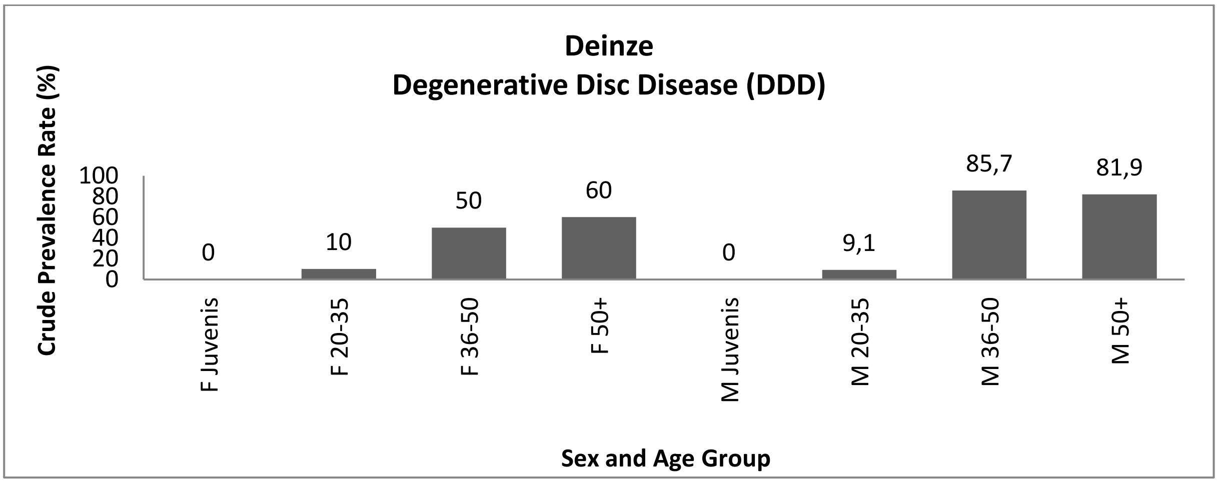

Fig. 5.22: CPR (Crude Prevalence Rate) in percentages for individuals affected with Degenerative Disc Disease (DDD) for each sex and age group within the Deinze skeletal assemblage.

* Slijpe

For Slijpe, 44/61 (72.1%) individuals (adult+juvenis) were observed with DDD: 24/34 (70.6%) were female individuals and 21/24 (87.5%) were males affected (fig. 5.23). The difference for DDD between males and females was not statistically significant (x^2=2.314, df=1, p=0.128, n=58). There was a statistically significant difference for DDD between all age groups (p<0.001, Fisher's exact test 2-sided, n=72), and between the age categories of known sex (p=0.001, Fisher's exact test 2-sided, n=54). DDD was identified in all middle and old adult males and females (60%; 6/10).

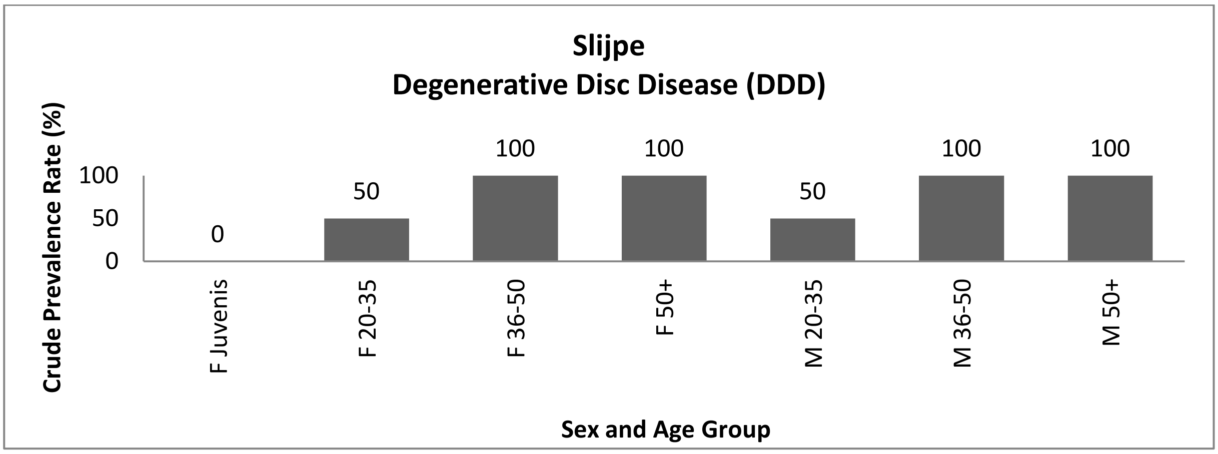

Fig. 5.23: CPR (Crude Prevalence Rate) in percentages for individuals affected with Degenerative Disc Disease (DDD) for each sex and age group within the Slijpe skeletal assemblage.

* Vichte

For Vichte, 25/42 (59.5%) individuals (adults+juvenis) were observed with DDD: 8/17 (47.1%) were female individuals and 17/23 (73.9%) were males affected (fig. 5.24). The difference for DDD between males and females was not statistically significant (x^2=3.008, df=1, p=0.083, n=40). There was a statistically significant difference for DDD between all age groups (p<0.001, Fisher's exact test 2-sided, n=42) and between the adult age groups (p<0.001, Fisher's exact test 2-sided, n=38). DDD was observed in all middle and old adult males (both 100%; 8/8) and in all old adult females (100%;6/6).

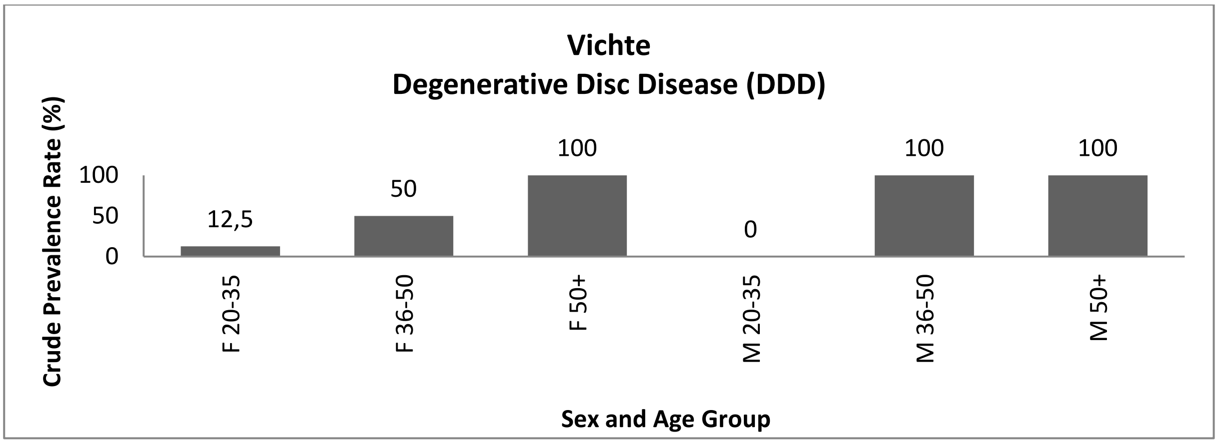

Fig. 5.24: CPR (Crude Prevalence Rate) in percentages for individuals affected with Degenerative Disc Disease (DDD) for each sex and age group within the Vichte skeletal assemblage.

* Zottegem

For Zottegem, 11/42 (26.2%) individuals (adult+juvenis) were observed with DDD: 5/21 (23.8%) were female individuals and 6/13 (46.2%) were males affected (fig. 5.25).
The difference for DDD between males and females was not statistically significant (x^2=1.832, df=1, p=0.176, n=34). There was no statistically significant difference for DDD between all age groups (p=0.052, Fisher's exact test 2-sided, n=36), and between the age categories of known sex (p=0.211, Fisher's exact test 2-sided, n=24). DDD was identified in all old adult females (100%; 2/2) and mostly observed in middle adult males (66.7%; 2/3).

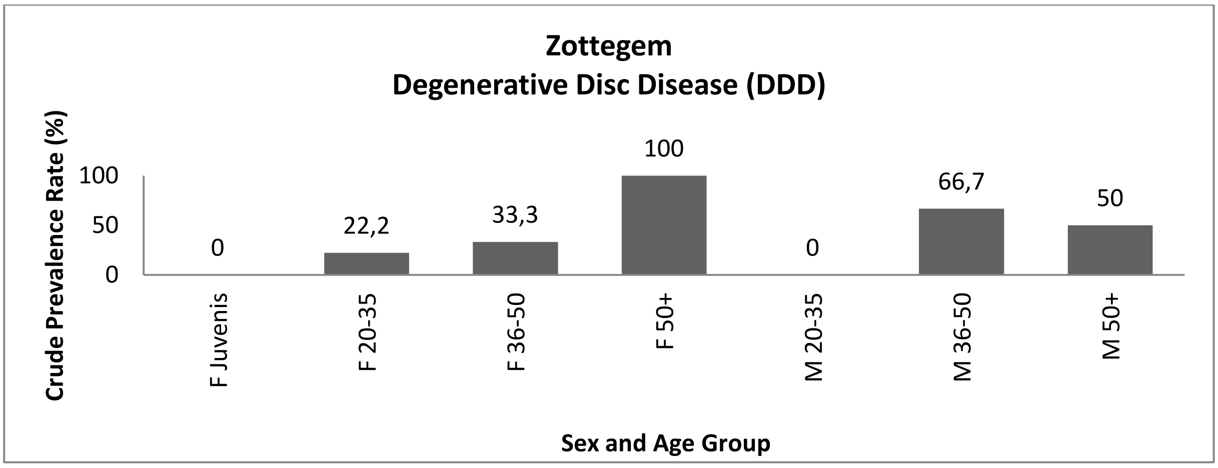

Fig. 5.25: CPR (Crude Prevalence Rate) in percentages for individuals affected with Degenerative Disc Disease (DDD) for each sex and age group within the Zottegem skeletal assemblage.

* Moorsel

For Moorsel, 13/36 (36.1%) individuals (adult+juvenis) were observed with DDD: 3/13 (23.1%) were female individuals and 9/16 (56.3%) were males affected (fig. 5.26). One individual is of unknown sex. The difference for DDD between males and females was not statistically significant (x^2=3.254, df=1, p=0.071, n=29). There was no statistically significant difference for DDD between all age groups (p=0.185, Fisher's exact test 2-sided, n=33) and between the age categories of known sex (p=0.166, Fisher's exact test 2-sided, n=22). DDD was mostly identified in young adult females (50%; 2/4) and in middle adult males (80%; 4/5).

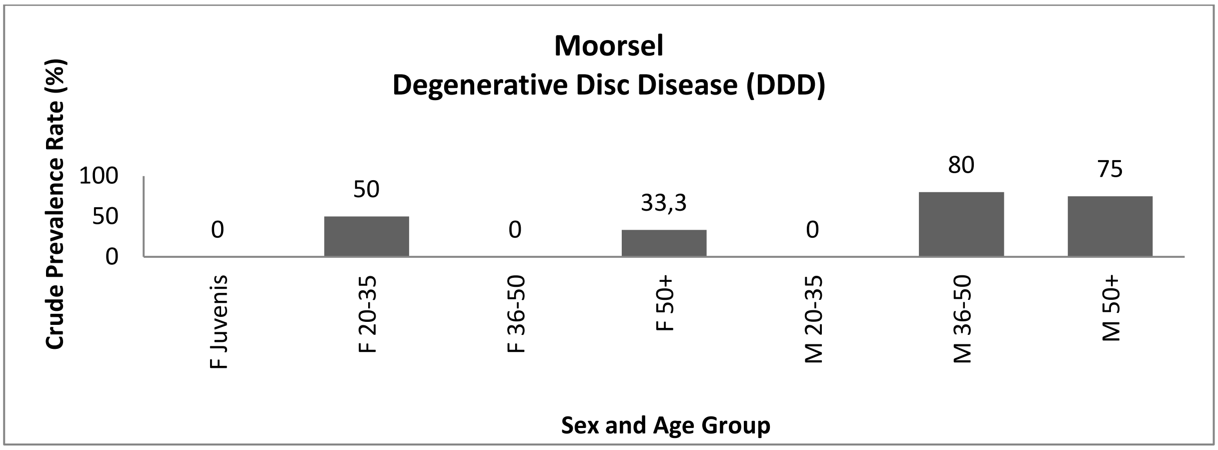

Fig. 5.26: CPR (Crude Prevalence Rate) in percentages for individuals affected with Degenerative Disc Disease (DDD) for each sex and age group within the Moorsel skeletal assemblage.

* Oosterweel

For Oosterweel, 8/19 (42.1%) individuals (adults+juvenis) were observed with DDD: 2/8 (25.0%) were female individuals and 6/8 (75%) were males affected (fig.5.27).

The difference for DDD between males and females was not statistically significant (p=0.066, Fisher's exact test 1-sided, n=16). There was no statistically significant difference for DDD between all age groups (p=0.217, Fisher's exact test 2-sided, n=17) and between the age categories of known sex (p=0.076, Fisher's exact test 2-sided, n=14). DDD was mostly identified in middle and old adult males, and was also observed in one young adult male and female.

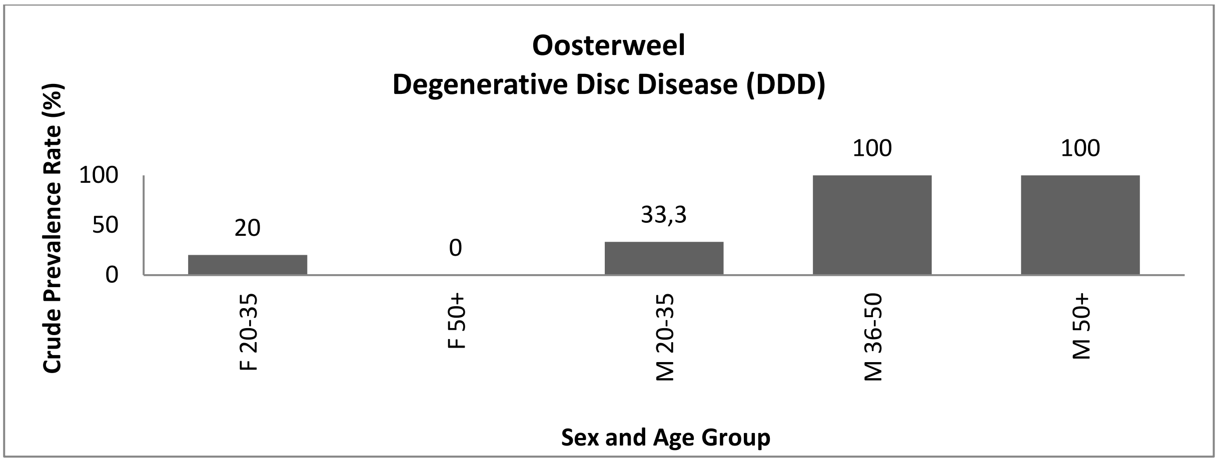

Fig. 5.27: CPR (Crude Prevalence Rate) in percentages for individuals affected with Degenerative Disc Disease (DDD) for each sex and age group within the Oosterweel skeletal assemblage.

5.4.1.3. DISH

* Deinze

DISH was only noticed with three old adult males within the Deinze adult skeletal assemblage (4.1%; 3/74). There was no statistically significant difference between the age groups of known sex (p=0.123, Fisher's exact test 2-sided, n=65), and between males (8.1%; 3/37) and females (0%; 0/37) (x^2=3.127, df=1, p=0.077, n=74).

* Slijpe

DISH was not observed within the Slijpe skeletal collection.

* Vichte

The CPR for DISH for the total adult assemblage of Vichte was 5.3% (2/38). There was no statistically significant difference between the sexes (x^2=1.556, df=1, p=0.212, n=40), and between both the adult groups (p=1.000, Fisher's exact test 2-sided, n=38) and all age categories (p=0.772, Fisher's exact test 2-sided, n=42). DISH was only identified in one middle and old adult male.

* Zottegem

For Zottegem, the CPR for DISH for the total assemblage of known sex and age was 8.3% (2/24), with no statistically significant difference between the sexes (x^2=0.034, df=1, p=0.854, n=32), and between both the adult groups (p=0.870, Fisher's exact test 2-sided, n=24) and all age categories (p=0.829, Fisher's exact test 2-sided, n=34). DISH was only identified in one young adult female and in one middle adult male.

* Moorsel

For Moorsel, DISH was only observed in one adult male for which no specific age category could be attributed. Therefore, the CPR for the adult group of known sex and age could not be presented. There was no statistically significant difference between the sexes (x^2=0.842, df=1, p= 0.359, n=29) and between all age categories (p=1.000, Fisher's exact test 2-sided, n=33).

* Oosterweel

The CPR for DISH for the total adult assemblage of known age of Oosterweel was 14.3% (2/14). There was no statistically significant difference between the sexes (x^2=2.286, df=1, p=0.131, n=16), and between both the adult groups (p=0.451, Fisher's exact test 2-sided, n=14) and all age categories (p=1.000, Fisher's exact test 2-sided, n=17). DISH was identified in two males: one young and one old adult.

5.4.1.4. Sacroiliac Joint Inflammation (SIJI)

* Deinze

The CPR for SIJI for the Deinze adult collection is presented in figure 5.28, and was 20% (15/75) for the total adult assemblage. There was a statistically significant difference in the prevalence of SIJI between males (29.7%; 11/37) and females (10.5%; 4/38) (x^2=4.321, df=1, p=0.038, n=75), and between the adult age categories (p<0.001, Fisher's exact test 2-sided, n=66). There was also a statistically significant difference for SIJI between all age groups (p<0.001, Fisher's exact test 2-sided, n=93). SIJI was mostly common in both old adult males (66.7%; 8/12) and in old adult females (40%; 4/10).

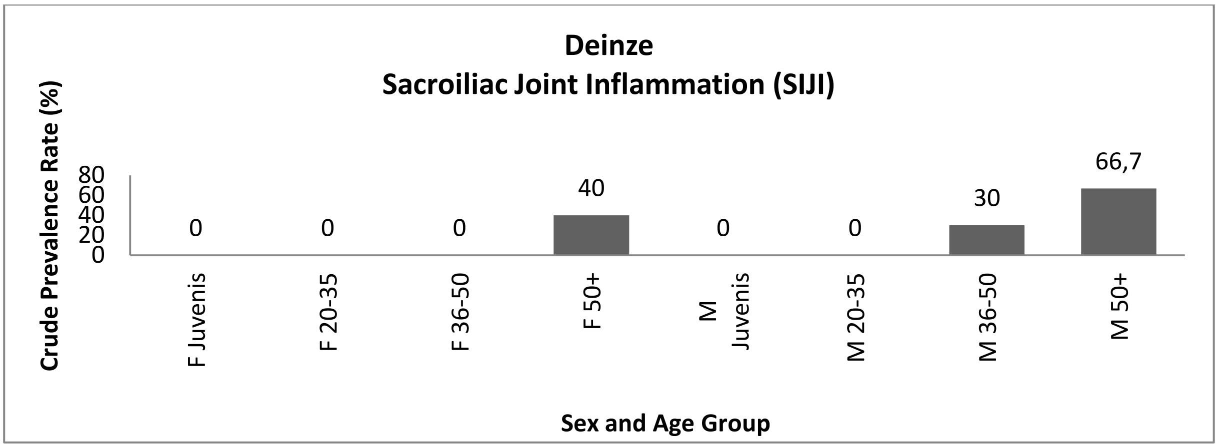

Fig. 5.28: CPR (Crude Prevalence Rate) in percentages for sacroiliac joint inflammation (SIJI) for each sex and age group within the Deinze skeletal assemblage.

* Slijpe

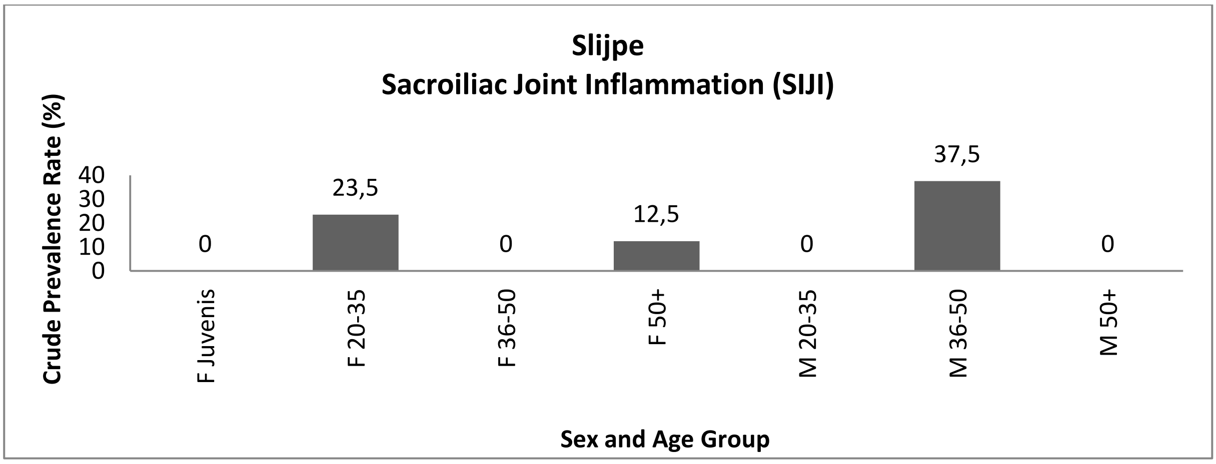

Fig. 5.29: CPR (Crude Prevalence Rate) in percentages for sacroiliac joint inflammation (SIJI) for each sex and age group within the Slijpe skeletal assemblage.

The CPR for SIJI of the adult collection of Slijpe was 16.7% (9/54) (fig. 5.29). There were no statistically significant differences between all age groups (p=0.395, Fisher's exact test 2-sided, n=67), between the age groups of known sex (p=0.394, Fisher's exact test 2-sided, n=51), and between males (13.6%; 3/22) and females (18.8%; 6/32) (x^2=0.245, df=1, p=0.620, n=54). The CPR for the complete assemblage for SIJI was 13.4% (9/67). SIJI was mostly common in middle adult males (37.5%; 3/8) and in young adult females (23.5%; 4/17).

* Vichte

The CPR for SIJI for the Vichte adult collection is presented in figure 5.30, and was 13.2% (5/38) for the total adult assemblage. There was no statistically significant difference in the prevalence of SIJI between males (9.1%; 2/22) and females (18.8%; 3/16) (x^2=0.756, df=1, p=0.384, n=38), between all age groups (p=0.386, Fisher's exact test 2-sided, n=40) and between the adult age categories (p=0.192, Fisher's exact test 2-sided, n=38). SIJI was mostly observed in middle adult females (50.0%; 1/2) and in old adult males (14.3%; 1/7).

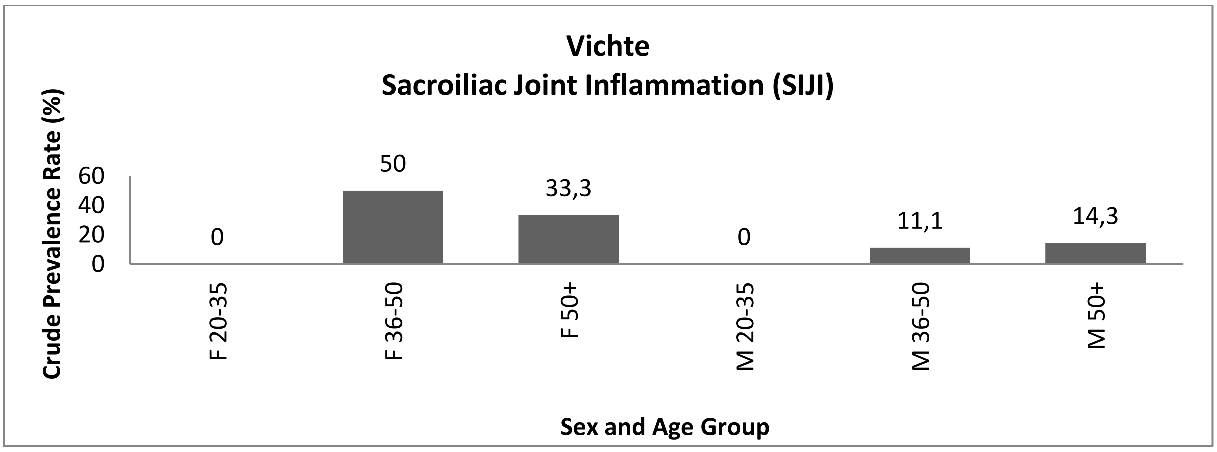

Fig. 5.30: CPR (Crude Prevalence Rate) in percentages for sacroiliac joint inflammation (SIJI) for each sex and age group within the Vichte skeletal assemblage.

* Zottegem

The CPR for SIJI for the Zottegem adult collection is shown in figure 5.31, and was 4.3% (1/23) for the total adult assemblage of known sex and age. There was no statistically significant difference in the prevalence of SIJI between males (0%; 0/12) and females (5.9%; 1/17) (x^2=0.731, df=1, p=0.393, n=29), between all age groups (p=0.226, Fisher's exact test 2-sided, n=31) and between the adult age categories (p=0.261, Fisher's exact test 2-sided, n=23). SIJI was only observed in one old adult female.

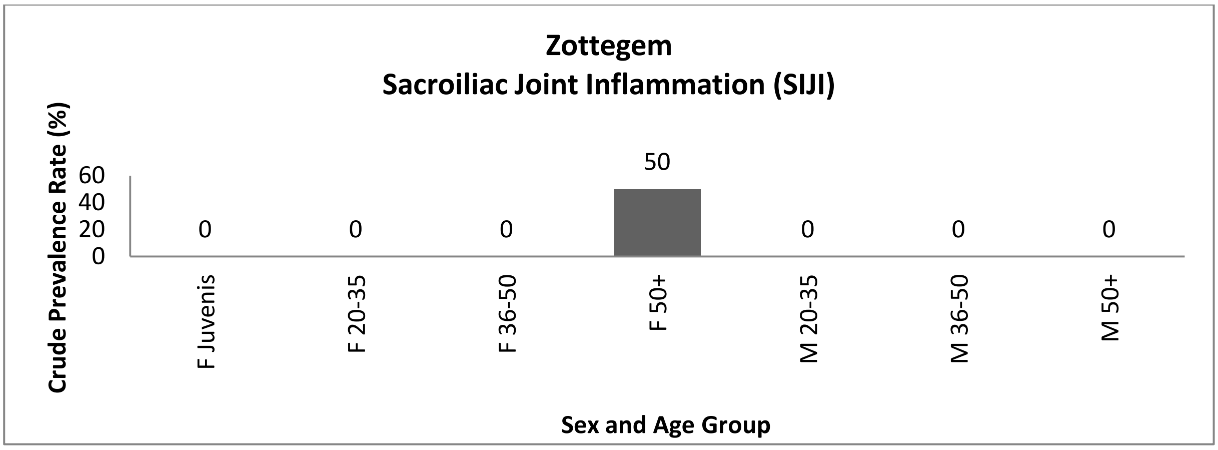

Fig. 5.31: CPR (Crude Prevalence Rate) in percentages for sacroiliac joint inflammation (SIJI) for each sex and age group within the Zottegem skeletal assemblage.

* Moorsel

The CPR for SIJI of the adult collection of known sex and age of Moorsel was 26.1% (6/23) (fig. 5.32), and 19.4% (7/36) for the complete assemblage. There were no statistically significant differences between males (23.5%; 4/17) and females (20%; 3/15) (x^2=0.058, df=1, p=0.810, n=32), between the age categories of known sex (p=0.966, Fisher's exact test 2-sided, n=23) and between all age groups (p=0.933, Fisher's exact test 2-sided, n=36). SIJI was noticed in one juvenile and young adult female and in males from the age of 36 years old.

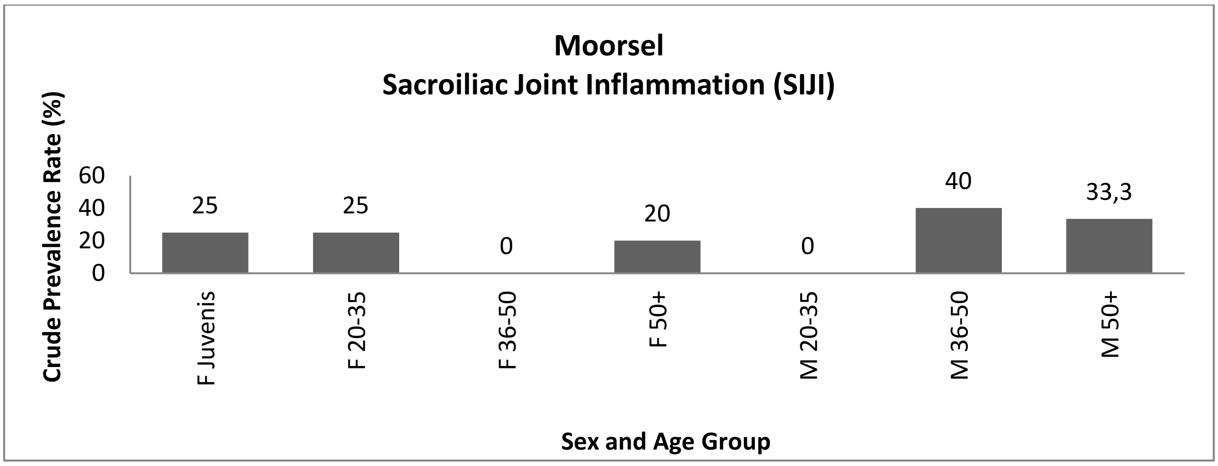

Fig. 5.32: CPR (Crude Prevalence Rate) in percentages for sacroiliac joint inflammation (SIJI) for each sex and age group within the Moorsel skeletal assemblage.

* Oosterweel

SIJI was not observed within the adult and total collection of Oosterweel .

5.4.2. Trauma

* Deinze

The CPR of trauma (TR) for the Deinze adult assemblage was 45.3% (34/75) (fig. 5.33). There was no statistically significant difference between males (54.1%; 20/37) and females (36.8%; 14/38) (x^2=2.241, df=1, p=0.134, n=75), between age groups of known sex (p=0.172, Fisher's exact test 2-sided, n=66) and between all age groups (p=0.137, Fisher's exact test 2-sided, n=93) for the prevalence of traumatic injuries. The CPR of trauma for the complete skeletal collection including both immature individuals and adults was 38.7% (36/93). Trauma was not identified with young and older children. The majority of traumatic lesions were observed with females in the age group of 50+ (40.0%; 4/10) and with males in the age category of 36-50 years (80.0%; 8/10).

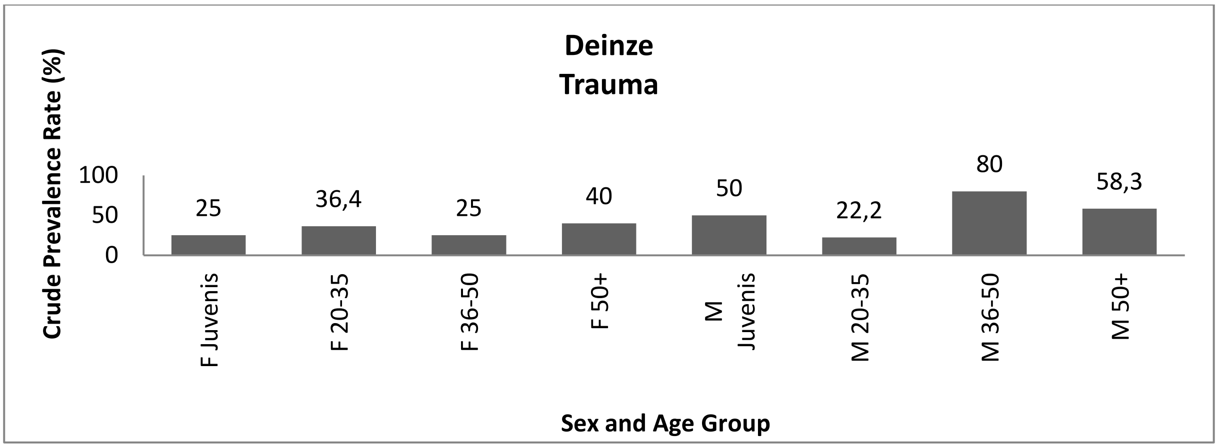

Fig. 5.33: CPR (Crude Prevalence Rate) in percentages for trauma for each sex and age group within the Deinze skeletal assemblage.

* Slijpe

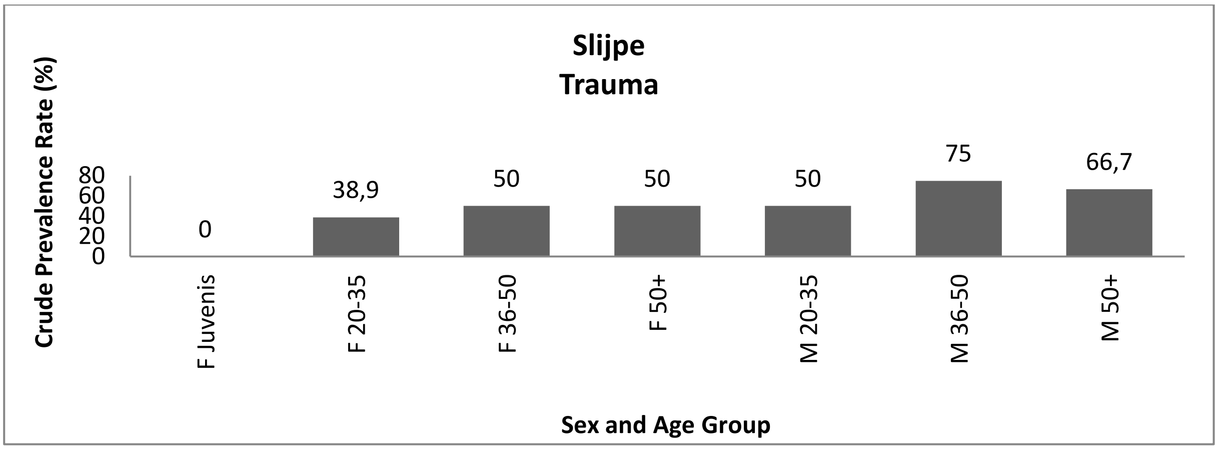

Fig. 5.34: CPR (Crude Prevalence Rate) in percentages for trauma for each sex and age group within the Slijpe skeletal assemblage.

For Slijpe, the CPR for trauma for the adult collection was 51.7% (30/58) and 42.5% (31/73) for the complete assemblage (fig. 5.34). Only one older child of c. 11-12 years was identified with a likely traumatic lesion of the left and right clavicle. There was no statistically significant difference for the prevalence of trauma between the sexes (males: 62.5%; 15/24; females: 44.1%; 15/34) (x^2=1.904, df=1, p=0.168, n=58) and between age categories of known sex (p=0.591, Fisher's exact test 2-sided, n=54). There was a statistically significant difference for trauma between all age groups (p=0.029, Fisher's exact test 2-sided, n=73). Most traumatic injuries were noticed in middle (50.0%; 2/4) and old adult females (50.0%; 4/8) and in middle adult males (75.0%; 6/8).

* Vichte

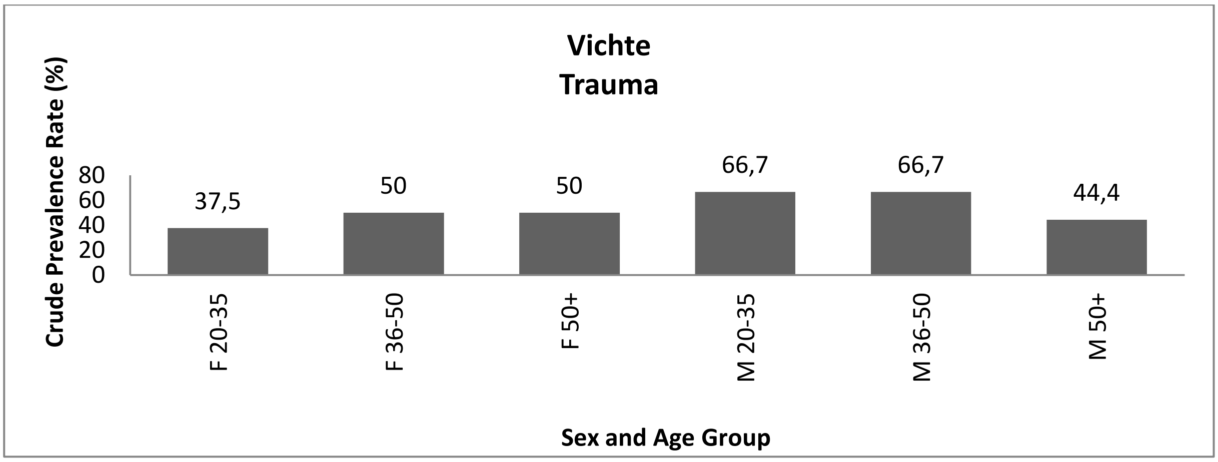

Fig. 5.35: CPR (Crude Prevalence Rate) in percentages for trauma for each sex and age group within the Vichte skeletal assemblage.

The CPR for trauma for the Vichte adult collection of known age and sex was 52.5% (21/40) (fig. 5.35), and 50.0% (24/48) for the complete assemblage. No trauma was observed within the subadult group. There was no statistically significant difference between males (63.0%; 17/27) and females (38.9%; 7/18) (x^2=2.515, df=1, p=0.113, n=45), between the adult age groups (p=0.871, Fisher's exact test 2-sided, n=40) and between all age groups (p=0.666, Fisher's exact test 2-sided, n=48) for the prevalence of traumatic injuries. The majority of traumatic lesions were observed with females in the age group of 36-50 years (50.0%; 1/2) and 50+ (50.0%; 3/6) and with males in the age category of 20-35 (66.7%; 4/6) and 36-50 years (66.7%; 6/9).

* Zottegem

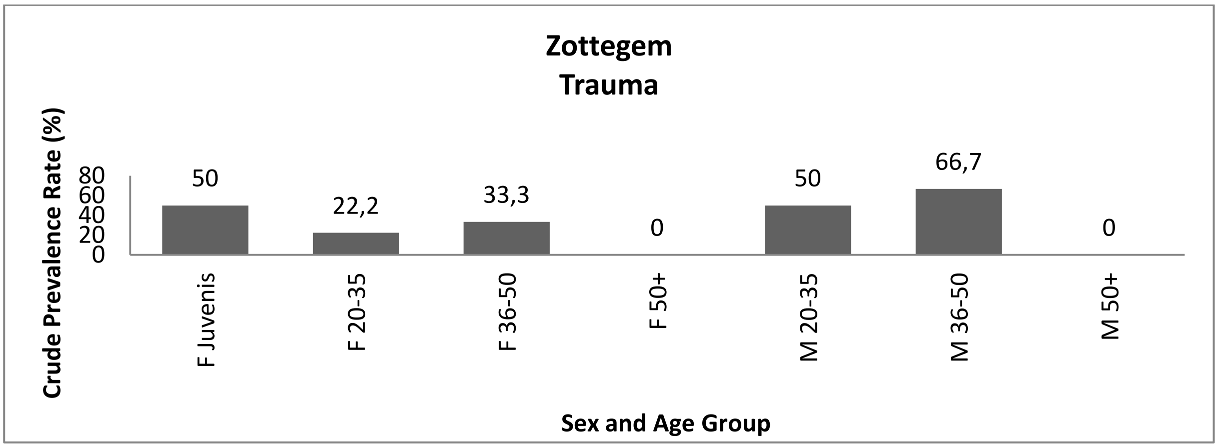

Fig. 5.36: CPR (Crude Prevalence Rate) in percentages for trauma for each sex and age group within the Zottegem skeletal assemblage.

The CPR for trauma for the Zottegem adult assemblage of known sex and age was 32.0% (8/25) (fig. 5.36) and 22.2% (10/45) for the complete assemblage. There was no statistically significant difference between males (29.4%; 5/17) and females (18.2%; 4/22) (x^2=0.681, df=1, p=0.409, n=39), between the adult age groups (p=0.631, Fisher's exact test 2-sided, n=25) and between all age groups (p=0.076, Fisher's exact test 2-sided, n=45) for the prevalence of traumatic injuries. Trauma was not identified in young children. The majority of traumatic lesions were observed with males in the age category of 36-50 years (66.7%; 2/3). One healed traumatic injury of the right tibia was identified with an individual of unknown sex and age (skeletal individual nr. 14-ZOT-MP-55).

* Moorsel

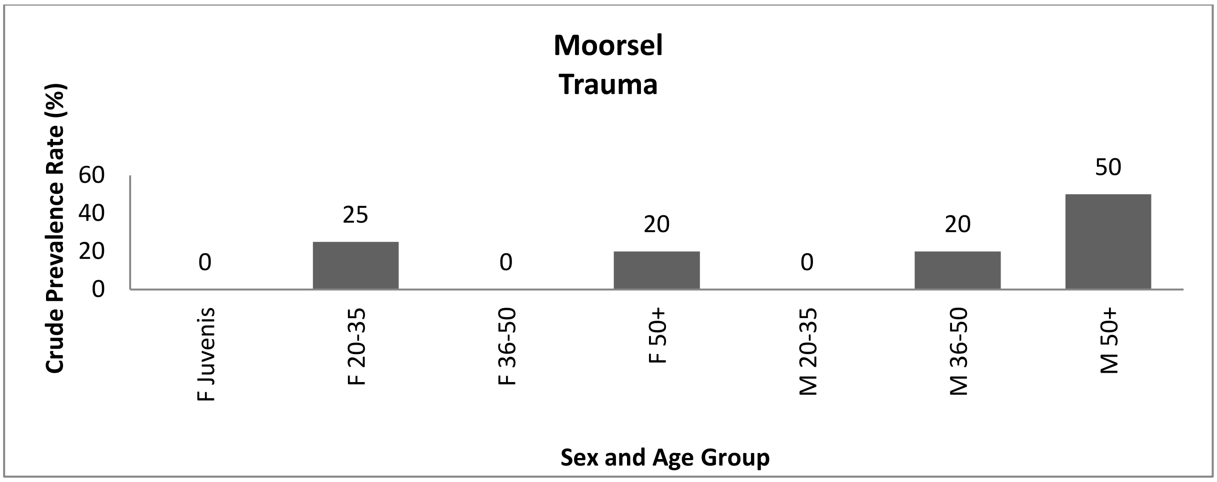

Fig. 5.37: CPR (Crude Prevalence Rate) in percentages for trauma for each sex and age group within the Moorsel skeletal assemblage.

For Moorsel, the CPR for trauma for the adult collection of known sex and age was 20.8% (5/24) (fig. 5.37) and 18.4% (7/38) for the complete assemblage. There was no statistically significant difference for the prevalence of trauma between males (22.2%; 4/18) and females (12.5%; 2/16) (x^2=0.551, df=1, p=0.458, n=34), between all age groups (p=0.626, Fisher's exact test 2-sided, n=38) and between the age categories of known sex (p=0.819, n=24). Most traumatic injuries were noticed in old adult males (50.0%; 2/4). In females, trauma was observed in one young and in one old adult. Trauma was not identified in subadults.

* Oosterweel

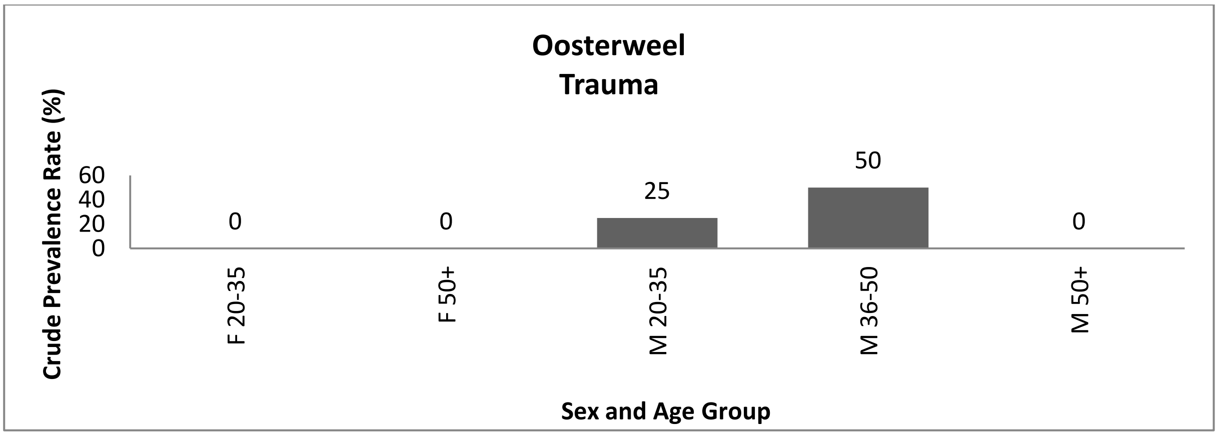

Fig. 5.38: CPR (Crude Prevalence Rate) in percentages for trauma for each sex and age group within the Oosterweel skeletal assemblage.

The CPR for TR (trauma) for the Oosterweel assemblage of known sex and age was 12.5% (2/16) (fig. 5.38). There was no statistically significant difference between males (20.0%; 2/10) and females (12.5%; 1/8) for the prevalence of traumatic lesions (x^2=0.180, df=1, p=0.671, n=18). The CPR of trauma for the complete skeletal collection including both immature individuals and adults was 15.8% (3/19). There was no statistically significant difference for trauma between the age categories of known sex (p=0.367, Fisher's exact test 2-sided, n=16) and between all age groups (p=0.254, Fisher's exact test 2-sided, n=19). Trauma was not identified in subadults and in female individuals, but only in one young (25%; 1/4) and in one middle adult (50%; 1/2) male.

5.4.2.1. Location of Traumatic Injuries: Deinze

Table 5.24 lists skeletal individuals from the Deinze assemblage observed with traumatic lesions, with description of location and type of injury and/or specifics if possible.

Skeleton nr.	Sex	Age group	Trauma location	Trauma type or specifics
WP1L4	M	36-50	right scapula (acromion) rib (left 9+10)	healed healed
WP1L5	M	50+	right clavicula (middle part) both femora rib (left 6 or 7?) (inferior near the angle)	torus OCD oblique
WP1L6	M	50+	right clavicula (lateral+middle part) both femora right fibula (distal; lateral malleolus) right calcaneus (articular surface) rib (right 6+7) cranium (occipital)	deformed/healed OCD crush crush healed depressed
WP1L8	M	50+	left clavicula (acromion) both humeri (shaft) left ulna (shaft) left radius (shaft) right tibia (distal) right fibula (distal) left metatarsal 1 (distal foot phalanx) rib (right 8?) (inferior shaft)	healed spiral spiral spiral healed/stress healed/stress crush healed

WP1L11	F	50+	cranium (left occipital) lumbar spine (L5) right metatarsal 5 (base)	depressed avulsion avulsion
WP1L12	ND	13-19	right femur	OCD
WP1L14	F	36-50	cranium (right frontal)	depressed
WP1L15	M	20-35	left femur	OCD
WP1L16	F	18+	right metacarpal 2 (proximal end)	healed; oblique
WP2L17	M	36-50	right humerus (medial epicondyle) sacrum (coccyx)	healed; avulsion healed
WP2L19	F	20-35	both fibulae (lateral shaft) sacrum (coccyx)	healed healed
WP2L23	M	36-50	left femur (shaft) pelvis (left ilium near anterior superior iliac spine)	spiral; deformed penetrating (oval in shape)
WP2L29	F	20-35	left clavicula (acromial end)	greenstick
WP2L30	F	36-50	right humerus (midshaft)	spiral
WP2L36	F	18+	right femur (head) right hip (acetabulum)	dislocation dislocation (or congenital?, see Lovell 2008: 345)
WP1L41	F	20-35	right scapula (acromion) rib (right 6+7) (near sternal end)	depression periosteal reaction
WP1L44	M	50+	both fibulae (proximal shaft) left metatarsal 1 (distal foot phalanx)	healed crush
WP1L48	M	18+	left femur (shaft) left tibia (shaft) left fibula (shaft)	oblique oblique transverse
WP2L49	M	18+	right clavicula (acromial end)	deformed
WP2L50	M	50+	right clavicula (midshaft) right tibia (distal shaft) right fibula (distal shaft) left hip (left ilium/left greater trochanter) manubrium/rib (left 1) (sternocostal joint)	torus healed/stress healed/stress secondary (likely related to osteoporosis) ossified (may be caused by traumatic injury if not age related)
WP2L56	M	50+	cranium (middle part of parietal bone)	depressed
WP2L60	F	20-35	spine (T7 to T9)	avulsion
WP2L68	F	16-18	both fibulae (lateral proximal shaft at *m.peroneus longus*)	avulsion
WP2L70	M	20-35	sacrum (coccyx)	healed
WP2L71	M	36-50	left fibula (lateral malleolus) rib (unspecified) (inferior)	healed healed
WP2L79	F	50+	left clavicula (lateral shaft)	avulsion
WP3L73	M	36-50	right clavicula (midshaft) left femur (posterior proximal shaft)	torus mysositis ossificans
WP3L77	F	18+	right humerus (head)	dislocation

WP3L78	M	36-50	sacrum (coccyx)	healed
WP3L84	ND	50+	left humerus (medial supracondylar ridge) both radii (lateral midshaft at *m. pronator teres*) pelvis (left+right sacroiliac joint)	myositis ossificans avulsion avulsion
WP3L88	M	18-19	right femur (shaft) right fibula (shaft)	shortening shortening
WP3L94	M	36-50	left humerus (medial supracondylar ridge) right tibia (posterior proximal and lateral condyle) right metatarsal 4 rib (left 5+6) (superior part near sternal end)	myositis ossificans avulsion healed healed
WP3L97	M	50+	both radii (shaft)	oblique
WP3L100	F	50+	rib (right 9) (near the angle)	healed
WP9L135	F	50+	right clavicula (posterior superior at origo *m. deltoideus*)	avulsion
WP12L165	M	36-50	right radius (midshaft) lumbar spine (L4)	torus avulsion

Table 5.24: Overview of individuals from the Deinze skeletal assemblage observed with traumatic injuries, with annotation of location and trauma type (if possible) and/or specifics.

5.4.2.1.1. Upper Extremities

Traumatic lesions identified in the upper limbs (claviculae, scapulae, humeri, ulnae and radii) did not indicate significant differences between adult males and females. Eighty-three right scapulae or scapular fragments and 76 left scapulae or scapular fragments of the total population were available for analysis. Scapular lesions were noticed with one male in the age category of 36-50 years, and one female aged 20-35 years.

Eighty-three right clavicles and 79 left clavicles of the total collection were analysed, and revealed five right clavicular trauma with males, and one right clavicular lesion with a female, mostly with an age older than 50 years. Left clavicular injuries were less common: this was observed with one male older than 50 years and two females aged 20-35 and 50+ years.

Eighty-two right humeri and 81 left humeri were examined. Trauma of the right humerus was identified with two females (aged 18+ and 36-50 years) and two males (aged 36-50 years and 50+), and of the left humerus with two males aged 36-50 years and 50+.

Seventy-eight right ulnae, 77 left ulnae, 73 right radii and 80 left radii of the total assemblage were analysed. No traumatic injuries of the right ulna were observed. Left ulnar and right and left radial lesions were further identified among male adults only: one trauma of the left ulna with a male aged 50+, and fractures of the right radius of two males aged 36-50 years and 50+. Two old adult males exhibited trauma of the left radius. One old adult of unknown sex however was observed with a traumatic injury of both radii.

Cranial trauma was only identified in one female aged 50+, and in one male of the same age group. Rib fractures were mostly observed within the total assemblage analysed on pathologies (25.0%; 9/36). Old adult males exhibited most rib fractures. There was no statistically significant difference between the adult sexes for the prevalence of rib trauma.

5.4.2.1.2. Lower Extremities

Seventy-eight right femora and 81 left femora of the total population were analysed on pathologies (93). No females exhibited trauma of the left femur. There was a statistically significant difference for traumatic injuries of the left femur between both sexes (p=0.011, Fisher's exact test). Only one adult female aged 18+ was diagnosed with a right femoral fracture. There was no statistically significant difference for the prevalence of femoral trauma between all age groups. Further, three males exhibited fractures of the right femur (one young adult, and two aged older than 50 years), and six males from the age of 30 were observed with trauma of the left femur.

Seventy-five right tibiae and 79 left tibiae were examined. There were no females identified with tibial fractures. Only four males (one of 18+, one aged 36-50 years and two aged 50+) were diagnosed with tibial injuries. Seventy-four right fibulae and 78 left fibulae were available for analysis. There was no statistically significant difference between males and females for the prevalence of fibular fractures within the adult assemblage. Traumatic injuries of the right fibula were further noticed with two females (one juvenile and one young adult) and five males (one young adult and four old adults). Left fibular lesions were identified with two females (one juvenile and one aged 20-35 years) and three males (aged respectively 18+, 36-50 and 50+ years).

5.4.2.2. Location of Traumatic Injuries: Slijpe

Table 5.25 lists skeletal individuals from the Slijpe assemblage observed with traumatic lesions, with description of location and type of injury and/or specifics if possible.

Skeleton nr.	Sex	Age group	Trauma location	Trauma type or specifics
3	F	20-35	right fibula (shaft)	healed; stress
4	ND	7-12	both claviculae (costoclavicular ligament)	Avulsion
6	F	20-35	spine (T6+T7)	Avulsion
20	F	50+	right clavicula (midshaft)	Deformed
21	F	20-35	spine (T6 to T9)	Avulsion

26	M	20-35	right scapula (acromion) hand (right first metacarpal; lateral distal shaft)	secondary/pathological (os acromiale) healed; longitudinal compression
27	F	20-35	right clavicula (inferior midshaft at origo *m. pectoralis major*)	Avulsion
28	M	36-50	spine (T7 to T9)	Avulsion
30	M	20-35	right scapula (acromion) right humerus (anterior distal shaft) spine (spinous process of T10 to T12)	acromioclavicular separation condylar fracture/displacement ante-mortem missing (or congenital?)
34	F	36-50	foot (left+right midshaft of metatarsal 2, 3+4)	Healed
37	M	36-50	right tibia (tibial tuberosity) sacrum (coccyx)	Avulsion healed
39	M	36-50	cranium (right mentum) rib (left 6) near the angle foot (distal end of right proximal phalanx of metatarsal 4)	Healed healed crushing; transverse
40	F	36-50	spine (spinous process of T12)	Oblique
45	M	36-50	sacrum (coccyx)	Healed
46	M	36-50	left clavicula (midshaft medial side)	Depression
47	M	50+	right clavicula (superior side near acromial end) hand (lateral midshaft of right metacarpal 5)	Oblique healed
48	F	20-35	rib (left 6?) near the angle spine (T6+T8) left femur (diaphysis)	Healed avulsion secondary/pathological (?)
50	F	50+	right scapula (acromion) hand (proximal phalanx of right metacarpal 2)	- Oblique
52	M	50+	hand (distal phalanx of left metacarpal 1)	Transverse
53	F	20-35	right clavicula (superior side near sternal end at rhomboid ligament)	Avulsion
54	M	50+	left fibula (diaphysis) hand (distal end of proximal phalanx of left metacarpal 1)	Stress avulsion
56	F	20-35	right maxilla right femur (distal end)	- OCD
57	F	50+	rib (unspecified fragment)	Healed
60	F	50+	foot (plantar side midshaft of right metatarsal 3)	secondary (?)
64	M	50+	rib (body of right 8?) both femora (condyle) left fibula (diaphysis)	Healed OCD Stress
67	M	36-50	right humerus (proximal shaft at m. *latissimus dorsi*) spine (spinous process of L5) hand (left scaphoid at articulation side with trapezoid) rib (right 10+11)	Avulsion healed - -
68	M	50+	hand (proximal head of right metacarpal 1 and base of its proximal and distal phalanx) foot (right distal phalanx of unspecified metatarsal)	healed; longitudinal compression impact healed; likely crushing injury

70	M	36-50	sacrum (coccyx)	healed
74	F	18+	hand (right hamate+right trapezoid)	healed
76	M	50+	right clavicula (origo of *m. pectoralis major*) spine (T10 to T12) hand (right trapezoid+articulation with distal end of right metacarpal 2) left femur (diaphysis) right tibia (tibial tuberosity)	avulsion avulsion transverse spiral (deformed; shortening) avulsion
77	M	20-35	cranium (left frontal) right clavicula (midshaft)	linear (blunt force) deformed

Table 5.25: Overview of individuals from the Slijpe skeletal assemblage observed with traumatic injuries, with annotation of location and trauma type (if possible) and/or specifics.

5.4.2.2.1. Upper Extremities

Similar to Deinze, the prevalence of traumatic lesions identified in the upper limbs (claviculae, scapulae, humeri, ulnae and radii) did not indicate significant differences between adult males and females. Sixty-seven right scapulae or scapular fragments and 65 left scapulae or scapular fragments of the total population were available for analysis. Only one female aged 50+, and two young adult males were observed with a right scapular lesion.

Sixty-one right clavicles and 59 left clavicles of the total collection were analysed, which revealed six right clavicular trauma with three males and three females from different age groups, and one left clavicular lesion with a female aged 36-50 years. Seventy-one right humeri and 59 left humeri were examined. Trauma of the right humerus was identified with two males (one young and one middle adult). Sixty-six right ulnae, 60 left ulnae, 67 right radii and 58 left radii of the total assemblage were analysed, and revealed no traumatic injuries.

Injuries of the hand bones revealed statistically significant differences between males and females (x^2=5.346, df=1, p=0.021). The TPR for hand trauma of the total Slijpe collection including immature individuals was 14.3% (9/63). There was no statistically significant difference for hand bone lesions for all age groups. Seven males and two females, all older than 30 years, were observed with hand trauma. Most cases (3/9) for fractures of the hand bones were reported within the old age category.

Cranial trauma was identified in two males aged 20-35 and 36-50 years, and one young adult female showed an injury of the right maxilla.Rib fractures were observed in two females and three males from different age categories. There was no statistically significant difference between the adult sexes for the prevalence of rib trauma.

5.4.2.2.2. Lower Extremities

Forty-eight right femora and 44 left femora of the total population were analysed on pathologies (74). Among the subadults there were no injuries in either the left or right femora. Among the adults, trauma of the right femur was diagnosed in one young adult female and in one old adult male (both OCD). Trauma of the left femur was noticed in two old adult males (OCD and a spiral fracture) and in one young adult female (possible secondary trauma).

Thirty-one right tibiae and 32 left tibiae were examined. There were no individuals identified with left tibial fractures. Only two males (one middle and old adult) were diagnosed with an avulsion fracture of the right tibia.

Thirty right fibulae and 28 left fibulae were available for analysis. There was no statistically significant difference between males and females for the prevalence of fibular fractures within the adult assemblage. Traumatic injuries of the right fibula were only noticed with one female aged 20-35 years. In contrast, left fibular lesions were identified in two old adult males.

5.4.2.3. Location of Traumatic Injuries: Vichte

Table 5.26 lists skeletal individuals from the Vichte assemblage observed with traumatic lesions, with description of location and type of injury and/or specifics if possible.

Skeleton nr.	Sex	Age group	Trauma location	Trauma type or specifics
560	F	20-35	both ulnae (olecranon process) right femur (distal end; medial condyle)	crack OCD
559	F	50+	both femora (distal end; medial condyle)	OCD
534	F	50+	rib (left 8)	healed
554	M	18+	left hip	dislocation
553	F	20-35	both fibulae (shaft)	stress
558	M	18+	right clavicula (superior midshaft) foot (right metatarsals 2 to 4 and left metatarsal 4)	displacement healed
557	M	20-35	left femur (medial condyle)	OCD
525	M	36-50	right scapula (acromion) left calcaneus	dislocation (?) crush
530	M	36-50	sacrum (posterior side)	healed
528	M	20-35	cranium (frontal)	depressed
548	F	50+	right radius (distal shaft)	-
524	M	20-35	left knee (patella/distal femur) spine (T9)	crack avulsion
538	F	20-35	left ulna (proximal shaft)	dislocation

			left radius (proximal shaft)	dislocation
539	M	50+	both tibiae (tibial tuberosity) left fibula (distal shaft)	avulsion stress
523	F	36-50	sacrum (os coccyx)	healed
521	M	18+	cranium (left frontal)	antemortem healed
555	M	50+	both ulnae (midshaft) both radii (midshaft) spine (unspecified T)	transverse transverse avulsion
541	M	20-35	spine (T9)	avulsion
500	M	36-50	right rib (unspecified) hand (shaft of left first metacarpal)	healed oblique
526	M	50+	both tibiae (tibial tuberosity) left fibula (distal shaft)	avulsion stress
545	M	36-50	foot (right talus)	(possibly) stress
550	M	36-50	right clavicula (near sternal end; sternoclavicular joint) left and right elbow left femur (knee)	avulsion dislocation crack
512	M	36-50	left femur (medial condyle)	oblique
511	M	50+	hand (shaft of right metacarpal 2)	oblique

Table 5.26: Overview of individuals from the Vichte skeletal assemblage observed with traumatic injuries, with annotation of location and trauma type (if possible) and/or specifics.

5.4.2.3.1. Upper Extremities

Trauma observed in the upper limbs (claviculae, scapulae, humeri, ulnae and radii) did not indicate significant differences between the adult age categories and between adult males and females of the Vichte collection. There were no traumatic injuries observed in subadults. Forty-four right scapulae or scapular fragments and 38 left scapulae or scapular fragments of the total population were available for analysis. Only one middle adult male aged was observed with a right scapular lesion.

Forty-two right clavicles and 38 left clavicles of the total collection were analysed, which revealed right clavicular lesions with two males from the age groups 36-50 years and 18+. Forty-three right humeri and 38 left humeri were examined. There were no humeral fractures identified within the Vichte collection.

Forty right ulnae, 40 left ulnae, 40 right radii and 42 left radii of the total assemblage were analysed, which revealed both right and left ulnar and radial fractures. A left and right ulnar fracture was identified in two individuals: one young adult female and one old adult male, and a single left ulnar trauma in a young adult female. The former old adult male with ulnar fractures was also observed with a left and right radial trauma. More radial lesions were noted in a female aged 50+ (right radius) and in the former young adult female (left radius) who was also observed with a fracture of the left ulna (dislocation).

Injuries of the hand bones revealed no significant differences between males and females. Only two males from the age categories 36-50 and 50+ were observed with lesions of the hand bones (both an oblique fracture of a metacarpal).

Cranial trauma was only identified in two males aged 20-35 years and 18+ (both located in the frontal bone). Rib fractures were observed in one female aged 50+ years and one male aged 36-50 years. There was no statistically significant difference between the adult sexes of both cranial and rib trauma.

5.4.2.3.2. Lower Extremities

Forty-three right femora and 48 left femora of the total population were analysed for pathologies (62). Among the subadults there were no injuries in either the left or right femora. One female aged 50+ was diagnosed with OCD of both femora. Another female of the age group 20-35 years was observed with a similar traumatic lesion, but here only in the right femur. Further, four males (two aged 20-35 and two aged 36-50) were observed with a trauma of the left femur. One adult male displayed a dislocation of the left hip.

Forty-five right and left tibiae were examined. Two old adult males were observed with an avulsion fracture of both the right and left tibia. Forty-three right fibulae and 35 left fibulae were available for analysis. One young adult female was noticed with a trauma of both the right and left fibula. Traumatic injuries of the left fibula were further identified in two old adult males. All fibular fractures involved stress lesions. There were no subadults observed with lower limb fractures.

5.4.2.4. Location of Traumatic Injuries: Zottegem

Table 5.27 lists skeletal individuals from the Zottegem assemblage observed with traumatic lesions, with description of location and type of injury and/or specifics if possible.

Skeleton nr.	Sex	Age group	Trauma location	Trauma type or specifics
1	M	36-50	hand (lateral side of shaft of left metacarpal 5) left fibula (midshaft)	healed healed; stress
118	M	20-35	spine (T11)	avulsion
138	F	36-50	spine (T8 to T10)	avulsion
136	M	18+	left fibula (midshaft)	stress or secondary
28	M	20-35	rib (right 7+8 anterior vertebral end)	healed; possibly stress

55	ND	ND	right tibia (midshaft)	spiral; deformed
143	M	36-50	right tibia (soleal line)	avulsion
44	F	18-19	left fibula (lateral inferior midshaft)	stress or secondary
45	F	20-35	foot (anterior lateral midshaft of right metatarsal 5)	stress or pathological
56	F	36-50	spine (T6)	avulsion

Table 5.27: Overview of individuals from the Zottegem skeletal assemblage observed with traumatic injuries, with annotation of location and trauma type (if possible) and/or specifics.

5.4.2.4.1. Upper Extremities

There were no traumata identified in the upper limbs (claviculae, scapulae, humeri, ulnae and radii) of the complete Zottegem assemblage analysed on pathologies. Nineteen right scapulae or scapular fragments and 20 left scapulae or scapular fragments of the total population were available for analysis as well as 23 right clavicles, 29 left clavicles, 29 right and left humeri, 28 right ulnae, 27 left ulnae, 28 right radii and 29 left radii.

There was no cranial trauma of the 32 crania available for analysis. Avulsion fractures in the thoracic spine were observed in one young adult male (T11), and in two middle adult females (T8 to T10 and T6). One young adult male had a fracture of the seventh and eighth right rib. Further, a healed hand injury of the left fifth metacarpal was only identified in a male aged 36-50 years.

5.4.2.4.2. Lower Extremities

Thirty-one right femora and 30 left femora of the total population were analysed on pathologies (42). Among the subadults there were no injuries in either the left or right femora.

Twenty-five right and 24 left tibiae were examined. A fracture of the right tibia was identified in a male aged 36-50 years (avulsion) as well as with an individual of unknown sex and age (spiral). Twenty-one right fibulae and 22 left fibulae were available for analysis. Stress injuries of the left fibula were observed in a male aged 36-50 years, an adult male of 18+ and a female juvenile. A young adult female had a fracture of the right fifth metatarsal. There were no subadults observed with lower limb fractures.

5.4.2.5. Location of Traumatic Injuries: Moorsel

Table 5.28 lists skeletal individuals from the Moorsel assemblage observed with traumatic lesions, with description of location and type of injury and/or specifics if possible.

Skeleton nr.	Sex	Age group	Trauma location	Trauma type or specifics
157	F	20-35	cranium (left frontal)	depressed
161	ND	20-35	left mandibula (angle)	healed
164	M	18+	cranium (parietal)	healed; possible trepanation; indication of treatment of a head injury
172	M	36-50	both tibiae (tibial tuberosity)	avulsion
175	M	50+	cranium (parietal)	depressed
176	M	50+	both tibiae (lateral side of distal shaft) right fibula (lateral side of distal shaft)	stress stress
181	F	50+	right radius (diaphysis) sacrum (os coccyx)	oblique healed

Table 5.28: Overview of individuals from the Moorsel post-medieval skeletal assemblage observed with traumatic injuries, with annotation of location and trauma type (if possible) and/or specifics.

5.4.2.5.1. Upper Extremities

One old adult female was observed with a healed trauma of the right radius. There were no other traumatic lesions identified in the upper limbs (claviculae, scapulae, humeri, ulnae and radii) of the post-medieval group of Moorsel analysed on pathologies. Twenty-eight right and left scapulae or scapular fragments of the total population were available for analysis as well as 29 right clavicles, 28 left clavicles, 32 right and 31 left humeri, 33 right and left ulnae, 33 right radii and 32 left radii.

Twenty-two crania were analysed, which revealed three cranial injuries in one female (20-35 years) of the frontal bone and two males (50+ and 18+) with injuries of the parietal bone. One young adult individual of unknown sex had a mandibular trauma.

5.4.2.5.2. Lower Extremities

Pathological analysis of the lower limbs of the post-medieval group of Moorsel revealed a healed trauma of both the right and left tibia with two males from the age groups 36-50 years and 50+. The latter individual had also a healed stress fracture of the right fibula. A total of 34 right femora and 35 left femora of the complete population were analysed on pathologies as well as 33 right and left tibiae and 32 right and left fibulae. Neither females nor subadults were observed with lower limb fractures.

5.4.2.6. Location of Traumatic Injuries: Oosterweel

Table 5.29 lists skeletal individuals from the Oosterweel assemblage observed with traumatic lesions, with description of location and type of injury and/or specifics if possible.

Skeleton nr.	**Sex**	**Age group**	**Trauma location**	**Trauma type or specifics**
23	M	36-50	right clavicula (midshaft)	healed; deformed
24	M	20-35	left clavicula (inferior acromial end)	healed
58	F	18+	spine (L3)	avulsion

Table 5.29: Overview of individuals from the Oosterweel skeletal assemblage observed with traumatic injuries, with annotation of location and trauma type (if possible) and/or specifics.

5.4.2.6.1. Upper Extremities

One young adult male and one middle adult male were observed with a healed clavicular fracture. There were no other traumatic lesions identified in the upper limbs (claviculae, scapulae, humeri, ulnae and radii) of the selected cluster of Oosterweel analysed on pathologies. Sixteen right and seventeen left scapulae or scapular fragments of this group were available for analysis as well as sixteen right clavicles, seventeen left clavicles, sixteen right and eighteen left humeri, fourteen right and left ulnae, seventeen right radii and fifteen left radii. One female aged 18+ had a likely avulsion fracture of L3. Examination of fifteen crania indicated no cranial injuries.

5.4.2.6.2. Lower Extremities

Seventeen right femora, sixteen left femora, sixteen right and left tibiae, and twelve right and thirteen left fibulae of the Oosterweel selected individuals were analysed on trauma, which revealed no lower limb fractures.

5.4.3. Infectious Disease

5.4.3.1. Periosteal Reaction (PS)

* Deinze

Within the Deinze adult population, the CPR of periosteal reaction (PS) was 20% (15/75) (fig. 5.39). There was no statistically significant difference between the sexes (males: 27%; 10/37; females: 13.2%; 5/38) (x^2=2.254, df=1, p=0.133, n=75), between all age groups (p=0.880, Fisher's exact test 2-sided, n=93) or between the adult age groups for the prevalence of periosteal reaction (p=0.151, Fisher's exact test 2-sided, n=66). The TPR for PS for the complete collection was 19.4% (18/93), which included three juveniles of unknown sex. PS was mostly observed in the old adult male category (41.7%; 5/12) and in female juveniles (50%; 2/4).

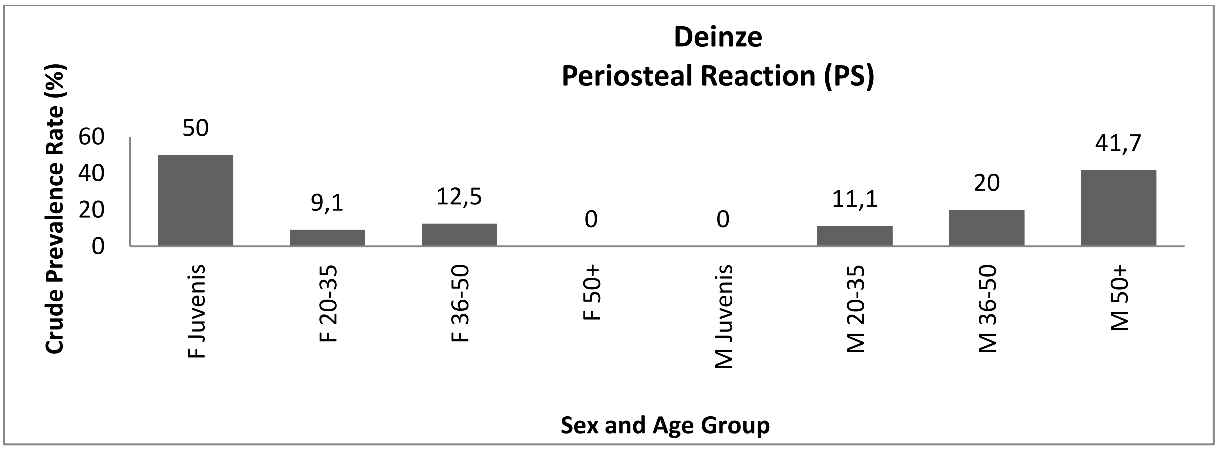

Fig. 5.39: CPR (Crude Prevalence Rate) in percentages for periosteal reaction (PS) for each sex and age group within the Deinze skeletal assemblage.

* Slijpe

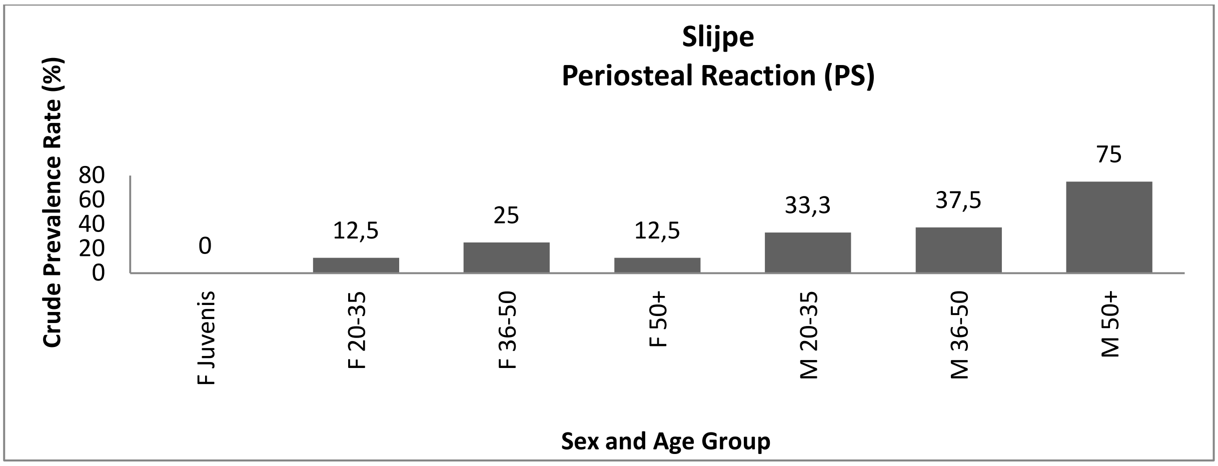

Fig. 5.40: CPR (Crude Prevalence Rate) in percentages for periosteal reaction (PS) for each sex and age group within the Slijpe skeletal assemblage.

The CPR for PS for the adult assemblage of Slijpe was 27.3% (15/55) (fig. 5.40). There was a statistically significant difference between males (47.8%; 11/23) and females (12.5%; 4/32) for PS (x^2 = 8.419, df=1, p=0.004, n=55). The CPR for the complete collection for PS was 22.9% (16/70) with no statistically significant difference between all age categories (p=0.298, Fisher's exact test 2-sided, n=70) and between the age groups of known sex (p=0.050, Fisher's exact test 2-sided, n=51). No subadults were identified with PS. PS was mostly observed in old adult males (75%; 6/8).

* Vichte

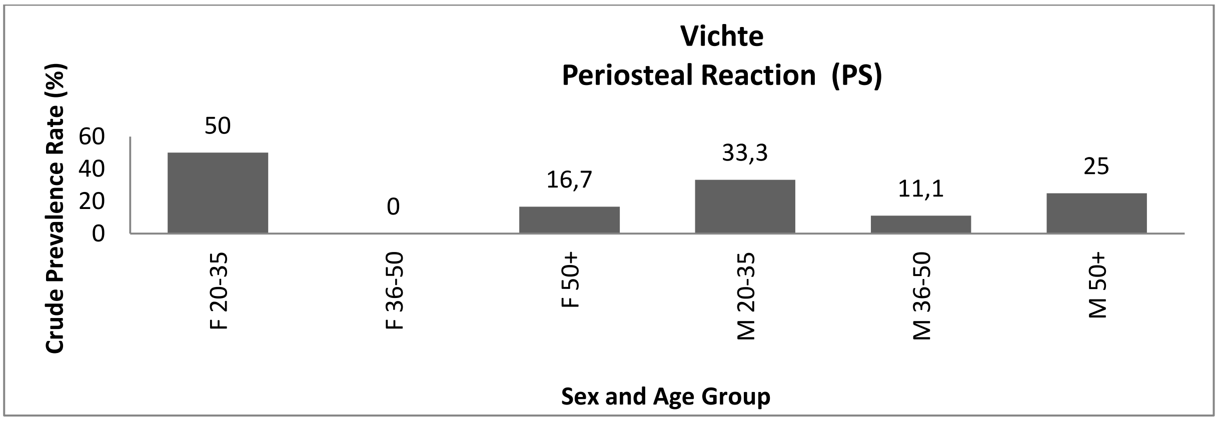

Fig. 5.41: CPR (Crude Prevalence Rate) in percentages for periosteal reaction (PS) for each sex and age group within the Vichte skeletal assemblage.

The CPR for PS for the adult assemblage of known age of Vichte was 27.3% (10/39) (fig. 5.41). There was no statistically significant difference between males (20.0%; 5/25) and females (31.3%; 5/16) for PS (x^2=0.670, df=1, p=0.413, n=41). The CPR for the complete collection for PS was 23.3% (10/43) with no statistically significant difference between all age categories (p=0.448, Fisher's exact test 2-sided, n=43) and between the adult age groups (p=0.536, Fisher's exact test 2-sided, n=39). No subadults were identified with PS. PS was mostly observed in both young adult males (33.3%; 2/6) and females (50%; 4/8).

* Zottegem

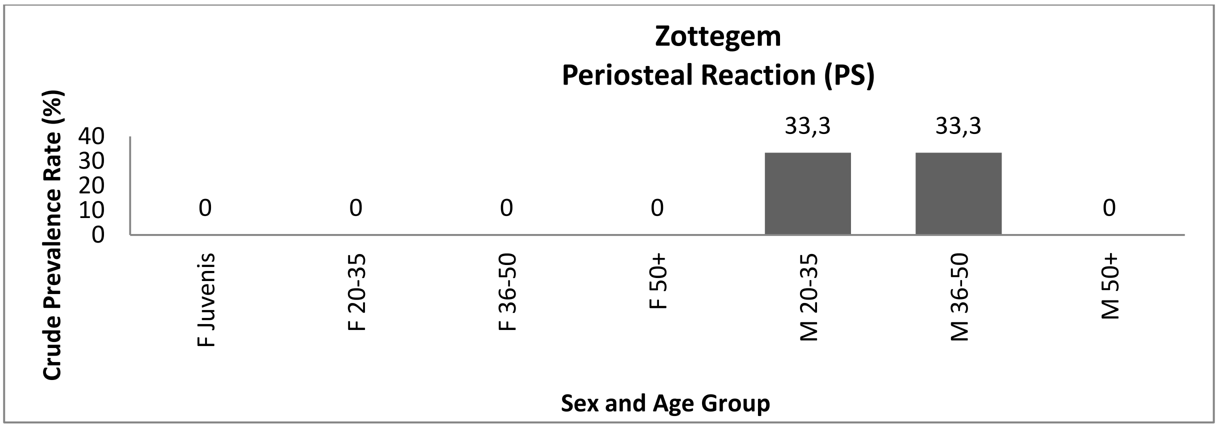

Fig. 5.42: CPR (Crude Prevalence Rate) in percentages for periosteal reaction (PS) for each sex and age group within the Zottegem skeletal assemblage.

The CPR for PS for the adult assemblage of known age and sex of Zottegem was 8.3% (2/24) (fig. 5.42) and 11.6% (5/43) for the total collection. There was a statistically significant difference between males (33.3%; 5/15) and females (0.0%; 0/22) for PS (x^2=8.479, df=1, p=0.004, n=37), but not between the age groups of known sex (p=0.380, Fisher's exact test 2-sided, n=24). PS was only observed in adult males (one young and one middle adult and three aged 18+).

* Moorsel

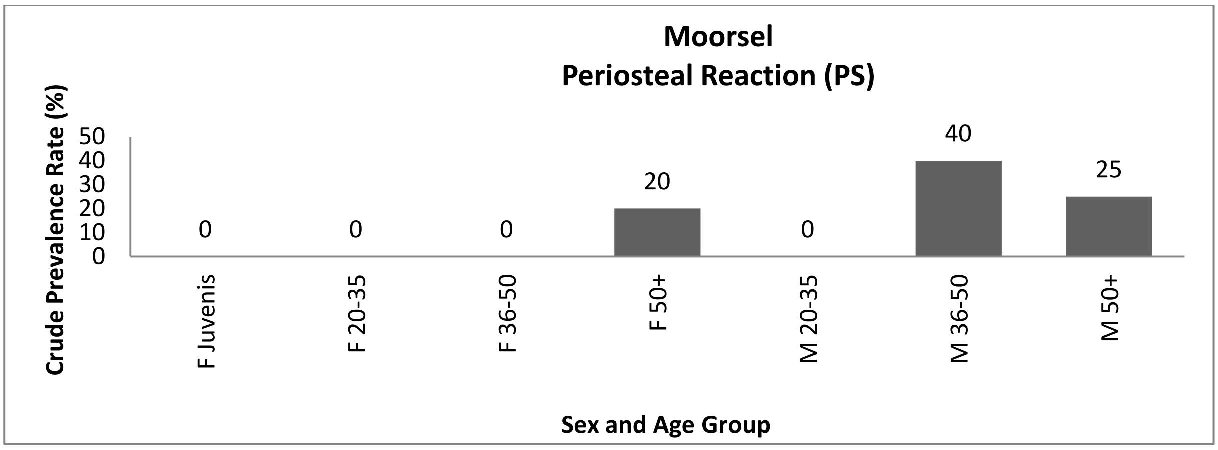

Fig. 5.43: CPR (Crude Prevalence Rate) in percentages for periosteal reaction (PS) for each sex and age group within the Moorsel skeletal assemblage.

The CPR for PS for the adult assemblage of known age and sex of Moorsel was 16.7% (4/24) (fig. 5.43) and 10.5% (4/38) for the total collection. There was no statistically significant difference between males (16.7%; 3/18) and females (6.3%; 1/16) (x^2=0.885, df=1, p=0.347, n=34), between the age groups of known sex (p=0.827, Fisher's exact test 2-sided, n=24) and between all age groups (p=0.214, Fisher's exact test 2-sided, n=38) for PS. No subadults displayed PS. PS was observed in one old adult male and female and in two middle adult males.

* Oosterweel

There was no PS within both the adult and complete assemblage of Oosterweel.

5.4.3.2. Osteomyelitis (OM)

* Deinze

The CPR for osteomyelitis (OM) is shown in figure 5.44, which indicated no statistically significant difference between the adult sexes (x^2=2.110, df=1, p=0.146, n=75) and between the adult age groups (p=0.938, Fisher's exact test 2-sided, n=66) from Deinze. The disease was observed with two adult males, one in the age group of 36-50 (skeletal individual nr. WP1L9, left tibia affected) and another male aged 50+ years (skeletal individual nr. WP3L86, both tibiae, especially right bone, affected) (5.4%; 2/37). No females exhibited OM (0.0%; 0/38). The CPR for OM for the adult assemblage including individuals from the age group 18+ was 2.7% (2/75). For the total group, the

CPR for OM was 3.2% (3/93), and involved the diagnosis of OM with one juvenile of unknown sex (skeletal individual nr. WP2L33, left fibula affected).

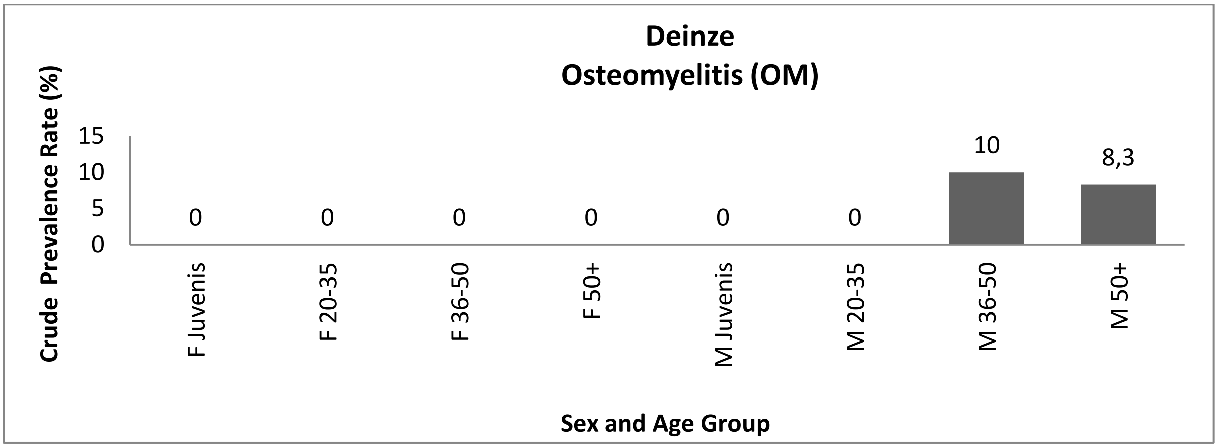

Fig. 5.44: CPR (Crude Prevalence Rate) in percentages for osteomyelitis (OM) for each sex and age group within the Deinze skeletal assemblage.

* Slijpe

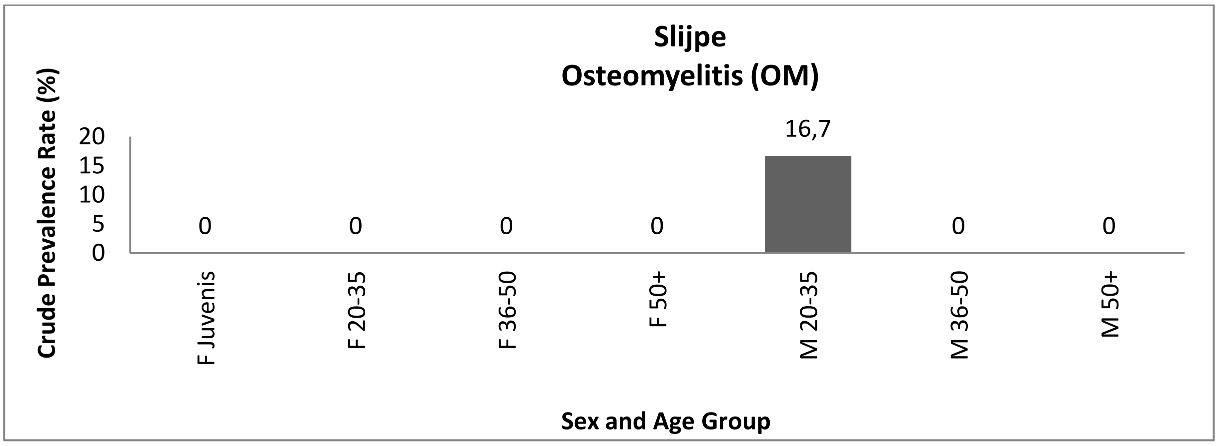

Fig. 5.45: CPR (Crude Prevalence Rate) in percentages for osteomyelitis (OM) for each sex and age group within the Slijpe skeletal assemblage.

The CPR for the complete Slijpe collection was 1.4% (1/73) and 1.7% (1/58) for the adult assemblage for the prevalence of OM (fig. 5.45). Neither females nor immature individuals were observed with OM. Only one male adult in the age group of 20-35 years was observed with OM (skeletal individual nr. 30, both fibulae affected) (16.7%; 1/6). There was no statistically significant difference between the age groups of known sex (p=0.204, Fisher's exact test 2-sided, n=54), or between males (4.2%; 1/24) and females (0.0%; 0/34) (x^2=1.442, df=1, p=0.230, n=58).

* Vichte

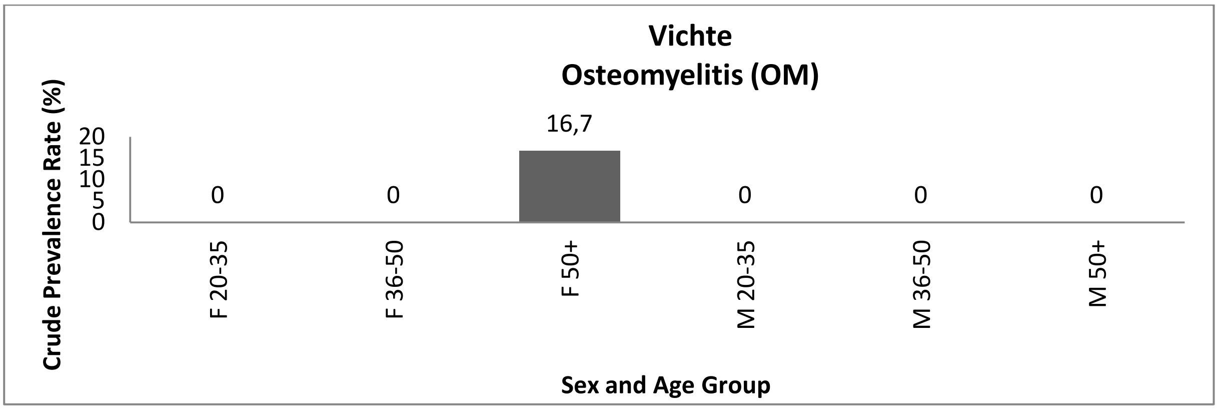

Fig. 5.46: CPR (Crude Prevalence Rate) in percentages for osteomyelitis (OM) for each sex and age group within the Vichte skeletal assemblage.

The CPR for the complete Vichte collection was 2.3% (1/43) and 2.6% (1/39) for the adult assemblage of known age for the prevalence of OM (fig. 5.46). Neither males nor immature individuals were observed with OM. Only one old adult female exhibited OM (skeletal individual nr. 548, right tibia and right fibula affected). There was no statistically significant difference for OM between the adult age groups (p=0.359, Fisher's exact test 2-sided, n=39), or between males (0.0%; 0/25) and females (6.3%; 1/16) (x^2=1.602, df=1, p=0.206, n=41).

* Moorsel

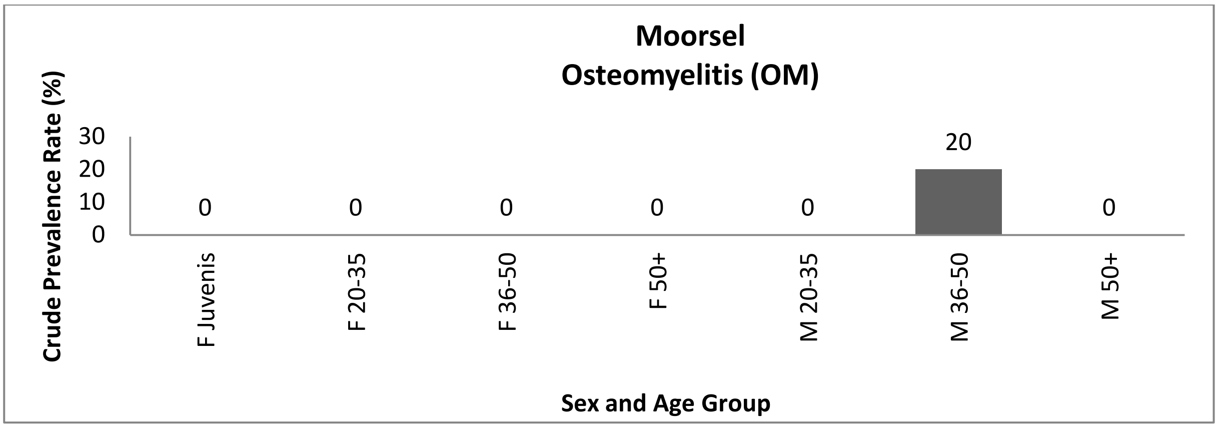

Fig. 5.47: CPR (Crude Prevalence Rate) in percentages for osteomyelitis (OM) for each sex and age group within the Moorsel skeletal assemblage.

The CPR for OM for the adult collection of known sex and age of Moorsel was 4.2% (1/24) (fig. 5.47), and 2.6% (1/38) for the complete assemblage. There was no statistically significant difference for OM between the age groups of known sex (p=1.000, Fisher's exact test 2-sided, n=24), or between males (5.6%; 1/18) and females (0.0%; 0/16) (x^2=0.916, df=1, p=0.339, n=34). OM was only identified in one middle adult male (skeletal individual nr. 241, right radius affected) (20%; 1/5).

* Zottegem and Oosterweel

OM was not recorded within the total and adult assemblages of Zottegem and Oosterweel.

5.4.3.3. Respiratory Infections

* Deinze

Figure 5.48 illustrates the CPR's for the possible evidence of respiratory infections for each adult sex and age group in Deinze. The CPR for the total adult assemblage was 16.4% (12/73), with no statistically significant difference between males (19.4%; 7/36) and females (13.5%; 5/37) (x^2=0.467, df=1, p=0.494, n=73), between all age groups (p=0.186, Fisher's exact test 2-sided, n=91) and between the adult age categories (p=0.200, Fisher's exact test 2-sided, n=64). Within the female group, infections of the respiratory system were mostly observed in the age category of 36-50 years (37.5%; 3/8), and for males in the age category of 50+ (41.7%; 5/12).

The CPR for the complete collection including immature individuals for respiratory infections was 15.4% (14/91), including two juveniles of unknown sex. No children were identified with respiratory infections.

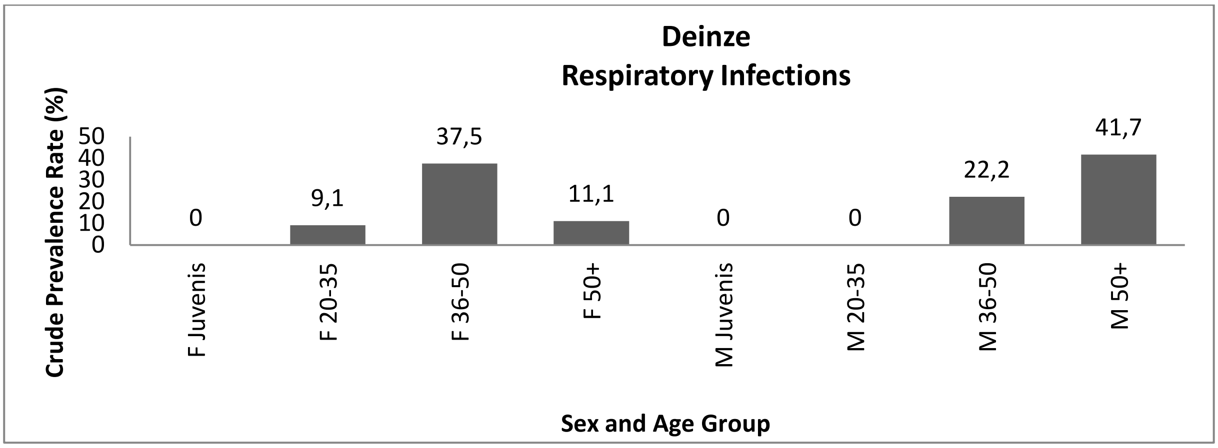

Fig. 5.48: CPR (Crude Prevalence Rate) in percentages for respiratory infections for each sex and age group within the Deinze skeletal assemblage.

Table 5.30 lists skeletal individuals from Deinze observed with lesions indicative of respiratory infections and/or pulmonary conditions such as pulmonary TB.

Skeleton nr.	Sex	Age group	Lesion suggestive of respiratory infection/pulmonary condition/pulmonary TB
WP1L6	M	50+	new bone formation on visceral surface of unspecified rib fragments
WP1L8	M	50+	new bone formation in the proximal and distal diaphyses of the right tibia and fibula (see Roberts and Manchester 2010: 191)
WP1L14	F	36-50	new bone formation on visceral surface of unspecified rib fragments
WP2L19	F	20-35	severe osteolytic lesions of lateral side of vertebral bodies of T10 to L2
WP2L26	F	50+	pulmonary infection (likely related to TB) of the *discus intervertebralis* could have possibly caused the ossification of T4 to T6 (differential diagnosis: congenital disease)
WP1L43	F	36-50	new bone formation on visceral surface of unspecified rib fragments
WP2L50	M	50+	new bone formation on visceral surface of three unspecified rib fragments
WP2L51	M	50+	pulmonary infection (likely related to TB) of the *discus intervertebralis* could have possibly caused the ossification of C3 and C4 (differential diagnosis: congenital disease)
WP2L83	M	50+	new bone formation on visceral surface of unspecified right rib fragments
WP3L73	M	36-50	pulmonary infection (likely related to TB) of the *discus intervertebralis* could have possibly caused the ossification of C5 and C6 (differential diagnosis: congenital disease)
WP3L74	ND	13-19	new bone formation on visceral surface of unspecified rib fragments
WP3L75	F	36-50	pulmonary infection (likely related to TB) of the *discus intervertebralis* could have possibly caused the ossification of T4 and T5 (differential diagnosis: congenital disease)
WP3L94	M	36-50	pulmonary infection (likely related to TB) of the *discus intervertebralis* could have possibly caused the ossification of C2 and C3, C4 and C5 (differential diagnosis: congenital disease)
WP9L134	ND	13-19	new bone formation on visceral surface of possible right ribs 5 to 7

Table 5.30: Overview of individuals from the Deinze skeletal assemblage observed with lesions suggestive of respiratory infection.

Regarding individuals WP2L26, WP2L51, WP3L73, WP3L75 and WP3L94 with observed ankyloses in the cervical and/or thoracic vertebrae, clinical studies have reported on the presence of ankyloses in the vertebral region that preceded the development of pulmonary TB or pulmonary infections may be considered as a concomitant cause of ankyloses (see e.g. Carter 1955: 297-298; Cofield 1922).

* Slijpe

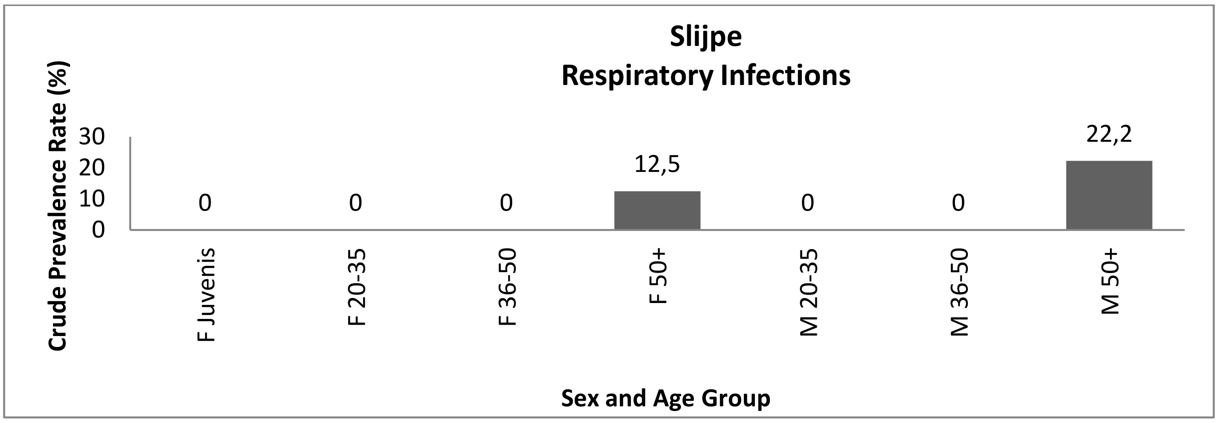

Fig. 5.49: CPR (Crude Prevalence Rate) in percentages for respiratory infections for each sex and age group within the Slijpe skeletal assemblage.

The CPR for respiratory infections for the adult assemblage of Slijpe was 5.2% (3/58) (fig. 5.49), and 4.1% (3/73) for the complete assemblage. There was no statistically significant difference between both sexes (males: 8.3%; 2/24; females: 2.9%; 1/34) (x^2=0.834, df=1, p=0.361, n=58), between all age groups (p=0.250, Fisher's exact test 2-sided, n=73) and between the age groups of known sex (p=0.261, Fisher's exact test 2-sided, n=54) for respiratory infections. One old adult female (12.5%; 1/8) and two old adult males (22.2%; 2/9) were observed with lesions suggestive of an infection of the respiratory system. The old adult affected individuals were observed with periosteal new bone formation on the visceral surface of rib fragments, which might be indicative of a pulmonary infection, or be regarded as 'nonspecific indicators of intrathoracic infection' (Mays *et al.* 2002: 35).

Table 5.31 lists skeletal individuals from Slijpe observed with lesions indicative of respiratory infections and/or pulmonary conditions such as pulmonary TB.

Skeleton nr.	**Sex**	**Age group**	**Lesion suggestive of respiratory infection/pulmonary condition/pulmonary TB**
60	F	50+	new bone formation on visceral surface of unspecified rib fragments
68	M	50+	new bone formation on visceral surface of unspecified rib fragments
76	M	50+	new bone formation on visceral surface of an unspecified rib fragment

Table 5.31: Overview of individuals from the Slijpe skeletal assemblage observed with lesions suggestive of respiratory infection.

* Vichte

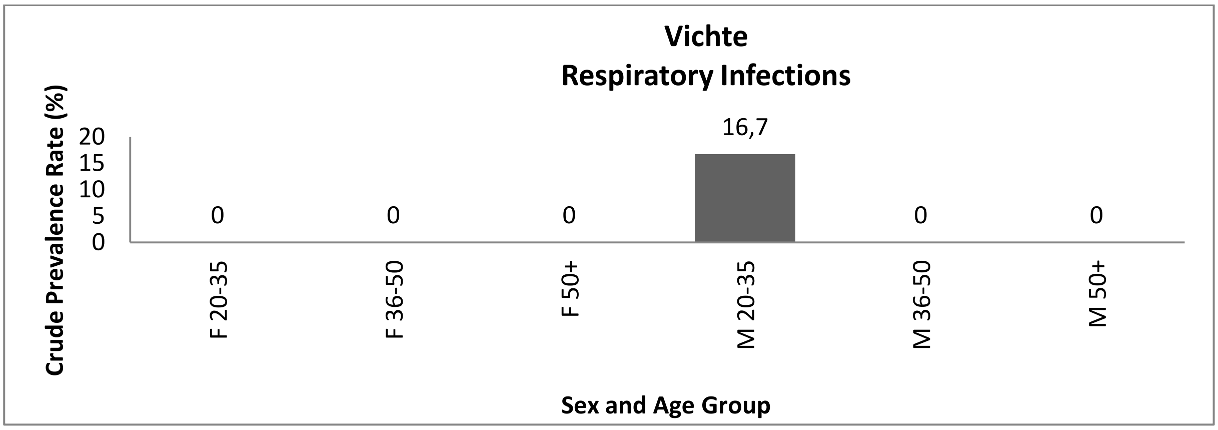

Fig. 5.50: CPR (Crude Prevalence Rate) in percentages for respiratory infections for each sex and age group within the Vichte skeletal assemblage.

For Vichte, the CPR for respiratory infections for the adult assemblage was 2.6% (1/39) (fig. 5.50), and 2.2% (1/46) for the complete assemblage. There was no statistically significant difference between both sexes (males: 4.0%; 1/25; females: 0.0%; 0/18) (x^2=0.737, df=1, p=0.391, n=43), between all age groups (p=1.000, Fisher's exact test 2-sided, n=46) and between the adult age groups (p=0.359, Fisher's exact test 2-sided, n=39) for respiratory infections. Only one young adult male (16.7%; 1/6) exhibited an infection of the respiratory system (skeletal individual nr. 557-56).

Table 5.32 lists the skeletal individual from Vichte observed with lesions indicative of respiratory infections and/or pulmonary conditions such as pulmonary TB.

Skeleton nr.	**Sex**	**Age group**	**Lesion suggestive of respiratory infection/pulmonary condition/pulmonary TB**
557	M	20-35	erosive lesions on the visceral surface of a left unspecified rib may be suggestive of a pulmonary infection (TB?)

Table 5.32: Overview of the individual from the Vichte skeletal assemblage observed with lesions suggestive of respiratory infection.

* Zottegem, Moorsel and Oosterweel

There was no evidence for respiratory infections within both the adult and subadult assemblages of Zottegem, Moorsel and Oosterweel.

5.4.3.4. Other Infectious Diseases

* Deinze

The CPR for other infectious diseases such as ear infections or mastoiditis within the Deinze adult population of known sex was 5.5% (4/73), with no significant difference between males (5.6%; 2/36) and females (5.4%; 2/37) (x^2=0.001, df=1, p=0.978, n=73) and between the adult age groups (p=0.419, Fisher's exact test 2-sided, n=64) (fig. 5.51). The CPR for the total Deinze skeletal population which could be identified on the prevalence of other infectious diseases however was 11.0% (10/91), which showed a statistically significant difference between all age groups (p=0.014, Fisher's exact test 2-sided, n=91). Other infectious diseases were mostly present in the Infans I (50.0%; 1/2), Infans II (40.0%; 2/5) and the total Juvenis (33.3%; 4/12) age categories. The majority of other infectious diseases involved infections of the right ear (7), one left ear infection, one possible case of sinusitis with a senior adult male aged 50+, and a possible case of meningitis in a juvenile of c. 15 years old. The latter individual (skeleton nr. WP3 L74) is also listed in table 5.30 of individuals with lesions suggestive of pulmonary/respiratory infection since the likelihood of TB involving the parietal bone (as this is the case) in persons less than twenty years old has been reported in clinical studies (Kupta *et al.* 1998; Singh and Dutta 2006). The possibility of meningitis TB in the Deinze juvenile will be further discussed in Chapter 6.

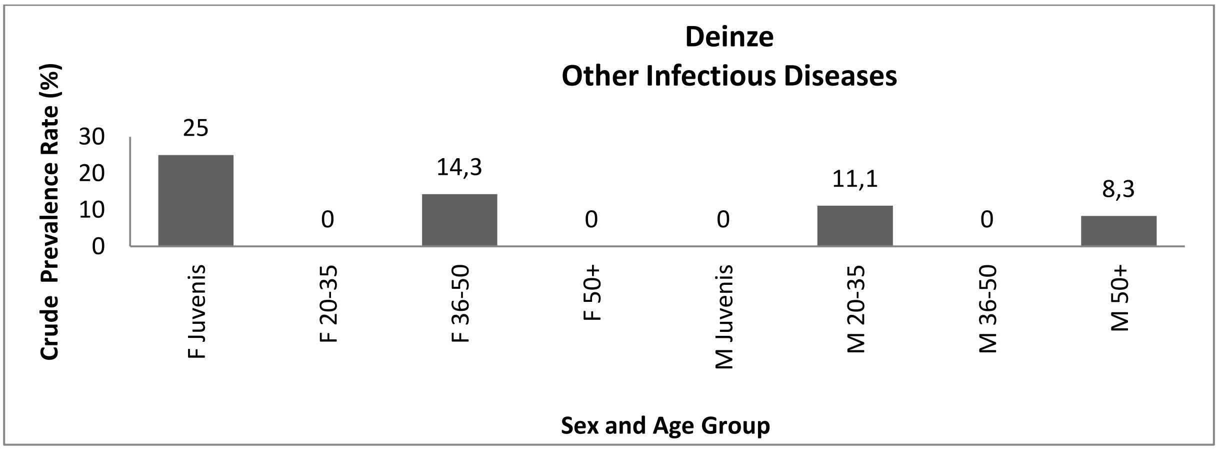

Fig. 5.51: CPR (Crude Prevalence Rate) in percentages for other infectious diseases for each sex and age group within the Deinze skeletal assemblage.

* Slijpe

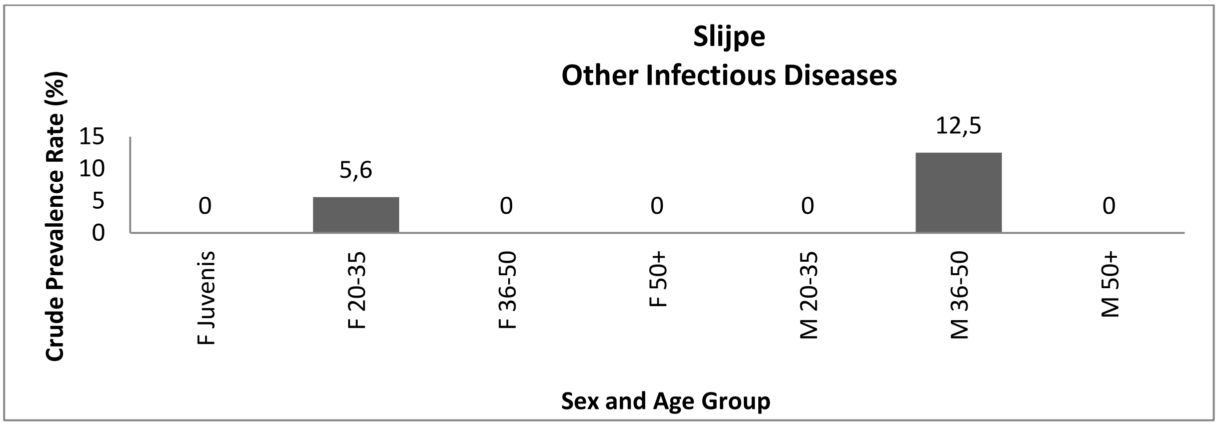

Fig. 5.52: CPR (Crude Prevalence Rate) in percentages for other infectious diseases for each sex and age group within the Slijpe skeletal assemblage.

The CPR for other infectious diseases for the adult Slijpe collection was 3.4% (2/58) (fig. 5.52) and 4.1% (3/73) for the complete collection. Only one young child of c. 6-7 years within the subadult group was observed with a possible infection of the left and right ear. There was no statistically significant difference for the prevalence of other infectious diseases between both sexes (males: 4.2%; 1/24; females: 2.9%; 1/34) (x^2=0.063, df=1, p=0.801, n=58), between the age groups of known sex (p=0.780, Fisher's exact test 2-sided, n=54), and between all age groups (p=0.624, Fisher's exact test 2-sided, n=73). Other infections included a possible case of sinusitis in a young adult female and an infection of the left and right ear in a middle adult male.

* Vichte

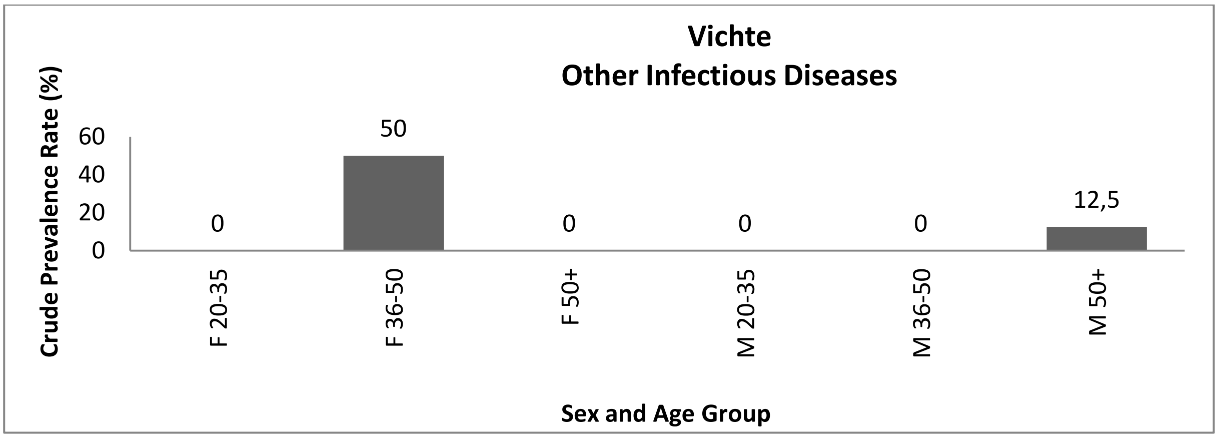

Fig. 5.53: CPR (Crude Prevalence Rate) in percentages for other infectious diseases for each sex and age group within the Vichte skeletal assemblage.

The CPR for other infectious diseases for the adult Vichte collection of known age was 5.1% (2/39) (fig. 5.53) and 6.4% (3/47) for the complete collection. Only one young child of the Infans I group (1-6 years) was observed with a likely infection of the right ear (skeletal individual nr. 535-22). More ear infections were recorded in a middle adult female and in an old adult male (skeletal individuals nr. 523-11 and 542-2). There was no statistically significant difference for the prevalence of other infectious diseases between both sexes (males: 3.8%; 1/26; females: 5.6%; 1/18) (x^2=0.072, df=1, p=0.789, n=44), between the adult age groups (p=0.117, Fisher's exact test 2-sided, n=39) and between all age groups (p=0.211, Fisher's exact test 2-sided, n=47).

* Zottegem

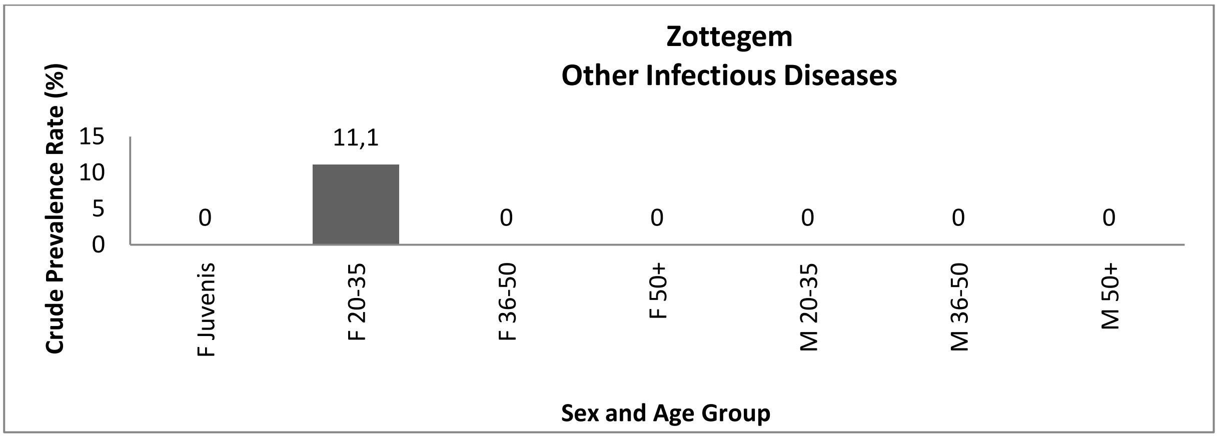

Fig. 5.54: CPR (Crude Prevalence Rate) in percentages for other infectious diseases for each sex and age group within the Zottegem skeletal assemblage.

The CPR for other infectious diseases for the adult Zottegem collection of known age was 4.0% (1/25) (fig. 5.54) and 4.4% (2/45) for the complete collection. One young child of c. 5 years old was observed with a possible infection of the right and left ear (skeletal individual nr. 14-ZOT-MP-37). An infection of both ears was also identified in a young adult female (skeletal individual nr. 14-ZOT-MP-135). There was no statistically significant difference for the prevalence of other infectious diseases between males (0.0%; 0/17) and females (4.5%; 1/22) (x^2=0.793, df=1, p=0.373, n=39) and between the adult age groups (p=1.000, Fisher's exact test 2-sided, n=25).

* Moorsel and Oosterweel

There were no other infectious diseases identified in both the adult and total skeletal collections of Moorsel and Oosterweel.

5.4.4. Metabolic Diseases

5.4.4.1. Cribra Orbitalia (CO) within the Six Sites

* Deinze

For Deinze, CO was observed in one young adult female (2.9%; 1/34), none male individuals (0.0%; 0/32), and in two young children (aged 1-6 years) (50.0%; 2/4; 50.0%). The TPR for CO for the complete skeletal collection was 4.0% (5/125). The CPR for CO for the total Deinze adult assemblage was 1.5% (1/66) and 3.6% (3/83) for the total collection. There was no statistically significant difference between the sexes (x^2=0.956, df=1, p=0.328, n=66), but the difference between all age groups for the CPR of CO (p=0.002, Fisher's exact test 2-sided, n=83), and between adults and subadults when using the TPR data from table 5.34 (p=0.006, one tailed Fisher's exact test) was identified as statistically significant.

* Slijpe

For Slijpe, CO was observed in six females (21.4%; 6/28), five males (22.7%; 5/22) and in five subadults (50%; 5/10): three young children (37.5%; 3/8) and two older children (aged 7-12 years) (33.3%; 2/6). There was no statistically significant difference between the adult sexes (x^2=0.012, df=1, p=0.912, n=50), between all age groups (p=0.404, Fisher's exact test 2-sided, n=60), and between the age groups of known sex (p=0.847, Fisher's exact test 2-sided,n=46). The CPR for CO for the Slijpe adult collection of known age and sex was 21.7% (10/46) and 26.7% (16/60) for the complete assemblage. When using the TPR data from table 5.34, there was no statistically significant difference between males and females (x^2=5.625, df=1, p=0.227). There was a statistically significant difference between subadults and adults when using the TPR data from table 5.33 (p=0.033, one tailed Fisher's exact test).

Table 5.33 presents the TPR's of CO in the different age groups of the Slijpe skeletal collection since CO is mostly observed here compared to the other case studies. Figures 5.55 and 5.56 show the distribution of CO within the complete collection of Slijpe and within the adult age groups according to sex.

Cribra Orbitalia	Age Category	Slijpe M	F		Total %
		n/N		n/N - %	M - F
	Infans I (1-6)			5/9 - 55.5	
	Infans II (7-12)			3/10 - 30.0	
	YA	2/10	6/33		20.0 - 18.2
	MA	6/15	0/9		40.0 - 0.0
	OA	2/16	2/12		12.5 - 16.7

Table 5.33: TPR's of cribra orbitalia in the different age groups of the Slijpe skeletal assemblage. Two affected orbits of an adult female for which no specific age group could be attributed, are not included. n=number of affected orbits; N= number of observed orbits

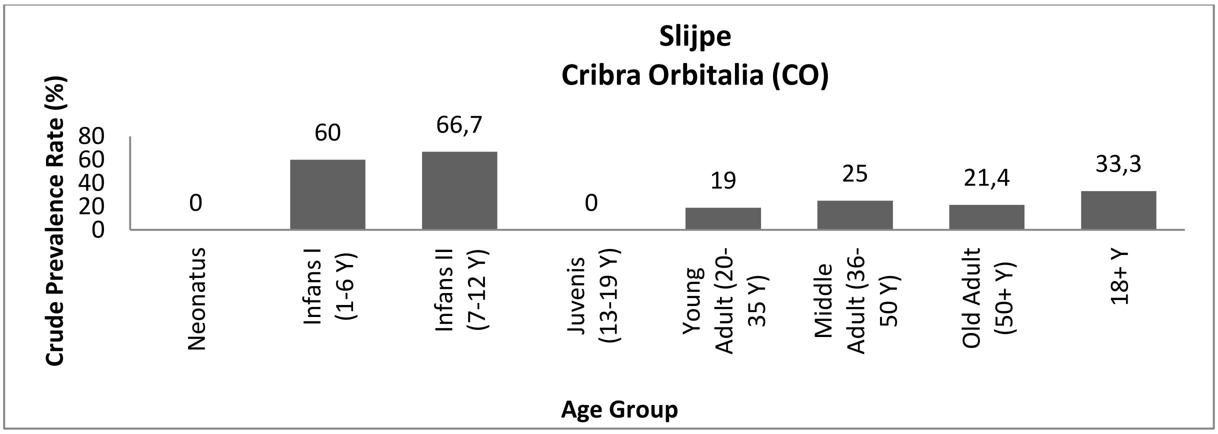

Fig. 5.55: CPR (Crude Prevalence Rate) in percentages for cribra orbitalia (CO) according to age for all skeletal individuals with observable orbits within the Slijpe skeletal assemblage.

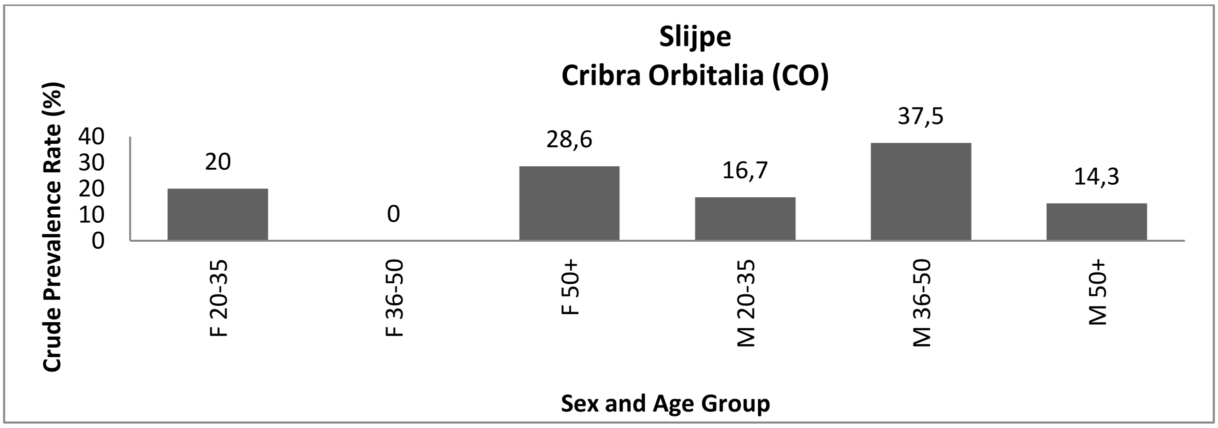

Fig. 5.56: CPR (Crude Prevalence Rate) in percentages for cribra orbitalia (CO) for each sex and age group of individuals with observable orbits within the Slijpe skeletal assemblage.

* Vichte

For Vichte, CO was not observed in females (0.0%; 0/14). One young adult male and one old adult male were observed with CO (8.7%; 2/23). One young child (aged 1-6 years) (50.0%; 1/2) was affected with CO. The CPR for CO for the Vichte adult collection was 5.4% (2/37) and 5.1% (2/39) for the complete assemblage. There was no statistically significant difference between the adult sexes (x^2=1.287, df=1, p=0.257, n=37), between all age groups (p=0.352, Fisher's exact test 2-sided, n=40), and between the age groups of known sex (p=0.697, Fisher's exact test 2-sided, n=33). When using the TPR data from table 5.34, there was no statistically significant difference between adults and subadults (p=0.236, one tailed Fisher's exact test).

* Zottegem, Moorsel and Oosterweel

CO was not identified in the skeletal individuals from Zottegem, Moorsel and Oosterweel.

Cribra Orbitalia	**Site**	**M**		**F**		**ND**		**Total**	
		n/N	**TPR (%)**	**n/N**	**TPR (%)**	**n/N**	**TPR (%)**	**n/N**	**TPR (%)**
	Deinze	0/48	0.0	1/52	1.9	4/25	16.0	5/125	4.0
	Oosterweel	0/10	0.0	0/12	0.0	0/2	0.0	0/24	0.0
	Moorsel	0/11	0.0	0/13	0.0	0/4	0.0	0/28	0.0
	Slijpe	10/43	23.2	10/58	17.2	8/21	38.1	28/122	22.9
	Vichte	2/40	5.0	0/25	0.0	1/6	16.7	3/71	4.2
	Zottegem	0/18	0.0	0/25	0.0	0/0	0.0	0/43	0.0

Table 5.34: TPR's of cribra orbitalia in the skeletal collections. n=number of affected orbits; N=number of observed orbits.

5.4.4.2. Porotic Hyperostosis (PH)

* Deinze

The TPR for porotic hyperostosis (PH) for the adult assemblage was 1.5% (1/66). PH was identified with only one middle adult female (age group 36-50 years). No adult males exhibited PH. The TPR for PH for the total assemblage including subadults was 1.2% (1/83). PH was not identified within the younger age groups. There was no statistically significant difference between the adult sexes (x^2=0.956, df=1, p=0.328, n=66), between age groups of known sex (p=0.356, Fisher's exact test 2-sided, n=59) and between all age categories for the prevalence of PH (p=0.542, Fisher's exact test 2-sided, n=83).

* Slijpe

The TPR for PH for the adult group of Slijpe was 1.8% (1/55) and 3.0% (2/66) for the complete collection. PH was further identified with one young child aged c.4-5 years old and one young adult female. There was no statistically significant difference for the prevalence of PH between both sexes (x^2=0.732, df=1, p=0.392, n=55), between all age groups (p=0.418, Fisher's exact test 2-sided, n=66), and between the adult age groups (p=1.000, Fisher's exact test 2-sided, n=51).

* Vichte

The TPR for porotic hyperostosis (PH) for the adult assemblage was 1.5% (1/66). The TPR for PH for the total assemblage including subadults was 2.4% (1/41). PH was not identified within the younger age groups. There was no statistically significant difference between the adult sexes (x^2=0.670, df=1, p=0.413, n=38), between the adult age groups (p=1.000, Fisher's exact test 2-sided, n=34) and between all age categories for the prevalence of PH (p=1.000, Fisher's exact test 2-sided, n=41). PH was only identified in one old adult male.

* Zottegem

The TPR for porotic hyperostosis (PH) for the total assemblage including subadults was 3.0% (1/33). PH was not identified within the younger age groups. There was no statistically significant difference between the adult sexes (x^2=1.695, df=1, p=0.193, n=29) and between all age categories (p=1.000, Fisher's exact test 2-sided, n=33) for the prevalence of PH. PH was only identified in one adult male aged 18+.

* Moorsel and Oosterweel

There was no evidence for PH within the adult and total assemblages of Moorsel and Oosterweel.

5.4.4.3. Rickets/Osteomalacia

* Deinze

The CPR for rickets/osteomalacia was 5.3% (4/75) for the Deinze adult group. There was no statistically significant difference between the adult males (8.1%; 3/37) and females (2.6%; 1/38) (x^2=1.114, df=1, p=0.291, n=75), between age categories of known sex (p=0.982, Fisher's exact test 2-sided, n=66) and between all age categories (p=0.936, Fisher's exact test 2-sided, n=93). The CPR for the total skeletal collection was 5.4% (5/93), with only one juvenile of unknown sex exhibiting the disease (8.3%; 1/12).

* Slijpe

There were no individuals observed with rickets or osteomalacia within the complete skeletal assemblage of Slijpe.

* Vichte

The CPR for rickets/osteomalacia was 7.7% (3/39) for the adult group of known age, and 7.0% (3/43) for the total skeletal collection. Rickets/osteomalacia was observed in one young and old adult female and in one old adult male. There was no statistically significant difference between males (4%; 1/25) and females (12.5%; 2/16) (x^2=1.039, df=1, p=0.308, n=41), between the adult age categories (p=0.748, Fisher's exact test 2-sided, n=39) and between all age categories (p=0.825, Fisher's exact test 2-sided, n=43).

* Moorsel

The CPR for rickets/osteomalacia was 2.6% (1/38) for the total skeletal collection. It was not possible to provide the CPR for the adult collection of known sex and age as rickets/osteomalacia was observed in one adult male aged 18+ for which no specific age group could be assigned. There was no statistically significant difference between males (5.6%; 1/18) and females (0%; 0/16) (x^2=0.916, df=1, p=0.339, n=34) and between all age categories (p=1.000, Fisher's exact test 2-sided, n=38).

* Zottegem and Oosterweel

Rickets/osteomalacia was not identified within the adult and total collections of Zottegem and Oosterweel.

5.4.5. Enthesopathies of the Hand Bones

Figure 5.57 shows the CPR's for the prevalence of hand bone enthesopathies within the skeletal assemblage of Deinze of known sex and age which was 24.6% (15/61). There was a statistically significant difference between the groups of known sex and age (p=0.004, Fisher's exact test 2-sided, n=61) and between all age categories (p<0.001, Fisher's exact test 2-sided, n=85). The CPR for hand bone enthesopathies for the complete assemblage was 24.7% (21/85). There was no statistically significant difference between males (36.1%; 13/36) and females (21.2%; 7/33) (x^2=1.857, df=1, p=0.173).

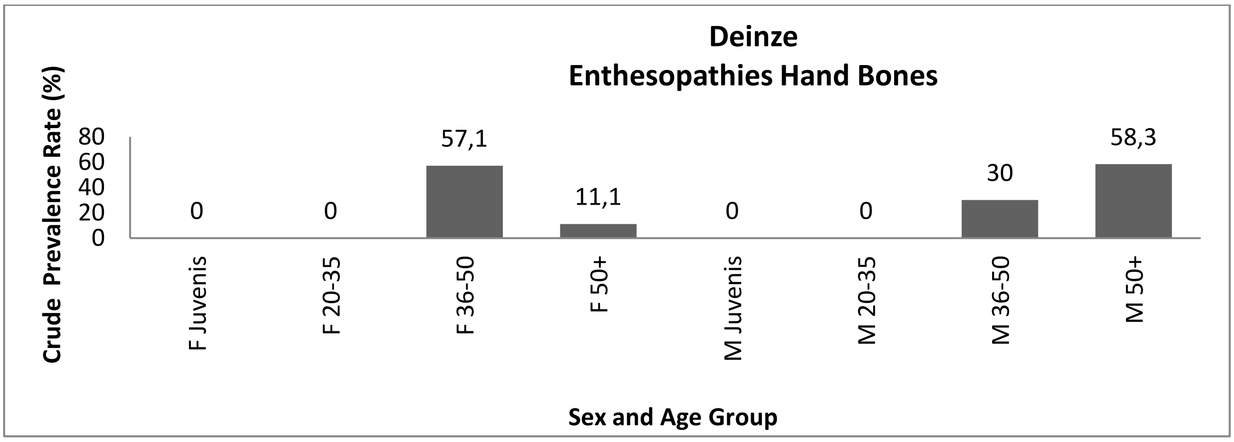

Fig. 5.57: CPR (Crude Prevalence Rate) in percentages for hand bones enhesopathies for each sex and age group within the Deinze skeletal assemblage.

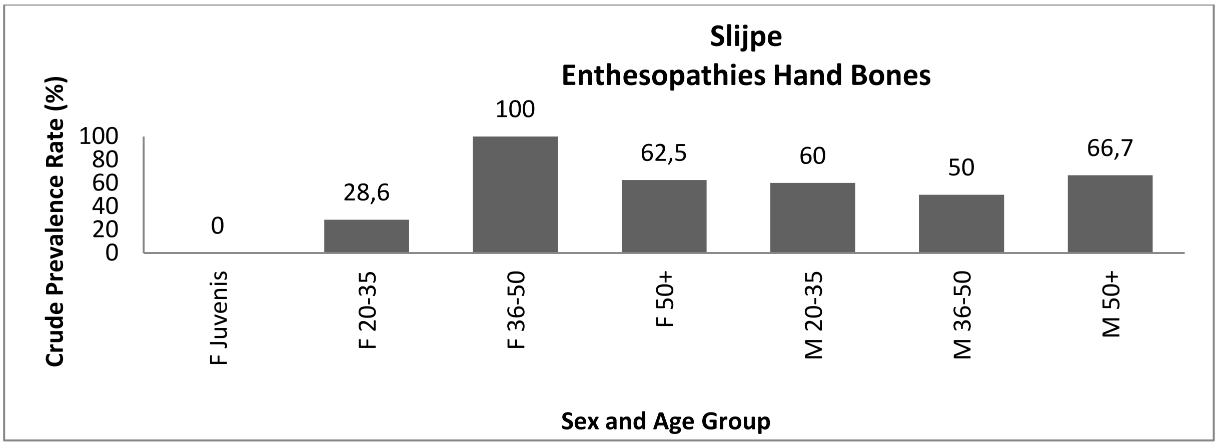

Fig. 5.58: CPR's (Crude Prevalence Rats) in percentages for hand bones enhesopathies for each sex and age group within the Slijpe skeletal assemblage.

The CPR for hand bone enthesopathies for the Slijpe adult assemblage was 52.9% (27/51) (fig. 5.58), and 41.5% (27/65) for the complete assemblage. No subadults were identified with enthesopathies of the hand bones. There was no statistically significant difference between males (59.1%; 13/22) and females (48.3%; 14/29) (x^2=0.587, df=1, p=0.443, n=51) and between the adult age categories (p=0.226, Fisher's exact test 2-sided, n=48) in the prevalence of hand bone enthesopathies. There was a statistically significant difference between all age groups (p=0.009, Fisher's exact test 2-sided, n=65). Enthesopathies of the hand bones were mostly observed in middle (66.7%; 8/12) and old (64.7%; 11/17) adults.

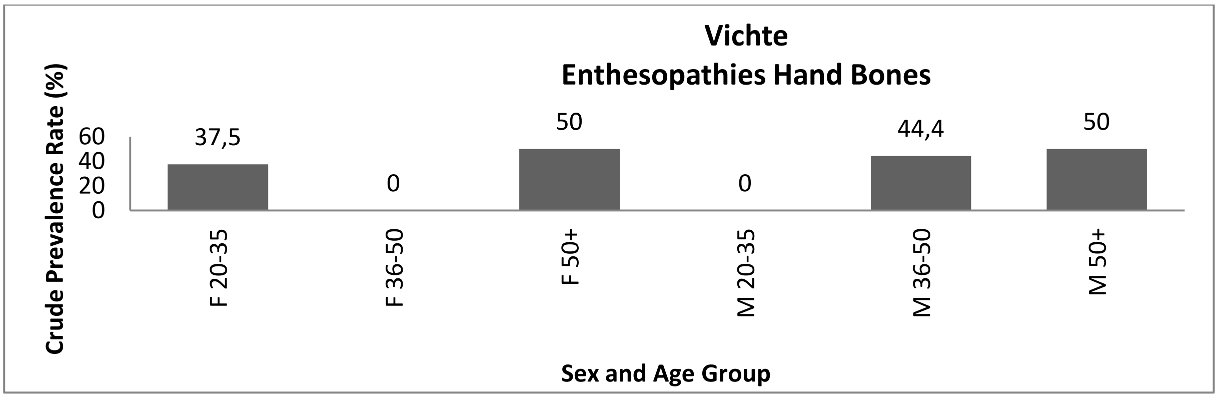

Fig. 5.59: CPR's (Crude Prevalence Rats) in percentages for hand bones enhesopathies for each sex and age group within the Vichte skeletal assemblage.

The CPR for hand bone enthesopathies for the Vichte adult assemblage of known age was 35.9% (14/39) (fig. 5.59), and 37.2% (16/43) for the complete assemblage. No subadults and young adult males were identified with enthesopathies of the hand bones. There was no statistically significant difference between the adult age groups (p=0.312, Fisher's exact test 2-sided, n=39) and between all age categories (p=0.211, Fisher's exact test 2-sided, n=43). There was no statistically significant difference between males (40.0%; 10/25) and females (37.5%; 6/16) in the prevalence of hand bone enthesopathies (x^2=0.026, df=1, p=0.873, n=41). Enthesopathies of the hand bones were mostly observed in both old adult males (50.0%; 4/8) and females (50.0%; 3/6), and was also noticed in young adult females (37.5%; 3/8).

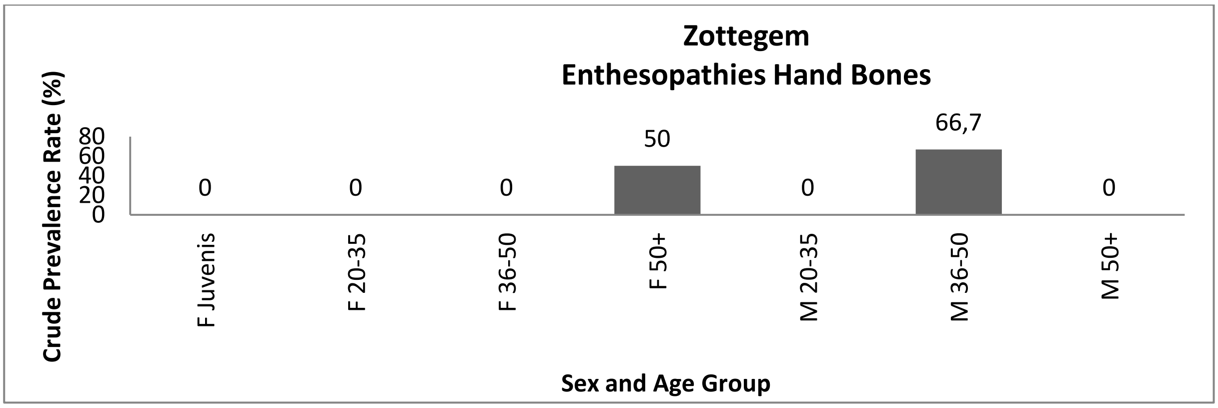

Fig. 5.60: CPR's (Crude Prevalence Rats) in percentages for hand bones enhesopathies for each sex and age group within the Zottegem skeletal assemblage.

The CPR for hand bone enthesopathies for the Zottegem adult assemblage of known age was 13.0% (3/23) (fig. 5.60) and 15.6% (5/32) for the complete assemblage with hand bones available for analysis. There was no statistically significant difference between the adult age groups (p=0.054, Fisher's exact test 2-sided, n=23) and between all age categories (p=0.262, Fisher's exact test 2-sided, n=32). There was no statistically significant difference between males (21.4%; 3/14) and females (11.8%; 2/17) in the prevalence of hand bone enthesopathies (x^2=0.530, df=1, p=0.467, n=31). Enthesopathies of the hand bones were not observed in subadults and in young male and female adults.

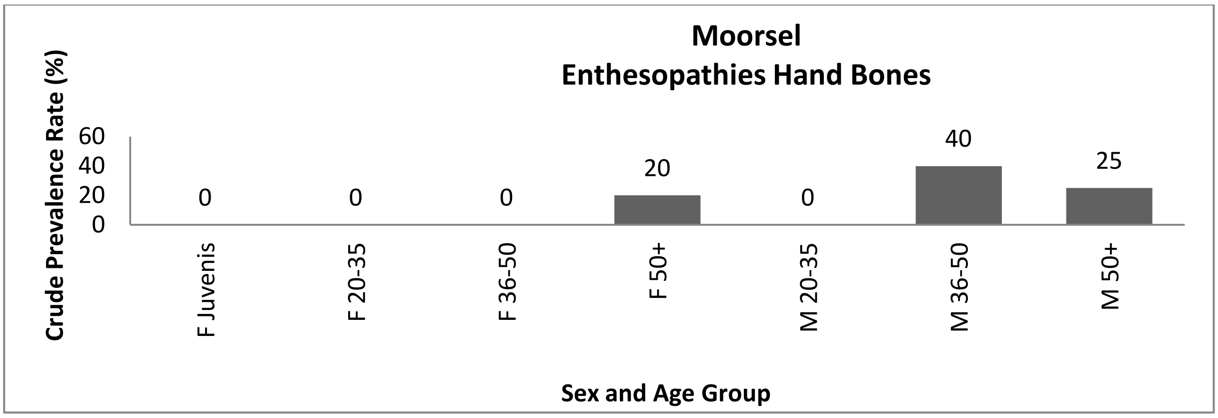

Fig. 5.61: CPR's (Crude Prevalence Rats) in percentages for hand bones enhesopathies for each sex and age group within the Moorsel skeletal assemblage.

The CPR for hand bone enthesopathies for the Moorsel collection of known sex and age was 16.7% (4/24) (fig. 5.61), and 19.4% (7/36) for the complete assemblage. Neither subadults nor young adults were identified with enthesopathies of the hand bones. Further, there were no statistically significant differences between males (35.3%; 6/17) and females (6.7%; 1/15) (x^2=3.821, df=1, p=0.051, n=32), between all age groups (p=0.444, Fisher's exact test 2-sided, n=36) and between the age categories of known sex (p=0.827, Fisher's exact test 2-sided, n=24) for hand bone enthesopathies.

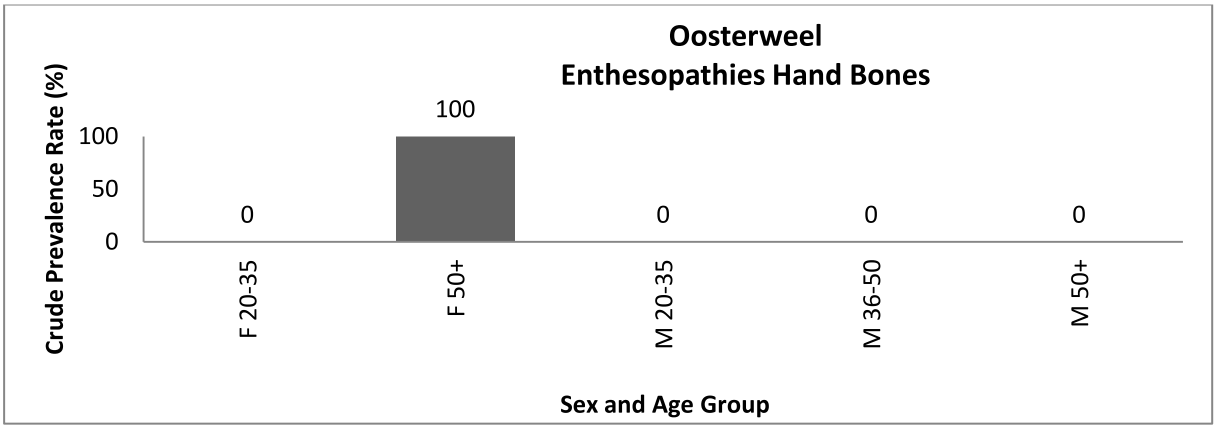

Fig. 5.62: CPR's (Crude Prevalence Rats) in percentages for hand bones enhesopathies for each sex and age group within the Oosterweel skeletal assemblage.

The CPR for hand bone enthesopathies for the Oosterweel collection of known sex and age was 7.1% (1/14) (fig. 5.62), and 5.9% (1/17) for the complete assemblage. Neither subadults nor young and middle adults and males were observed with enthesopathies of the hand bones. There were no statistically significant differences between males (0.0%; 0/8) and females (12.5%; 1/8) (x^2=1.067, df=1, p=0.302, n=16), between all age groups (p=0.529, Fisher's exact test 2-sided, n=17) and between the age categories of known sex (p=0.071, Fisher's exact test 2-sided, n=14) for hand bone enthesopathies.

5.5. Dental Pathologies

5.5.1. Caries, Abscess, EH and AMTL

Tables 5.35 to 5.37 present the TPR's of caries, abscess, dental enamel hypoplasia (EH) and antemortem tooth loss (AMTL) within the total skeletal assemblages of the six sites, the adult and subadult groups and within the adult individuals of known sex.

Dental pathology	Deinze		Oosterweel		Moorsel		Slijpe		Vichte		Zottegem	
	Teeth affected	TPR (%)	Teeth affected	TPR (%)	Teeth affected	TPR (%)	Teeth affected	TPR (%)	Teeth affected	TPR (%)	Teeth affected	TPR (%)
Caries	107	9.4	14	9.7	20	10.9	100	9.0	26	9.7	30	7.1
Abscess	9	0.8	0	0.0	0	0.0	17	1.5	2	0.7	4	0.9
EH	214	18.7	31	21.5	0	0.0	253	22.9	41	15.2	64	15.2
AMTL	371/1471	25.2	36/217	16.6	96/284	33.8	196/1410	13.9	189/395	47.8	114/507	22.5

Table 5.35: Overview of dental disease in the skeletal assemblages. The TPR's represent the percentage of teeth affected by dental pathologies. EH=Enamel hypoplasia; AMTL=antemortem tooth loss. Total inspected teeth representing all age groups: Deinze: N=1141; Oosterweel: N=144; Moorsel: N=184; Slijpe: N=; 1105; Vichte: N=269; Zottegem: N=421. AMTL is calculated as the number of teeth lost antemortem divided by the total count of dental alveoli or tooth sockets.

Dental pathology	Deinze Teeth affected	TPR (%)	Oosterweel Teeth affected	TPR (%)	Moorsel Teeth affected	TPR (%)	Slijpe Teeth affected	TPR (%)	Zottegem Teeth affected	TPR (%)
Caries	7	2.0	0	0.0	3	3.8	2	1.3	3	6.5
Abscess	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
EH	129	37.5	5	26.3	0	0.0	13	8.7	10	21.7
AMTL	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

Table 5.36: Overview of dental disease in the subadult groups of the skeletal assemblages. The TPR's represent the percentage of teeth affected by dental pathologies. EH=Enamel hypoplasia; AMTL=antemortem tooth loss. Total observed subadult teeth: Deinze: N=344; Oosterweel: N=19; Moorsel: N=79; Slijpe: N=; 150; Vichte: N=0; Zottegem: N=46. For Vichte, no dentition of the four subadults was present for analysis.

Dental pathology		Deinze			Oosterweel			Moorsel			Slijpe			Vichte			Zottegem		
		M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total
		n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N	n/N
Caries		54/408	41/461	95/869	4/67	10/58	14/125	13/56	7/103	20/159	49/402	49/553	98/955	13/146	13/123	26/269	8/100	20/252	28/352
	%	13.2	8.9	10.9	6.0	17.2	11.2	23.2	6.8	12.6	12.2	8.9	10.3	8.9	10.6	9.7	8.0	7.9	7.9
Abscess		7/408	2/461	9/869	0/67	0/58	0/125	0/56	0/103	0/159	8/402	9/553	17/955	1/146	1/123	2/269	2/100	2/252	4/352
	%	1.7	0.4	1.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	1.6	1.8	0.7	0.8	0.7	2.0	0.8	1.1
EH		51/408	48/461	99/869	9/67	17/58	26/125	0/56	0/103	0/159	103/402	137/553	240/955	17/146	24/123	41/269	15/100	32/252	47/352
	%	12.5	10.4	11.4	13.4	29.3	20.8	0.0	0.0	0.0	25.7	24.8	25.1	11.6	19.5	15.2	15.0	12.7	13.3
AMTL		184/535	152/585	336/1120	11/103	25/89	36/192	41/94	45/157	86/251	106/500	92/699	198/1199	107/208	71/183	178/391	34/140	67/293	101/433
	%	34.4	26.0	30.0	10.7	29.4	18.7	43.6	28.7	34.3	21.2	13.2	16.5	51.4	38.8	45.5	24.3	22.9	23.3

Table 5.37: Overview of dental disease in the adult skeletal assemblages of known sex. The TPR's represent the percentage of teeth affected by dental pathologies. EH=Enamel hypoplasia; AMTL=antemortem tooth loss. n=teeth affected; N=total teeth

Table 5.38 presents the p-values of the TPR’s for dental pathologies between males and females of the six sites (using the raw data of table 5. to demonstrate p-values). Statistically significant differences are listed in bold.

Dental pathology	Deinze	Oosterweel	Moorsel	Slijpe	Vichte	Zottegem
Caries	**0.020**	**0.023**	**0.001**	**0.047**	0.323	0.492
Abcess	0.062	-	-	0.338	0.706	0.320
EH	0.167	**0.014**	-	0.382	**0.037**	0.283
AMTL	**0.001**	**0.001**	**0.008**	**p<0.001**	**0.006**	0.372

Table 5.38: P-values for TPR’s of dental pathologies between males and females (showing p-values). Numbers in red indicate the use of one tailed Fisher’s exact test, otherwise Chi-Square test of independence was applied. Statistically significant results are shown in bold.

* Deinze

When considering all individuals with teeth available for analysis, the prevalence of caries was not observed as statistically significant between males and females ($x^2=0.000$, df=1, p=1.000, n=60), between all age groups (p=0.083, Fisher's exact test 2-sided, n=74) and between age groups of known sex (p=0.368, Fisher's exact test 2-sided, n=54). Caries was mostly observed in young and middle adult females (both 62.5%; 5/8) and in middle adult males (66.7%; 6/9). When applying TPR data from tables 5.36 and 5.37, there was a statistically significant difference between adults and subadults for the prevalence of caries ($x^2=2.533$, df=1, $p<0.001$).

The CPR for abscesses (AB) for the adult assemblage was 11.7% (7/60). There was no statistically significant difference between males and females ($x^2=1.456$, df=1, p=0.228, n=60), between all age groups (p=0.949, Fisher's exact test 2-sided, n=74) and between the adult age categories (p=0.989, Fisher's exact test 2-sided, n=54). The CPR for AB for the complete collection was 9.5% (7/74). No subadults exhibited AB. AB was observed in one young and middle adult female and male and in two old adult males.

The CPR for EH was 38.3% (23/60) for the adult assemblage, and 40.5% (30/74) for the total assemblage including subadults. There was no statistically significant difference for EH between males (12/30; 40%) and females (11/30; 36.7%)($x^2=0.071$, df=1, p=0.791, n=60), between the age groups of known sex (p=0.631, Fisher's exact test 2-sided, n=54) and between all age categories (p=0.094, Fisher's exact test 2-sided, n=74). There was, however, a statistically significant difference for EH between the adult and subadult groups ($x^2=1.101$, df=1, $p<0.001$) when using the TPR data as shown in tables 5.36 and 5.37 EH was identified from the age of seven years (50%; 2/4). Most cases of EH were reported within juveniles (8/10; 80%), which is also reflected in the TPR's of the latter group (37.5%) compared to the TPR's of the adult group of known sex (11.4%). Figure 5.63 shows the distribution of EH within the Deinze skeletal individuals of known sex and age.

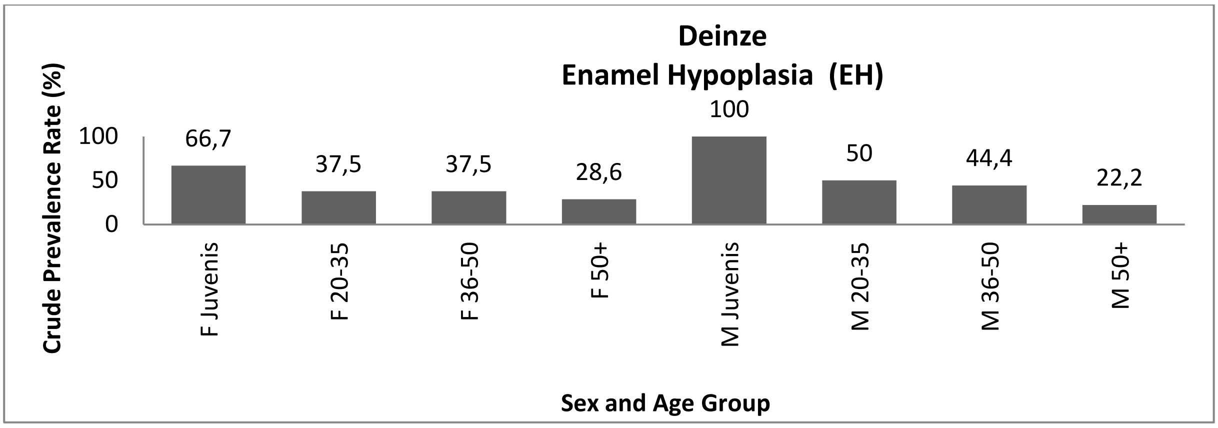

Fig. 5.63: CPR (Crude Prevalence Rate) in percentages showing the distribution for linear enamel hypoplasia (EH) for each sex and age group within the Deinze skeletal assemblage.

The CPR for antemortem tooth loss (AMTL) for the total adult assemblage was 71.7% (43/60) and 59.5% (44/74) for the complete collection. There was a statistically significant difference for the prevalence of AMTL between the age groups of known sex (p=0.002, Fisher's exact test 2-sided, n=54) and between all age categories (p<0.001, Fisher's exact test 2-sided, n=74). AMTL was not observed in subadults. There was no statistically significant difference between males (70%; 21/30) and females (73.3%; 22/30) for AMTL (x^2=0.082, df=1, p=0.774, n=60). The TPR for males was 34.4% and for females 26%. AMTL was identified in all old adult females (100%; 7/7), and most commonly in middle and old adult males (both 88.9%; 8/9).

* Slijpe

For Slijpe, the prevalence of caries was not statistically significant between males and females (x^2=0.187, df=1, p=0.665, n=51) and between the age groups of known sex (p=0.734, Fisher's exact test 2-sided, n=48). The difference between all age groups, however, was statistically significant for caries (p=0.007, Fisher's exact test 2-sided, n=60). Caries was mostly observed in old adult females (80%; 4/5) and in middle adult males (87.5%; 7/8). When applying TPR data from tables 5.36 and 5.37, there was a statistically significant difference between adults and subadults for the prevalence of caries (x^2=1.256, df=1, p=0.001).

The CPR for abscesses (AB) for the adult assemblage was 26.9% (14/52).There was no statistically significant difference between males and females (x^2=0.259, df=1, p=0.611, n=52), between all age groups (p=0.468, Fisher's exact test 2-sided, n=61) and between the adult age categories (p=0.964, Fisher's exact test 2-sided, n=49). The CPR for AB for the complete collection was 23% (14/61). No subadults exhibited AB. AB was mostly identified in both old adult females (33.3%; 2/6) and males (37.5%; 3/8).

The CPR for EH for the adult group of Slijpe was 60.8% (31/51) and 55% (33/60) for the complete collection. There was no statistically significant difference between males (69.6%; 16/23) and females (53.6%; 15/28) (x^2=1.355, df=1, p=0.244, n=51), and between the adult age categories (p=0.112, Fisher's exact test 2-sided, n=48) for EH. The total assemblage, however, showed a statistically significant difference between the age groups (p=0.036, Fisher's exact test 2-sided, n=60). There was also a statistically significant difference for EH between the adult and subadult groups (x^2=1.991, df=1, p<0.001) when using the TPR data as shown in tables 5.36 and 5.37. The majority of EH was observed in young adult males (83.3%; 5/6) and in middle adult females (75%; 3/4). Two older children (50%; 2/4) of the Infans II age category (7-12 years) were noticed with EH.

Figure 5.64 shows the distribution of EH within the Slijpe skeletal individuals of known sex and age.

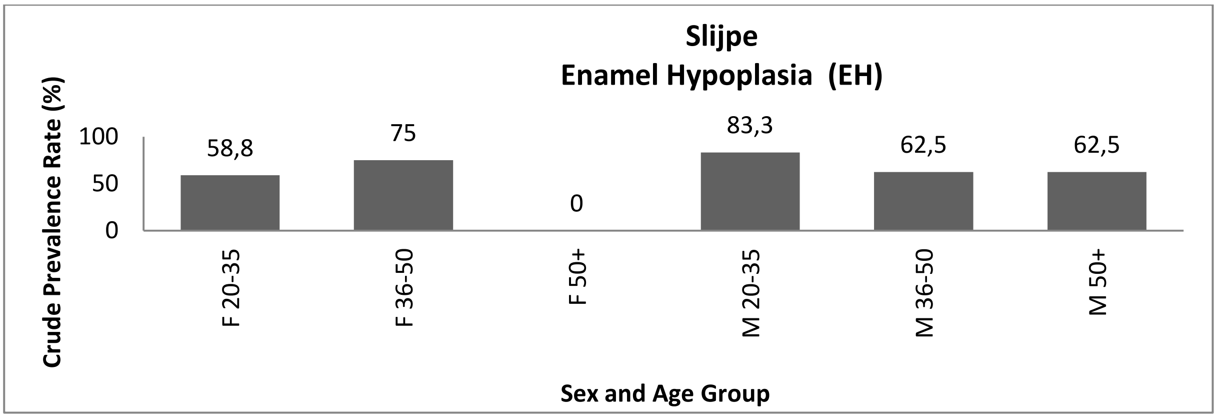

Fig. 5.64: CPR (Crude Prevalence Rate) in percentages showing the distribution for linear enamel hypoplasia (EH) for each sex and age group within the Slijpe skeletal assemblage.

The CPR for antemortem tooth loss (AMTL) for the total adult assemblage of Slijpe was 61.5% (32/52) and 52.5% (32/61) for the complete collection. There was a statistically significant difference for the prevalence of AMTL between all age categories (p=0.002, Fisher's exact test 2-sided, n=61). AMTL was not observed in subadults. There was no statistically significant difference between males (73.9%; 17/23) and females (51.7%; 15/29) (x^2=2.668, df=1, p=0.102, n=52) and between the adult age groups (p=0.285, Fisher's exact test 2-sided, n=49) for AMTL. The TPR for males was 21.2% and for females 13.2%. AMTL was mostly observed in old adult females (66.7%; 4/6) and in old adult males (87.5%; 7/8).

* Vichte

The prevalence of caries was not statistically significant between males and females (x^2=0.750, df=1, p=0.386, n=24), between all age groups (p=1.000, Fisher's exact test 2-sided, n=24) and between the adult age groups (p=0.833, Fisher's exact test 2-sided, n=22) within the Vichte skeletal collection. Caries was mostly observed in middle adult females (100%; 2/2) and in young and old adult males (both 50%; 2/4).

The CPR for abscesses (AB) for the adult assemblage was 7.7% (2/26).There was no statistically significant difference between males and females (x^2=0.133, df=1, p=0.715, n=29), between all age groups (p=1.000, Fisher's exact test 2-sided, n=29) and between the adult age categories (p=0.123, Fisher's exact test 2-sided, n=26). AB was identified in one young adult male and in one middle adult female.

The CPR for EH for the adult group of Vichte was 36.4% (8/22). There was no statistically significant difference between males (25%; 4/16) and females (50%; 4/8) (x^2=1.500, df=1, p=0.221, n=24) when using CPR data for EH. TPR data, however, demonstrated a statistically significant difference between both sexes (x^2=3.199, df=1, p=0.037). There was a statistically significant difference between the adult age groups (p=0.001, Fisher's exact test 2-sided, n=22) and between all age groups (p=0.003, Fisher's exact test 2-sided, n=24) for the prevalence of EH. Fig. 5.65 shows the distribution of EH within the Vichte skeletal individuals of known sex and age. EH was mostly observed in young adult males (100%; 4/4) and in young adult females (60%; 3/5).

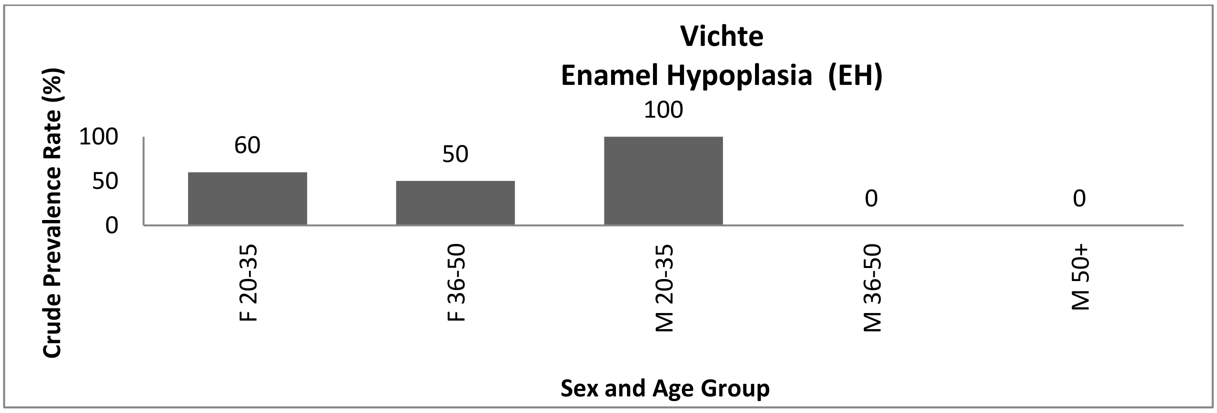

Fig. 5.65: CPR (Crude Prevalence Rate) in percentages showing the distribution for linear enamel hypoplasia (EH) for each sex and age group within the Vichte skeletal assemblage.

The CPR for antemortem tooth loss (AMTL) for the total adult assemblage of Vichte was 71.4% (20/28). There was no statistically significant difference between males (68.4%; 13/19) and females

(75%; 9/12) (x^2=0.155, df=1, p=0.694, n=31) and between the adult age groups (p=0.070, Fisher's exact test 2-sided, n=28) for AMTL. There was a statistically significant difference for AMTL between all age groups (p=0.023, Fisher's exact test 2-sided, n=31). The TPR for males was 51.4% and for females 38.8%. AMTL was observed in all middle and old adult females (both 100%; 2/2) and in all old adult males (100%; 7/7).

* Zottegem

The prevalence of caries was statistically significant between males (27.3%; 3/11) and females (76.5%; 13/17) (x^2=6.601, df=1, p=0.010, n=28) but not between the age groups of known sex (p=0.812, Fisher's exact test 2-sided, n=19) within the Zottegem skeletal collection. However, when using TPR data (table 5.37), the difference was observed as statistically insignificant (x^2=0.000, df=1, p=0.492). Caries was observed in all old adult males and females and female juveniles. Further, TPR data did not demonstrate a statistically significant difference between adults and subadults for the prevalence of caries (p=0.507, one tailed Fisher's exact test).

The CPR for abscesses (AB) for the adult assemblage of known sex and age was 5.3% (1/19) and 8.8% (3/34) for the complete collection.There was no statistically significant difference between males (18.2%; 2/11) and females (5.3%; 1/19) (x^2=1.292, df=1, p=0.256, n=30) and between the adult age categories (p=1.000, Fisher's exact test 2-sided, n=19). AB was identified in one young adult female and in two males aged 18+.

The CPR for EH for the adult group of known sex and age of Zottegem was 42.1% (8/19) and 38.7% (12/31) for the complete collection. There was no statistically significant difference between males (20%; 2/10) and females (47.1%; 8/17) (x^2=1.977, df=1, p=0.160, n=27) for EH. There was no statistically significant difference between the age groups of known sex (p=0.917, Fisher's exact test 2-sided, n=19) and between all age groups including 18+ (p=0.640, Fisher's exact test 2-sided, n=31). There was further no statistically significant difference for EH between the adult and subadult groups (x^2=2.332, df=1, p=0.063) when using the TPR data as shown in tables 5.36 and 5.37. Figure 5.66 shows the distribution of EH within the Zottegem skeletal individuals of known sex and age. EH was mostly observed in young adult males (33.3%; 1/3) and in young adult females (62.5%; 5/8).

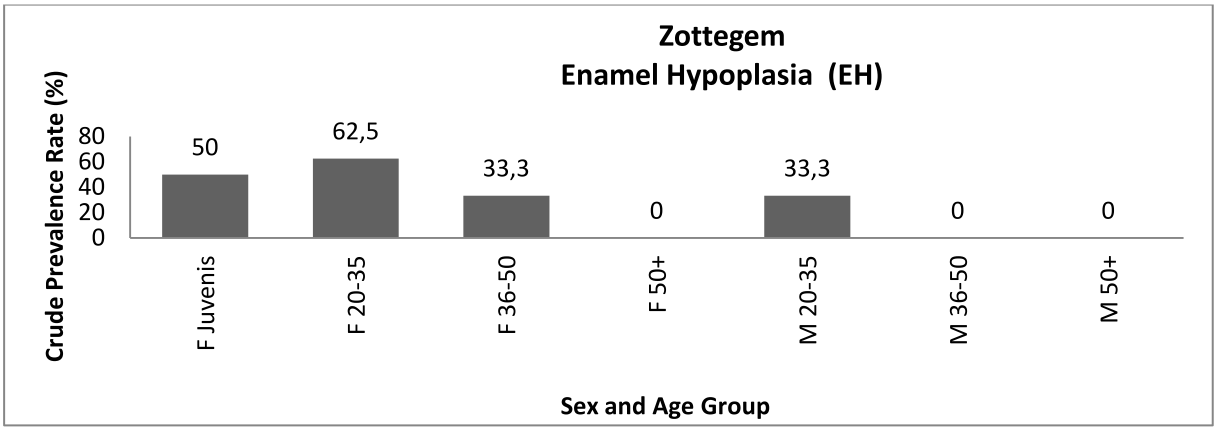

Fig. 5.66: CPR (Crude Prevalence Rate) in percentages showing the distribution for linear enamel hypoplasia (EH) for each sex and age group within the Zottegem skeletal assemblage.

The CPR for antemortem tooth loss (AMTL) for the total adult assemblage of Zottegem was 65% (13/20). There was no statistically significant difference between males (81.8%; 9/11) and females (70%; 14/20) (x^2=0.518, df=1, p=0.472, n=31) and between the age groups of known sex (p=0.278, Fisher's exact test 2-sided, n=20) for AMTL. There was a statistically significant difference for AMTL between all age groups of the complete collection (p=0.034, Fisher's exact test 2-sided, n=35). The TPR for males was 24.3% and for females 22.9%. AMTL was observed in all middle and old adult males and females.

* Moorsel

The prevalence of caries was not statistically significant between males and females (x^2=0.180, df=1, p=0.671, n=28) and between the adult age groups (p=0.694, Fisher's exact test 2-sided, n=14) within the Moorsel post-medieval skeletal collection. Caries was observed in all adult age groups apart from the only old adult female, and was mostly present in middle adult males and females. When applying TPR data from tables 5.36 and 5.37, there was a statistically significant difference between adults and subadults for the prevalence of caries (x^2=4.662, df=1, p=0.015).

Both abscesses (AB) and EH were not identified in the adult and complete collection of Moorsel.

The CPR for antemortem tooth loss (AMTL) for the collection of known sex and age of Moorsel was 76.5% (13/17). There was a statistically significant difference between all age groups (p=0.008, Fisher's exact test 2-sided, n=23) and between the age groups of known sex (p=0.003, Fisher's exact test 2-sided, n=17) for AMTL. There was no statistically significant difference between males (81.8%;

9/11) and females (70%; 7/10) (x^2=0.403, df=1, p=0.525, n=21). The TPR for males was 43.6% and for females 28.7%. AMTL was observed in all skeletal individuals from known sex and age, apart from the one young adult male.

* Oosterweel

The prevalence of caries was not statistically significant between males (62.5%; 5/8) and females (100%; 5/5) (p=0.196, Fisher's exact test 1-sided, n=13), between the age groups of known sex (p=0.345, n=12) and between all age groups (p=0.594, Fisher's exact test 2-sided, n=14) within the Oosterweel skeletal collection. Caries was observed in all young adult females and middle adult males.

Abscesses (AB) were not observed in the complete collection of Oosterweel.

The CPR for EH for the adult group of known sex and age of Oosterweel was 58.3% (7/12) and 64.3% (9/14) for the complete collection. There was no statistically significant difference between males (50.0%; 4/8) and females (80.0%; 4/5) (p=0.315, Fisher's exact test 1-sided, n=13) for EH when using CPR data. TPR data, however, demonstrated a statistically significant difference between both sexes (x^2=4.757, df=1, p=0.014). There was no statistically significant difference between the age groups of known sex (p=1.000, Fisher's exact test 2-sided, n=12) and between all age groups including 18+ (p=1.000, Fisher's exact test 2-sided, n=14). There was further no statistically significant difference for EH between the adult and subadult groups (p=0.388, one tailed Fisher's exact test) when using the TPR data as shown in tables 5.36 and 5.37. Although Fisher's exact test was applied due to the small sample size, it is important to note that dentition of only one subadult was available for analysis. Figure 5.67 shows the distribution of EH within the Oosterweel skeletal individuals of known sex and age. No dental elements were available for analysis of middle and old adult females. EH was mostly observed in all adult male groups (50.0%) and in young adult females (75.0%; 3/4).

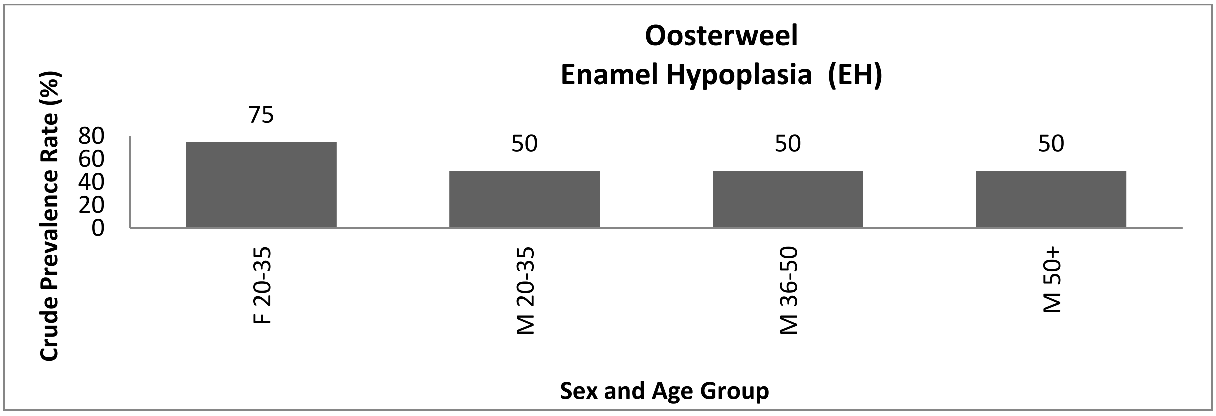

Fig. 5.67: CPR (Crude Prevalence Rate) in percentages showing the distribution for linear enamel hypoplasia (EH) for each sex and age group within the Oosterweel skeletal assemblage.

The CPR for antemortem tooth loss (AMTL) for the total adult assemblage of known sex and age of Oosterweel was 75% (9/12). There was no statistically significant difference between males (57.1%; 4/7) and females (85.7%; 6/7) (x^2=1.400, df=1, p=0.237, n=14), between the age groups of known sex (p=0.282, Fisher's exact test 2-sided, n=12) and between all age groups of the complete collection (p=0.730, Fisher's exact test 2-sided, n=15) for AMTL. The TPR for males was 10.7% and for females 29.4%. AMTL was observed in all adult skeletal individuals, and more specifically in all adult females and in all middle adult males.

5.5.2. Periodontal Disease

* Deinze

The CPR for periodontal disease (PD) for the adult assemblage was 18.3% (11/60) (fig. 5.68), and 16.2% (12/74) for the total collection. PD occurred mostly in both male and female middle adults. There was no statistically significant difference between males (23.3%; 7/30) and females (13.3%; 4/30) (x^2=1.002, df=1, p=0.317) and between all age groups of known sex for the prevalence of PD (p=0.640, Fisher's exact test 2-sided, n=54). PD was not observed in subadults.

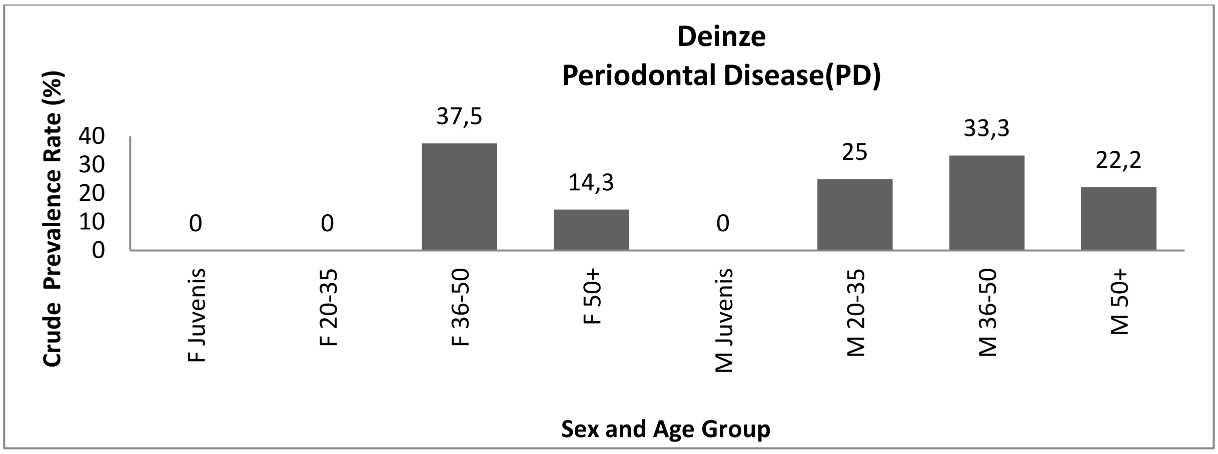

Fig. 5.68: CPR (Crude Prevalence Rate) in percentages for periodontal disease (PD) for each sex and age group within the Deinze skeletal assemblage.

* Slijpe

The CPR for PD for the Slijpe adult assemblage was 76.9% (40/52) (fig. 5.69) and 65.6% (40/61) for the complete collection. No subadults were observed with PD. There was a statistically significant difference between all age groups ($p<0.001$, Fisher's exact test 2-sided, n=61). There was no statistically significant difference for PD between males (87.0%; 20/23) and females (69.0%; 20/29) ($x^2=2.339$, df=1, $p=0.126$, n=52) and between the adult age groups ($p=0.279$, Fisher's exact test 2-sided, n=49). PD was mostly observed in middle adult males and females and in old adult males.

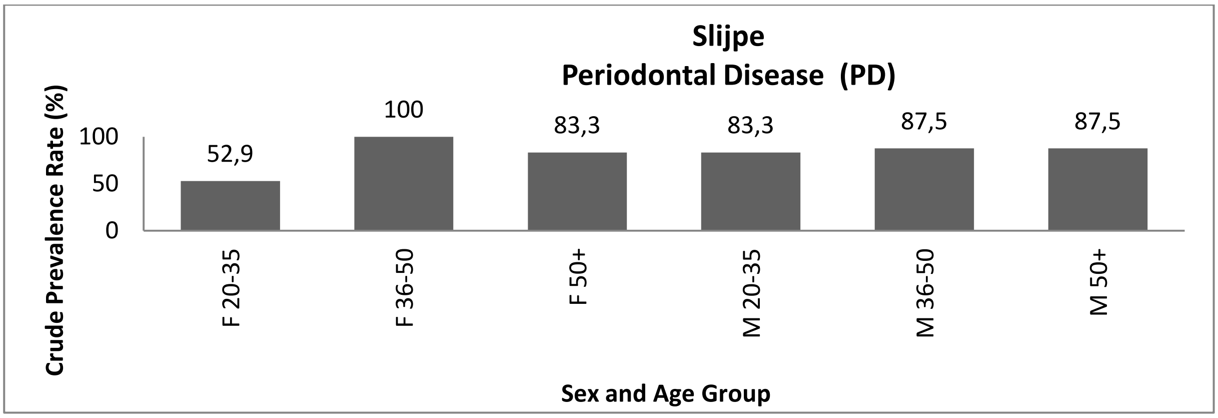

Fig. 5.69: CPR (Crude Prevalence Rate) in percentages for periodontal disease (PD) for each sex and age group within the Slijpe skeletal assemblage.

* Vichte

The CPR for PD for the Vichte adult assemblage of known age was 37.0% (10/27) (fig. 5.70). There was no statistically significant difference for PD between males (42.1%; 8/19) and females (18.2%; 2/11) (x^2=1.794, df=1, p=0.180, n=30), between all age groups (p=0.266, Fisher's exact test 2-sided, n=30) and between the adult age groups (p=0.738, Fisher's exact test 2-sided, n=27). PD was mostly observed in middle adult males (57.1%; 4/7) and females (50.0%; 1/2).

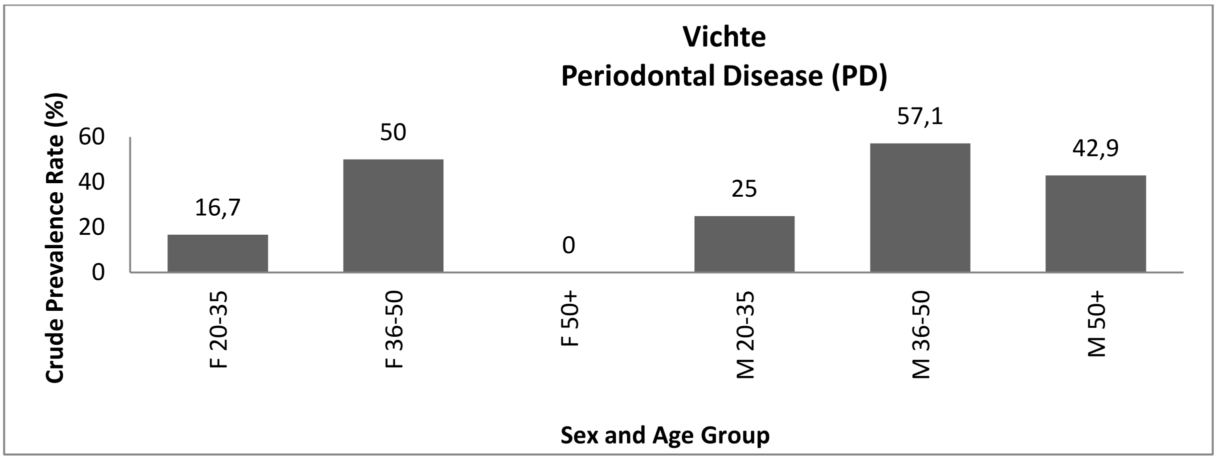

Fig. 5.70: CPR (Crude Prevalence Rate) in percentages for periodontal disease (PD) for each sex and age group within the Vichte skeletal assemblage.

* Zottegem

The CPR for PD for the Zottegem adult assemblage of known age was 22.2% (4/18) (fig. 5.71) and 21.2% (7/33) for the complete collection. There was no statistically significant difference for PD between males (30.0%; 3/10) and females (21.1%; 4/19) (x^2=0.286, df=1, p=0.593, n=29) and between the adult age groups (p=0.344, Fisher's exact test 2-sided, n=18). No subadults exhibited PD. PD was observed in all female adults (apart from two old adults) and in one old adult male.

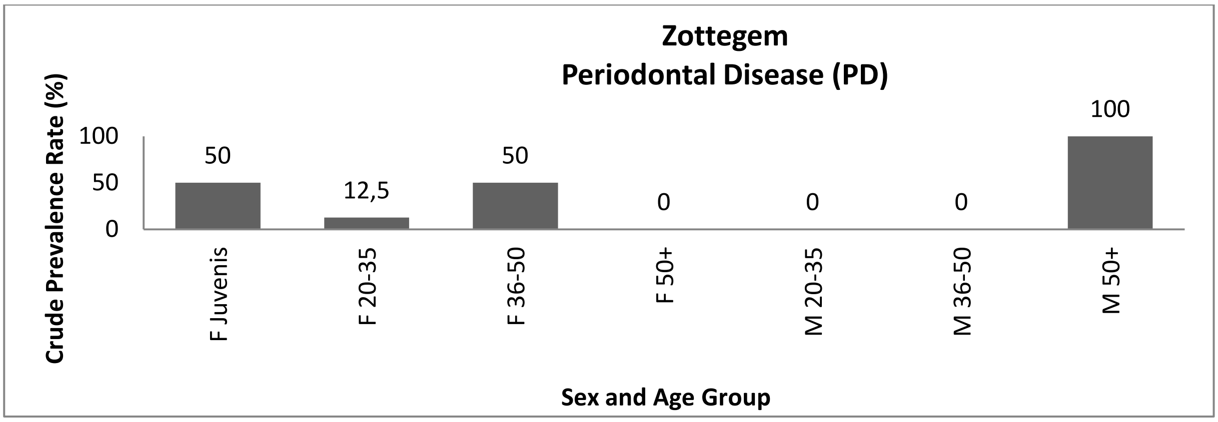

Fig. 5.71: CPR (Crude Prevalence Rate) in percentages for periodontal disease (PD) for each sex and age group within the Zottegem skeletal assemblage.

* Moorsel

The CPR for PD for the Moorsel assemblage of known age and sex was 26.7% (4/15) (fig. 5.72) and 25% (5/20) for the complete collection. There was no statistically significant difference for PD between males (44.4%; 4/9) and females (11.1%; 1/9) (x^2=2.492, df=1, p=0.114, n=18) and between the groups of known sex and age (p=0.221, Fisher's exact test 2-sided, n=15). No subadults exhibited PD. PD was observed in middle and old adult males and in the one old adult female.

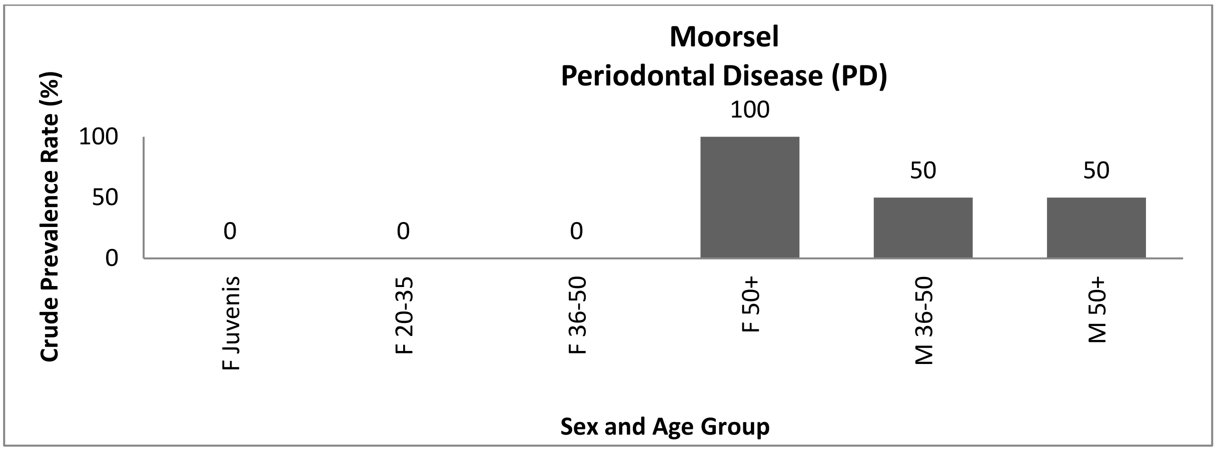

Fig. 5.72: CPR (Crude Prevalence Rate) in percentages for periodontal disease (PD) for each sex and age group within the Moorsel skeletal assemblage.

* Oosterweel

The CPR for PD for the Oosterweel assemblage of known age and sex was 45.5% (5/11) (fig. 5.73) and 38.5% (5/13) for the complete collection. There was no statistically significant difference for PD between males (57.1%; 4/7) and females (20.0%; 1/5) (p=0.247, Fisher's exact test 1-sided, n=12) and between the groups of known sex and age (p=0.061, Fisher's exact test 2-sided, n=11). There was a statistically significant difference between all age categories (p=0.021, Fisher's exact test 2-sided, n=13) for PD. No subadults exhibited PD. PD was observed in one young adult female (25%; 1/4) and in all middle and old adult males (both 100%; 2/2).

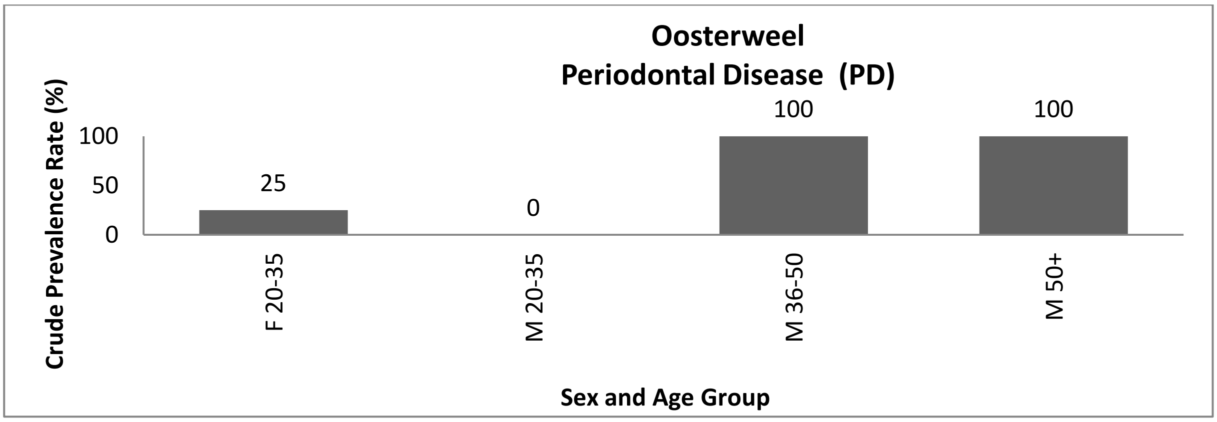

Fig. 5.73: CPR (Crude Prevalence Rate) in percentages for periodontal disease (PD) for each sex and age group within the Oosterweel skeletal assemblage.

5.6. Entheseal Changes (EC)

The following figures represent the distribution of each observed EC (left and right combined) within males and females and within the age categories (juvenis, young adult, middle adult and old adult) of the six skeletal assemblages as explained in Chapter 4. The adult age group of 18+ is included in the charts to demonstrate male-female discrepancies, but was left out in the statistical analysis when testing for a correlation between age and sex. When the difference between the left and right side of an enthesis was identified as statistically significant, a chart is included to demonstrate the preferential use of males and females.

5.6.1. Deinze

** Upper Limb EC*

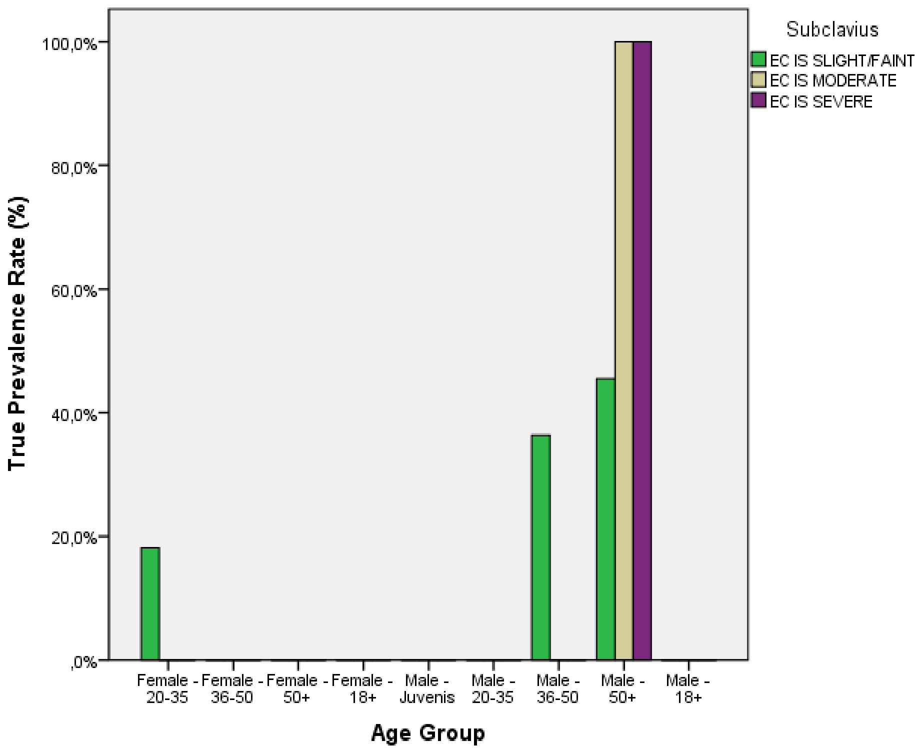

Fig. 5.74: TPR (True Prevalence Rate) in percentages of the subclavius scores for each sex and age group of the Deinze skeletal assemblage.

The severity of EC of the subclavius was statistically significant between males and females (U=1435, p=0.006, n1 (f)=60, n2 (m)=57) (fig. 5.74). More males (16.1%; 9/56) than females (0/57; 0.0%) display a moderate score. When testing age versus sex, there was no statistically significant difference for EC of the subclavius for males (x^2=7.641, df=3, p=0.054, n=54), and for females (x^2=3.963, df=2, p=0.138, n=50). There was no statistically significant difference in EC of the subclavius between left (l) and right (r) (U=1819.5, p=0.517, n1 (l)=60, n2 (r)=63).

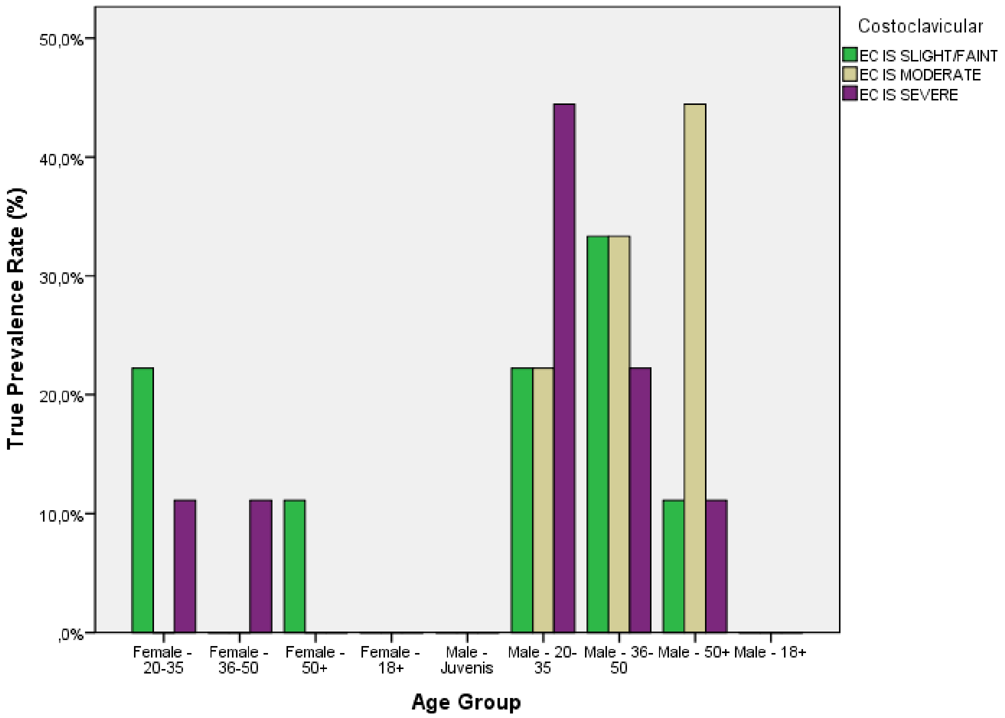

Fig. 5.75: TPR (True Prevalence Rate) in percentages of the costoclavicular scores for each sex and age group of the Deinze skeletal assemblage.

There was a statistically significant difference between males and females for the costoclavicular ligament (U=1100, p<0.001, n1 (f)=57, n2 (m)=56) (fig. 5.75). More males (16.1%; 9/56) than females (0/57; 0.0%) show a moderate score. When testing age versus sex, there was no statistically significant difference for EC of the costoclavicular ligament for males (x^2=3.704, df=3, p=0.296, n=54), and for females (x^2=1.964, df=2, p=0.375, n=47). There was no statistically significant difference in EC of the costoclavicular ligament between left (l) and right (r) (U=1765, p=0.971, n1 (l)=60, n2 (r)=59).

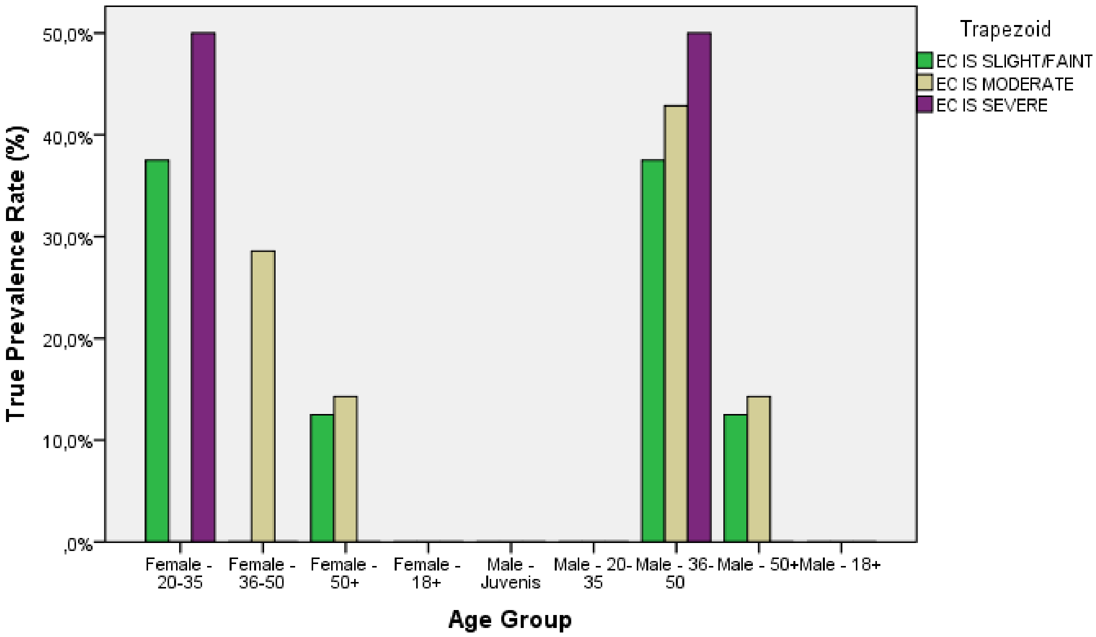

Fig. 5.76: TPR (True Prevalence Rate) in percentages of the trapezoid scores for each sex and age group of the Deinze skeletal assemblage.

For EC of the trapezoid, the difference between males and females is not statistically significant (U=1594.5, p=0.784, n1 (f)=57, n2 (m)=57) (fig. 5.76). When testing age versus sex, there was a statistically significant difference for EC of the trapezoid for males (x^2=10.181, df=3, p=0.017, n=54), but none for females (x^2=1.212, df=2, p=0.545, n=47). There was no statistically significant difference in EC of the trapezoid between left (l) and right (r) (U=1738.5, p=0.606, n1 (l)=59, n2 (r)=61).

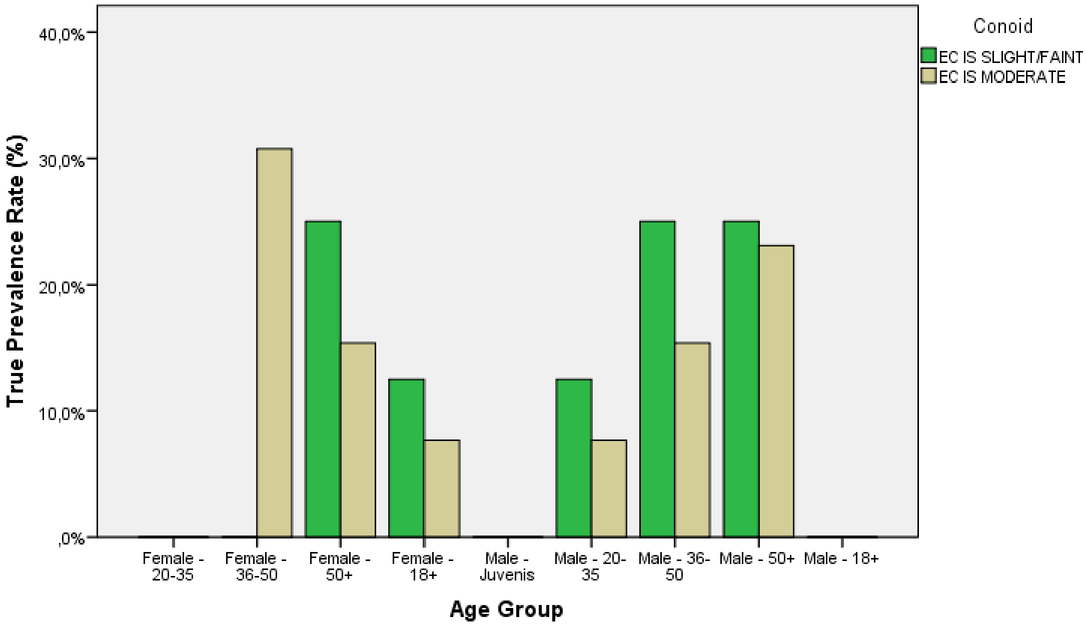

Fig. 5.77: TPR (True Prevalence Rate) in percentages of the conoid scores for each sex and age group of the Deinze skeletal assemblage.

For EC of the conoid, the difference between males and females is not statistically significant (U=1581.5, p=0.902, n1 (f)=56, n2 (m)=57) (fig. 5.77). When testing age versus sex, there was no statistically significant difference for EC of the conoid for males (x^2=1.426, df=3, p=0.699, n=54), and for females (x^2=4.555, df=2, p=0.103, n=46). There was no statistically significant difference in EC of the conoid between left (l) and right (r) (U=1733, p=0.767, n1 (l)=59, n2 (r)=60).

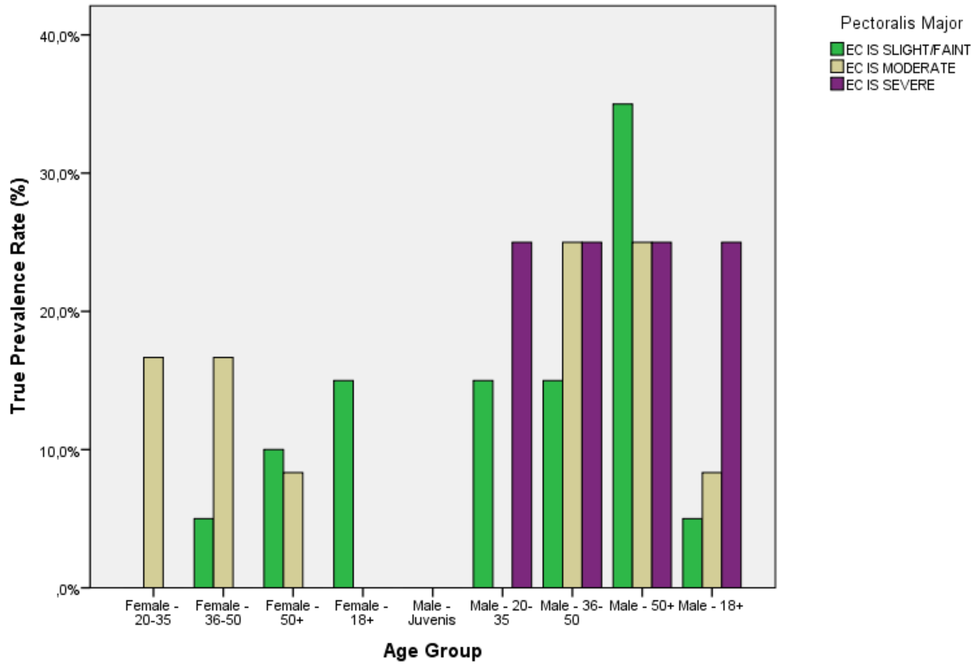

Fig. 5.78: TPR (True Prevalence Rate) in percentages of the pectoralis major scores for each sex and age group of the Deinze skeletal assemblage.

Only males across all adult age groups were observed with severe EC of the pectoralis major (4/60; 6.7%), resulting in a statistically significant difference between the sexes (U=1406, p=0.011, n1 (f)=58, n2 (m)=62) (fig. 5.78). When testing age versus sex, there was no statistically significant difference for EC of the pectoralis major for males (x^2=2.736, df=3, p=0.434, n=57), and for females (x^2=0.255, df=2, p=0.880, n=48). There was no statistically significant difference in EC of the pectoralis major between left (l) and right (r) (U=1902.5, p=0.621, n1 (l)=63, n2 (r)=63).

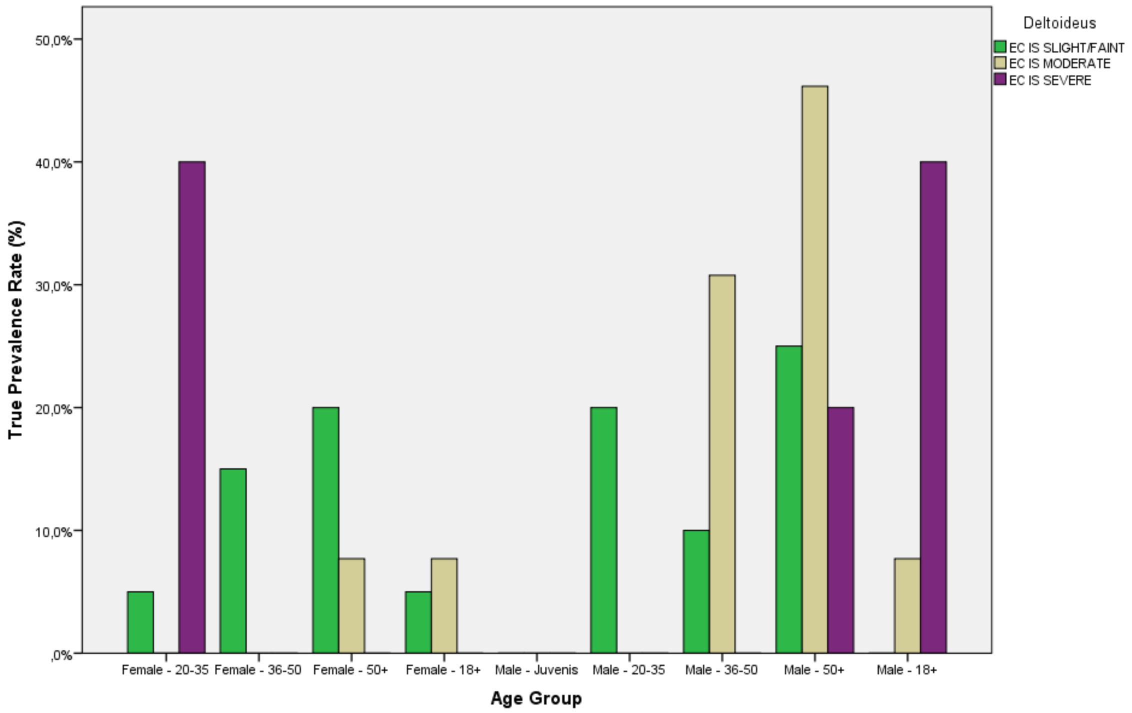

Fig. 5.79: TPR (True Prevalence Rate) in percentages of the deltoideus scores for each sex and age group of the Deinze skeletal assemblage.

There was a statistically significant difference between males and females for the deltoideus (U=1480, p=0.017, n1 (f)=60, n2 (m)=62) (fig. 5.79). When testing age versus sex, there was no statistically significant difference for EC of the deltoideus for males (x^2=5.479, df=3, p=0.140, n=57) and for females (x^2=0.249, df=2, p=0.883, n=50). There was no statistically significant difference in EC of the deltoideus between left (l) and right (r) (U=1826.5, p=0.197, n1 (l)=64, n2 (r)=64).

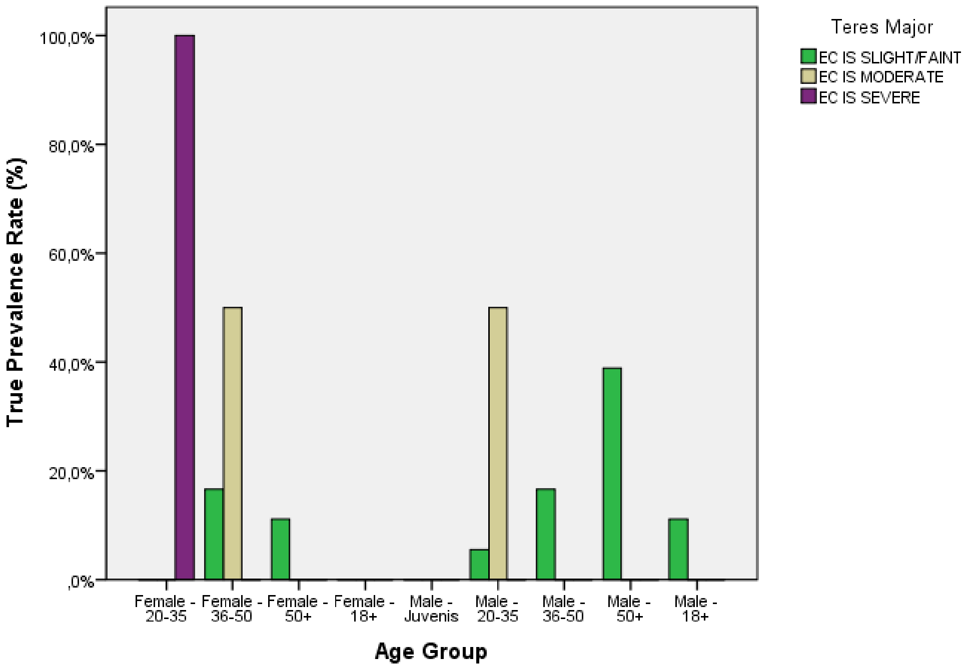

Fig. 5.80: TPR (True Prevalence Rate) in percentages of the teres major scores for each sex and age group of the Deinze skeletal assemblage.

There was no statistically significant difference between males and females for the teres major (U=1658, p=0.274, n1 (f)=58, n2 (m)=62) (fig. 5.80). When testing age versus sex, there was no statistically significant difference for EC of the teres major for males (x^2=2.465, df=3, p=0.482, n=57) and for females (x^2=1.335, df=2, p=0.513, n=48). There was no statistically significant difference in EC of the teres major between left (l) and right (r) (U=1923.5, p=0.652, n1 (l)=63, n2 (r)=63).

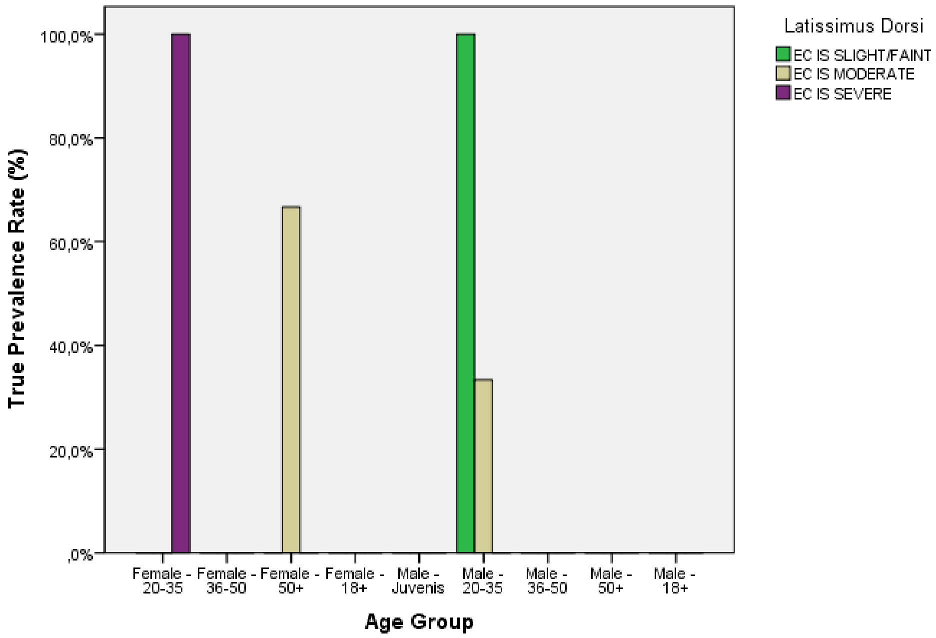

Fig. 5.81: TPR (True Prevalence Rate) in percentages of the latissimus dorsi scores for each sex and age group of the Deinze skeletal assemblage.

There was no statistically significant difference between males and females for the latissimus dorsi (U=1729, p=0.337, n1 (f)=58, n2 (m)=62) (fig. 5.81). When testing age versus sex, there was no statistically significant difference for EC of the latissimus dorsi for males (x^2=6.253, df=3, p=0.100, n=57) and for females (x^2=1.971, df=2, p=0.373, n=48). There was no statistically significant difference in EC of the latissimus dorsi between left (l) and right (r) (U=1983.5, p=0.989, n1 (l)=63, n2 (r)=63).

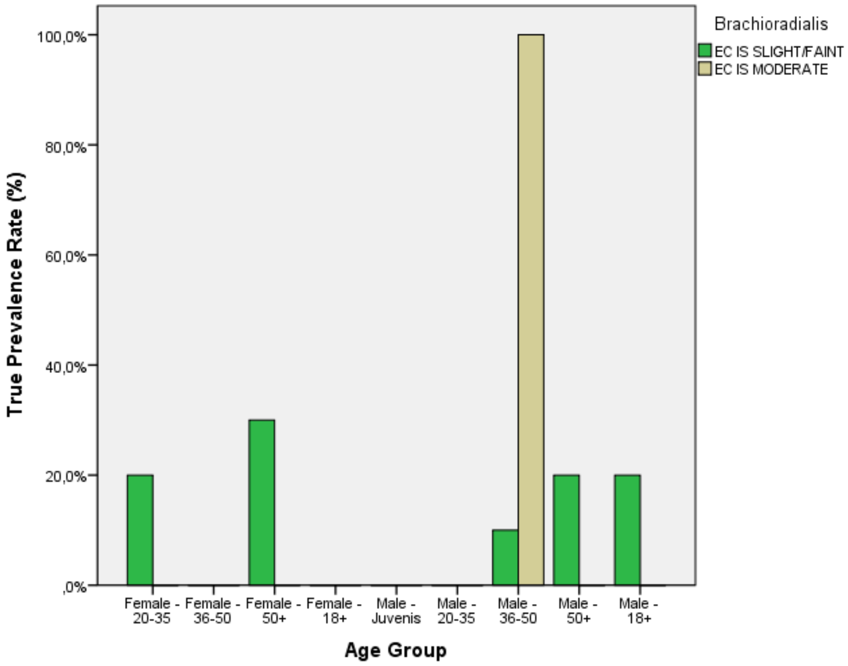

Fig. 5.82: TPR (True Prevalence Rate) in percentages of the brachioradialis scores for each sex and age group of the Deinze skeletal assemblage.

There was no statistically significant difference between males and females for the brachioradialis (U=1772.5, p=0.572, n1 (f)=59, n2 (m)=62) (fig. 5.82). When testing age versus sex, there was no statistically significant difference for EC of the brachioradialis for males (x^2=2.779, df=3, p=0.427, n=57) and for females (x^2=2.564, df=2, p=0.278, n=49). There was no statistically significant difference in EC of the brachioradialis between left (l) and right (r) (U=2006, p=0.932, n1 (l)=65, n2 (r)=62).

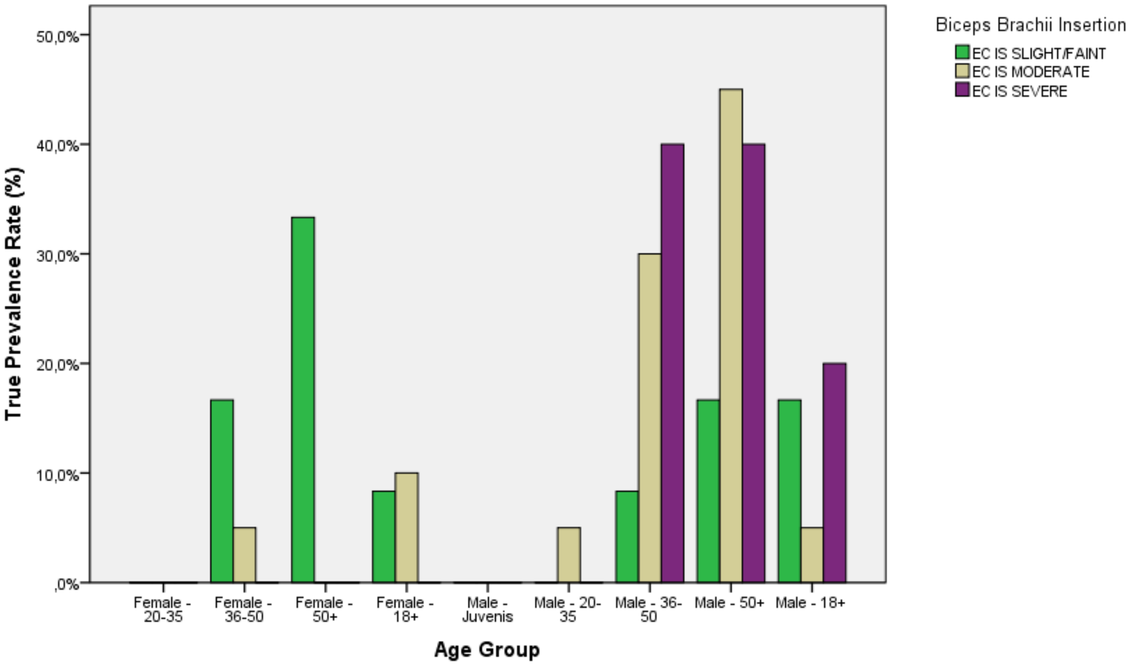

Fig. 5.83: TPR (True Prevalence Rate) in percentages of the biceps brachii insertion scores for each sex and age group of the Deinze skeletal assemblage.

There was a statistically significant difference between males and females for the biceps brachii insertion ($U=971.5$, $p<0.001$, n1 (f)=53, n2 (m)=56) (fig. 5.83). When testing age versus sex, there was a statistically significant difference for EC of the biceps brachii insertion for males ($x^2=9.997$, df=3, $p=0.019$, n=52), and none for females ($x^2=4.206$, df=2, $p=0.122$, n=45). There was no statistically significant difference in EC of the biceps brachii insertion between left (l) and right (r) ($U=1472.5$, $p=0.231$, n1 (l)=59, n2 (r)=56). Only males from the age of 36 years old were identified with a severe score (9.2%; 5/54).

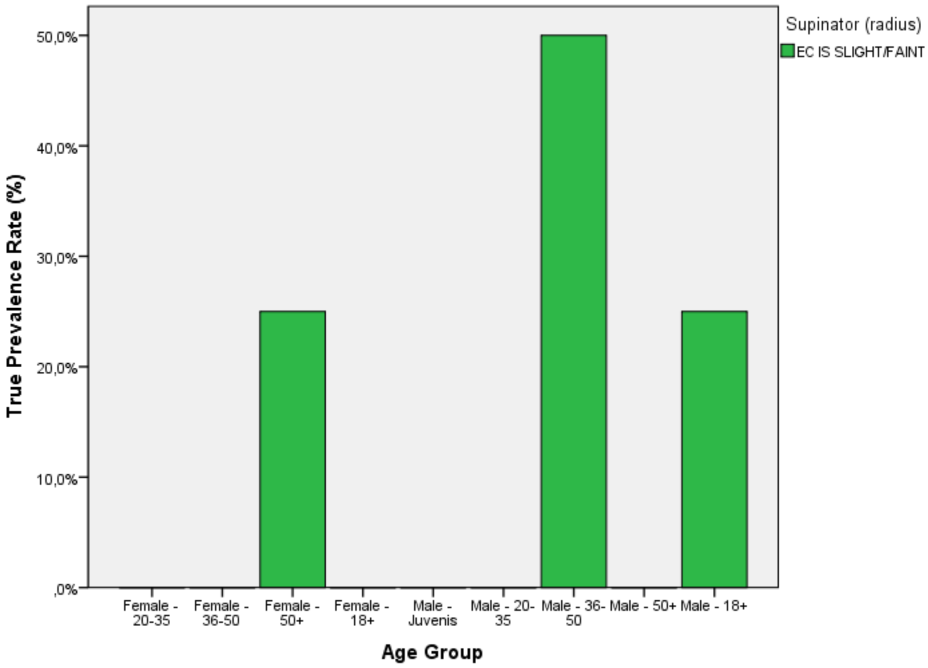

Fig. 5.84: TPR (True Prevalence Rate) in percentages of the supinator (radius) scores for each sex and age group of the Deinze skeletal assemblage.

There was no statistically significant difference between males and females for the supinator (radius) (U=1459.5, p=0.347, n1 (f)=53, n2 (m)=57) (fig. 5.84). When testing age versus sex, there was no statistically significant difference for EC of the supinator (radius) for males (x^2=4.318, df=3, p=0.229, n=53) and for females (x^2=2.000, df=2, p=0.368, n=45). There was no statistically significant difference in EC of the supinator (radius) between left (l) and right (r) (U=1621.5, p=0.388, n1 (l)=59, n2 (r)=57).

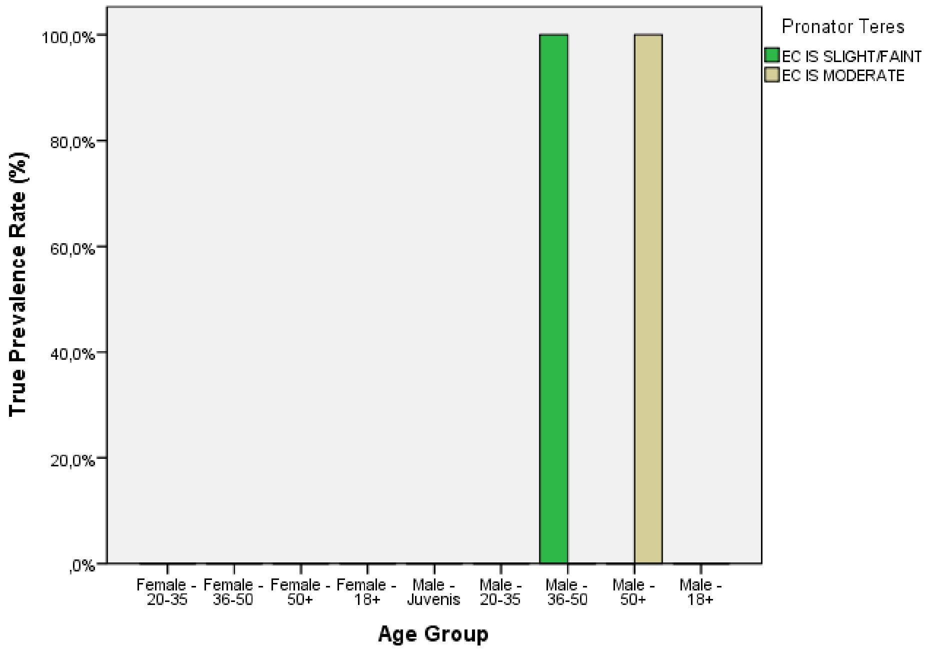

Fig. 5.85: TPR (True Prevalence Rate) in percentages of the pronator teres scores for each sex and age group of the Deinze skeletal assemblage.

No females were observed with EC of the pronator teres resulting in a statistically significant difference between both sexes (U=1430, p=0.045, n1 (f)=55, n2 (m)=56) (fig. 5.85). When testing age versus sex, there was no statistically significant difference for EC of the pronator teres for males (x^2=1.589, df=3, p=0.662, n=52). There was no statistically significant difference in EC of the pronator teres between left (l) and right (r) (U=1707, p=0.959, n1 (l)=60, n2 (r)=57).

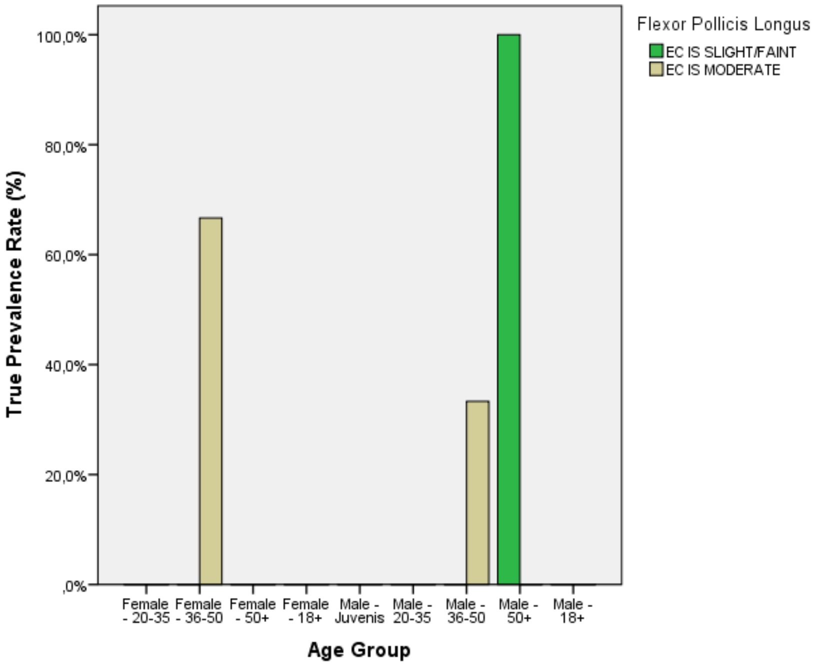

Fig. 5.86: TPR (True Prevalence Rate) in percentages of the flexor pollicis longus scores for each sex and age group of the Deinze skeletal assemblage.

There was no statistically significant difference between males and females for the flexor pollicis longus (U=1538, p=0.971, n1 (f)=55, n2 (m)=56) (fig. 5.86). When testing age versus sex, there was no statistically significant difference for EC of the flexor pollicis longus for males (x^2=0.795, df=3, p=0.851, n=52) and for females (x^2=3.835, df=2, p=0.147, n=46). There was no statistically significant difference in EC of the flexor pollicis longus between left (l) and right (r) (U=1649, p=0.291, n1 (l)=60, n2 (r)=57).

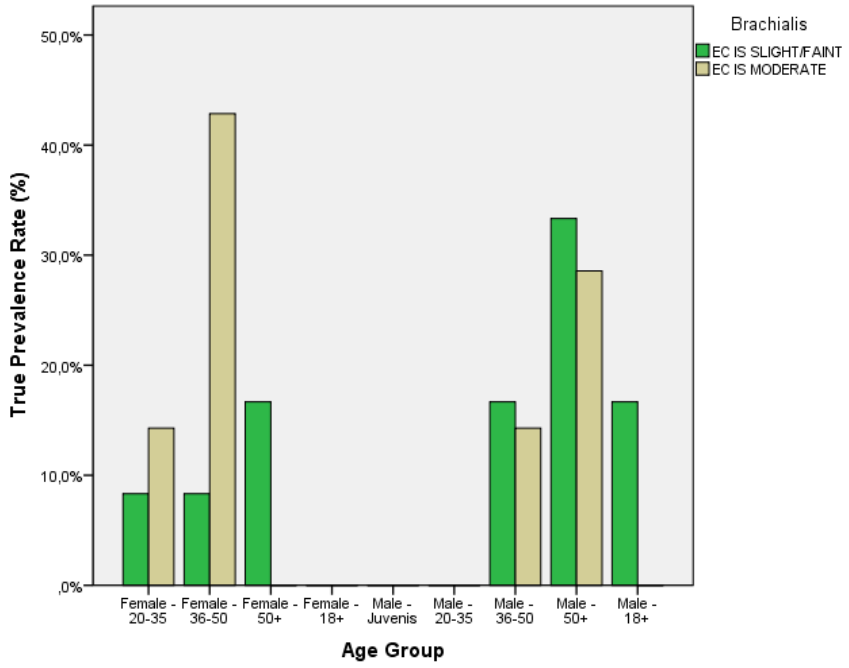

Fig. 5.87: TPR (True Prevalence Rate) in percentages of the brachialis scores for each sex and age group of the Deinze skeletal assemblage.

There was no statistically significant difference between males and females for the brachialis (U=1534.5, p=0.593, n1 (f)=55, n2 (m)=58) (fig. 5.87). When testing age versus sex, there was no statistically significant difference for EC of the brachialis for males (x^2=4.279, df=3, p=0.233, n=54) and for females (x^2=1.382, df=2, p=0.501, n=47). There was no statistically significant difference in EC of the brachialis between left (l) and right (r) (U=1661.5, p=0.380, n1 (l)=58, n2 (r)=61).

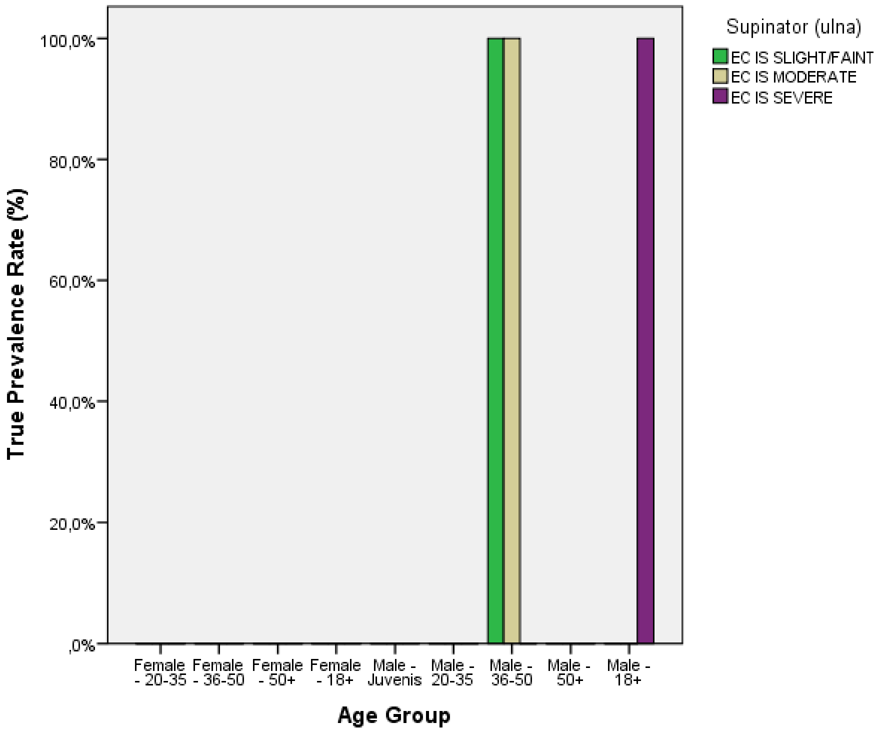

Fig. 5.88: TPR (True Prevalence Rate) in percentages of the supinator (ulna) scores for each sex and age group of the Deinze skeletal assemblage.

There was no statistically significant difference between males and females for the supinator (ulna) (U=1512.5, p=0.089, n1 (f)=55, n2 (m)=58) (fig. 5.88). When testing age versus sex, there was no statistically significant difference for EC of the supinator (ulna) for males (x^2=3.754, df=3, p=0.289, n=54). No females were observed with EC of the supinator (ulna). There was no statistically significant difference in EC of the supinator (ulna) between left (l) and right (r) (U=1740.5, p=0.577, n1 (l)=58, n2 (r)=61).

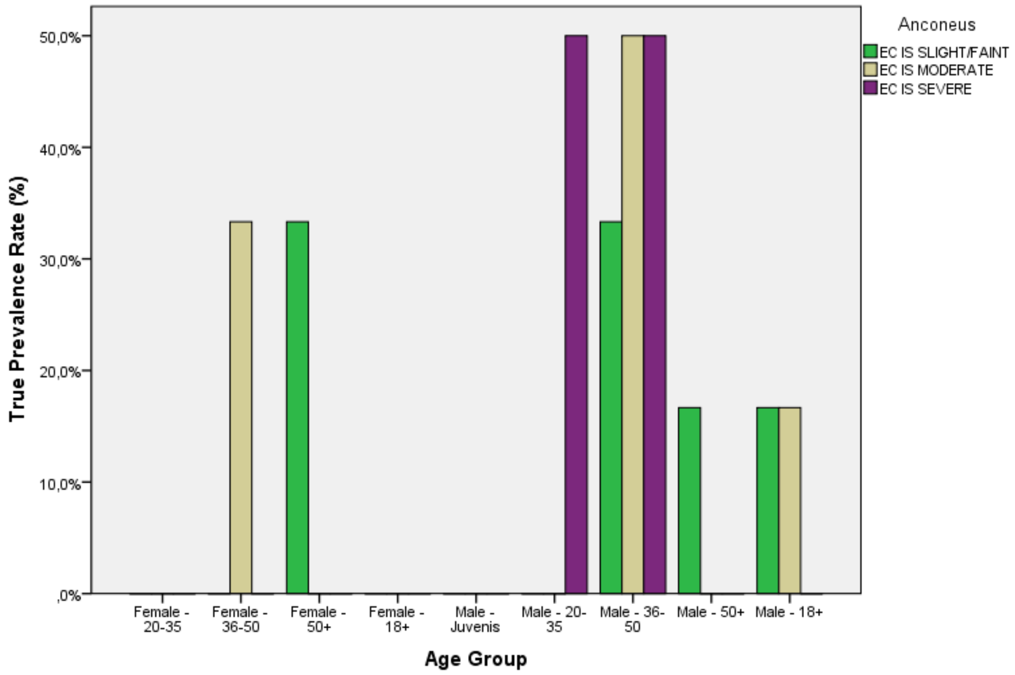

Fig. 5.89: TPR (True Prevalence Rate) in percentages of the anconeus scores for each sex and age group of the Deinze skeletal assemblage.

There was no statistically significant difference between males and females for the anconeus (U=1456, p=0.095, n1 (f)=56, n2 (m)=58) (fig. 5.89). When testing age versus sex, there was no statistically significant difference for EC of the anconeus for males (x^2=6.542, df=3, p=0.088, n=54) and for females (x^2=2.013, df=2, p=0.365, n=47).There was no statistically significant difference in EC of the anconeus between left (l) and right (r) (U=1746, p=0.624, n1 (l)=58, n2 (r)=62).

** Lower Limb EC*

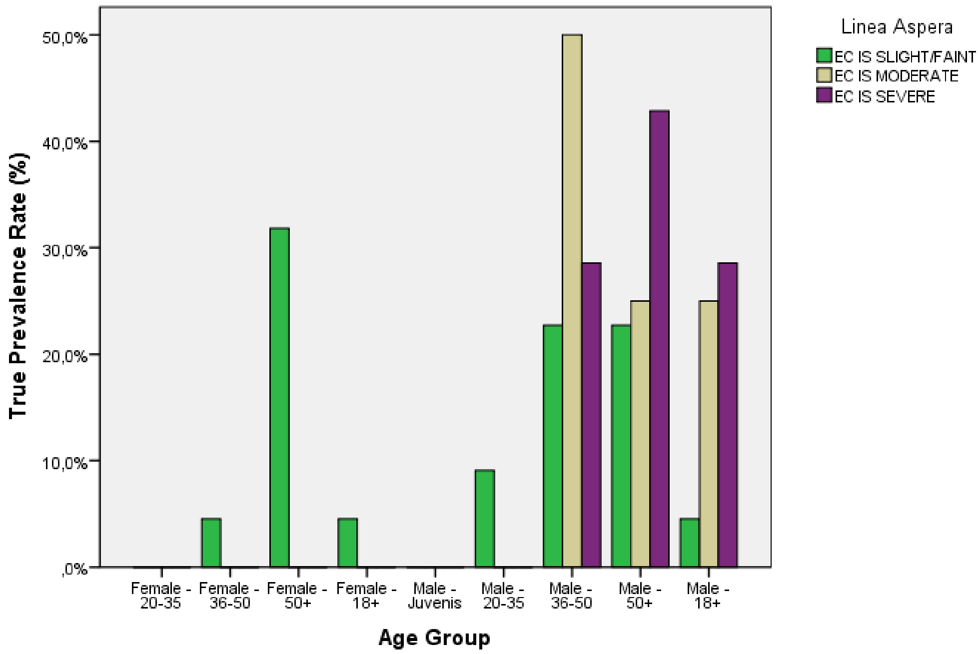

Fig. 5.90: TPR (True Prevalence Rate) in percentages of the linea aspera scores for each sex and age group of the Deinze skeletal assemblage.

There was a statistically significant difference between males and females for the linea aspera (U=1082.5, $p<0.001$, n1 (f)=55, n2 (m)=60) (fig. 5.90). When testing age versus sex, there was a statistically significant difference for EC of the linea aspera for males (x^2=8.424, df=3, p=0.038, n=53), and for females (x^2=12.784, df=2, p=0.002, n=45).There was no statistically significant difference in EC of the linea aspera between left (l) and right (r) (U=1729, p=0.526, n1 (l)=61, n2 (r)=60). Regarding adult age categories, only males from at least 36 years old were scored with severe EC of the linea aspera (9.4%; 5/53).

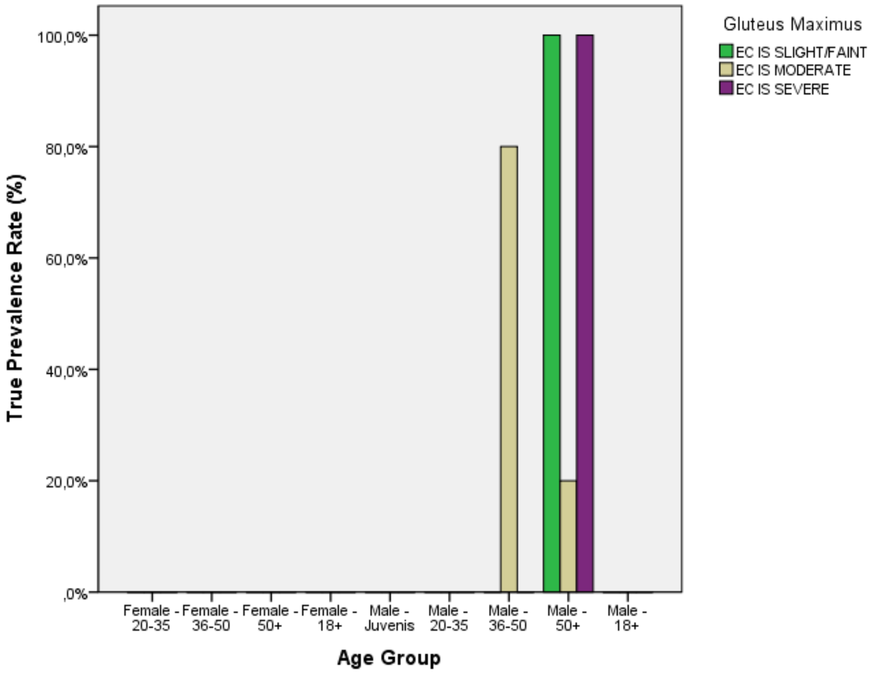

Fig. 5.91: TPR (True Prevalence Rate) in percentages of the gluteus maximus scores for each sex and age group of the Deinze skeletal assemblage.

There was a statistically significant difference between males and females for the gluteus maximus (U=1430, p=0.005, n1 (f)=55, n2 (m)=60) (fig. 5.91). When testing age versus sex, there was no statistically significant difference for EC of the gluteus maximus for males (x^2=3.630, df=3, p=0.304, n=53). There were no females observed with EC of the gluteus maximus. There was no statistically significant difference in EC of the gluteus maximus between left (l) and right (r) (U=1829.5, p=0.996, n1 (l)=61, n2 (r)=60).

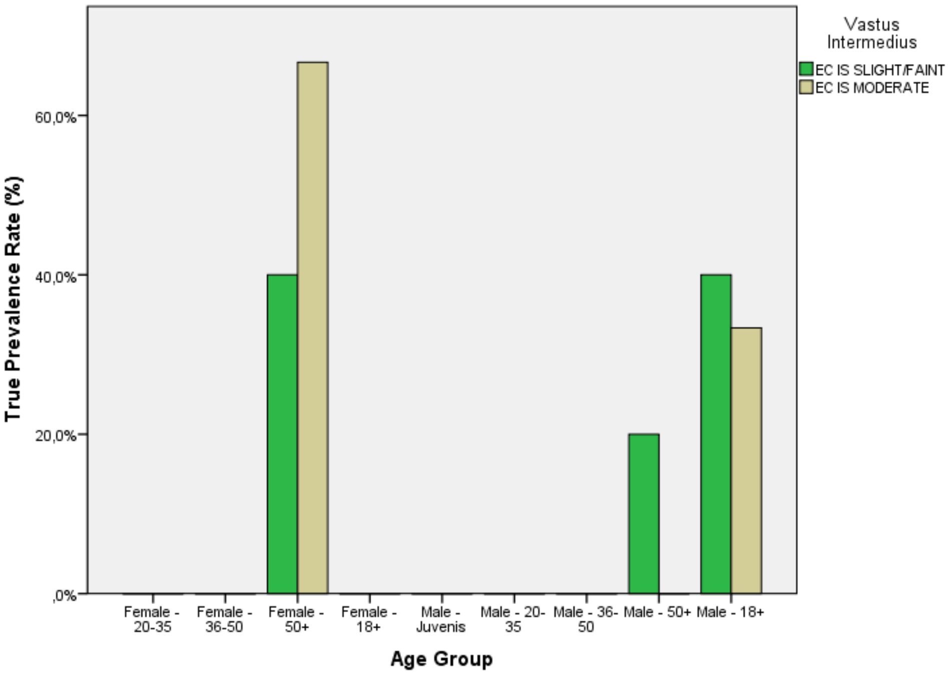

Fig. 5.92: TPR (True Prevalence Rate) in percentages of the vastus intermedius scores for each sex and age group of the Deinze skeletal assemblage.

There was no statistically significant difference between males and females for the vastus intermedius (U=1638, p=0.879, n1 (f)=55, n2 (m)=60) (fig. 5.92). When testing age versus sex, there was no statistically significant difference for EC of the vastus intermedius for males (x^2=1.789, df=3, p=0.617, n=53). For females, however, advancing age was statistically significant (x^2=8.567, df=2, p=0.014, n=47). There was no statistically significant difference in EC of the vastus intermedius between left (l) and right (r) (U=1771, p=0.478, n1 (l)=61, n2 (r)=60).

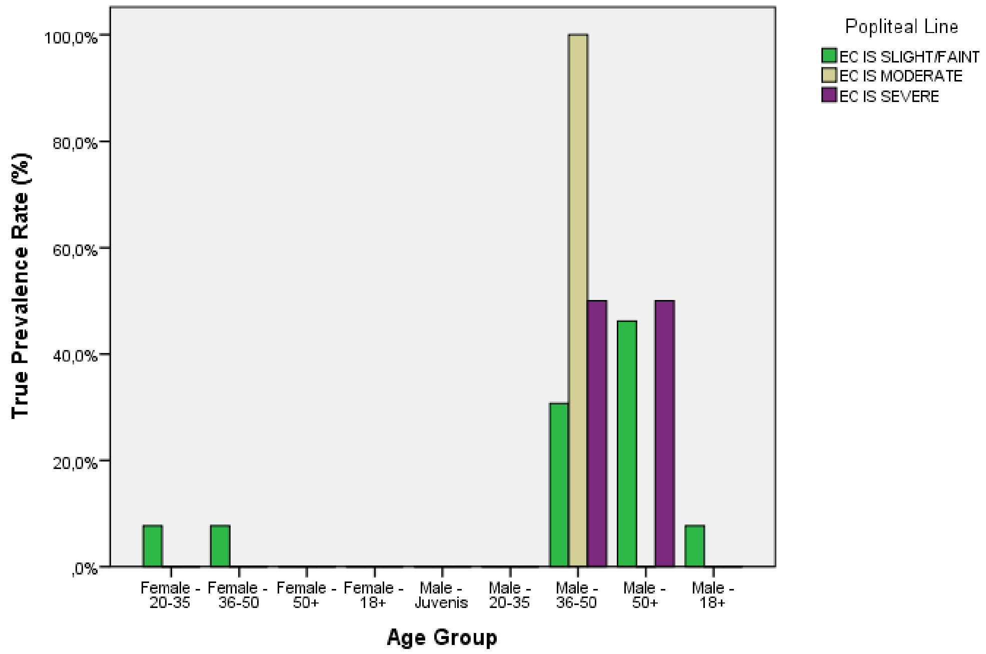

Fig. 5.93: TPR (True Prevalence Rate) in percentages of the popliteal line scores for each sex and age group of the Deinze skeletal assemblage.

There was a statistically significant difference between males and females for EC of the popliteal (U=1158.5, p=0.004, n1 (f)=49, n2 (m)=59) (fig. 5.93). When testing age versus sex, there was no statistically significant difference for EC of the popliteal line for males (x^2=7.017, df=3, p=0.071, n=51), and for females (x^2=0.880, df=2, p=0.644, n=40). There was no statistically significant difference in EC of the popliteal line between left (l) and right (r) (U=1594.5, p=0.802, n1 (l)=59, n2 (r)=55). Moderate and severe scores of EC of the popliteal line were observed only with males from the age of 36 years old.

5.6.2. Slijpe

** Upper Limb EC*

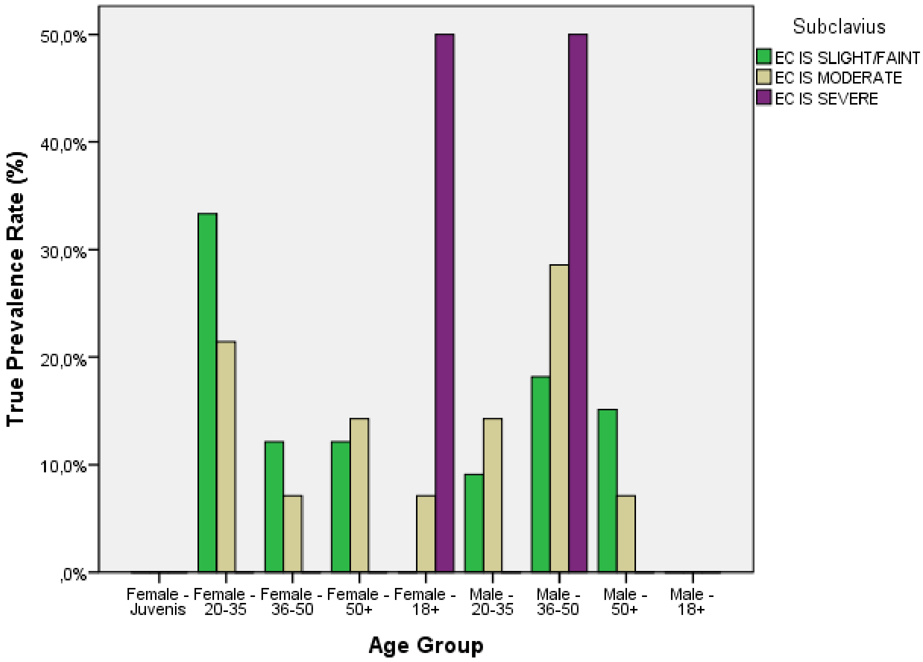

Fig. 5.94: TPR (True Prevalence Rate) in percentages of the subclavius scores for each sex and age group of the Slijpe adult skeletal assemblage.

The severity of EC of the subclavius was not statistically significant between males and females of the Slijpe skeletal assemblage (U=1021, p=0.082, n1 (f)=66, n2 (m)=38) (fig. 5.94). When testing age versus sex, there was no statistically significant difference for EC of the subclavius for males (x^2=4.281, df=2, p=0.118, n=36) and for females (x^2=0.683, df=3, p=0.877, n=62). There was no statistically significant difference in EC of the subclavius between left (l) and right (r) (U=1258.5, p=0.344, n1 (l)=41, n2 (r)=68).

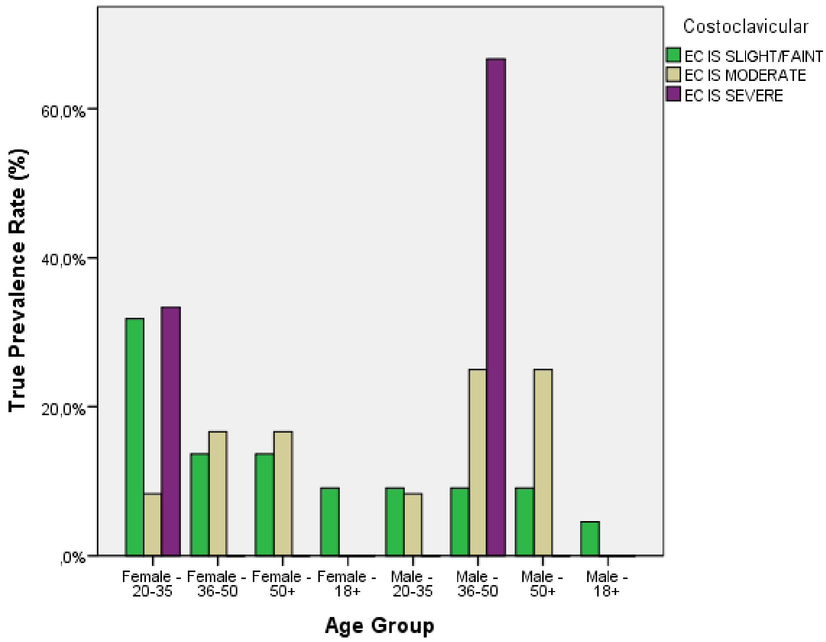

Fig. 5.95: TPR (True Prevalence Rate) in percentages of the costoclavicular scores for each sex and age group of the Slijpe adult skeletal assemblage.

There was a statistically significant difference between males and females for the costoclavicular ligament (U=361, p=0.024, n1 (f)=42, n2 (m)=25) (fig. 5.95). When testing age versus sex, there was a statistically significant difference for EC of the costoclavicular ligament for males (x^2=8.968, df=2, p=0.011, n=23), but none for females (x^2=1.249, df=2, p=0.536, n=39). There was no statistically significant difference in EC of the costoclavicular ligament between left (l) and right (r) (U=450.5, p=0.712, n1 (l)=18, n2 (r)=53).

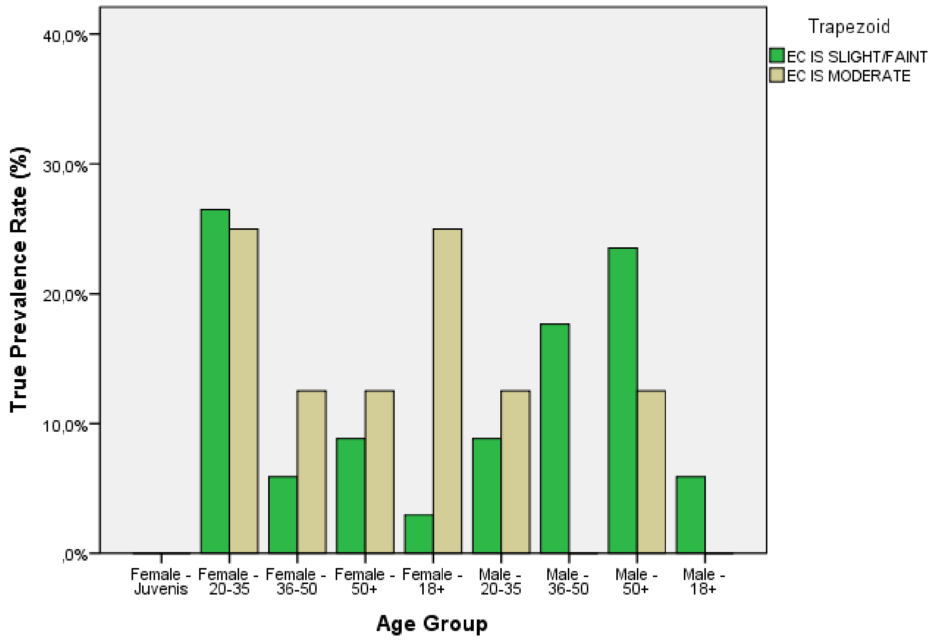

Fig. 5.96: TPR (True Prevalence Rate) in percentages of the trapezoid scores for each sex and age group of the Slijpe adult skeletal assemblage.

For EC of the trapezoid, the difference between males and females is not statistically significant (U=993.5, p=0.058, n1 (f)=65, n2 (m)=38) (fig. 5.96). When testing age versus sex, there was no statistically significant difference for EC of the trapezoid for males (x^2=2.199, df=2, p=0.333, n=36), and for females (x^2=0.729, df=3, p=0.866, n=61). There was no statistically significant difference in EC of the trapezoid between left (l) and right (r) (U=1287, p=0.589, n1 (l)=40, n2 (r)=68).

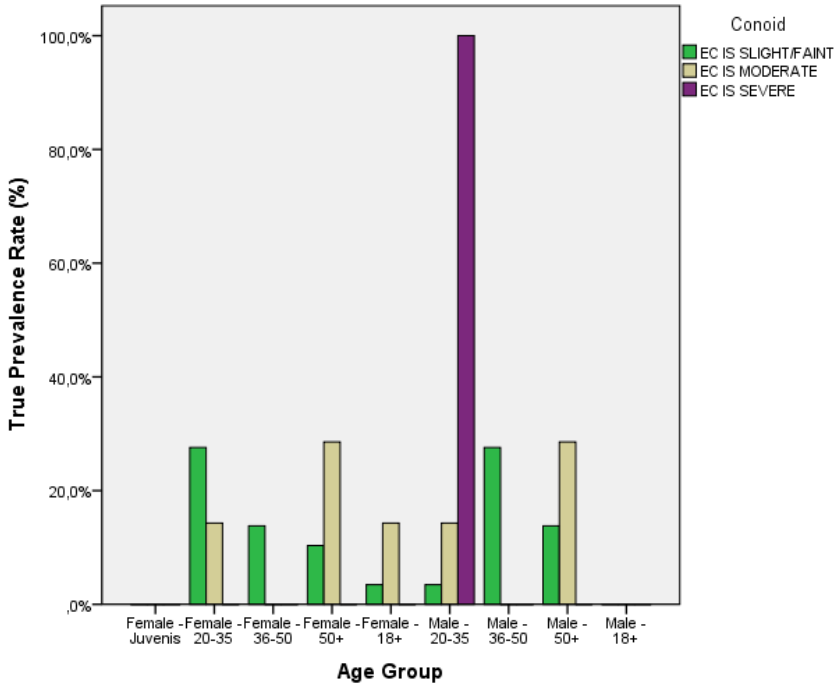

Fig. 5.97: TPR (True Prevalence Rate) in percentages of the conoid scores for each sex and age group of the Slijpe adult skeletal assemblage.

For EC of the conoid, the difference between males and females is not statistically significant ($U=1065$, $p=0.130$, n1 (f)=66, n2 (m)=38) (fig. 5.97). When testing age versus sex, there was no statistically significant difference for EC of the conoid for males ($x^2=0.204$, $df=2$, $p=0.903$, $n=36$) and for females ($x^2=0.653$, $df=3$, $p=0.884$, $n=62$). There was no statistically significant difference in EC of the conoid between left (l) and right (r) ($U=1144$, $p=0.060$, n1 (l)=41, n2 (r)=68).

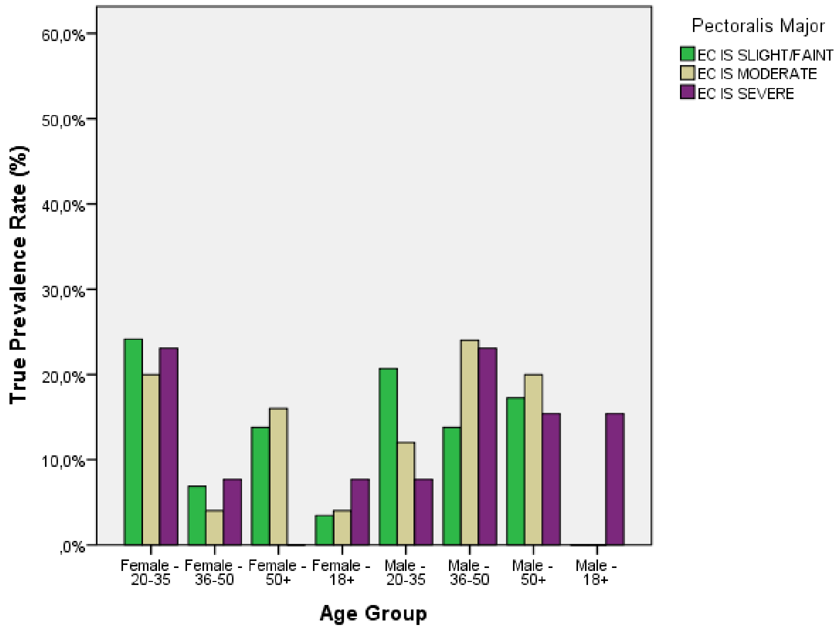

Fig. 5.98: TPR (True Prevalence Rate) in percentages of the pectoralis major scores for each sex and age group of the Slijpe adult skeletal assemblage.

There was a statistically significant difference between males and females for EC of the pectoralis major (U=773, p=0.001, n1 (f)=57, n2 (m)=43) (fig. 5.98). Severe scores were recorded for males in all age groups (14.6%, 6/41) and for females from the young and middle adult groups (7.4%; 4/54). When testing age versus sex, there was no statistically significant difference for EC of the pectoralis major for males (x^2=2.480, df=2, p=0.289, n=41) and for females (x^2=0.461, df=2, p=0.794, n=54). There was no statistically significant difference in EC of the pectoralis major between left (l) and right (r) (U=1184, p=0.101, n1 (l)=39, n2 (r)=74).

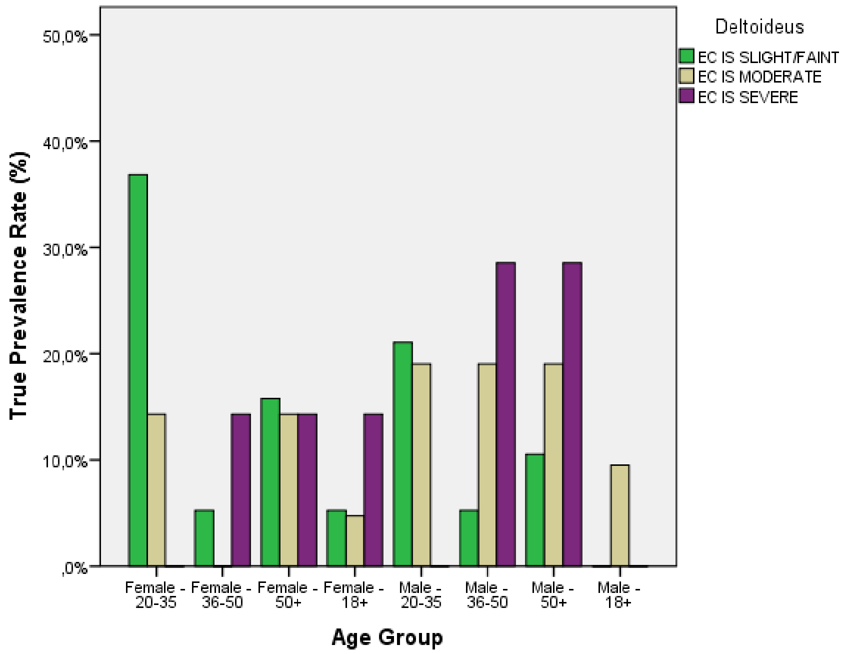

Fig. 5.99: TPR (True Prevalence Rate) in percentages of the deltoideus scores for each sex and age group of the Slijpe adult skeletal assemblage.

There was a statistically significant difference between males and females for the deltoideus (U=938, p=0.014, n1 (f)=59, n2 (m)=43) (fig. 5.99). When testing age versus sex, there was no statistically significant difference for EC of the deltoideus for males (x^2=0.000, df=2, p=1.000, n=41) and for females (x^2=2.781, df=2, p=0.249, n=56). There was no statistically significant difference in EC of the deltoideus between left (l) and right (r) (U=1299.5, p=0.183, n1 (l)=40, n2 (r)=75).

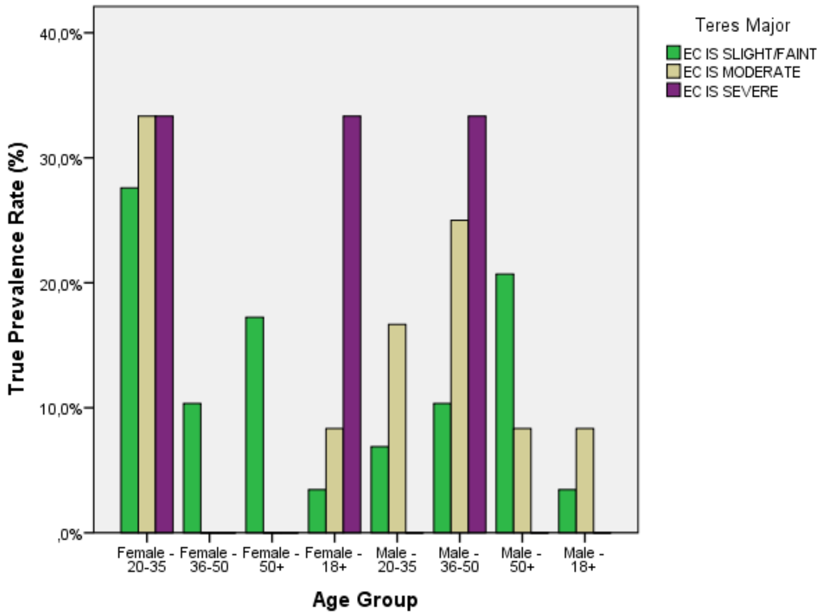

Fig. 5.100: TPR (True Prevalence Rate) in percentages of the teres major scores for each sex and age group of the Slijpe adult skeletal assemblage.

There was no statistically significant difference between males and females for the teres major ($U=1150$, $p=0.556$, n1 (f)=57, n2 (m)=43) (fig. 5.100). When testing age versus sex, there was no statistically significant difference for EC of the teres major for males ($x^2=0.994$, $df=2$, $p=0.608$, $n=41$) and for females ($x^2=0.555$, $df=2$, $p=0.758$, $n=54$). There was no statistically significant difference in EC of the teres major between left (l) and right (r) ($U=1434$, $p=0.951$, n1 (l)=39, n2 (r)=74).

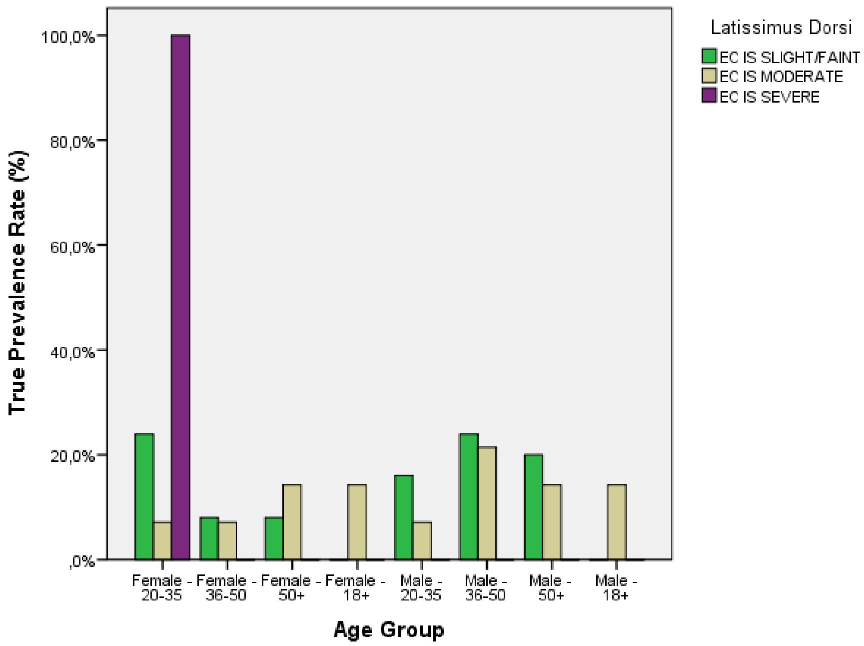

Fig. 5.101: TPR (True Prevalence Rate) in percentages of the latissimus dorsi scores for each sex and age group of the Slijpe adult skeletal assemblage.

There was a statistically significant difference between males and females for the latissimus dorsi (U=952, p=0.030, n1 (f)=57, n2 (m)=43) (fig. 5.101). When testing age versus sex, there was no statistically significant difference for EC of the latissimus dorsi for males (x^2=1.711, df=2, p=0.425, n=41) and for females (x^2=0.384, df=2, p=0.825, n=54). There was no statistically significant difference in EC of the latissimus dorsi between left (l) and right (r) (U=1231, p=0.131, n1 (l)=39, n2 (r)=74).

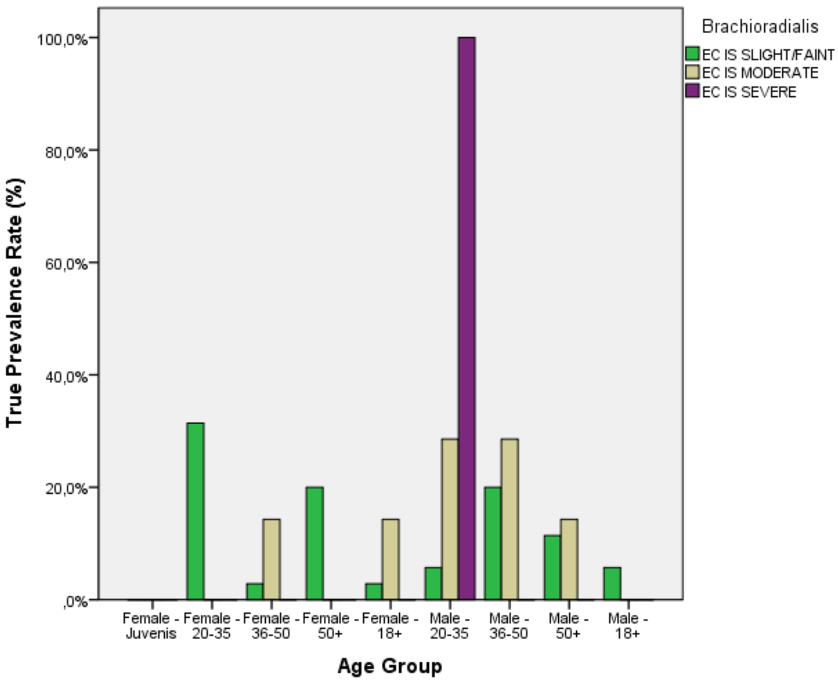

Fig. 5.102: TPR (True Prevalence Rate) in percentages of the brachioradialis scores for each sex and age group of the Slijpe adult skeletal assemblage.

There was no statistically significant difference between males and females for the brachioradialis (U=1093.5, p=0.210, n1 (f)=57, n2 (m)=44) (fig. 5.102). When testing age versus sex, there was no statistically significant difference for EC of the brachioradialis for males (x^2=2.777, df=2, p=0.249, n=57) and for females (x^2=1.778, df=3, p=0.620, n=55). There was no statistically significant difference in EC of the brachioradialis between left (l) and right (r) (U=1406.5, p=0.797, n1 (l)=39, n2 (r)=74).

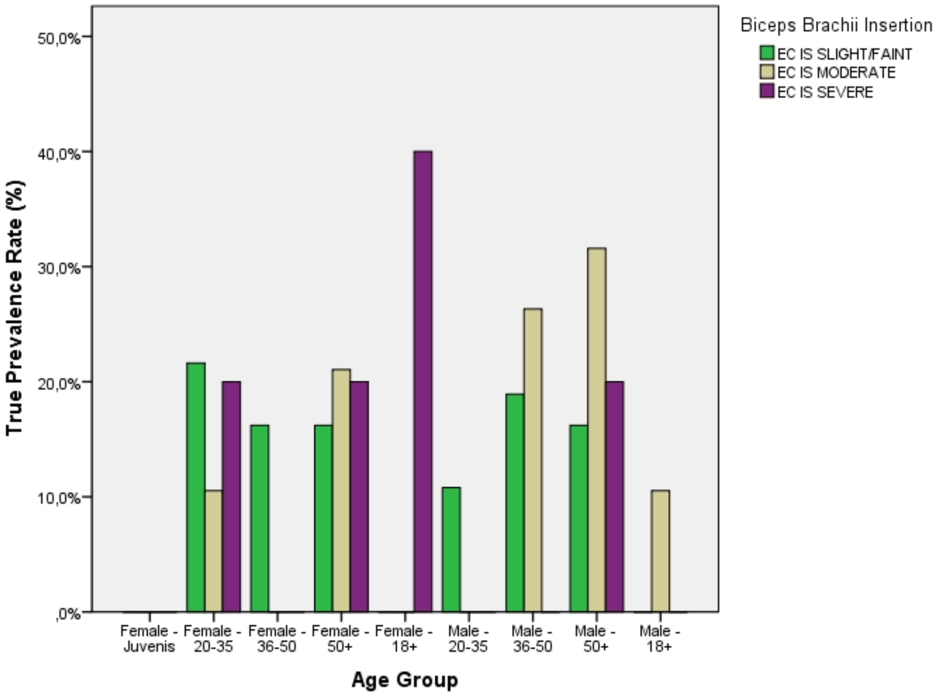

Fig. 5.103: TPR (True Prevalence Rate) in percentages of the biceps brachii insertion scores for each sex and age group of the Slijpe adult skeletal assemblage.

There was no statistically significant difference between males and females for the biceps brachii insertion (U=793, p=0.074, n1 (f)=50, n2 (m)=40) (fig. 5.103). When testing age versus sex, there was a statistically significant difference for EC of the biceps brachii insertion for males (x^2=8.324, df=2, p=0.016, n=38) but none for females (x^2=6.717, df=3, p=0.081, n=47). There was no statistically significant difference in EC of the biceps brachii insertion between left (l) and right (r) (U=1205, p=0.907, n1 (l)=37, n2 (r)=66).

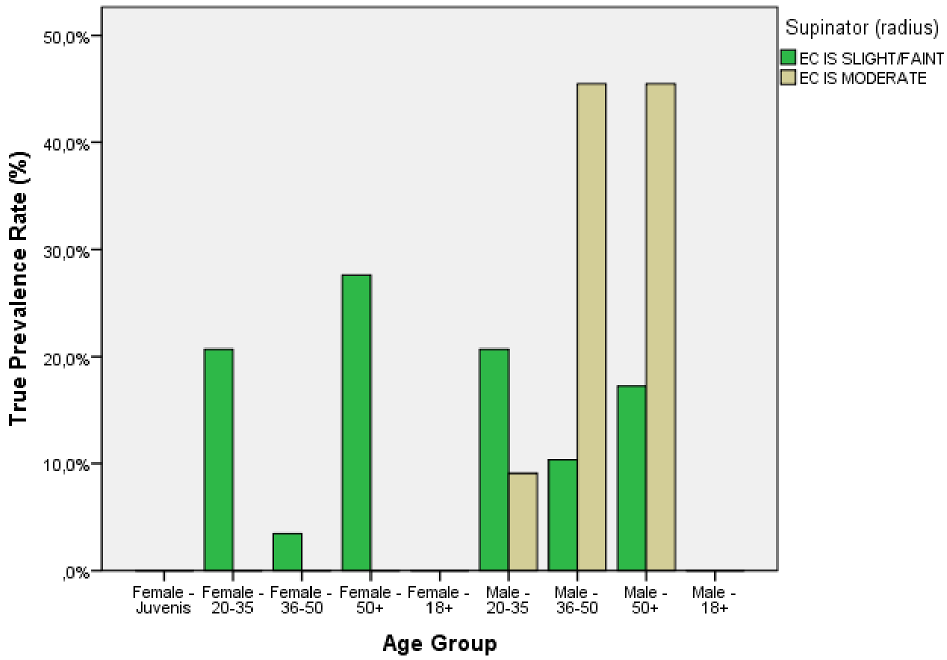

Fig. 5.104: TPR (True Prevalence Rate) in percentages of the supinator (radius) scores for each sex and age group of the Slijpe adult skeletal assemblage.

The supinator (radius) showed a statistically significant difference between both sexes of the Slijpe skeletal collection ($U=607.5$, $p<0.001$, $n1$ (f)=52, $n2$ (m)=40) (fig. 5.104). When testing age versus sex, there was no statistically significant difference for EC of the supinator (radius) for males ($x^2=0.079$, $df=2$, $p=0.961$, $n=38$) and for females ($x^2=4.089$, $df=3$, $p=0.252$, $n=48$). There was no statistically significant difference in EC of the supinator (radius) between left (l) and right (r) ($U=1213$, $p=0.931$, $n1$ (l)=36, $n2$ (r)=68).

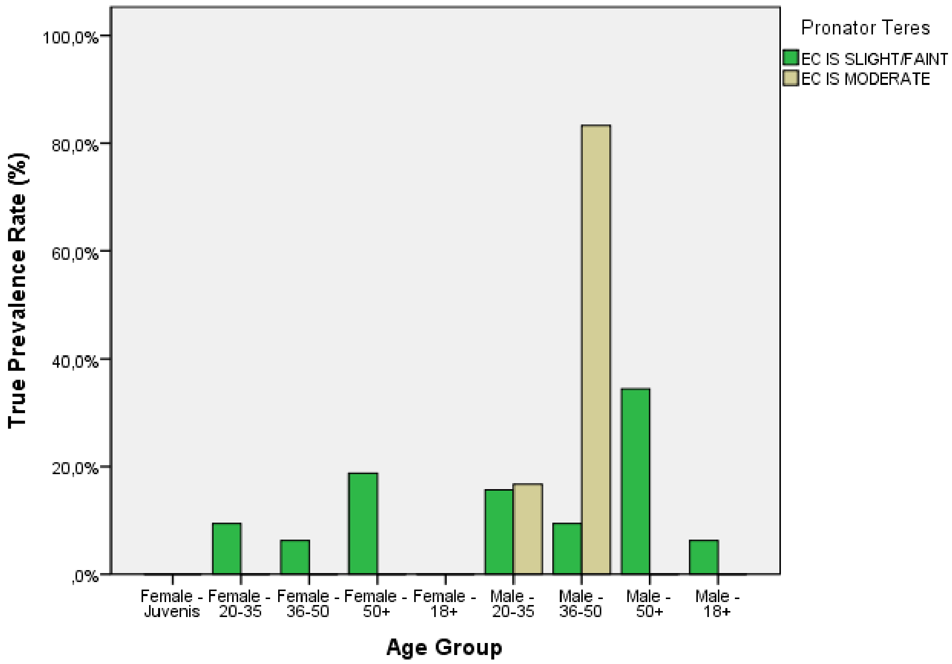

Fig. 5.105: TPR (True Prevalence Rate) in percentages of the pronator teres scores for each sex and age group of the Slijpe adult skeletal assemblage.

EC of the pronator teres showed a statistically significant difference between males and females (U=481.5, p<0.001, n1 (f)=50, n2 (m)=39) (fig. 5.105). When testing age versus sex, there was no statistically significant difference for EC of the pronator teres for males (x^2=0.712, df=2, p=0.700, n=37) and for females (x^2=5.305, df=3, p=0.151, n=47). There was no statistically significant difference in EC of the pronator teres between left (l) and right (r) (U=1145.5, p=0.937, n1 (l)=35, n2 (r)=66).

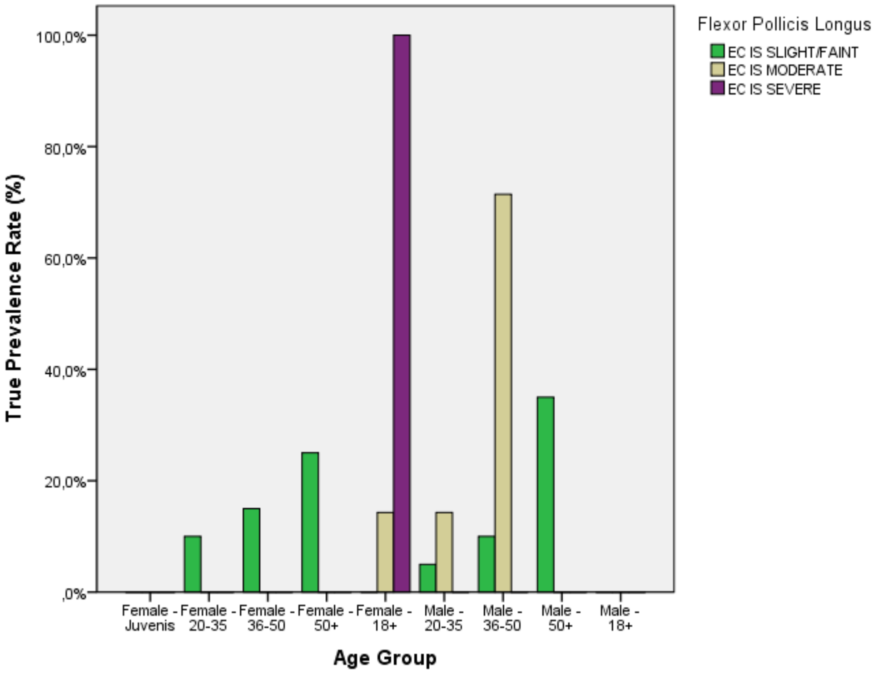

Fig. 5.106: TPR (True Prevalence Rate) in percentages of the flexor pollicis longus scores for each sex and age group of the Slijpe adult skeletal assemblage.

There was a statistically significant difference between males and females for the flexor pollicis longus (U=772, p=0.045, n1 (f)=51, n2 (m)=38) (fig. 5.106). When testing age versus sex, there was no statistically significant difference for EC of the flexor pollicis longus for males (x^2=2.567, df=2, p=0.277, n=36) and for females (x^2=7.345, df=3, p=0.062, n=48). There was no statistically significant difference in EC of the flexor pollicis longus between left (l) and right (r) (U=1125, p=0.684, n1 (l)=36, n2 (r)=65).

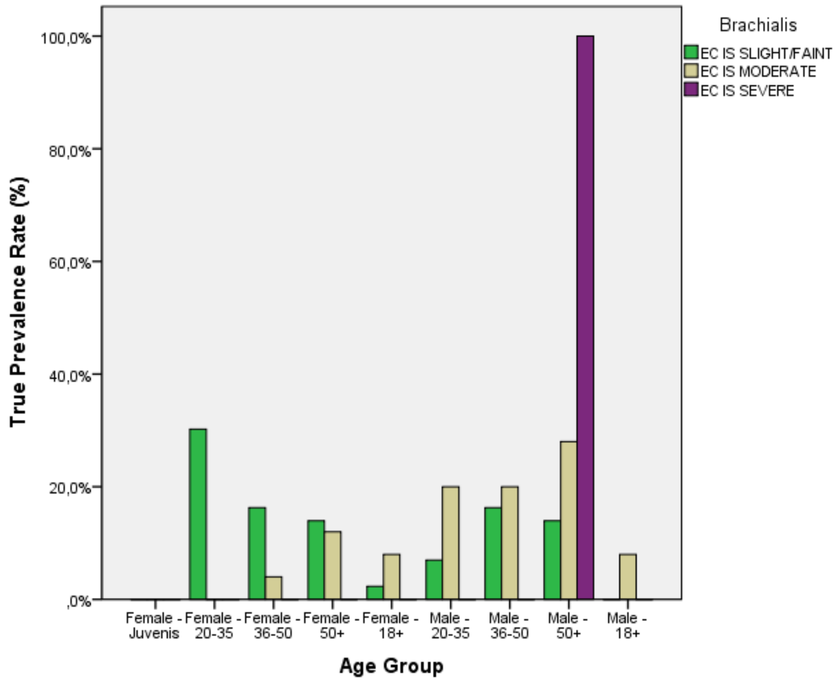

Fig. 5.107: TPR (True Prevalence Rate) in percentages of the brachialis scores for each sex and age group of the Slijpe adult skeletal assemblage.

There was a statistically significant difference between males and females for the brachialis (U=543, p<0.001, n1 (f)=54, n2 (m)=40) (fig. 5.107). When testing age versus sex, there was no statistically significant difference for EC of the brachialis for males (x^2=0.105, df=2, p=0.949, n=38) and for females (x^2=7.148, df=3, p=0.067, n=51). There was no statistically significant difference in EC of the brachialis between left (l) and right (r) (U=1179, p=0.373, n1 (l)=39, n2 (r)=67).

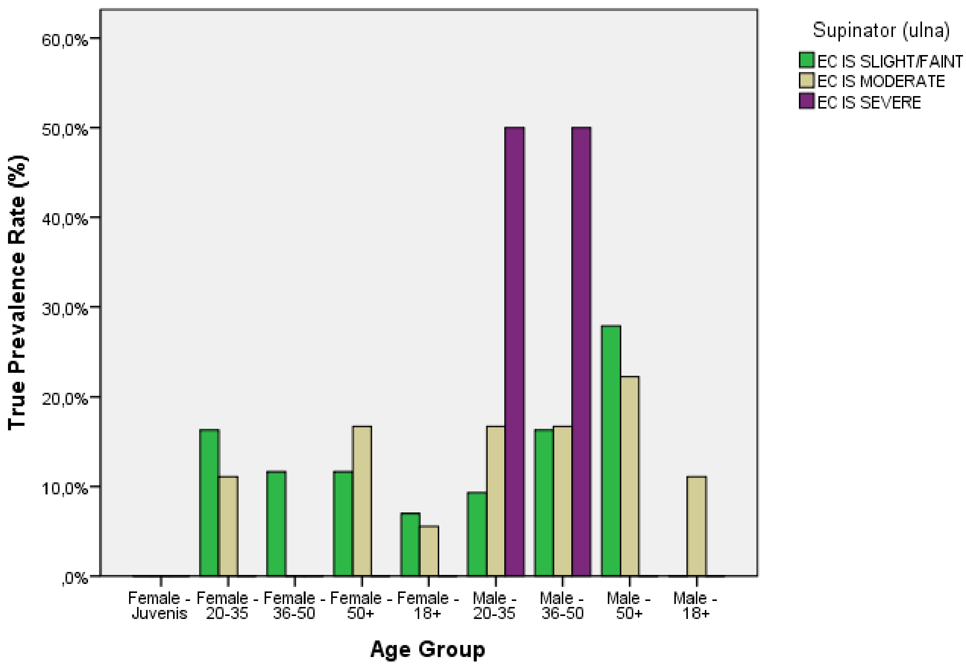

Fig. 5.108: TPR (True Prevalence Rate) in percentages of the supinator (ulna) scores for each sex and age group of the Slijpe adult skeletal assemblage.

There was a statistically significant difference between males and females for the supinator (ulna) (U=527, p<0.001, n1 (f)=56, n2 (m)=40) (fig. 5.108). When testing age versus sex, there was no statistically significant difference for EC of the supinator (ulna) for males (x^2=0.047, df=2, p=0.977, n=38) and for females (x^2=2.917, df=3, p=0.405, n=52). There was no statistically significant difference in EC of the supinator (ulna) between left (l) and right (r) (U=1173, p=0.234, n1 (l)=39, n2 (r)=69).

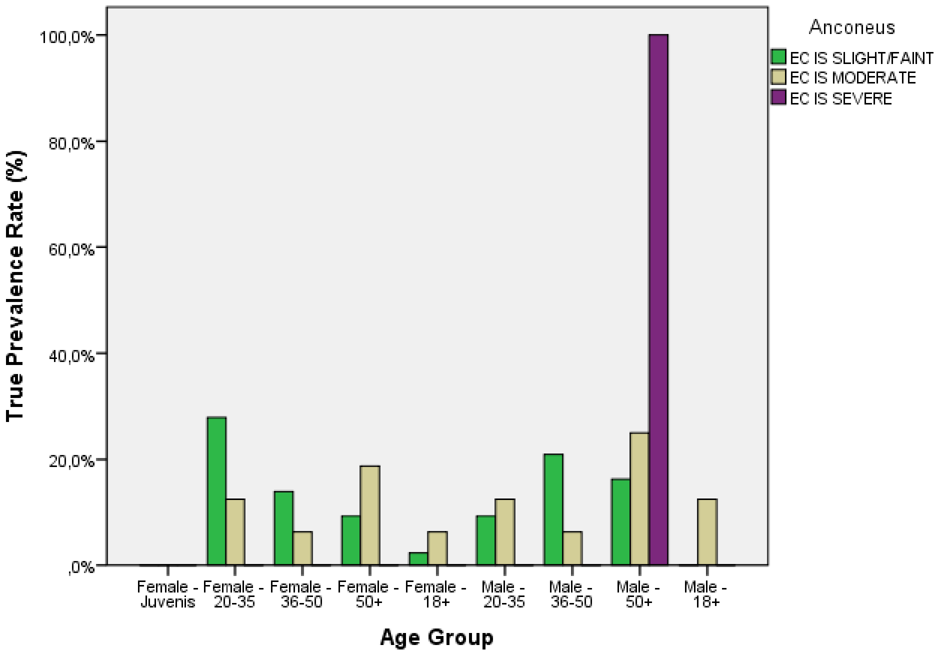

Fig. 5.109: TPR (True Prevalence Rate) in percentages of the anconeus scores for each sex and age group of the Slijpe adult skeletal assemblage.

There was a statistically significant difference between males and females for the anconeus (U=826.5, p=0.026, n1 (f)=55, n2 (m)=40) (fig. 5.109). When testing age versus sex, there was no statistically significant difference for EC of the anconeus for males (x^2=0.993, df=2, p=0.609, n=38) and for females (x^2=2.614, df=3, p=0.455, n=52).There was no statistically significant difference in EC of the anconeus between left (l) and right (r) (U=1099.5, p=0.111, n1 (l)=39, n2 (r)=68).

** Lower Limb EC*

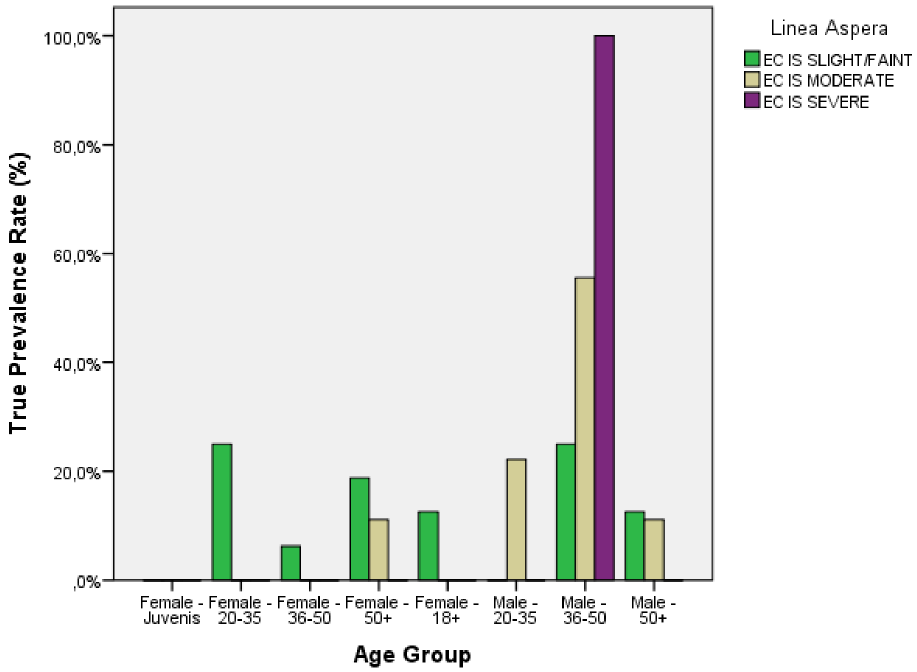

Fig. 5.110: TPR (True Prevalence Rate) in percentages of the linea aspera scores for each sex and age group of the Slijpe adult skeletal assemblage.

There was no statistically significant difference between males and females for the linea aspera (U=418, p=0.106, n1 (f)=31, n2 (m)=34) (fig. 5.110). When testing age versus sex, there was a statistically significant difference for EC of the linea aspera for males (x^2=9.708, df=2, p=0.006, n=34), but not for females (x^2=2.509, df=3, p=0.474, n=29).There was no statistically significant difference in EC of the linea aspera between left (l) and right (r) (U=606.5, p=0.397, n1 (l)=30, n2 (r)=45). Only males from the age group 36-50 years old were scored with severe EC of the linea aspera (5.8%; 2/34). Females were not observed with severe EC.

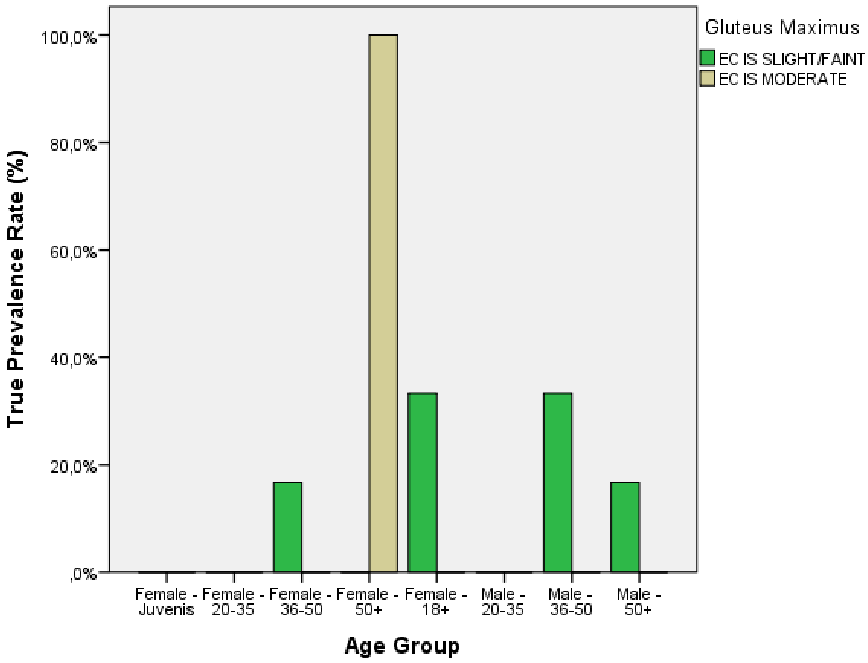

Fig. 5.111: TPR (True Prevalence Rate) in percentages of the gluteus maximus scores for each sex and age group of the Slijpe adult skeletal assemblage.

There was no statistically significant difference between males and females for the gluteus maximus (U=459.5, p=0.385, n1 (f)=31, n2 (m)=32) (fig. 5.111). When testing age versus sex, there was no statistically significant difference for EC of the gluteus maximus for males (x^2=1.408, df=2, p=0.495, n=32) and for females (x^2=4.133, df=3, p=0.247, n=29). There was no statistically significant difference in EC of the gluteus maximus between left (l) and right (r) (U=608, p=0.532, n1 (l)=29, n2 (r)=44).

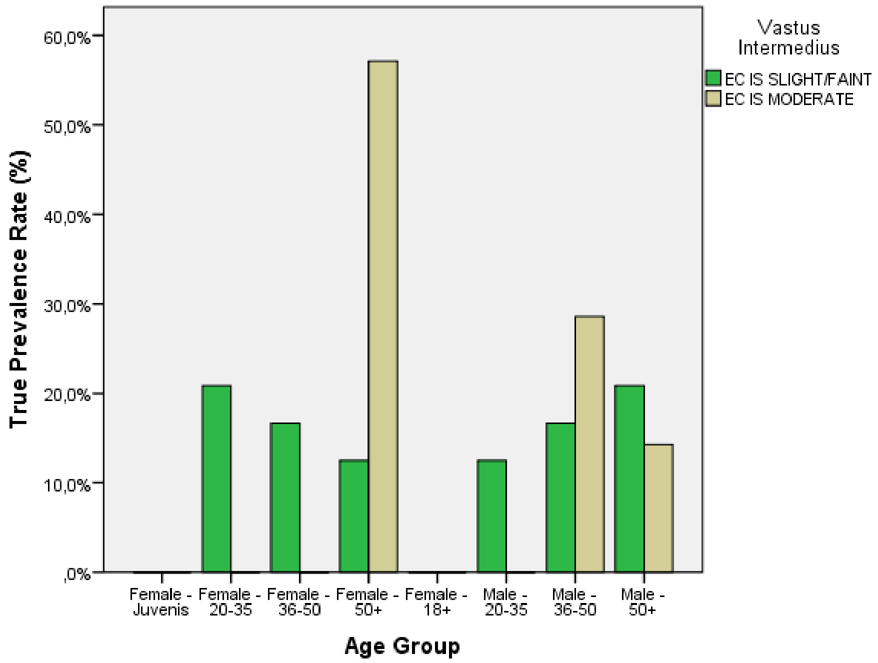

Fig. 5.112: TPR (True Prevalence Rate) in percentages of the vastus intermedius scores for each sex and age group of the Slijpe adult skeletal assemblage.

There was no statistically significant difference between males and females for the vastus intermedius (U=481.5, p=0.506, n1 (f)=31, n2 (m)=34) (fig. 5.112). When testing age versus sex, there was no statistically significant difference for EC of the vastus intermedius for males (x^2=0.032, df=2, p=0.984, n=34). For females, however, advancing age was statistically significant (x^2=11.356, df=3, p=0.010, n=29). There was no statistically significant difference in EC of the vastus intermedius between left (l) and right (r) (U=651.5, p=0.771, n1 (l)=30, n2 (r)=45).

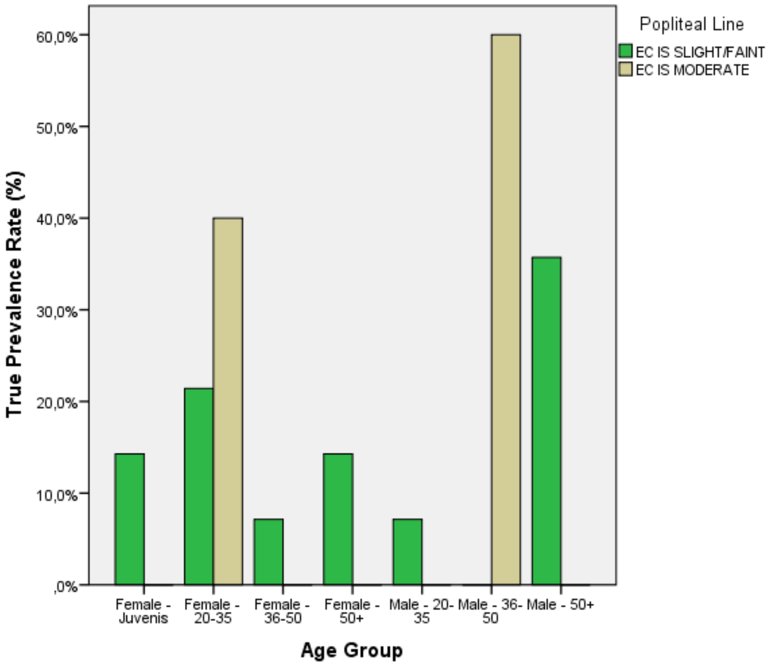

Fig. 5.113: TPR (True Prevalence Rate) in percentages of the popliteal line scores for each sex and age group of the Slijpe adult skeletal assemblage.

There was no statistically significant difference between males and females for EC of the popliteal (U=259, p=0.890, n1 (f)=23, n2 (m)=23) (fig. 5.113). When testing age versus sex, there was no statistically significant difference for EC of the popliteal line for males (x^2=1.491, df=2, p=0.475, n=23) and for females (x^2=5.790, df=3, p=0.122, n=23). There was no statistically significant difference in EC of the popliteal line between left (l) and right (r) (U=326.5, p=0.545, n1 (l)=23, n2 (r)=31). Severe EC of the popliteal line was not scored with both sexes.

5.6.3. Vichte

** Upper Limb EC*

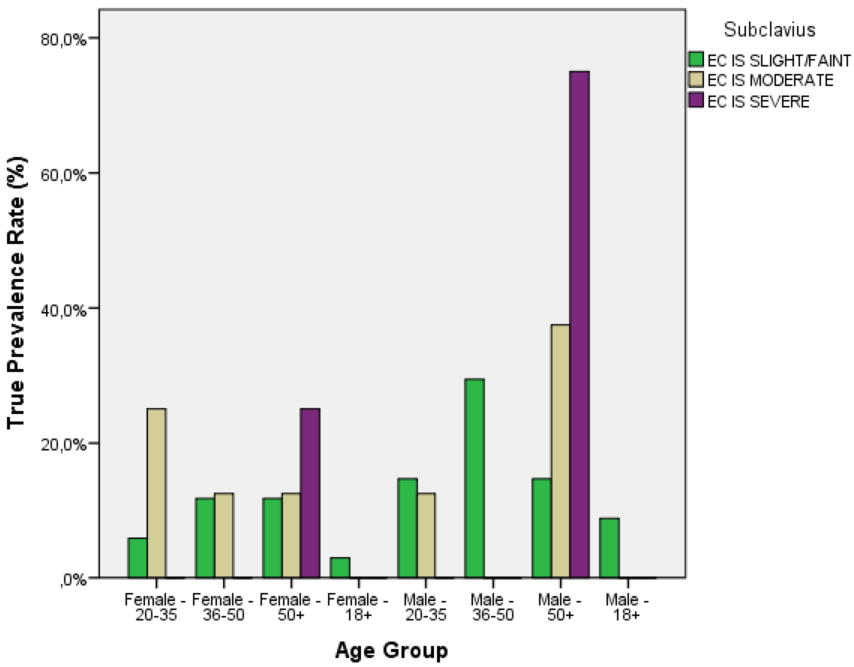

Fig. 5.114: TPR (True Prevalence Rate) in percentages of the subclavius scores for each sex and age group of the Vichte adult skeletal assemblage.

The extent of EC of the subclavius was not statistically significant between males and females of the Vichte skeletal assemblage (U=525, p=0.285, n1 (f)=29, n2 (m)=42) (fig. 5.114). When testing age versus sex, there was no statistically significant difference for EC of the subclavius for males (x^2=4.854, df=2, p=0.088, n=38) and for females (x^2=2.590, df=2, p=0.274, n=28). There was a statistically significant difference in EC of the subclavius between left (l) and right (r) (U=465.5, p=0.041, n1 (l)=34, n2 (r)=37) (fig. 5.115). A dominance in use of the right subclavius was seen in both sexes, with especially males showing severe scores (fig. 5.116).

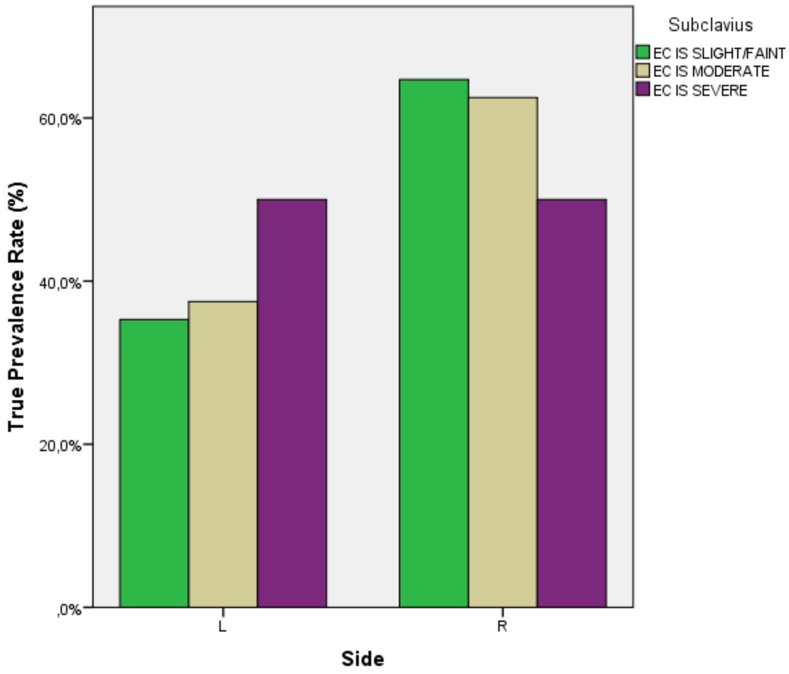

Fig. 5.115: TPR (True Prevalence Rate) in percentages of the left and right subclavius EC of the Vichte skeletal assemblage of known sex (total count of subclavius=71; total count of left side=34; total count of right side=37).

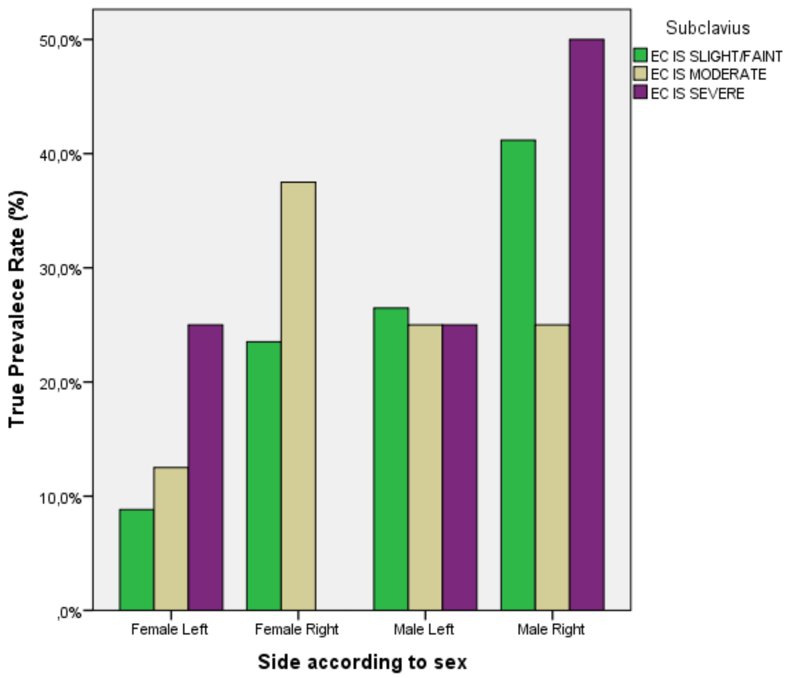

Fig. 5.116: TPR (True Prevalence Rate) in percentages of the left and right subclavius EC of the Vichte skeletal assemblage according to sex (total count of subclavius=71; total count of female left side=14; total count of female right side=15; total count of male left side=20; total count of male right side=22).

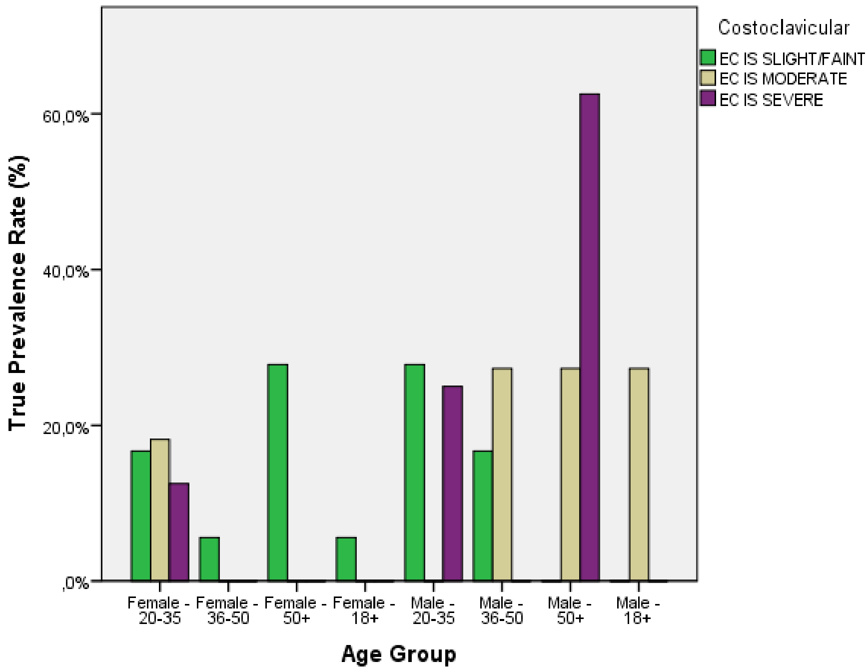

Fig. 5.117: TPR (True Prevalence Rate) in percentages of the costoclavicular scores for each sex and age group of the Vichte adult skeletal assemblage.

There was no statistically significant difference between males and females for the costoclavicular ligament (U=494, p=0.068, n1 (f)=30, n2 (m)=43) (fig. 5.117). When testing age versus sex, there was no statistically significant difference for EC of the costoclavicular ligament for males (x^2=1.656, df=2, p=0.437, n=39) and for females (x^2=2.443, df=2, p=0.295, n=29). There was no statistically significant difference in EC of the costoclavicular ligament between left (l) and right (r) (U=545.5, p=0.109, n1 (l)=35, n2 (r)=39).

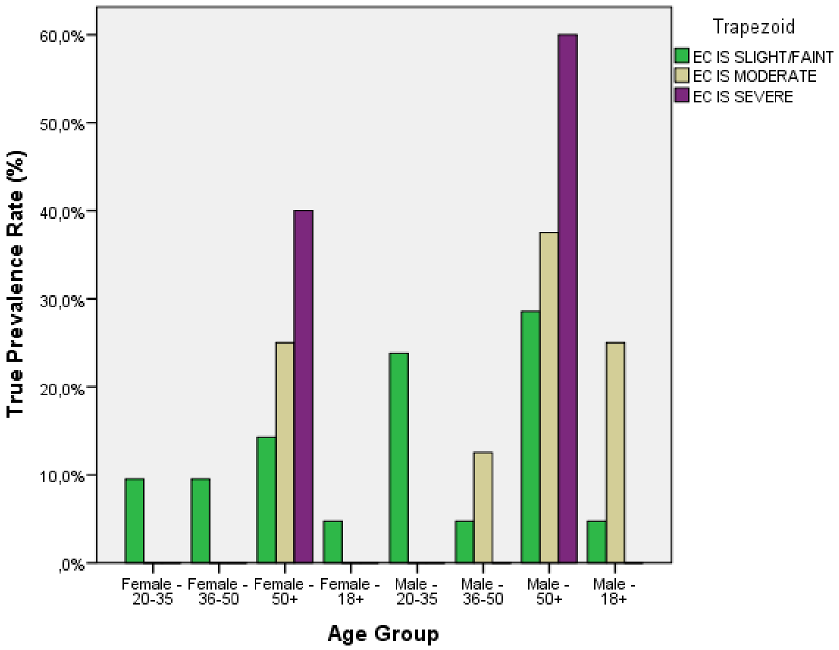

Fig. 5.118: TPR (True Prevalence Rate) in percentages of the trapezoid scores for each sex and age group of the Vichte adult skeletal assemblage.

For EC of the trapezoid, the difference between males and females is not statistically significant (U=456.5, p=0.323, n1 (f)=27, n2 (m)=39) (fig. 5.118). When testing age versus sex, there was a statistically significant difference for EC of the trapezoid for males (x^2=13.170, df=2, p=0.001, n=36) and for females (x^2=6.993, df=2, p=0.030, n=26). There was no statistically significant difference in EC of the trapezoid between left (l) and right (r) (U=483, p=0.396, n1 (l)=32, n2 (r)=34). Severe scores were recorded only in the male and female old adult groups.

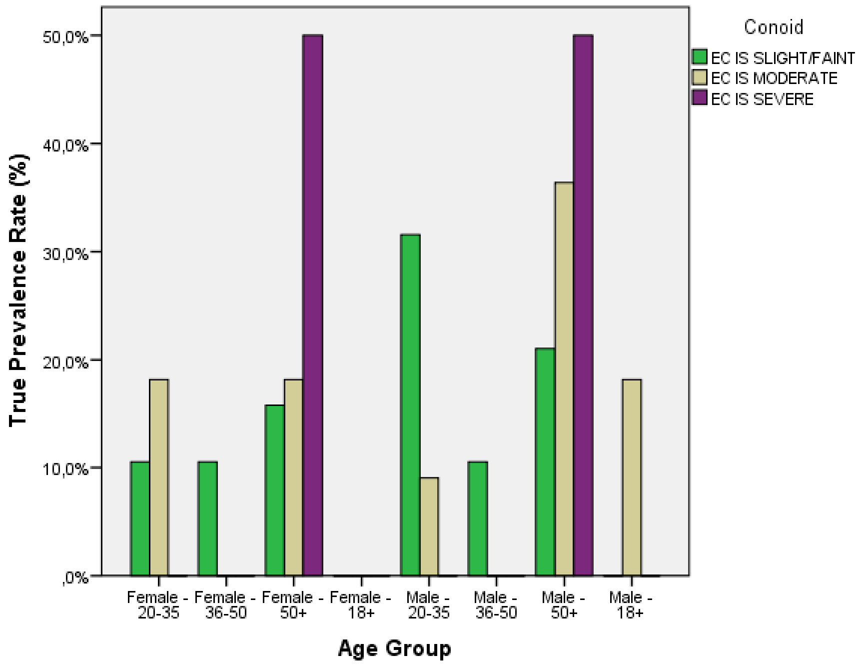

Fig. 5.119: TPR (True Prevalence Rate) in percentages of the conoid scores for each sex and age group of the Vichte adult skeletal assemblage.

For EC of the conoid, the difference between males and females is not statistically significant (U=503.5, p=0.553, n1 (f)=28, n2 (m)=39) (fig. 5.119). When testing age versus sex, there was a statistically significant difference for EC of the conoid for males (x^2=8.346, df=2, p=0.015, n=36), but not for females (x^2=2.083, df=2, p=0.353, n=27). There was no statistically significant difference in EC of the conoid between left (l) and right (r) (U=504, p=0.440, n1 (l)=32, n2 (r)=35).

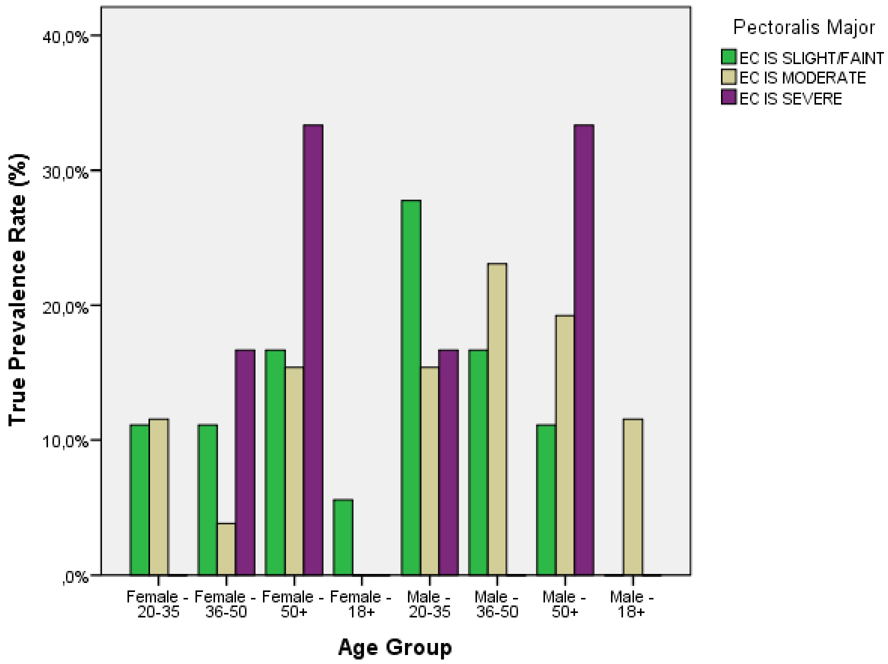

Fig. 5.120: TPR (True Prevalence Rate) in percentages of the pectoralis major scores for each sex and age group of the Vichte adult skeletal assemblage.

There was no statistically significant difference between males and females for EC of the pectoralis major (U=476.5, p=0.168, n1 (f)=30, n2 (m)=39) (fig. 5.120). When testing age versus sex, there was no statistically significant difference for EC of the pectoralis major for males (x^2=0.188, df=2, p=0.910, n=36) and for females (x^2=4.426, df=2, p=0.109, n=28). There was no statistically significant difference in EC of the pectoralis major between left (l) and right (r) (U=596.5, p=0.882, n1 (l)=33, n2 (r)=37).

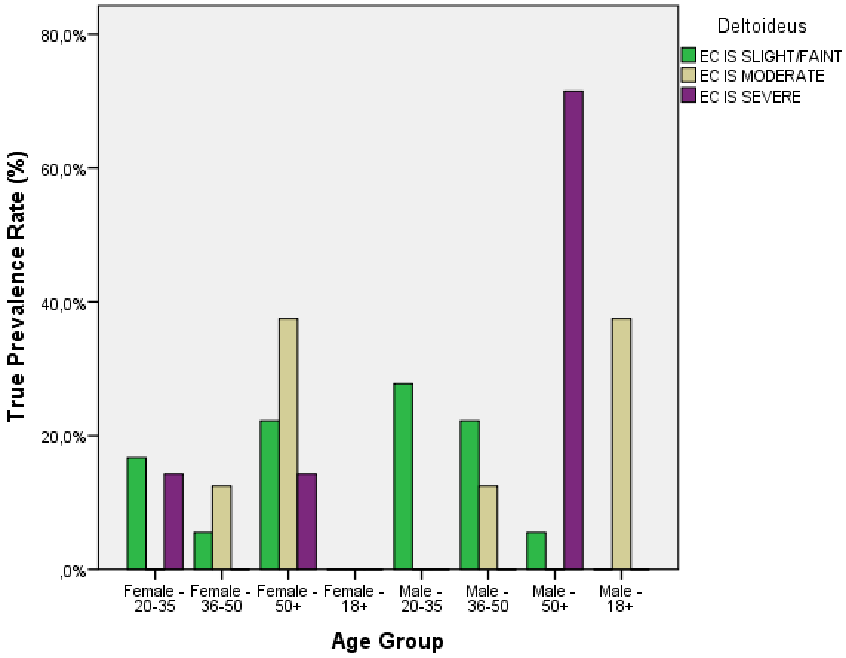

Fig. 5.121: TPR (True Prevalence Rate) in percentages of the deltoideus scores for each sex and age group of the Vichte adult skeletal assemblage.

There was no statistically significant difference between males and females for the deltoideus (U=616, p=0.807, n1 (f)=31, n2 (m)=41) (fig. 5.121). When testing age versus sex, there was no statistically significant difference for EC of the deltoideus for males (x^2=0.390, df=2, p=0.823, n=38) and for females (x^2=4.395, df=2, p=0.111, n=29). There was no statistically significant difference in EC of the deltoideus between left (l) and right (r) (U=550.5, p=0.169, n1 (l)=34, n2 (r)=39).

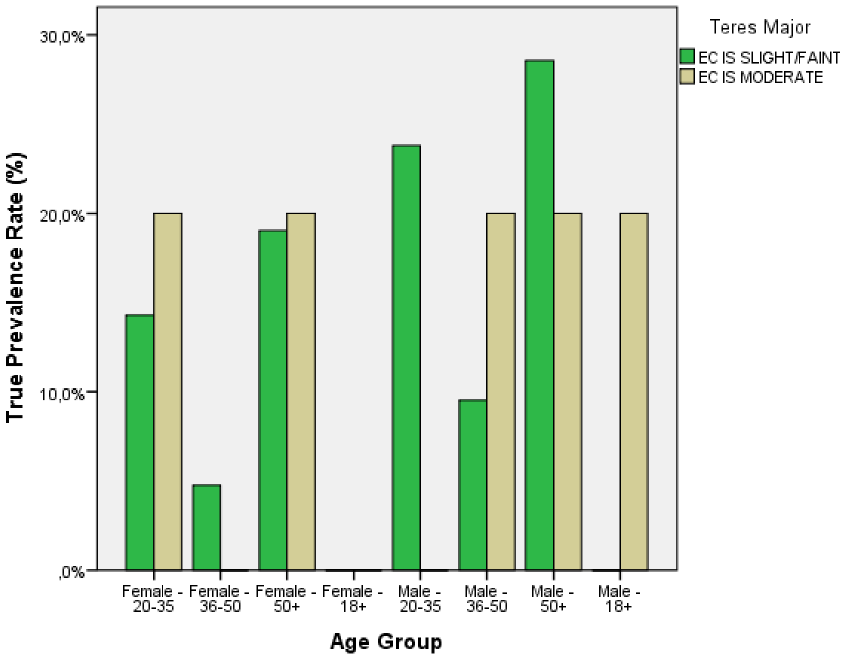

Fig. 5.122: TPR (True Prevalence Rate) in percentages of the teres major scores for each sex and age group of the Vichte adult skeletal assemblage.

There was no statistically significant difference between males and females for the teres major (U=561, p=0.587, n1 (f)=30, n2 (m)=40) (fig. 5.122). When testing age versus sex, there was no statistically significant difference for EC of the teres major for males (x^2=1.393, df=2, p=0.498, n=37) and for females (x^2=1.039, df=2, p=0.595, n=28). There was a statistically significant difference in EC of the teres major between left (l) and right (r) (U=476, p=0.040, n1 (l)=33, n2 (r)=38), with males showing more prominent EC of the left side compared to the right teres major and females (fig. 5.123 and 5.124).

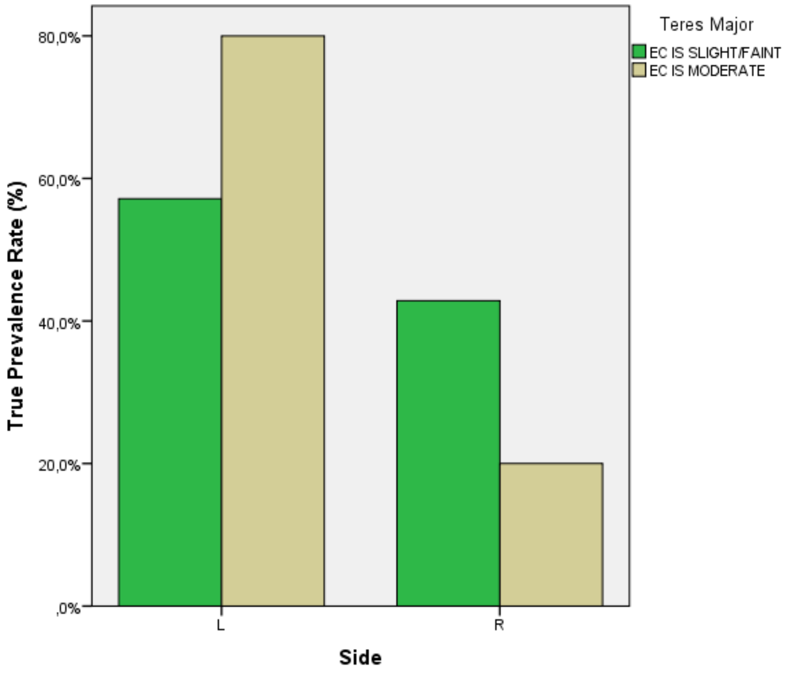

Fig. 5.123: TPR (True Prevalence Rate) in percentages of the left and right teres major EC of the Vichte skeletal assemblage of known sex (total count of teres major=70; total count of left side=32; total count of right side=38).

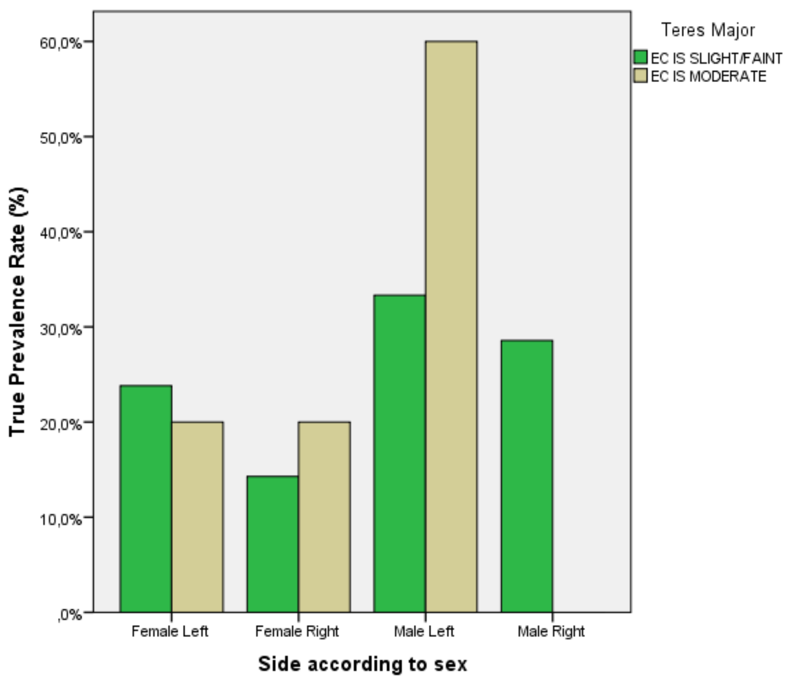

Fig. 5.124: TPR (True Prevalence Rate) in percentages of the left and right teres major EC of the Vichte skeletal assemblage according to sex (total count of teres major=70; total count of female left side=14; total count of female right side=16; total count of male left side=18; total count of male right side=22).

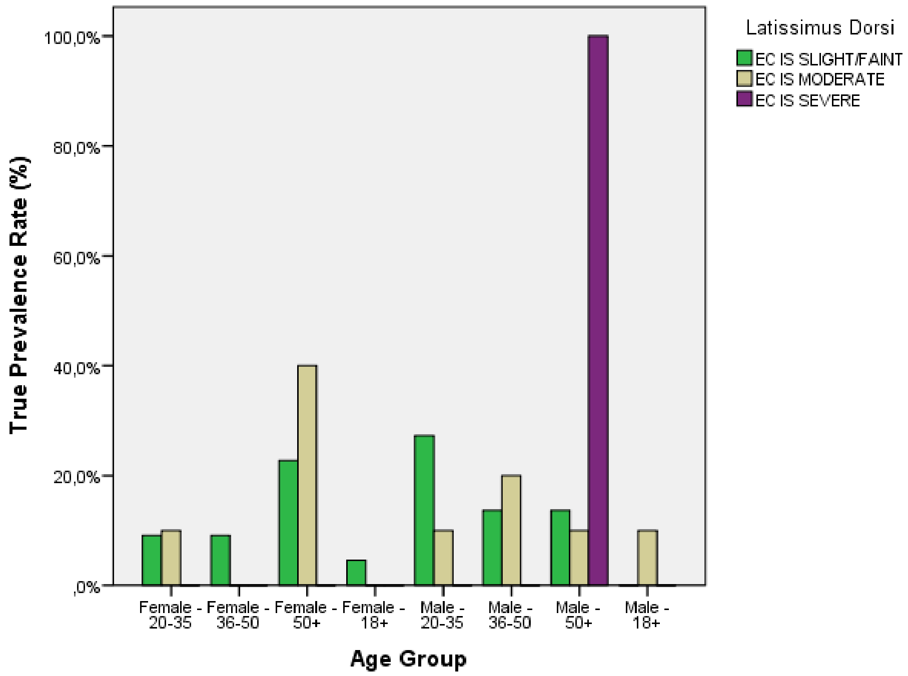

Fig. 5.125: TPR (True Prevalence Rate) in percentages of the latissimus dorsi scores for each sex and age group of the Vichte adult skeletal assemblage.

There was no statistically significant difference between males and females for the latissimus dorsi (U=582.5, p=0.974, n1 (f)=30, n2 (m)=39) (fig. 5.125). When testing age versus sex, there was no statistically significant difference for EC of the latissimus dorsi for males (x^2=0.458, df=2, p=0.795, n=36). For females, however, age was observed as statistically significant (x^2=7.932, df=2, p=0.019, n=28). There was no statistically significant difference in EC of the latissimus dorsi between left (l) and right (r) (U=547.5, p=0.416, n1 (l)=33, n2 (r)=37).

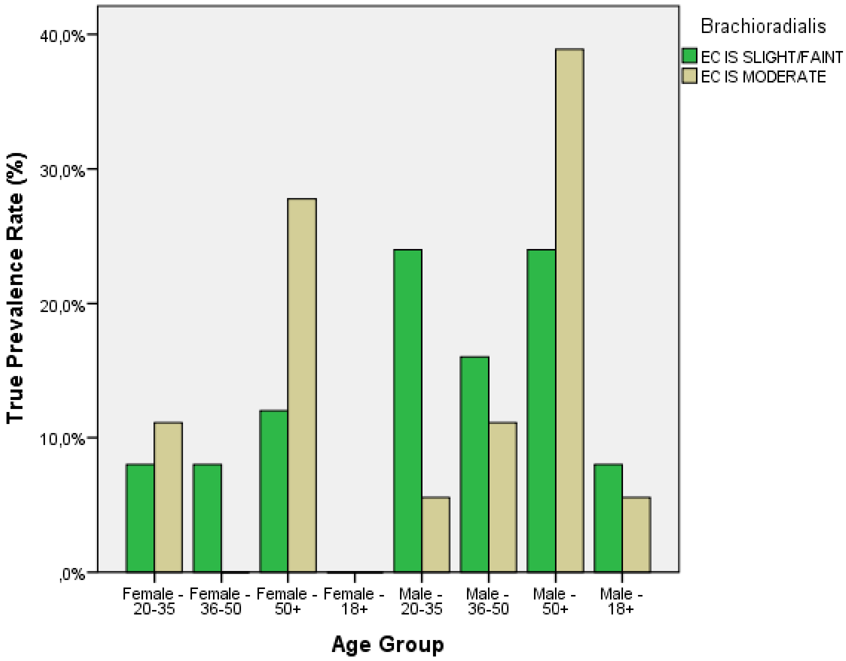

Fig. 5.126: TPR (True Prevalence Rate) in percentages of the brachioradialis scores for each sex and age group of the Vichte adult skeletal assemblage.

There was no statistically significant difference between males and females for the brachioradialis (U=513.5, p=0.155, n1 (f)=30, n2 (m)=42) (fig. 5.126). When testing age versus sex, there was a statistically significant difference for EC of the brachioradialis for males (x^2=6.934, df=2, p=0.031, n=39), but not for females (x^2=5.123, df=2, p=0.077, n=29). There was no statistically significant difference in EC of the brachioradialis between left (l) and right (r) (U=613, p=0.539, n1 (l)=35, n2 (r)=38).

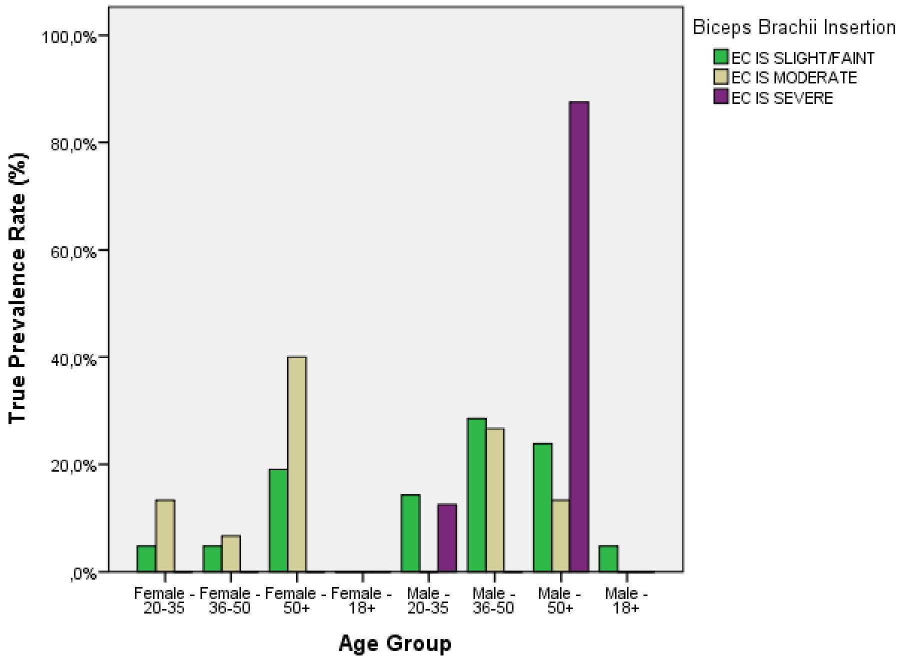

Fig. 5.127: TPR (True Prevalence Rate) in percentages of the biceps brachii insertion scores for each sex and age group of the Vichte adult skeletal assemblage.

There was no statistically significant difference between males and females for the biceps brachii insertion (U=489, p=0.051, n1 (f)=32, n2 (m)=41) (fig. 5.127). When testing age versus sex, there was a statistically significant difference for EC of the biceps brachii insertion for males (x^2=10.667, df=2, p=0.005, n=37) and for females (x^2=9.156, df=2, p=0.010, n=31). There was no statistically significant difference in EC of the biceps brachii insertion between left (l) and right (r) (U=631, p=0.546, n1 (l)=38, n2 (r)=36).

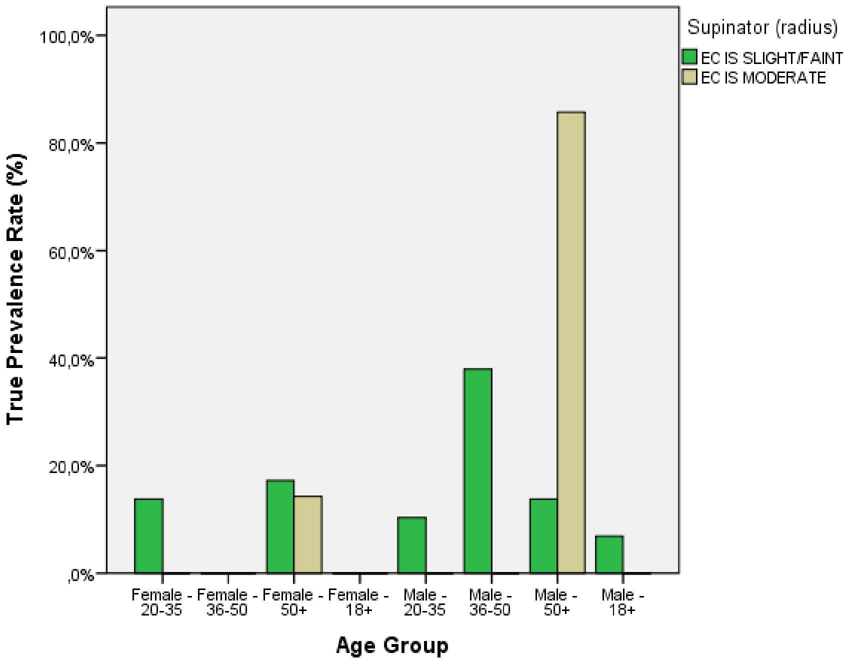

Fig. 5.128: TPR (True Prevalence Rate) in percentages of the supinator (radius) scores for each sex and age group of the Vichte adult skeletal assemblage.

The supinator (radius) showed a statistically significant difference between both sexes of the Vichte skeletal collection (U=407, p=0.003, n1 (f)=32, n2 (m)=40) (fig. 5.128). When testing age versus sex, there was a statistically significant difference for EC of the supinator (radius) for males (x^2=6.431, df=2, p=0.040, n=36), but not for females (x^2=3.947, df=2, p=0.139, n=31). There was no statistically significant difference in EC of the supinator (radius) between left (l) and right (r) (U=662, p=0.971, n1 (l)=38, n2 (r)=35).

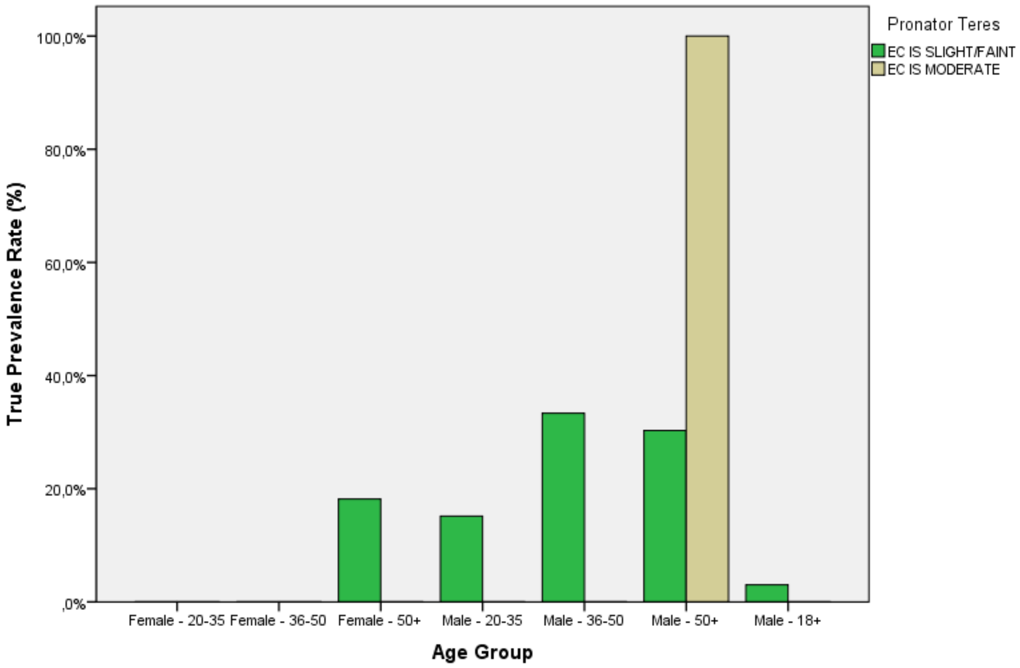

Fig. 5.129: TPR (True Prevalence Rate) in percentages of the pronator teres scores for each sex and age group of the Vichte adult skeletal assemblage.

EC of the pronator teres showed a statistically significant difference between males and females (U=340, $p<0.001$, n1 (f)=31, n2 (m)=43) (fig. 5.129). When testing age versus sex, there was a statistically significant difference for EC of the pronator teres for males (x^2=6.417, df=2, p=0.040, n=38) and for females (x^2=11.400, df=2, p=0.003, n=31). There was no statistically significant difference in EC of the pronator teres between left (l) and right (r) (U=693.5, p=0.908, n1 (l)=38, n2 (r)=37).

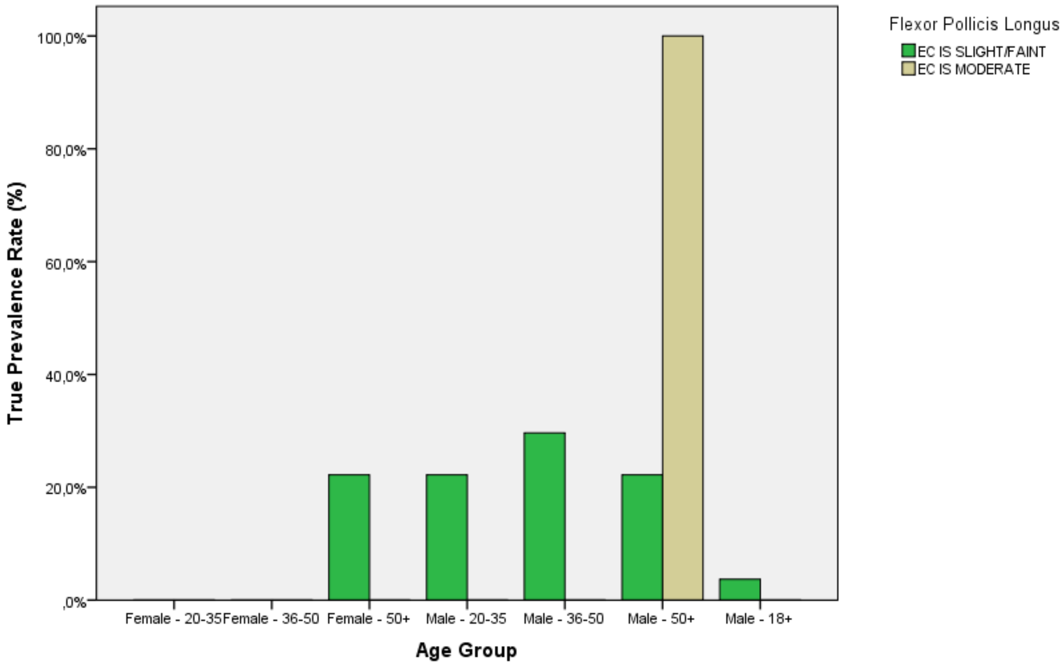

Fig. 5.130: TPR (True Prevalence Rate) in percentages of the flexor pollicis longus scores for each sex and age group of the Vichte adult skeletal assemblage.

There was a statistically significant difference between males and females for the flexor pollicis longus (U=430.5, p=0.006, n1 (f)=29, n2 (m)=44) (fig. 5.130). When testing age versus sex, there was no statistically significant difference for EC of the flexor pollicis longus for males (x^2=0.587, df=2, p=0.746, n=39). For females, however, age was identified as statistically significant (x^2=13.878, df=2, p=0.001, n=29). There was no statistically significant difference in EC of the flexor pollicis longus between left (l) and right (r) (U=680.5, p=0.965, n1 (l)=38, n2 (r)=36).

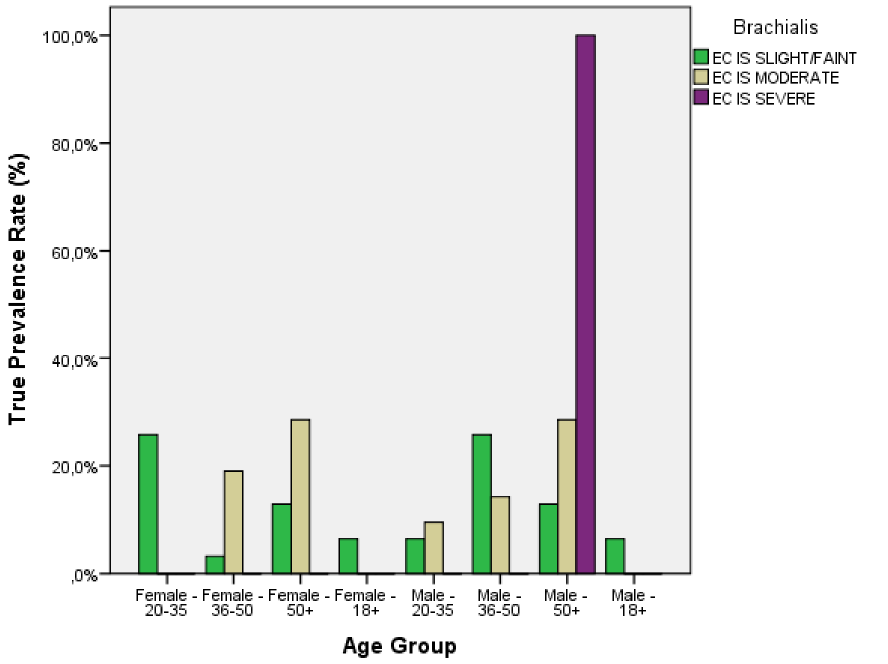

Fig. 5.131: TPR (True Prevalence Rate) in percentages of the brachialis scores for each sex and age group of the Vichte adult skeletal assemblage.

There was no statistically significant difference between males and females for the brachialis (U=625, p=0.443, n1 (f)=33, n2 (m)=42) (fig. 5.131). When testing age versus sex, there was a statistically significant difference for EC of the brachialis for males (x^2=12.192, df=2, p=0.002, n=39) and for females (x^2=14.679, df=2, p=0.001, n=31). There was no statistically significant difference in EC of the brachialis between left (l) and right (r) (U=646.5, p=0.526, n1 (l)=37, n2 (r)=38).

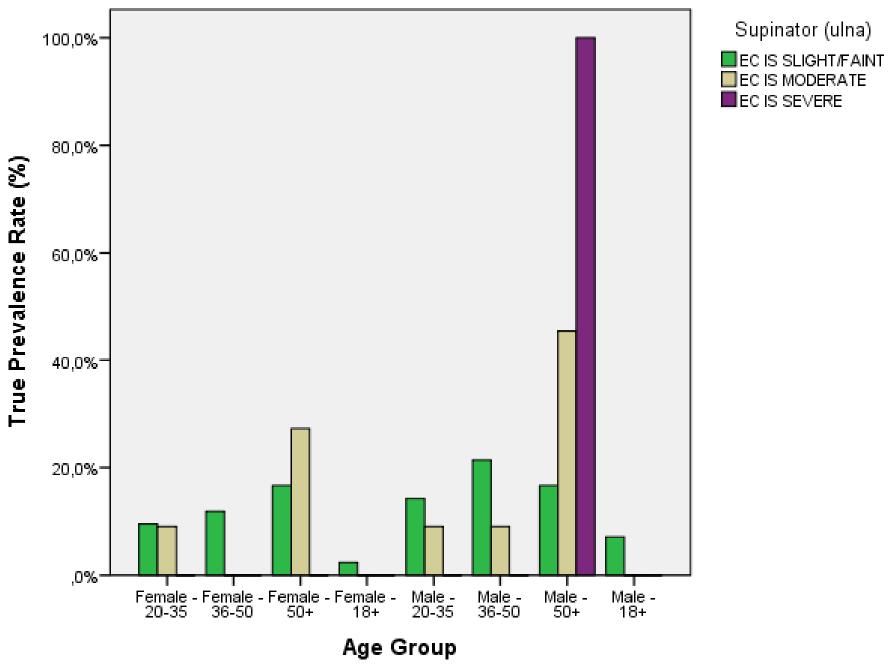

Fig. 5.132: TPR (True Prevalence Rate) in percentages of the supinator (ulna) scores for each sex and age group of the Vichte adult skeletal assemblage.

There was a statistically significant difference between males and females for the supinator (ulna) (U=488.5, p=0.022, n1 (f)=33, n2 (m)=41) (fig. 5.132). When testing age versus sex, there was a statistically significant difference for EC of the supinator (ulna) for males (x^2=11.455, df=2, p=0.003, n=38) and for females (x^2=10.173, df=2, p=0.006, n=31). There was no statistically significant difference in EC of the supinator (ulna) between left (l) and right (r) (U=681, p=0.966, n1 (l)=37, n2 (r)=37).

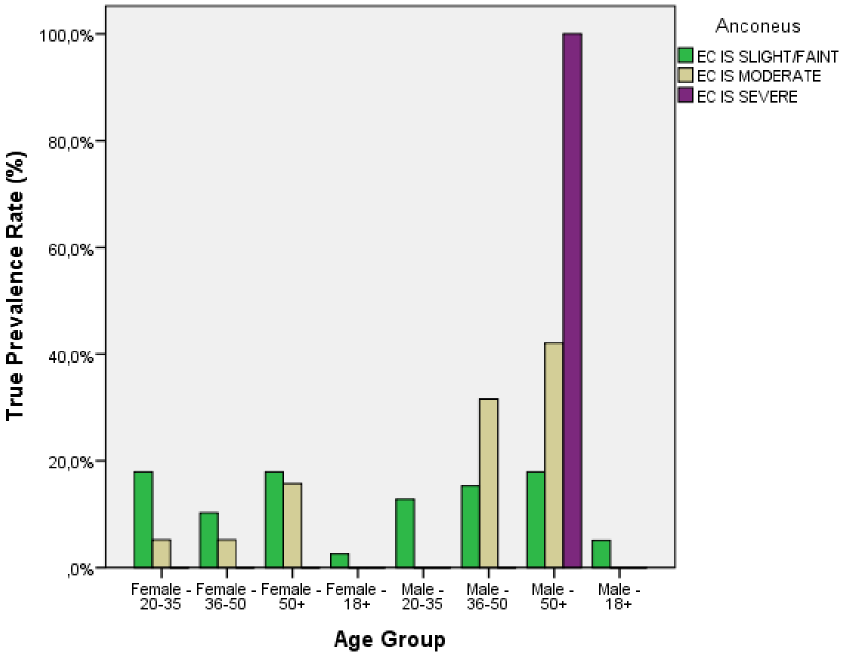

Fig. 5.133: TPR (True Prevalence Rate) in percentages of the anconeus scores for each sex and age group of the Vichte adult skeletal assemblage.

There was a statistically significant difference between males and females for the anconeus (U=524.5, p=0.049, n1 (f)=33, n2 (m)=42) (fig. 5.133). When testing age versus sex, there was a statistically significant difference for EC of the anconeus for males (x^2=13.967, df=2, p=0.001, n=39) and for females (x^2=6.484, df=2, p=0.039, n=31).There was no statistically significant difference in EC of the anconeus between left (l) and right (r) (U=641, p=0.472, n1 (l)=37, n2 (r)=38).

** Lower Limb EC*

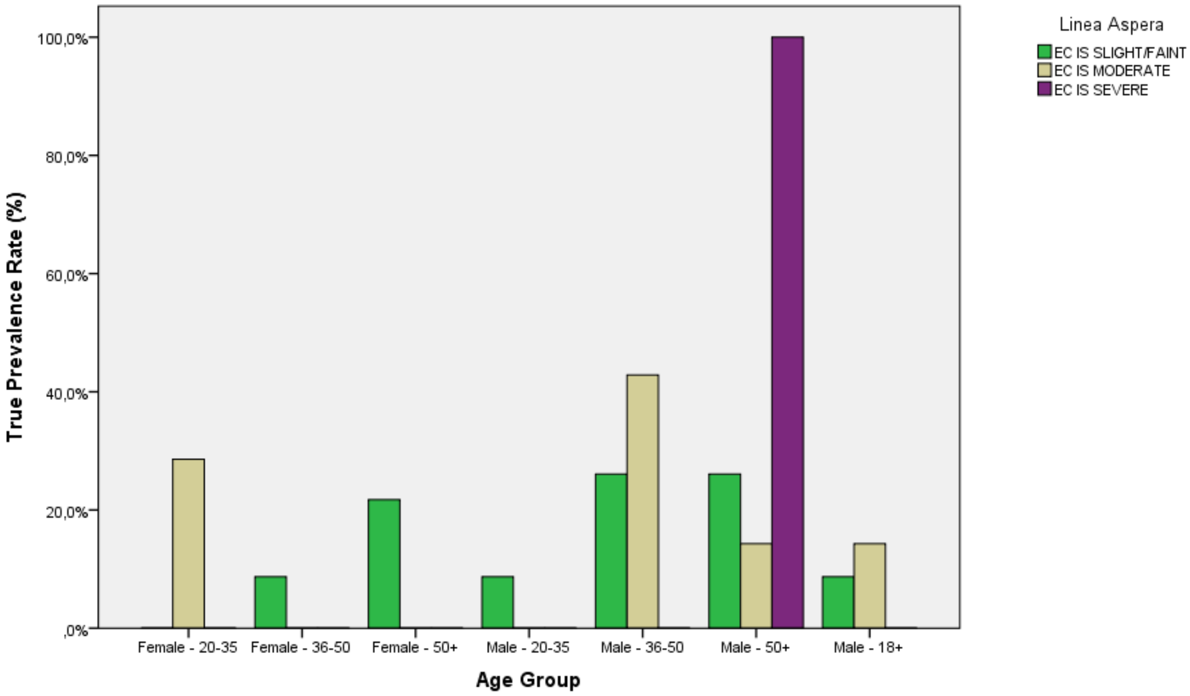

Fig. 5.134: TPR (True Prevalence Rate) in percentages of the linea aspera scores for each sex and age group of the Vichte adult skeletal assemblage.

There was a statistically significant difference between males and females for the linea aspera (U=587.5, p=0.010, n1 (f)=34, n2 (m)=49) (fig. 5.134). When testing age versus sex, there was a statistically significant difference for EC of the linea aspera for males (x^2=11.839, df=2, p=0.003, n=44), but not for females (x^2=2.047, df=2, p=0.359, n=34).There was no statistically significant difference in EC of the linea aspera between left (l) and right (r) (U=909, p=0.879, n1 (l)=43, n2 (r)=43). Severe EC of the linea aspera was only noticed in old adult males. Females were not observed with severe EC.

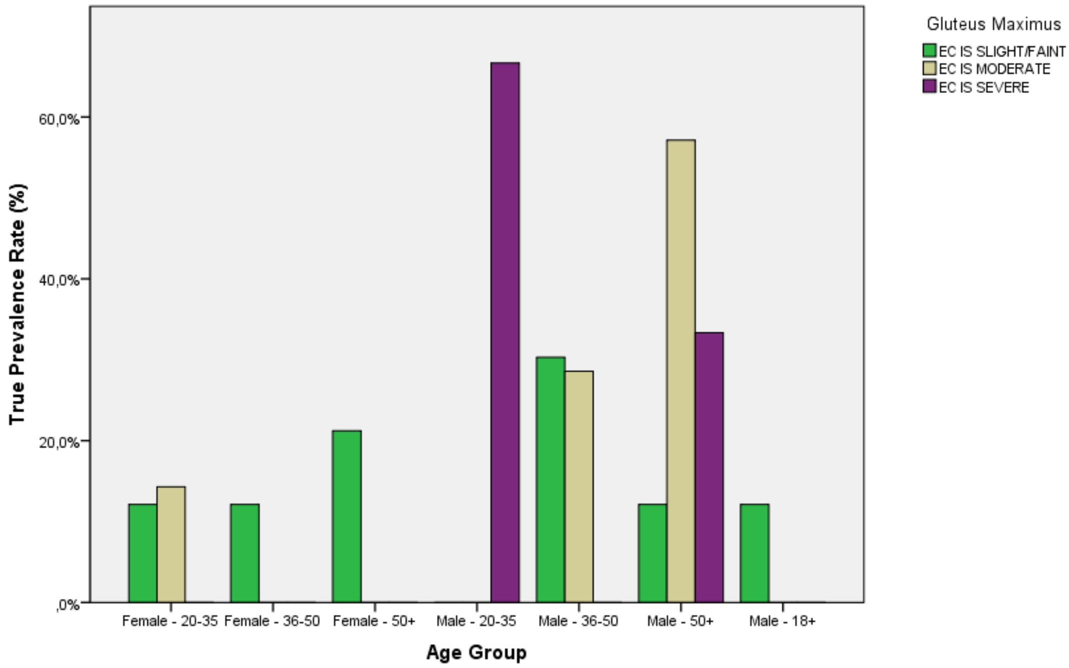

Fig. 5.135: TPR (True Prevalence Rate) in percentages of the gluteus maximus scores for each sex and age group of the Vichte adult skeletal assemblage.

There was no statistically significant difference between males and females for the gluteus maximus (U=706, p=0.195, n1 (f)=34, n2 (m)=49) (fig. 5.135). When testing age versus sex, there was no statistically significant difference for EC of the gluteus maximus for males (x^2=5.884, df=2, p=0.053, n=44) and for females (x^2=2.284, df=2, p=0.319, n=34). There was no statistically significant difference in EC of the gluteus maximus between left (l) and right (r) (U=908.5, p=0.880, n1 (l)=43, n2 (r)=43).

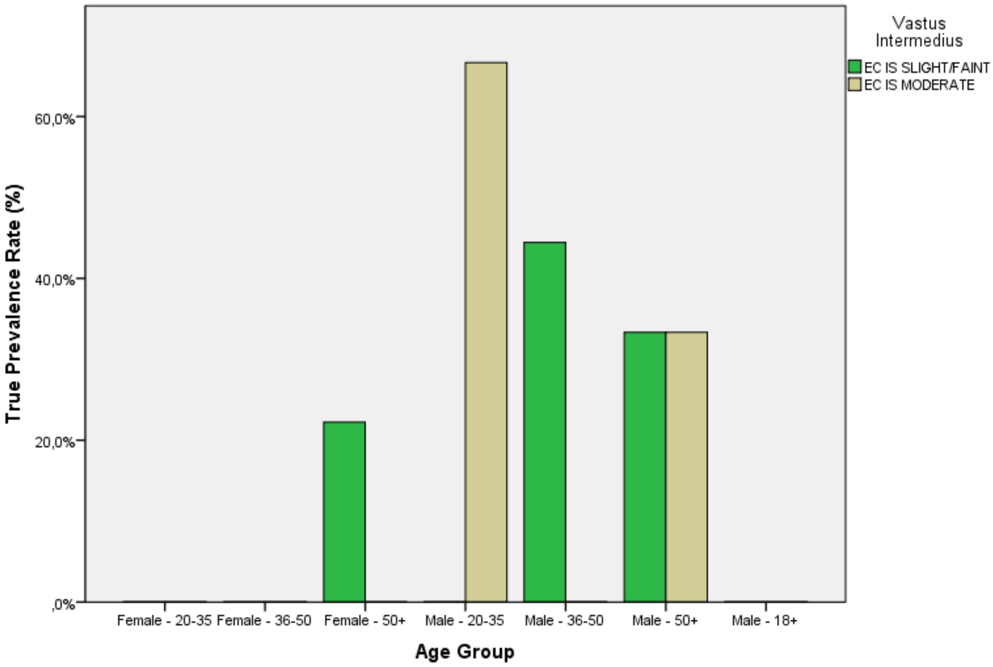

Fig. 5.136: TPR (True Prevalence Rate) in percentages of the vastus intermedius scores for each sex and age group of the Vichte adult skeletal assemblage.

There was no statistically significant difference between males and females for the vastus intermedius (U=709, p=0.060, n1 (f)=34, n2 (m)=49) (fig. 5.136). When testing age versus sex, there was no statistically significant difference for EC of the vastus intermedius for males (x^2=0.243, df=2, p=0.886, n=44) and for females (x^2=3.781, df=2, p=0.151, n=34). There was no statistically significant difference in EC of the vastus intermedius between left (l) and right (r) (U=880, p=0.523, n1 (l)=43, n2 (r)=43).

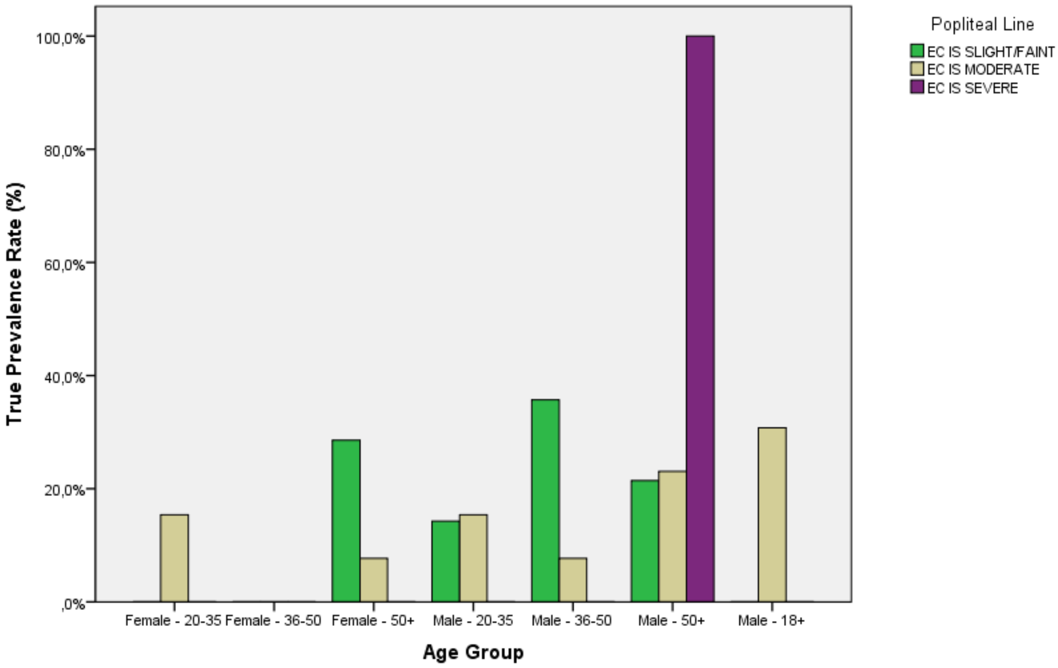

Fig. 5.137: TPR (True Prevalence Rate) in percentages of the popliteal line scores for each sex and age group of the Vichte adult skeletal assemblage.

There was a statistically significant difference between males and females for EC of the popliteal ($U=597$, $p=0.042$, n1 (f)=31, n2 (m)=50) (fig. 5.137). When testing age versus sex, there was no statistically significant difference for EC of the popliteal line for males ($x^2=1.557$, $df=2$, $p=0.459$, $n=43$) and for females ($x^2=3.734$, $df=2$, $p=0.155$, $n=31$). There was no statistically significant difference in EC of the popliteal line between left (l) and right (r) ($U=790.5$, $p=0.744$, n1 (l)=41, n2 (r)=40). Severe EC of the popliteal line was observed only in old adult males.

5.6.4. Zottegem

** Upper Limb EC*

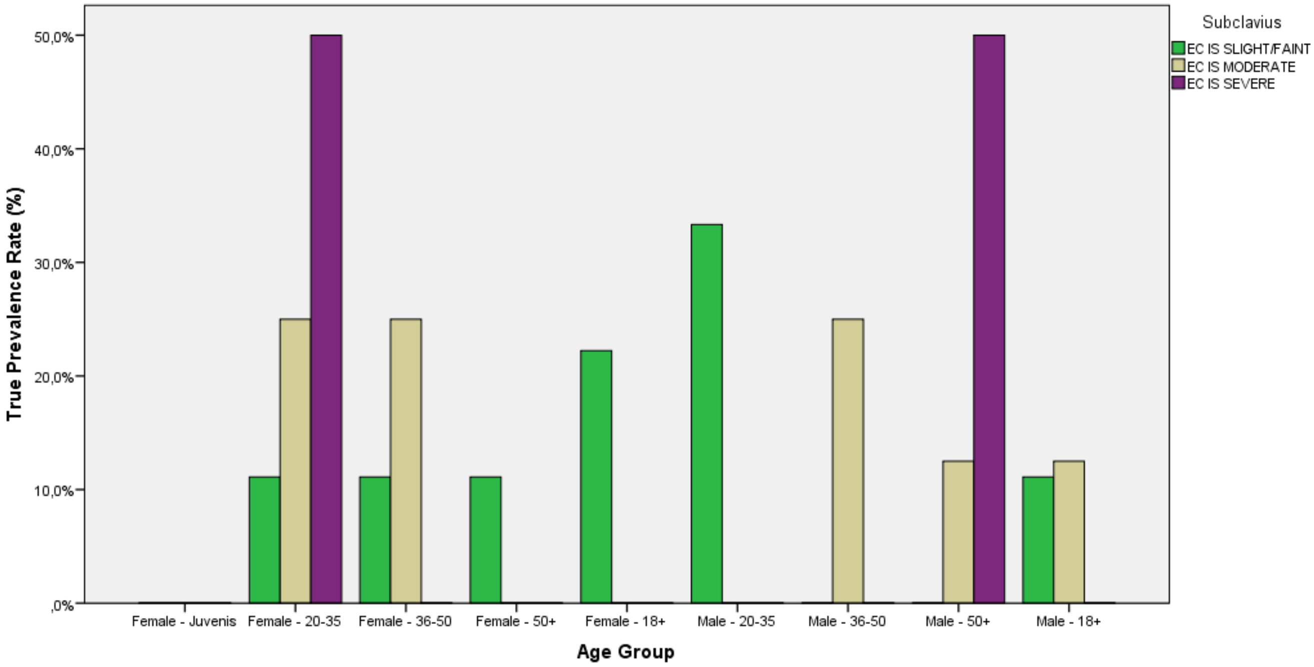

Fig. 5.138: TPR (True Prevalence Rate) in percentages of the subclavius scores for each sex and age group of the Zottegem skeletal assemblage.

The severity of EC of the subclavius was not statistically significant between males and females (U=158, p=0.419, n1 (f)=23, n2 (m)=16) (fig. 5.138). When testing age versus sex, there was no statistically significant difference for EC of the subclavius for males (x^2=4.270, df=2, p=0.118, n=11) and for females (x^2=0.766, df=3, p=0.858, n=19). There was no statistically significant difference in EC of the subclavius between left (l) and right (r) (U=141.5, p=0.093, n1 (l)=22, n2 (r)=18).

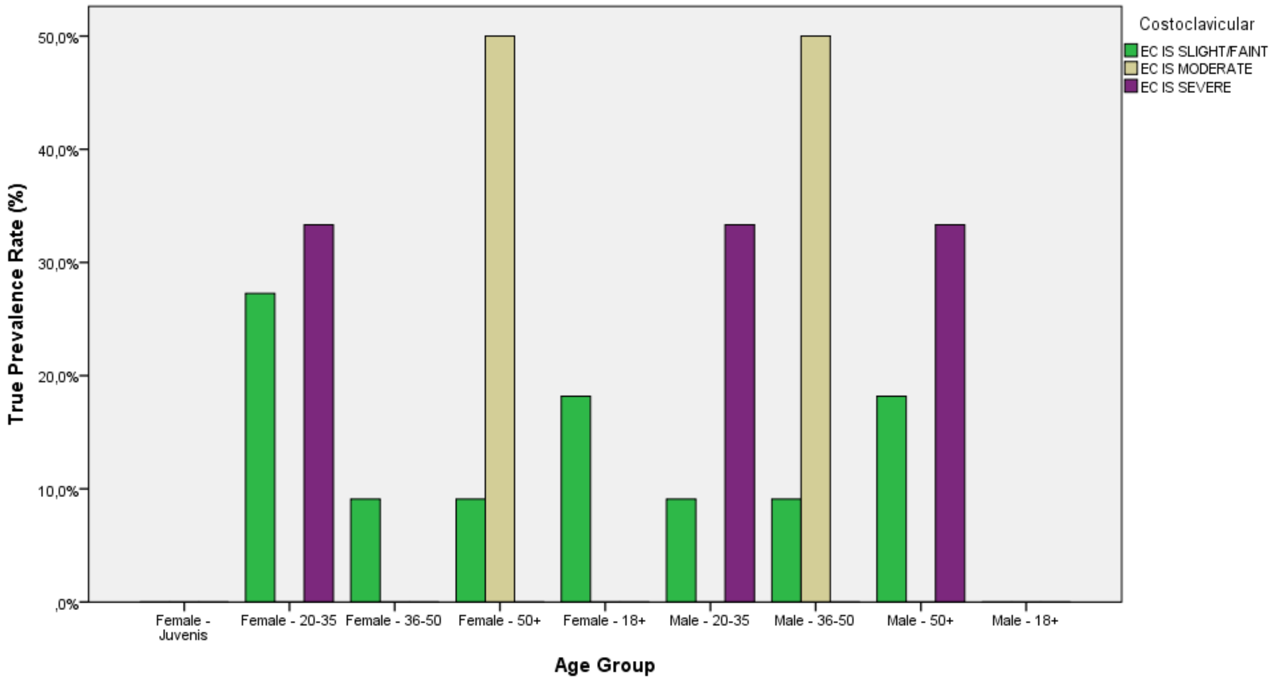

Fig. 5.139: TPR (True Prevalence Rate) in percentages of the costoclavicular scores for each sex and age group of the Zottegem skeletal assemblage.

There was no statistically significant difference between males and females for the costoclavicular ligament (U=129.5, p=0.512, n1 (f)=21, n2 (m)=14) (fig. 5.139). When testing age versus sex, there was no statistically significant difference for EC of the costoclavicular ligament for males (x^2=2.986, df=2, p=0.225, n=11) and for females (x^2=6.505, df=3, p=0.089, n=17). There was no statistically significant difference in EC of the costoclavicular ligament between left (l) and right (r) (U=140, p=0.446, n1 (l)=19, n2 (r)=17).

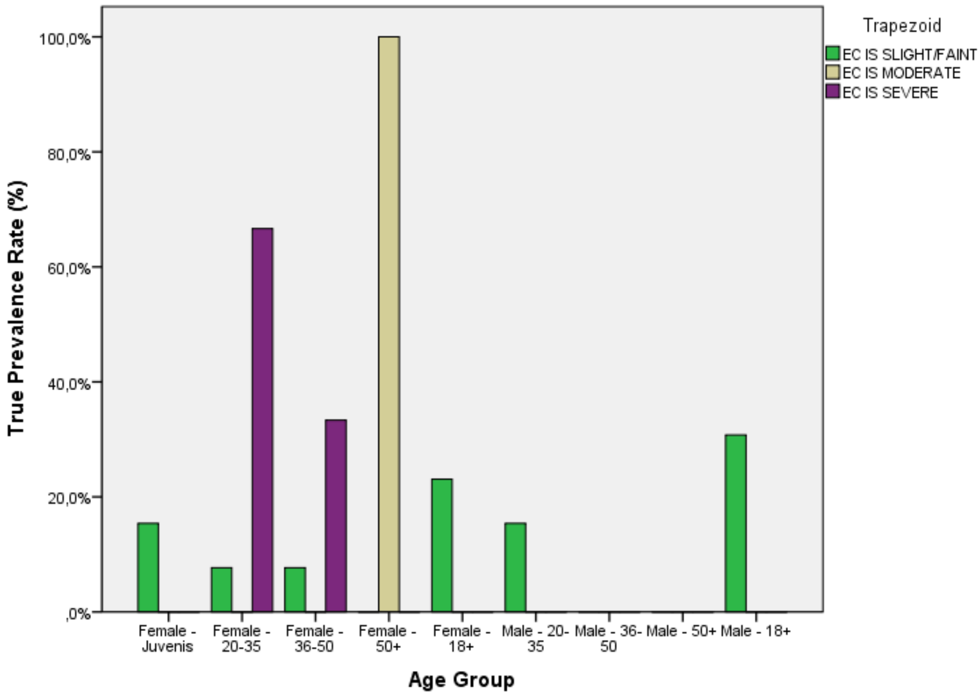

Fig. 5.140: TPR (True Prevalence Rates) in percentage of the trapezoid scores for each sex and age group of the Zottegem skeletal assemblage.

For EC of the trapezoid, the difference between males and females is not statistically significant (U=106.5, p=0.246, n1 (f)=21, n2 (m)=13) (fig. 5.140). When testing age versus sex, there was no statistically significant difference for EC of the trapezoid for males (x^2=1.143, df=2, p=0.565, n=9) and for females (x^2=2.505, df=3, p=0.474, n=17). There was a statistically significant difference in EC of the trapezoid between left (l) and right (r) (U=97, p=0.028, n1 (l)=20, n2 (r)=16), with especially females showing a preferential use of the right trapezoid (fig. 5.141 and 5.142). Severe scores were recorded only in young, middle and old adult female groups.

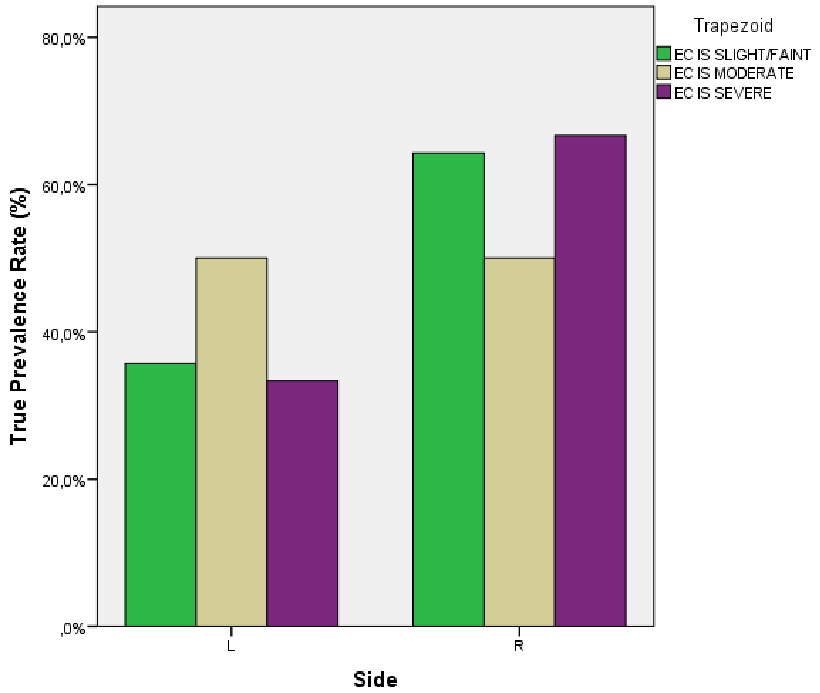

Fig. 5.141: TPR (True Prevalence Rate) in percentages of the left and right trapezoid EC of the Zottegem skeletal assemblage (total count of trapezoid=36; total count of left side=20; total count of right side=16).

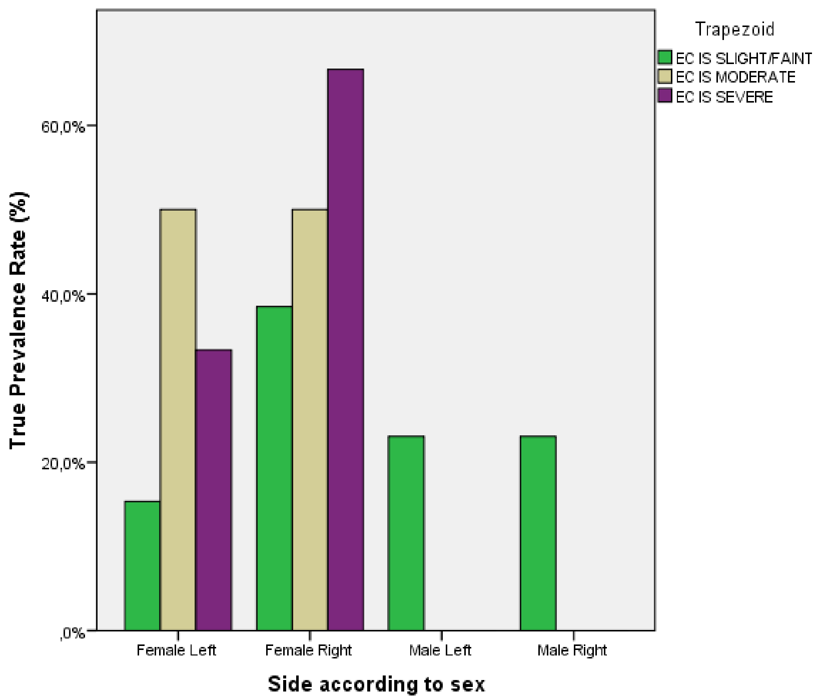

Fig. 5.142: TPR (True Prevalence Rate) in percentages of the left and right trapezoid EC of the Zottegem skeletal assemblage according to sex (total count of trapezoid=34; total count of female left side=11; total count of female right side=10; total count of male left side=8; total count of male right side=5).

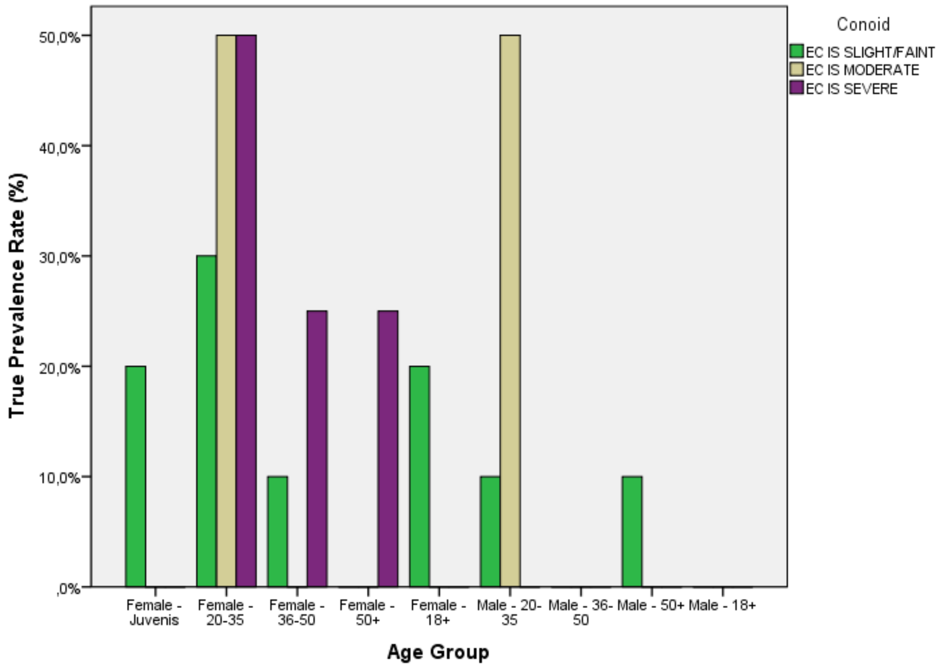

Fig. 5.143: TPR (True Prevalence Rate) in percentages of the conoid scores for each sex and age group of the Zottegem skeletal assemblage.

For EC of the conoid, the difference between males and females is statistically significant (U=93, p=0.027, n1 (f)=22, n2 (m)=14) (fig. 5.143). When testing age versus sex, there was no statistically significant difference for EC of the conoid for males (x^2=0.438, df=2, p=0.804, n=10) and for females (x^2=3.386, df=3, p=0.336, n=18). There was no statistically significant difference in EC of the conoid between left (l) and right (r) (U=142.5, p=0.270, n1 (l)=22, n2 (r)=16).

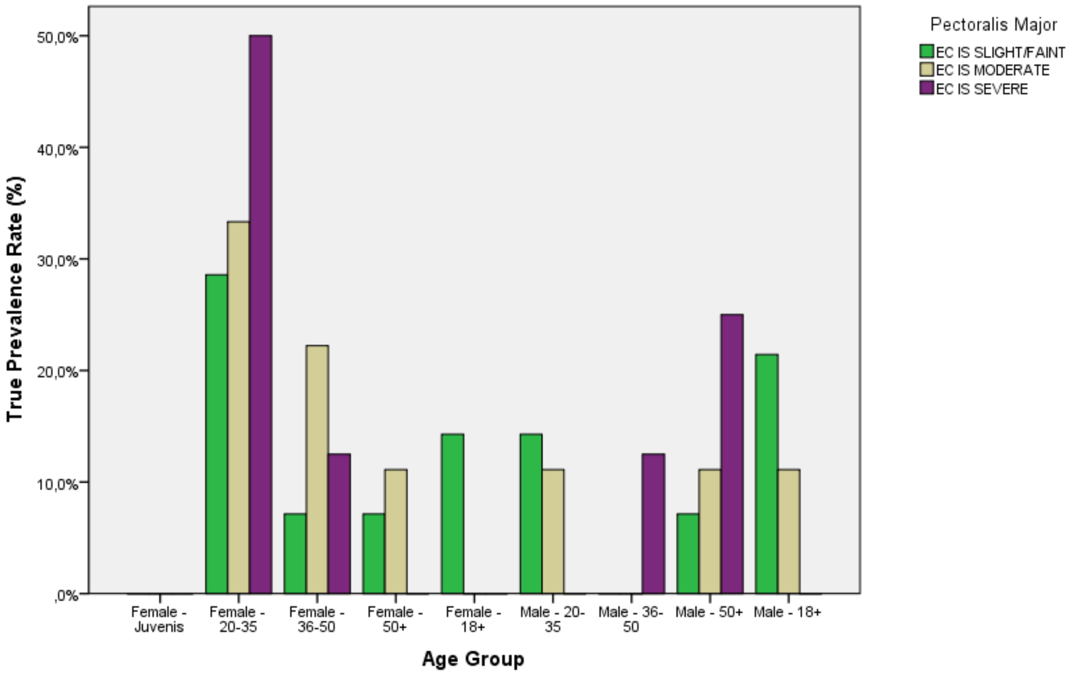

Fig. 5.144: TPR (True Prevalence Rate) in percentages of the pectoralis major scores for each sex and age group of the Zottegem skeletal assemblage.

There was no statistically significant difference between males and females for EC of the pectoralis major (U=164.5, p=0.912, n1 (f)=24, n2 (m)=14) (fig. 5.144). When testing age versus sex, there was no statistically significant difference for EC of the pectoralis major for males (x^2=4.972, df=2, p=0.083, n=10) and for females (x^2=4.809, df=3, p=0.186, n=21). There was no statistically significant difference in EC of the pectoralis major between left (l) and right (r) (U=151.5, p=0.188, n1 (l)=22, n2 (r)=18).

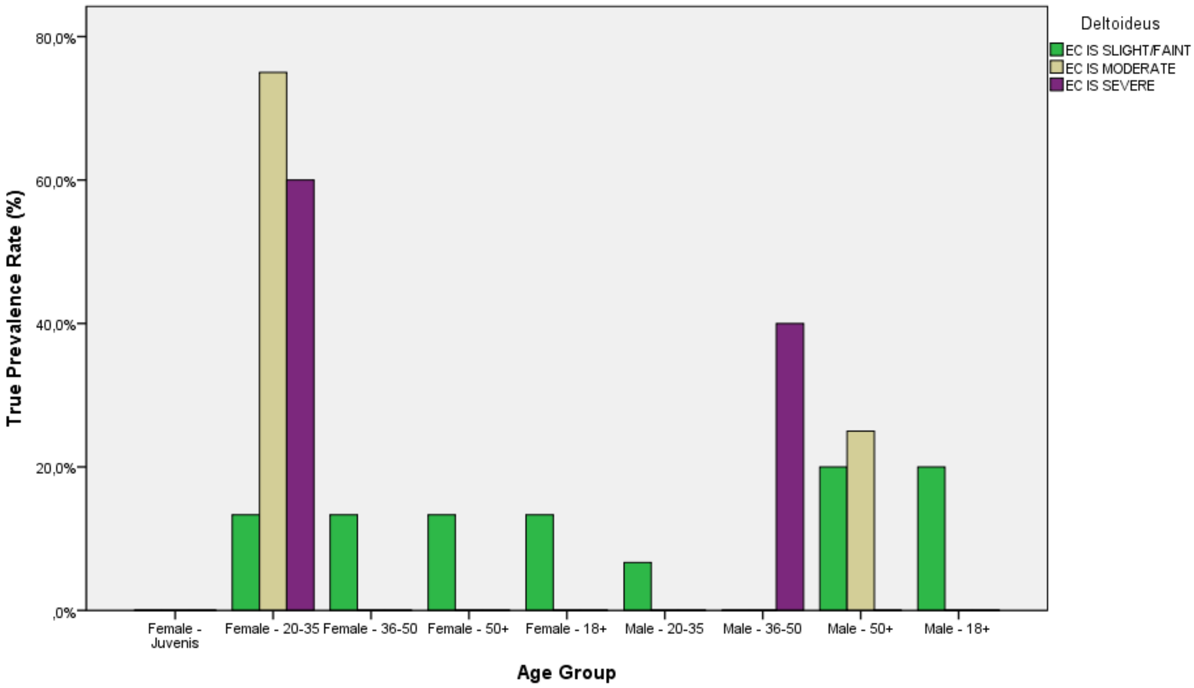

Fig. 5.145: TPR (True Prevalence Rate) in percentages of the deltoideus scores for each sex and age group of the Zottegem skeletal assemblage.

There was no statistically significant difference between males and females for the deltoideus (U=175, p=0.710, n1 (f)=25, n2 (m)=15) (fig. 5.145). When testing age versus sex, there was a statistically significant difference for EC of the deltoideus for males (x^2=8.242, df=2, p=0.016, n=11), but not for females (x^2=3.534, df=, p=0.316, n=21). There was no statistically significant difference in EC of the deltoideus between left (l) and right (r) (U=171, p=0.199, n1 (l)=23, n2 (r)=19).

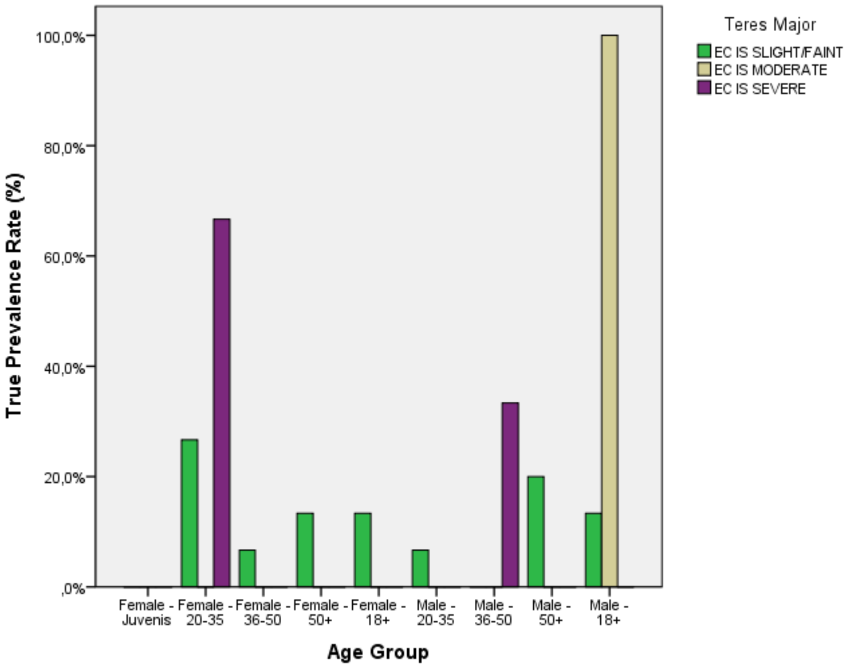

Fig. 5.146: TPR (True Prevalence Rate) in percentages of the teres major scores for each sex and age group of the Zottegem skeletal assemblage.

There was no statistically significant difference between males and females for the teres major (U=131.5, p=0.226, n1 (f)=24, n2 (m)=14) (fig. 5.146). When testing age versus sex, there was no statistically significant difference for EC of the teres major for males (x^2=4.815, df=2, p=0.090, n=10) and for females (x^2=3.772, df=3, p=0.287, n=21). There was no statistically significant difference in EC of the teres major between left (l) and right (r) (U=195.5, p=0.940, n1 (l)=22, n2 (r)=18).

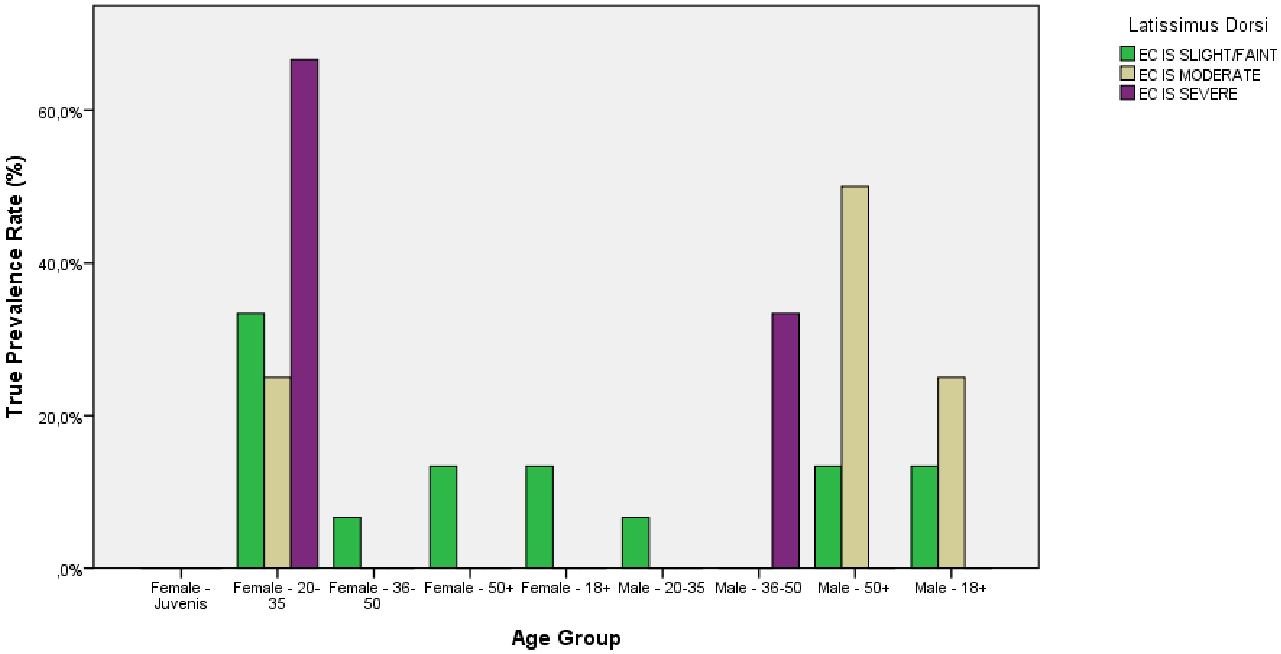

Fig. 5.147: TPR (True Prevalence Rate) in percentages of the latissimus dorsi scores for each sex and age group of the Zottegem skeletal assemblage.

There was no statistically significant difference between males and females for the latissimus dorsi (U=141, p=0.379, n1 (f)=24, n2 (m)=14) (fig. 5.147). When testing age versus sex, there was a statistically significant difference for EC of the latissimus dorsi for males (x^2=7.074, df=2, p=0.029, n=10), but not for females (x^2=4.635, df=3, p=0.201, n=21). There was no statistically significant difference in EC of the latissimus dorsi between left (l) and right (r) (U=173, p=0.462, n1 (l)=22, n2 (r)=18).

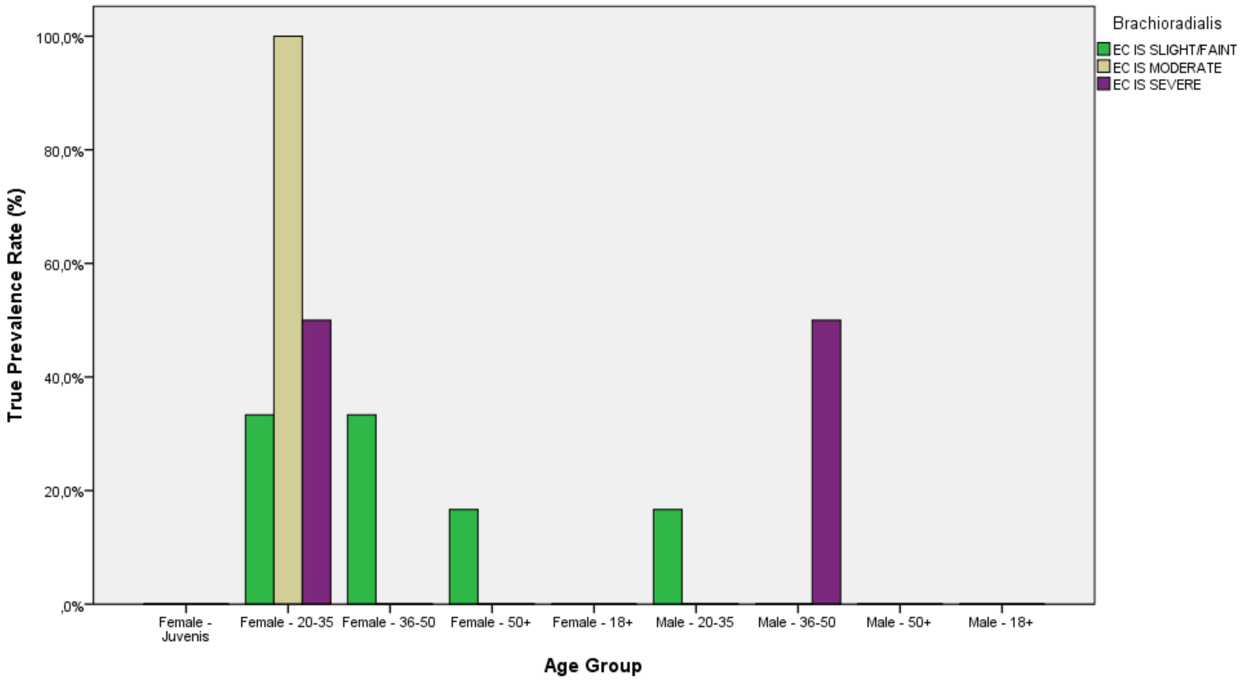

Fig. 5.148: TPR (True Prevalence Rate) in percentages of the brachioradialis scores for each sex and age group of the Zottegem skeletal assemblage.

There was no statistically significant difference between males and females for the brachioradialis (U=86.5, p=0.517, n1 (f)=18, n2 (m)=11) (fig. 5.148). When testing age versus sex, there was a statistically significant difference for EC of the brachioradialis for males (x^2=6.133, df=2, p=0.047, n=9), but not for females (x^2=2.223, df=3, p=0.527, n=17). There was no statistically significant difference in EC of the brachioradialis between left (l) and right (r) (U=89, p=0.159, n1 (l)=16, n2 (r)=15).

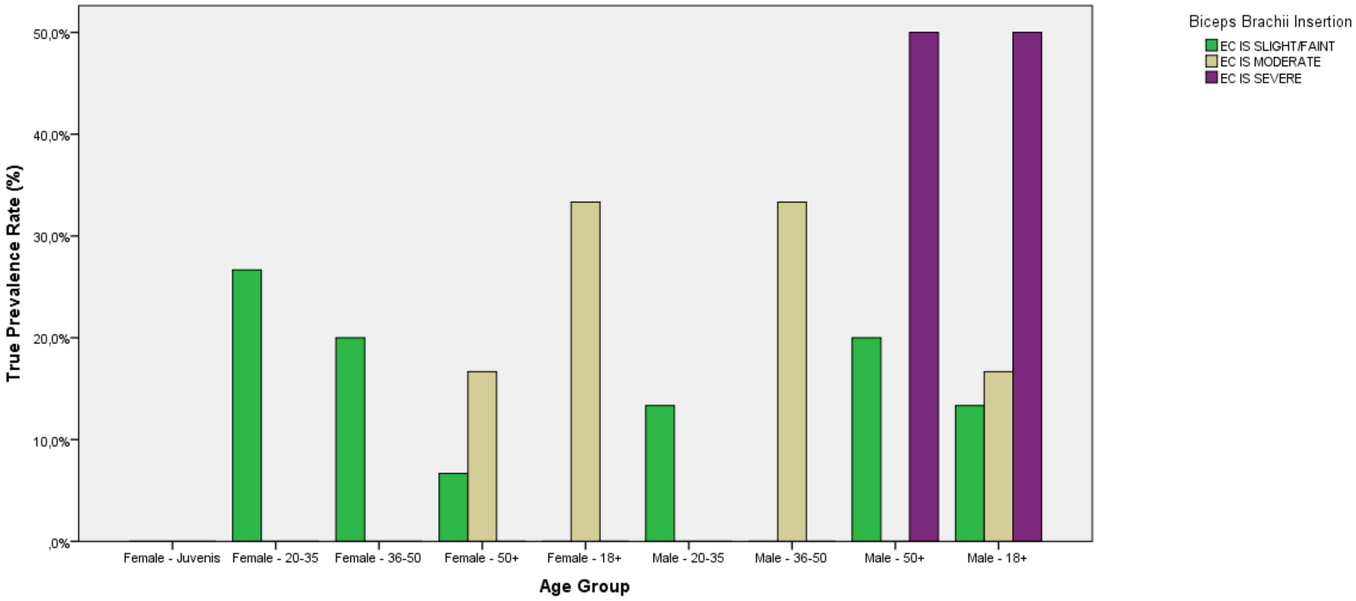

Fig. 5.149: TPR (True Prevalence Rate) in percentages of the biceps brachii insertion scores for each sex and age group of the Zottegem skeletal assemblage.

There was no statistically significant difference between males and females for the biceps brachii insertion (U=155.5, p=0.145, n1 (f)=23, n2 (m)=18) (fig. 5.149). When testing age versus sex, there was no statistically significant difference for EC of the biceps brachii insertion for males (x^2=3.872, df=2, p=0.144, n=14) and for females (x^2=5.589, df=3, p=0.133, n=20). There was no statistically significant difference in EC of the biceps brachii insertion between left (l) and right (r) (U=184.5, p=0.228, n1 (l)=21, n2 (r)=22).

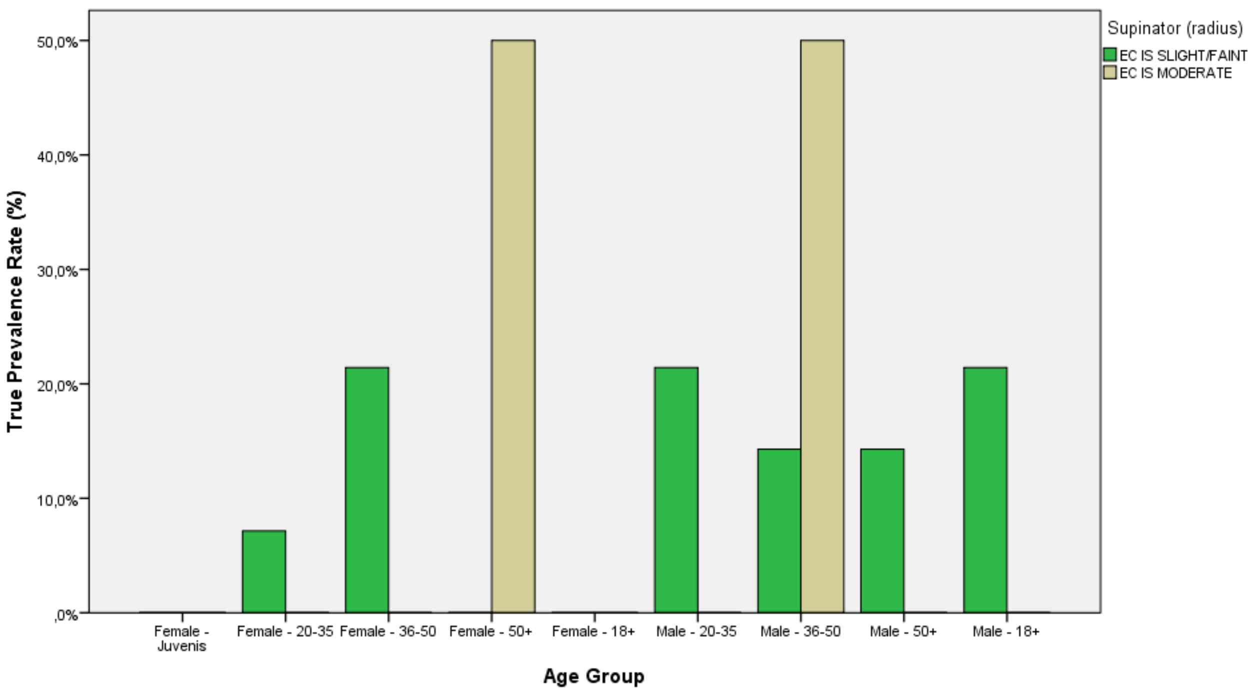

Fig. 5.150: TPR (True Prevalence Rate) in percentages of the supinator (radius) scores for each sex and age group of the Zottegem skeletal assemblage.

The supinator (radius) did not show a statistically significant difference between males and females of the Zottegem skeletal collection (U=136.5, p=0.055, n1 (f)=21, n2 (m)=19) (fig. 5.150). When testing age versus sex, there was a statistically significant difference for EC of the supinator (radius) for females (x^2=9.310, df=3, p=0.025, n=18), but not for males (x^2=5.417, df=2, p=0.067, n=14). There was no statistically significant difference in EC of the supinator (radius) between left (l) and right (r) (U=201.5, p=0.593, n1 (l)=21, n2 (r)=21).

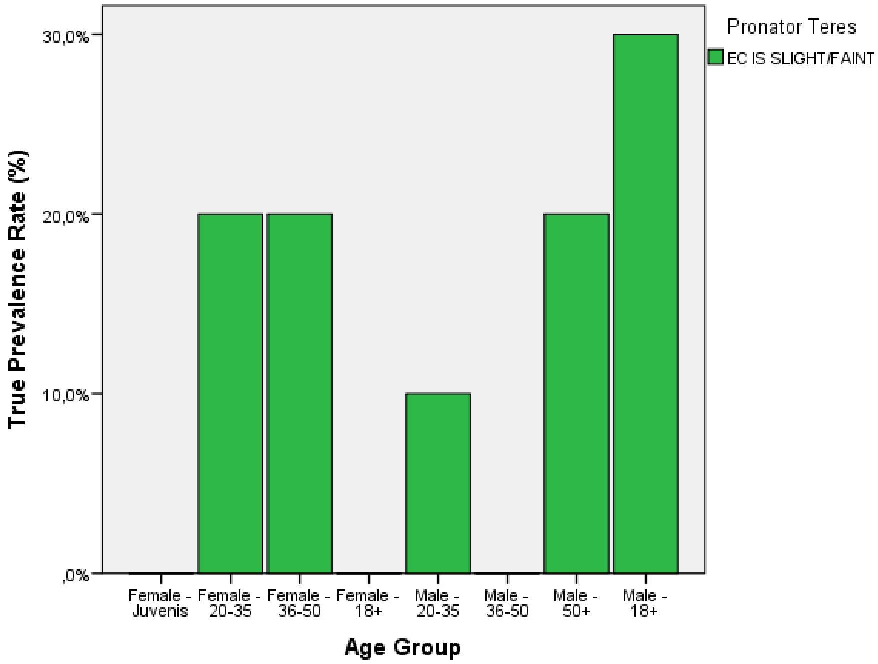

Fig. 5.151: TPR (True Prevalence Rate) in percentages of the pronator teres scores for each sex and age group of the Zottegem skeletal assemblage.

EC of the pronator teres did not show a statistically significant difference between males and females (U=115.5, p=0.236, n1 (f)=19, n2 (m)=15) (fig. 5.151). When testing age versus sex, there was no statistically significant difference for EC of the pronator teres for males (x^2=1.500, df=2, p=0.472, n=10) and for females (x^2=0.833, df=2, p=0.659, n=16). There was no statistically significant difference in EC of the pronator teres between left (l) and right (r) (U=162, p=1.000, n1 (l)=18, n2 (r)=18).

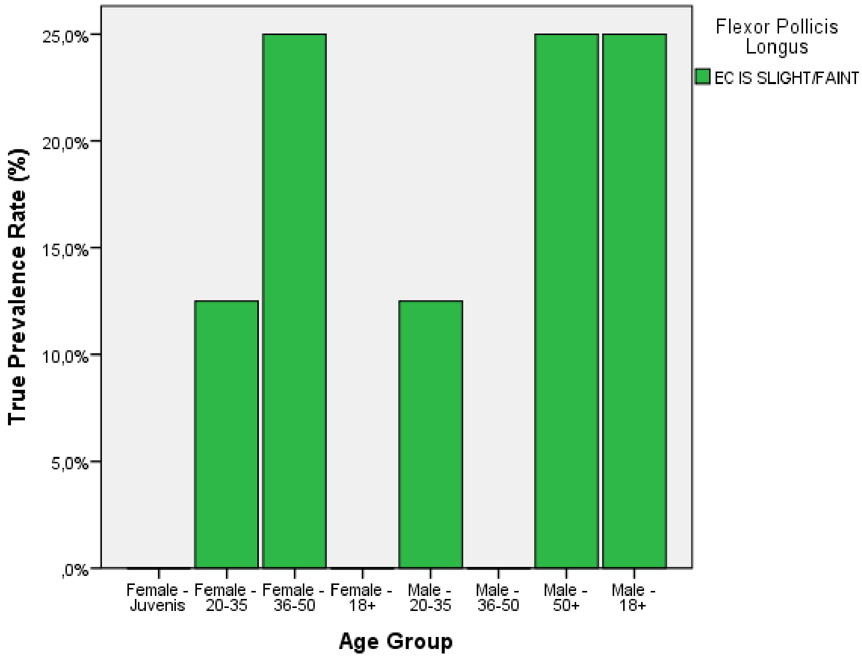

Fig. 5.152: TPR (True Prevalence Rate) in percentages of the flexor pollicis longus scores for each sex and age group of the Zottegem skeletal assemblage.

There was no statistically significant difference between males and females for the flexor pollicis longus (U=67, p=0.274, n1 (f)=14, n2 (m)=12) (fig. 5.152). When testing age versus sex, there was no statistically significant difference for EC of the flexor pollicis longus for males (x^2=4.200, df=2, p=0.122, n=8) and for females (x^2=0.907, df=2, p=0.636, n=13). There was no statistically significant difference in EC of the flexor pollicis longus between left (l) and right (r) (U=86.5, p=0.789, n1 (l)=14, n2 (r)=13).

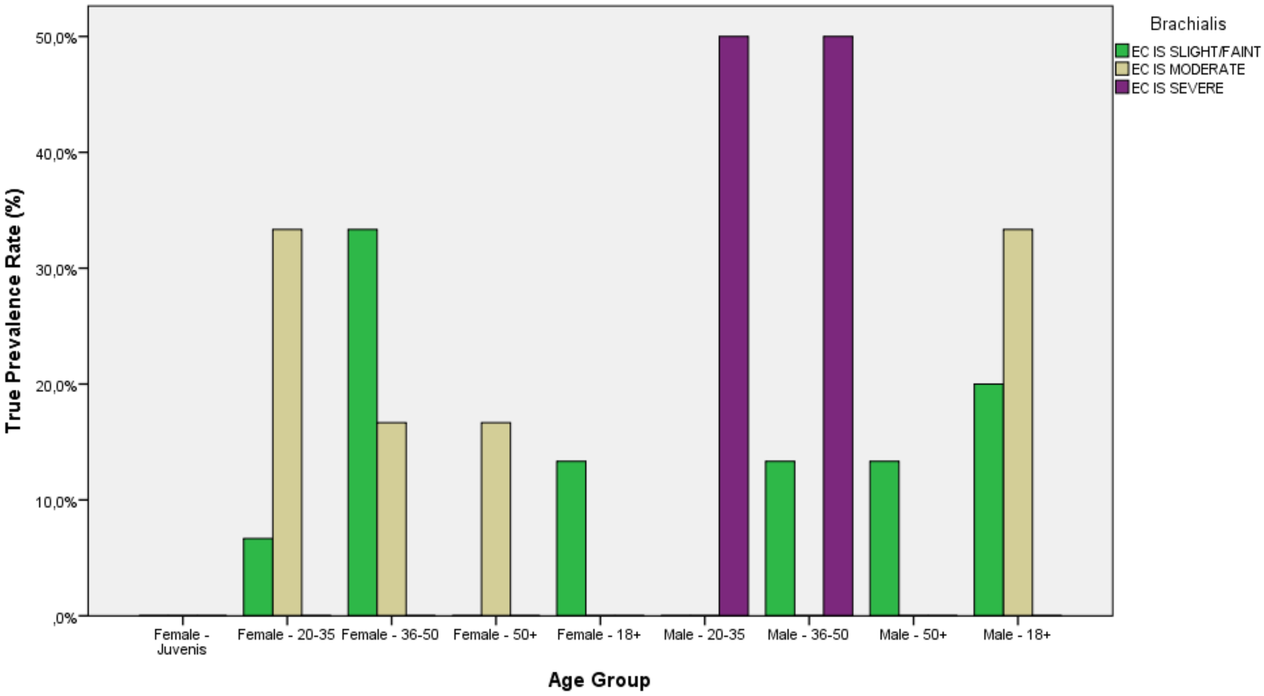

Fig. 5.153: TPR (True Prevalence Rate) in percentages of the brachialis scores for each sex and age group of the Zottegem skeletal assemblage.

There was no statistically significant difference between males and females for the brachialis (U=156, p=0.312, n1 (f)=20, n2 (m)=19) (fig. 5.153). When testing age versus sex, there was no statistically significant difference for EC of the brachialis for males (x^2=3.315, df=2, p=0.191, n=14) and for females (x^2=5.667, df=3, p=0.129, n=17). There was no statistically significant difference in EC of the brachialis between left (l) and right (r) (U=165.5, p=0.247, n1 (l)=23, n2 (r)=18).

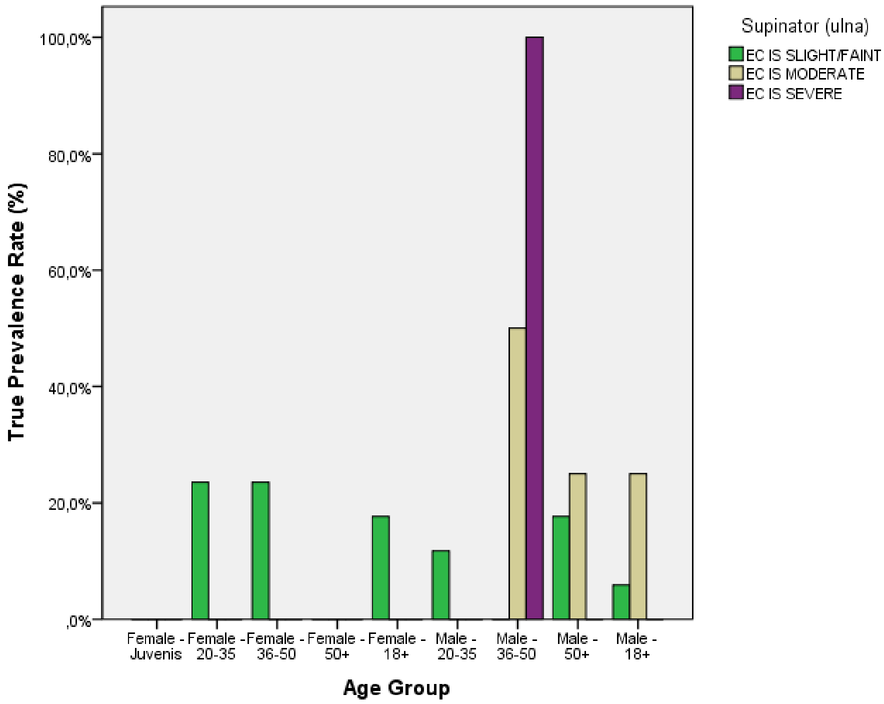

Fig. 5.154: TPR (True Prevalence Rate) in percentages of the supinator (ulna) scores for each sex and age group of the Zottegem skeletal assemblage.

There was no statistically significant difference between males and females for the supinator (ulna) (U=132, p=0.051, n1 (f)=22, n2 (m)=18) (fig. 5.154). When testing age versus sex, there was a statistically significant difference for EC of the supinator (ulna) for males (x^2=10.199, df=2, p=0.006, n=14), but not for females (x^2=2.720, df=3, p=0.437, n=18). There was no statistically significant difference in EC of the supinator (ulna) between left (l) and right (r) (U=173, p=0.210, n1 (l)=23, n2 (r)=19).

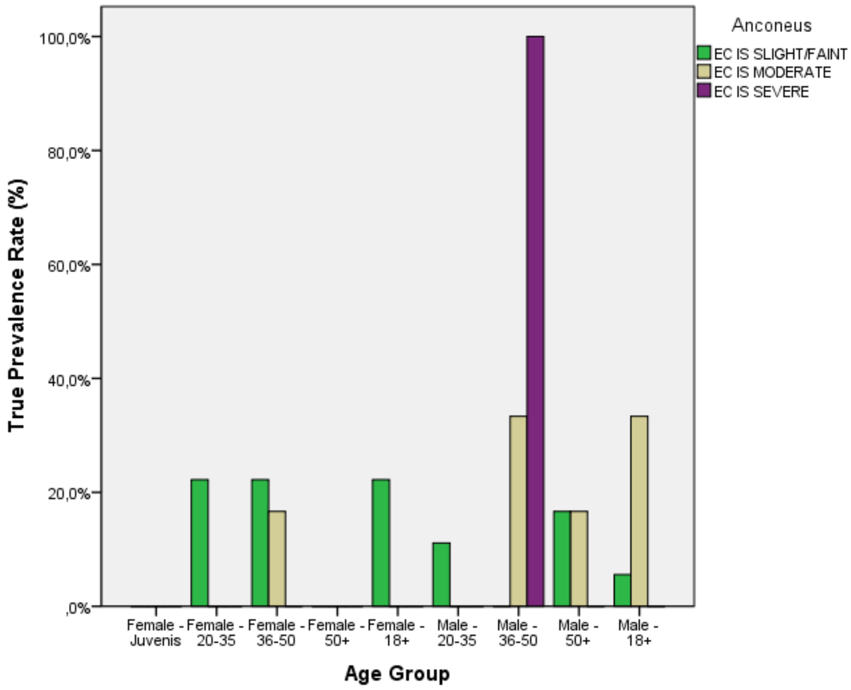

Fig. 5.155: TPR (True Prevalence Rate) in percentages of the anconeus scores for each sex and age group of the Zottegem skeletal assemblage.

There was no statistically significant difference between males and females for the anconeus ($U=149.5$, $p=0.094$, $n1$ (f)=22, $n2$ (m)=19) (fig. 5.155). When testing age versus sex, there was a statistically significant difference for EC of the anconeus for males ($x^2=10.199$, $df=2$, $p=0.006$, $n=14$), but not for females ($x^2=5.301$, $df=3$, $p=0.151$, $n=18$).There was no statistically significant difference in EC of the anconeus between left (l) and right (r) ($U=155.5$, $p=0.051$, $n1$ (l)=23, $n2$ (r)=20).

** Lower Limb EC*

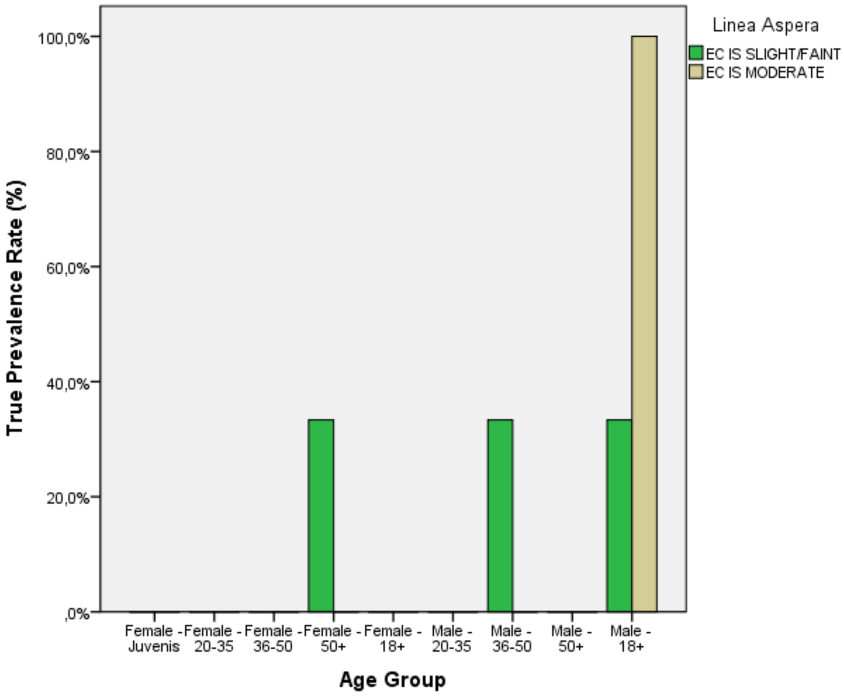

Fig. 5.156: TPR (True Prevalence Rate) in percentages of the linea aspera scores for each sex and age group of the Zottegem skeletal assemblage.

There was a statistically significant difference between males and females for the linea aspera (U=114, p=0.026, n1 (f)=18, n2 (m)=19) (fig. 5.156). When testing age versus sex, there was a statistically significant difference for EC of the linea aspera for females (x^2=15.000, df=3, p=0.002, n=16), but not for males (x^2=4.909, df=2, p=0.086, n=13).There was no statistically significant difference in EC of the linea aspera between left (l) and right (r) (U=187.5, p=0.927, n1 (l)=20, n2 (r)=19). Severe EC of the linea aspera was not observed in the Zotttegem skeletal assemblage.

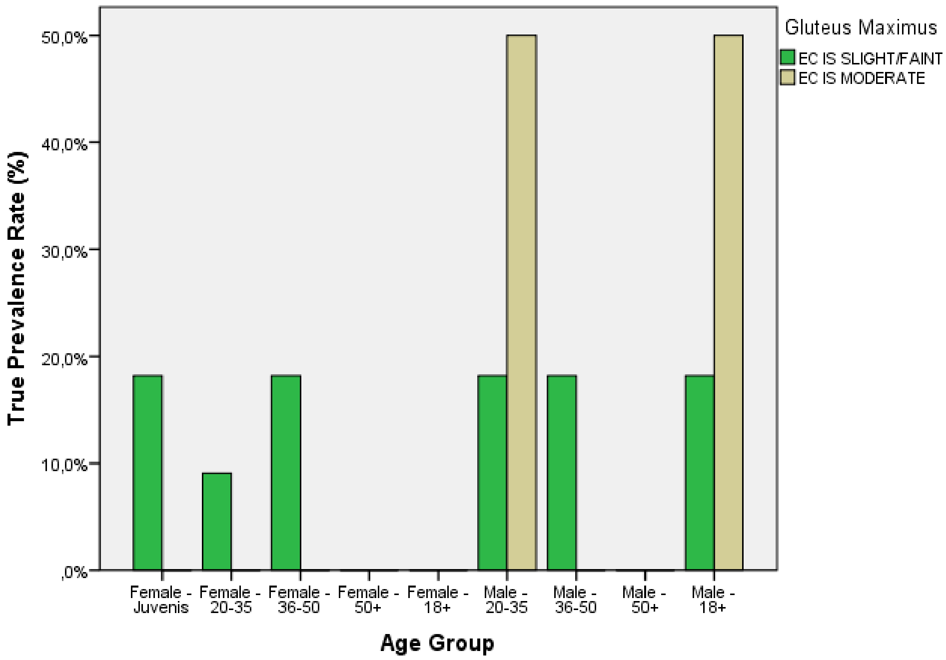

Fig. 5.157: TPR (True Prevalence Rate) in percentages of the gluteus maximus scores for each sex and age group of the Zottegem skeletal assemblage.

There was no statistically significant difference between males and females for the gluteus maximus ($U=118.5$, $p=0.068$, n1 (f)=18, n2 (m)=19) (fig. 5.157). When testing age versus sex, there was no statistically significant difference for EC of the gluteus maximus for males ($x^2=3.549$, $df=2$, $p=0.170$, $n=13$) and for females ($x^2=6.023$, $df=3$, $p=0.110$, $n=16$). There was no statistically significant difference in EC of the gluteus maximus between left (l) and right (r) ($U=164.5$, $p=0.420$, n1 (l)=20, n2 (r)=19).

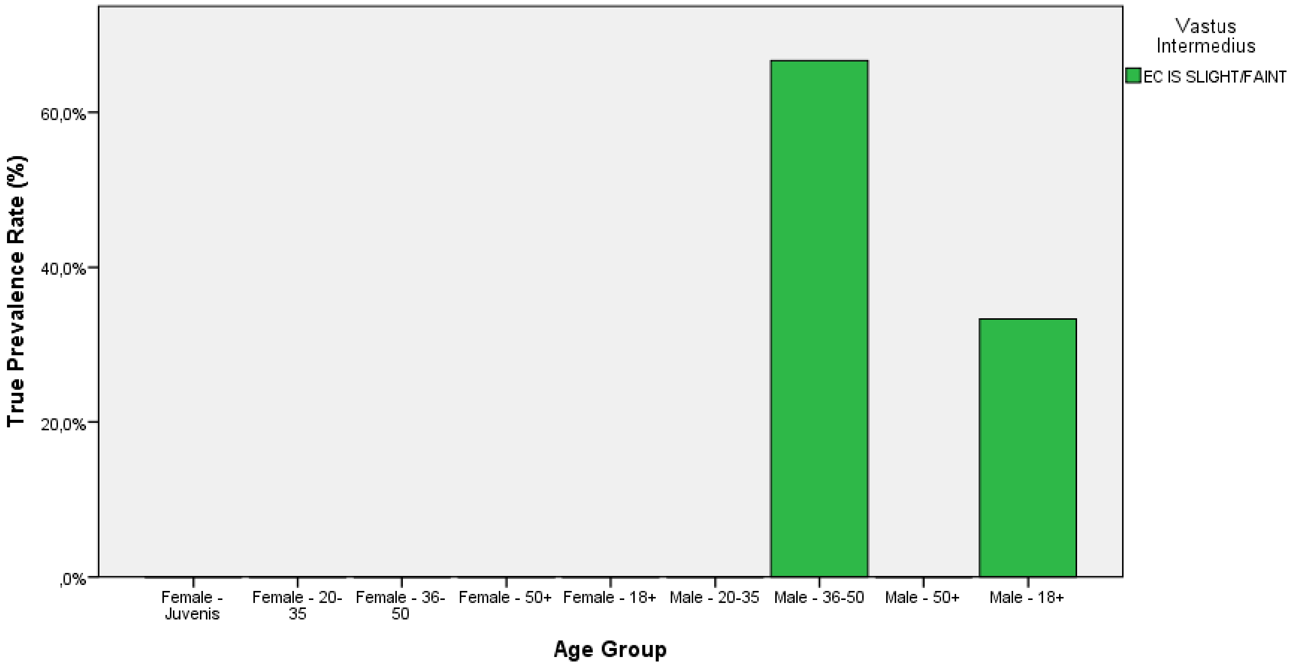

Fig. 5.158: TPR (True Prevalence Rate) in percentages of the vastus intermedius scores for each sex and age group of the Zottegem skeletal assemblage.

There was no statistically significant difference between males and females for the vastus intermedius (U=144, p=0.083, n1 (f)=18, n2 (m)=19) (fig. 5.158). When testing age versus sex, there was no statistically significant difference for EC of the vastus intermedius for males (x^2=4.909, df=2, p=0.086, n=13). Females of known age (n=16) were not scored with EC of the vastus intermedius. There was no statistically significant difference in EC of the vastus intermedius between left (l) and right (r) (U=179, p=0.594, n1 (l)=20, n2 (r)=19).

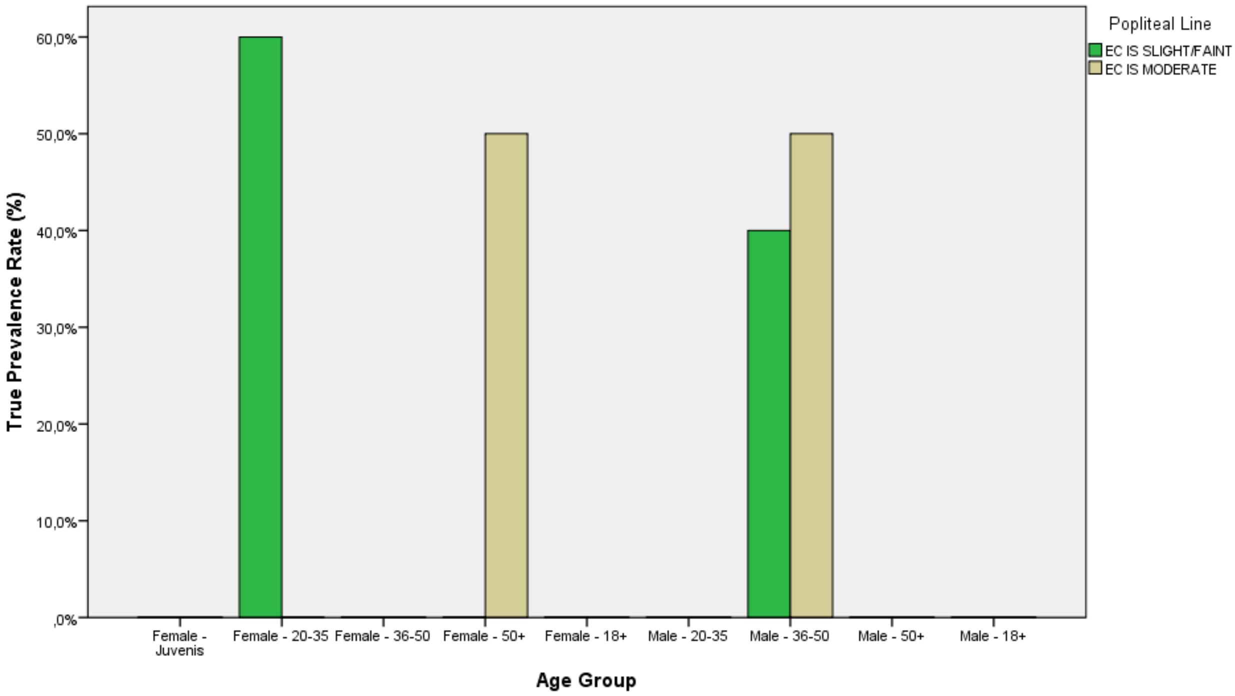

Fig. 5.159: TPR (True Prevalence Rate) in percentages of the popliteal line scores for each sex and age group of the Zottegem skeletal assemblage.

There was no statistically significant difference between males and females for EC of the popliteal (U=105, p=0.647, n1 (f)=19, n2 (m)=12) (fig. 5.159). When testing age versus sex, there was a statistically significant difference for EC of the popliteal line for males (x^2=8.438, df=2, p=0.015, n=10) and for females (x^2=8.942, df=3, p=0.030, n=16). There was no statistically significant difference in EC of the popliteal line between left (l) and right (r) (U=115.5, p=0.824, n1 (l)=15, n2 (r)=16). Severe EC of the popliteal line was not observed. Moderate EC of the popliteal line was recorded in old adult females and middle adult males.

5.6.5. Moorsel

** Upper Limb EC*

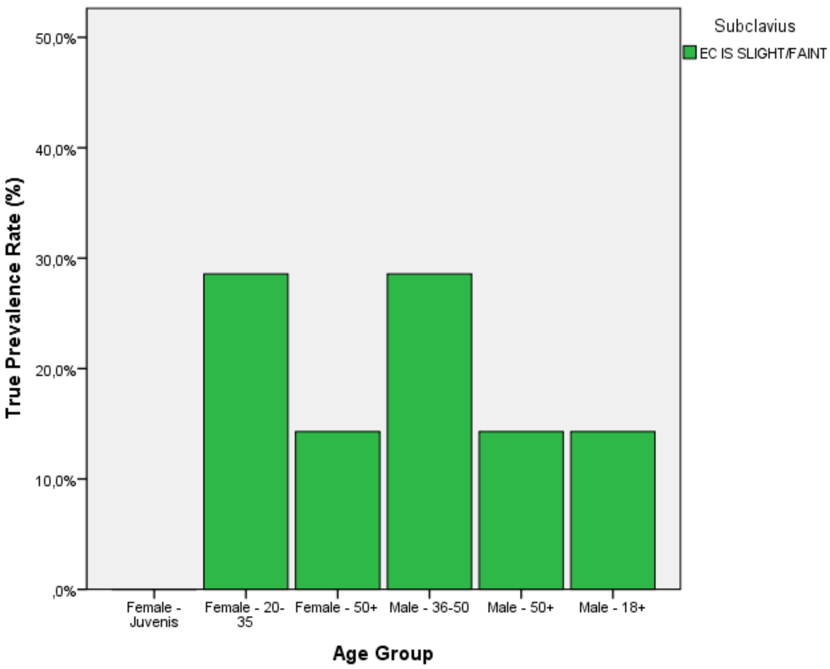

Fig. 5.160: TPR (True Prevalence Rate) in percentages of the subclavius scores for each sex and age group of the Moorsel skeletal assemblage.

The severity of EC of the subclavius was not statistically significant between males and females (U=24, p=1.000, n1 (f)=6, n2 (m)=8) (fig. 5.160). When testing age versus sex, there was no statistically significant difference for EC of the subclavius for males (x^2=2.500, df=1, p=0.114, n=6) and for females (x^2=2.778, df=2, p=0.249, n=6). There was no statistically significant difference in EC of the subclavius between left (l) and right (r) (U=17, p=0.298, n1 (l)=8, n2 (r)=6).

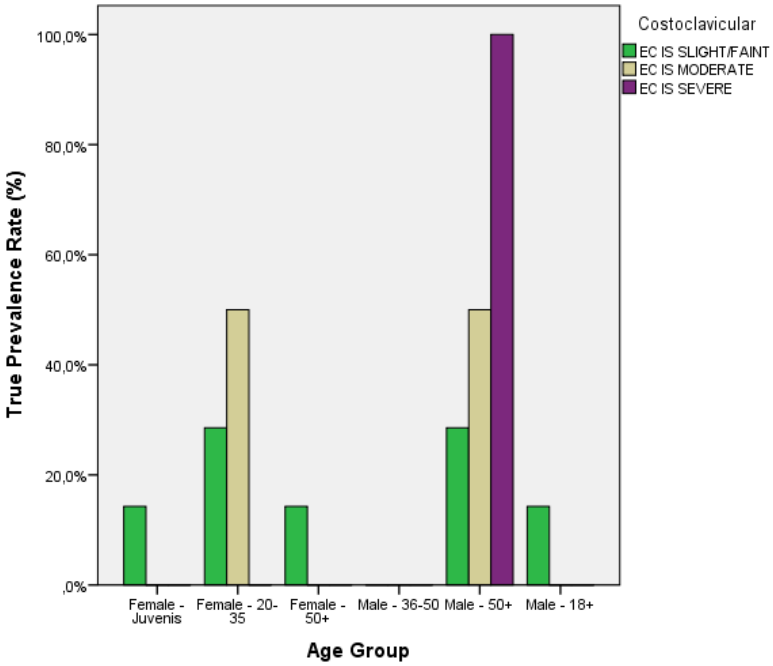

Fig. 5.161: TPR (True Prevalence Rate) in percentages of the costoclavicular scores for each sex and age group of the Moorsel skeletal assemblage.

There was no statistically significant difference between males and females for the costoclavicular ligament (U=20.5, p=0.938, n1 (f)=6, n2 (m)=7) (fig. 5.161). When testing age versus sex, there was no statistically significant difference for EC of the costoclavicular ligament for males (x^2=3.636, df=1, p=0.057, n=6) and for females (x^2=2.083, df=2, p=0.353, n=6). There was no statistically significant difference in EC of the costoclavicular ligament between left (l) and right (r) (U=14.5, p=0.378, n1 (l)=8, n2 (r)=5).

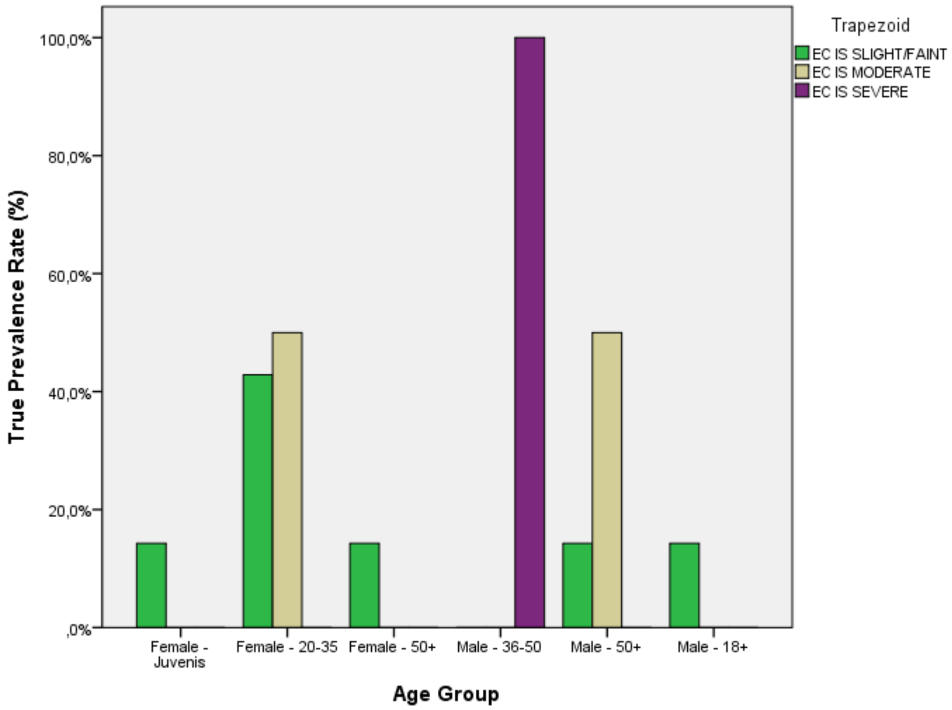

Fig. 5.162: TPR (True Prevalence Rate) in percentages of the trapezoid scores for each sex and age group of the Moorsel skeletal assemblage.

For EC of the trapezoid, the difference between males and females is not statistically significant (U=27, p=0.902, n1 (f)=7, n2 (m)=8) (fig. 5.162). When testing age versus sex, there was no statistically significant difference for EC of the trapezoid for males (x^2=3.636, df=1, p=0.057, n=6) and for females (x^2=2.250, df=2, p=0.325, n=7). There was no statistically significant difference in EC of the trapezoid between left (l) and right (r) (U=28, p=1.000, n1 (l)=8, n2 (r)=7).

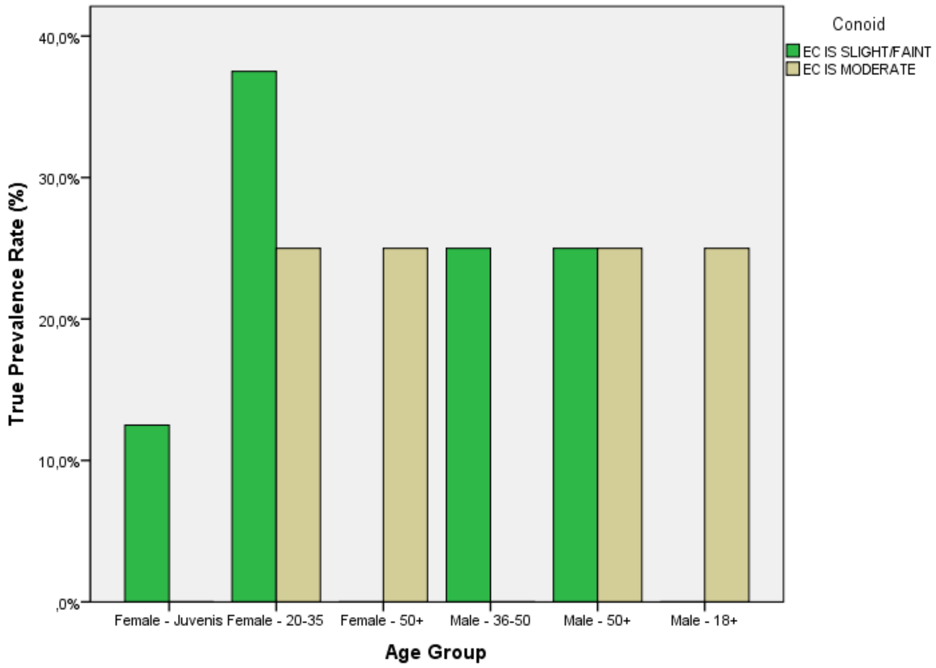

Fig. 5.163: TPR (True Prevalence Rate) in percentages of the conoid scores for each sex and age group of the Moorsel skeletal assemblage.

For EC of the conoid, the difference between males and females is not statistically significant (U=25, p=0.702, n1 (f)=7, n2 (m)=8) (fig. 5.163). When testing age versus sex, there was no statistically significant difference for EC of the conoid for males (x^2=0.000, df=1, p=1.000, n=6) and for females (x^2=3.367, df=2, p=0.186, n=7). There was no statistically significant difference in EC of the conoid between left (l) and right (r) (U=19, p=0.252, n1 (l)=8, n2 (r)=7).

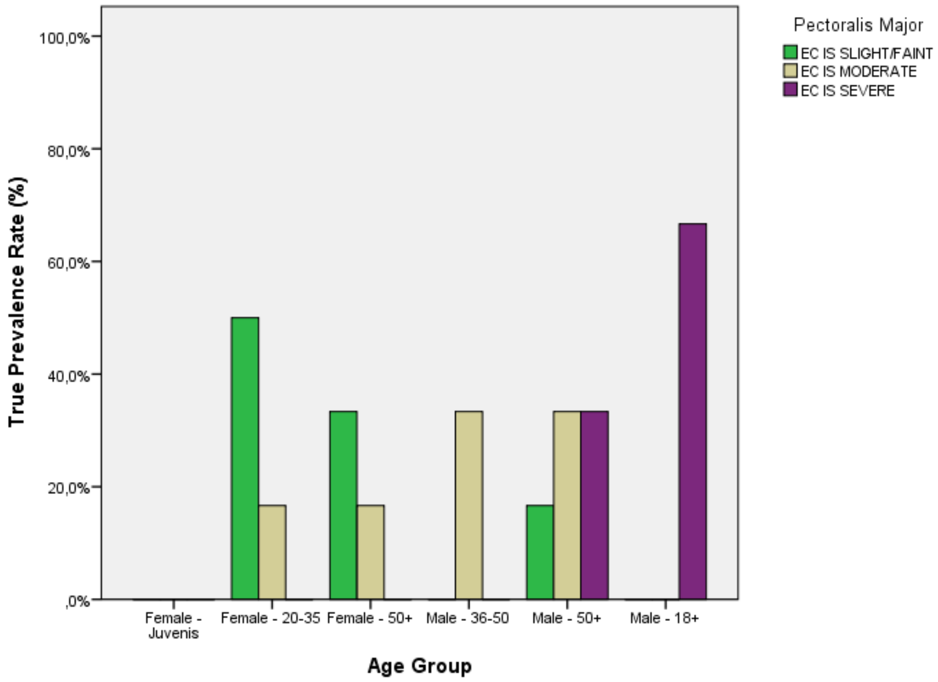

Fig. 5.164: TPR (True Prevalence Rate) in percentages of the pectoralis major scores for each sex and age group of the Moorsel skeletal assemblage.

EC of the pectoralis major was identified as statistically significant between males and females (U=8.5, p=0.005, n1 (f)=9, n2 (m)=8) (fig. 5.164). When testing age versus sex, there was no statistically significant difference for EC of the pectoralis major for males (x^2=0.000, df=1, p=1.000, n=6) and for females (x^2=5.167, df=2, p=0.076, n=9). There was no statistically significant difference in EC of the pectoralis major between left (l) and right (r) (U=29, p=0.480, n1 (l)=9, n2 (r)=8).

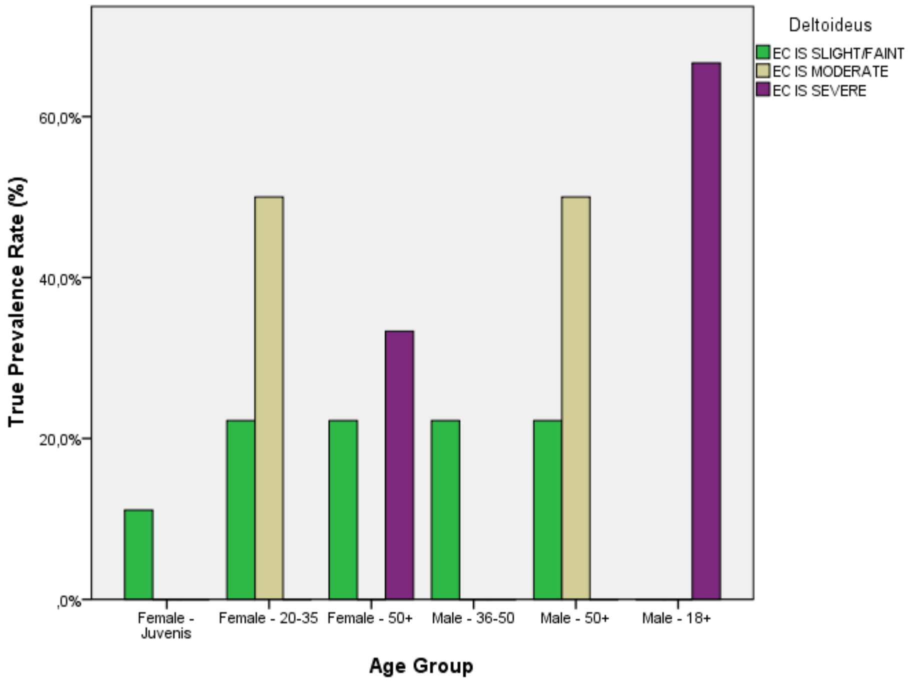

Fig. 5.165: TPR (True Prevalence Rate) in percentages of the deltoideus scores for each sex and age group of the Moorsel skeletal assemblage.

There was no statistically significant difference between males and females for the deltoideus (U=28.5, p=0.432, n1 (f)=9, n2 (m)=8) (fig. 5.165). When testing age versus sex, there was no statistically significant difference for EC of the deltoideus for males (x^2=0.000, df=1, p=1.000, n=6) and for females (x^2=1.862, df=2, p=0.394, n=9). There was no statistically significant difference in EC of the deltoideus between left (l) and right (r) (U=31, p=0.600, n1 (l)=9, n2 (r)=8).

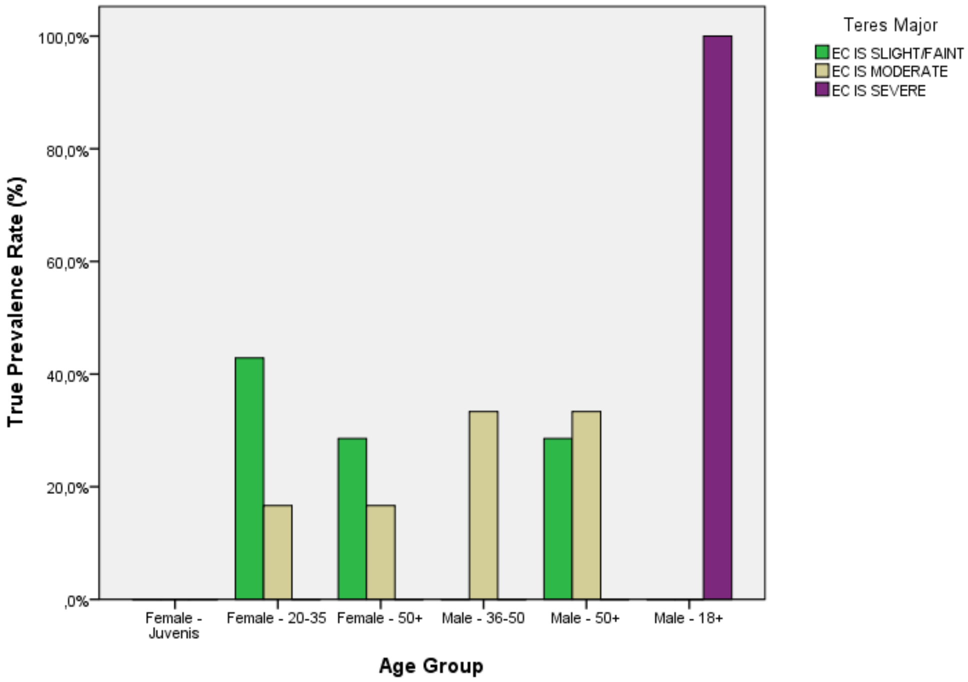

Fig. 5.166: TPR (True Prevalence Rate) in percentages of the teres major scores for each sex and age group of the Moorsel skeletal assemblage.

There was a statistically significant difference between males and females for the teres major (U=13, p=0.019, n1 (f)=9, n2 (m)=8) (fig. 5.166). When testing age versus sex, there was no statistically significant difference for EC of the teres major for males (x^2=1.250, df=1, p=0.264, n=6) and for females (x^2=5.167, df=2, p=0.076, n=9). There was no statistically significant difference in EC of the teres major between left (l) and right (r) (U=34.5, p=0.878, n1 (l)=9, n2 (r)=8).

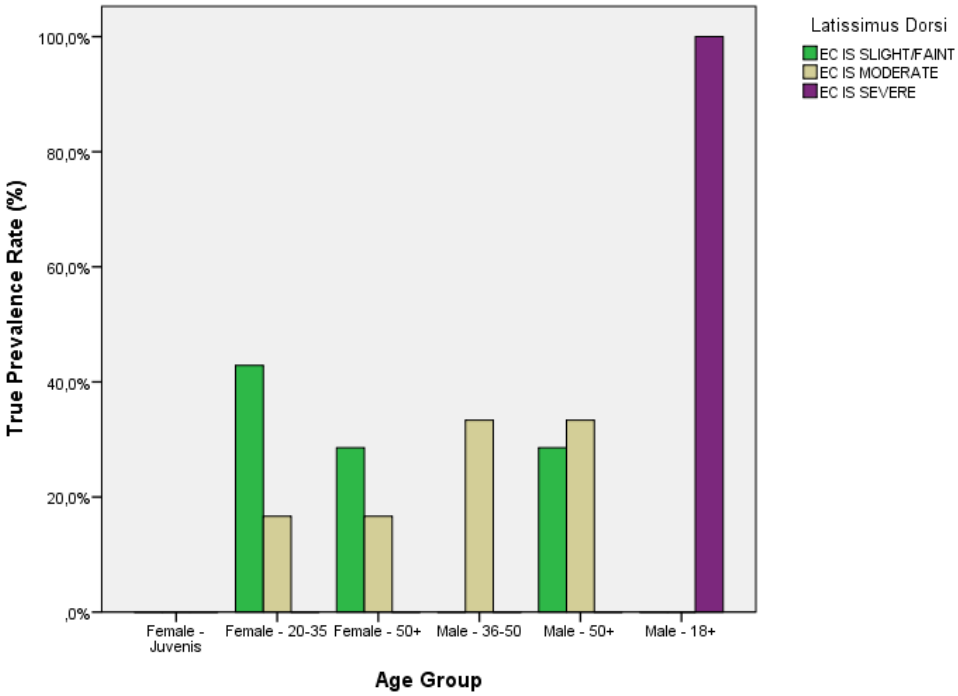

Fig. 5.167: TPR (True Prevalence Rate) in percentages of the latissimus dorsi scores for each sex and age group of the Moorsel skeletal assemblage.

There was a statistically significant difference between males and females for the latissimus dorsi (U=13, p=0.019, n1 (f)=9, n2 (m)=8) (fig. 5.167). When testing age versus sex, there was no statistically significant difference for EC of the latissimus dorsi for males (x^2=1.250, df=1, p=0.264, n=6) and for females (x^2=5.167, df=2, p=0.076, n=9). There was no statistically significant difference in EC of the latissimus dorsi between left (l) and right (r) (U=28, p=0.413, n1 (l)=9, n2 (r)=8).

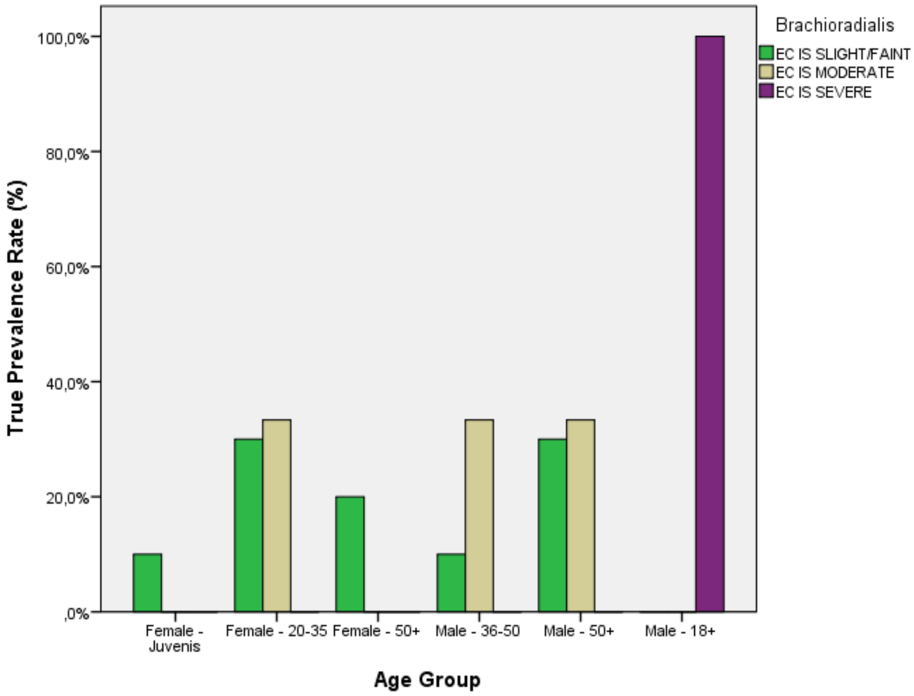

Fig. 5.168: TPR (True Prevalence Rate) in percentages of the brachioradialis scores for each sex and age group of the Moorsel skeletal assemblage.

There was no statistically significant difference between males and females for the brachioradialis (U=25, p=0.131, n1 (f)=9, n2 (m)=9) (fig. 5.168). When testing age versus sex, there was no statistically significant difference for EC of the brachioradialis for males (x^2=0.156, df=1, p=0.693, n=7) and for females (x^2=4.218, df=2, p=0.121, n=9). There was no statistically significant difference in EC of the brachioradialis between left (l) and right (r) (U=28, p=0.239, n1 (l)=8, n2 (r)=10).

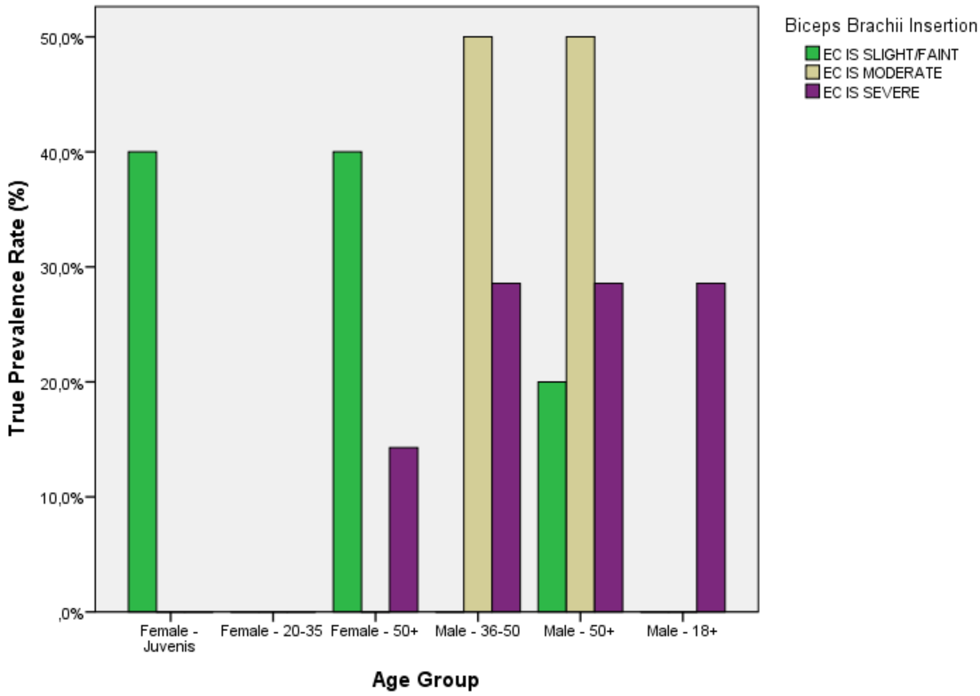

Fig. 5.169: TPR (True Prevalence Rate) in percentages of the biceps brachii insertion scores for each sex and age group of the Moorsel skeletal assemblage.

There was a statistically significant difference between males and females for the biceps brachii insertion (U=8, p=0.003, n1 (f)=9, n2 (m)=9) (fig. 5.169). When testing age versus sex, there was no statistically significant difference for EC of the biceps brachii insertion for males (x^2=0.350, df=1, p=0.554, n=7) and for females (x^2=4.773, df=2, p=0.092, n=9). There was no statistically significant difference in EC of the biceps brachii insertion between left (l) and right (r) (U=40, p=0.963, n1 (l)=9, n2 (r)=9).

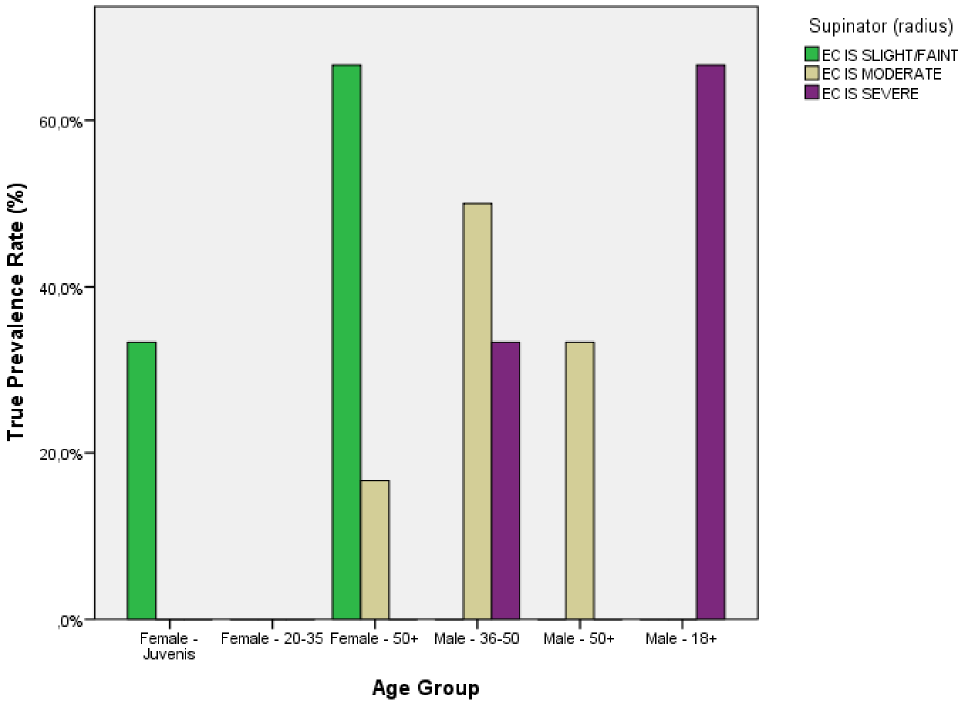

Fig. 5.170: TPR (True Prevalence Rate) in percentages of the supinator (radius) scores for each sex and age group of the Moorsel skeletal assemblage.

There was a statistically significant difference between males and females for the supinator (radius) (U=16.5, p=0.008, n1 (f)=10, n2 (m)=10) (fig. 5.170). When testing age versus sex, there was no statistically significant difference for EC of the supinator (radius) for males (x^2=2.778, df=1, p=0.096, n=8) and for females (x^2=3.589, df=2, p=0.166, n=10). There was no statistically significant difference in EC of the supinator (radius) between left (l) and right (r) (U=45.5, p=0.749, n1 (l)=9, n2 (r)=11).

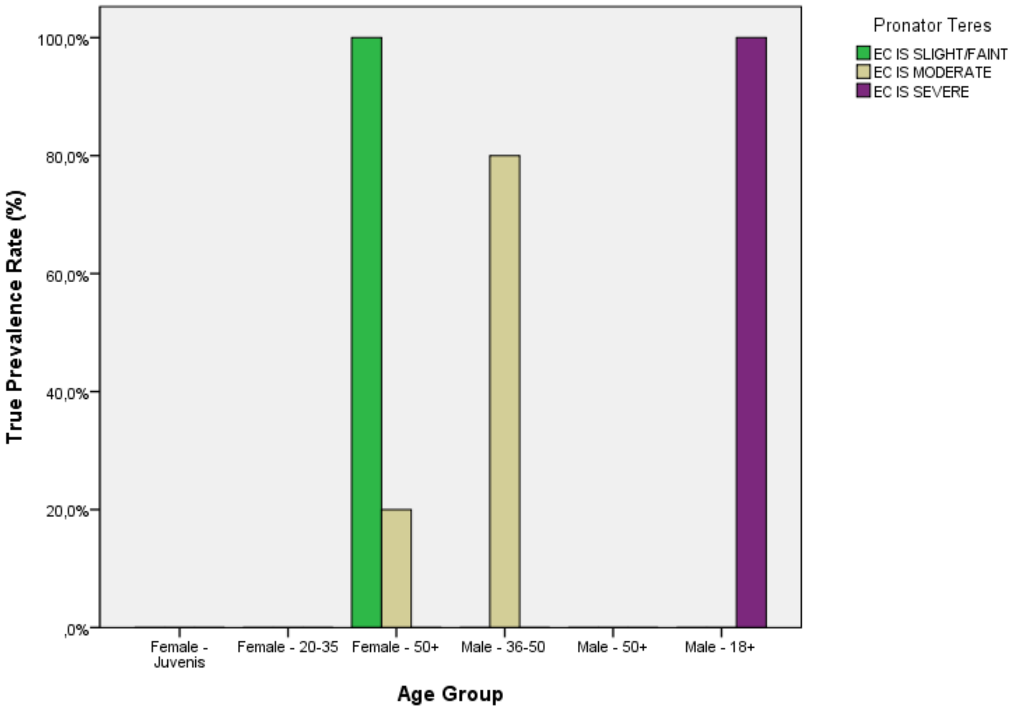

Fig. 5.171: TPR (True Prevalence Rate) in percentages of the pronator teres scores for each sex and age group of the Moorsel skeletal assemblage.

EC of the pronator teres showed a statistically significant difference between both sexes (U=32, p=0.037, n1 (f)=12, n2 (m)=10) (fig. 5.171). When testing age versus sex, there was a statistically significant difference for EC of the pronator teres for males (x^2=7.000, df=1, p=0.008, n=8) and for females (x^2=7.200, df=2, p=0.027, n=12). There was no statistically significant difference in EC of the pronator teres between left (l) and right (r) (U=59, p=0.941, n1 (l)=10, n2 (r)=12).

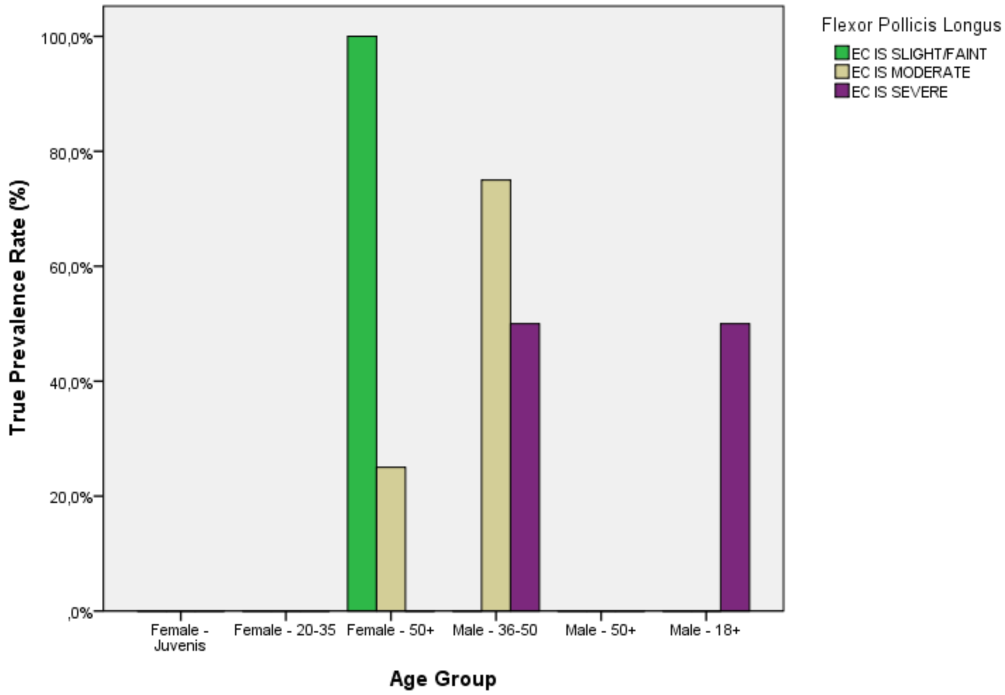

Fig. 5.172: TPR (True Prevalence Rate) in percentages of the flexor pollicis longus scores for each sex and age group of the Moorsel skeletal assemblage.

There was no statistically significant difference between males and females for the flexor pollicis longus (U=25.5, p=0.064, n1 (f)=10, n2 (m)=9) (fig. 5.172). When testing age versus sex, there was a statistically significant difference for EC of the flexor pollicis longus for males (x^2=6.400, df=1, p=0.011, n=8), but not for females (x^2=5.185, df=2, p=0.075, n=10). There was no statistically significant difference in EC of the flexor pollicis longus between left (l) and right (r) (U=37, p=0.447, n1 (l)=9, n2 (r)=10).

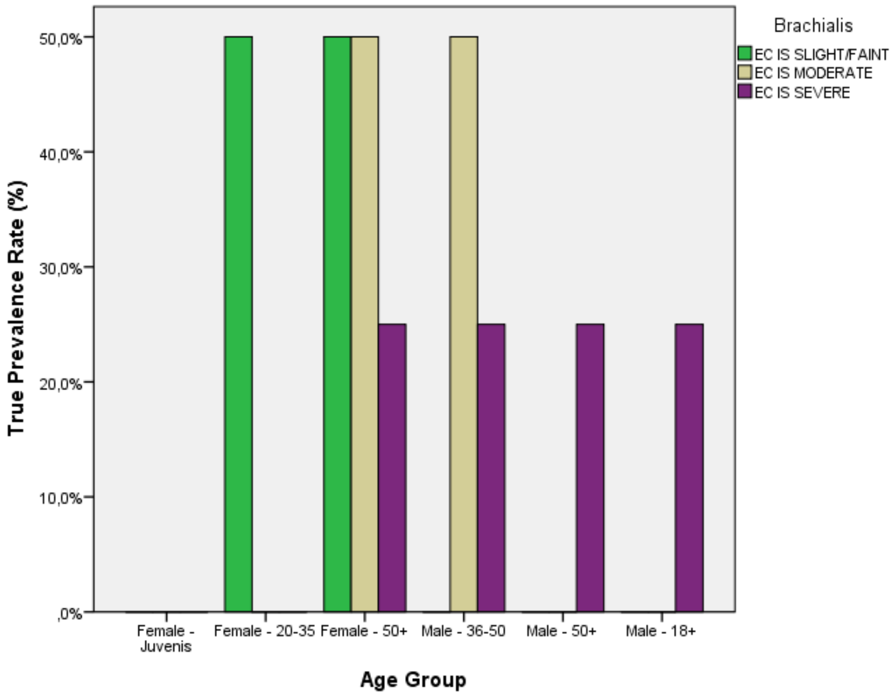

Fig. 5.173: TPR (True Prevalence Rate) in percentages of the brachialis scores for each sex and age group of the Moorsel skeletal assemblage.

There was a statistically significant difference between males and females for the brachialis (U=34, p=0.028, n1 (f)=14, n2 (m)=10) (fig. 5.173). When testing age versus sex, there was a statistically significant difference for EC of the brachialis for females (x^2=9.792, df=2, p=0.007, n=14), but not for males (x^2=0.389, df=1, p=0.533, n=8). There was no statistically significant difference in EC of the brachialis between left (l) and right (r) (U=72, p=1.000, n1 (l)=12, n2 (r)=12).

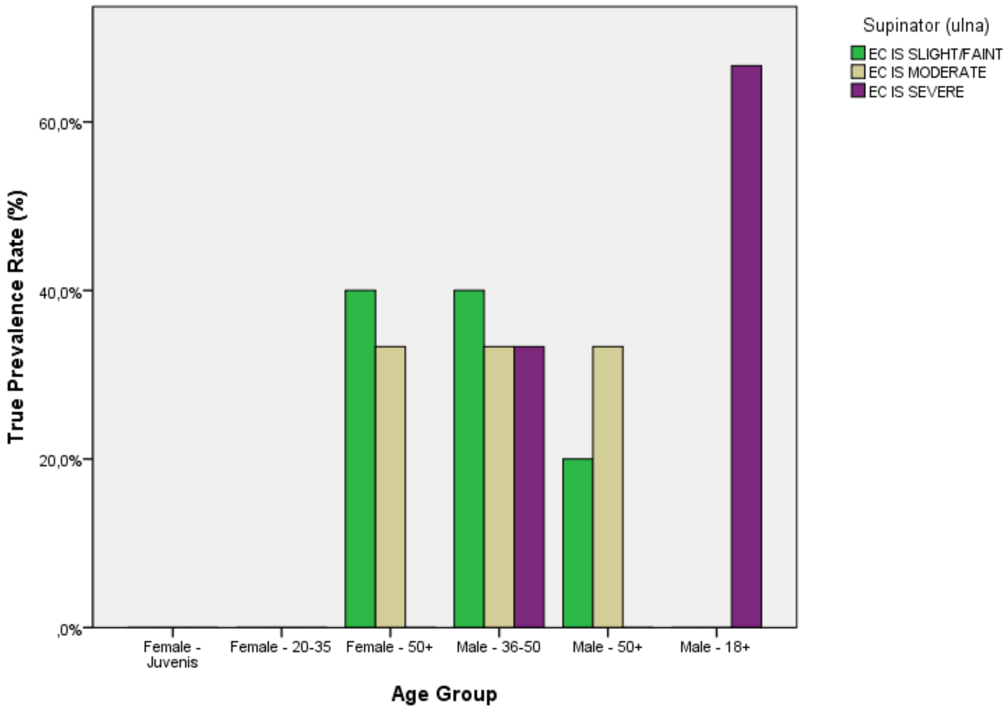

Fig. 5.174: TPR (True Prevalence Rate) in percentages of the supinator (ulna) scores for each sex and age group of the Moorsel skeletal assemblage.

There was a statistically significant difference between males and females for the supinator (ulna) (U=24, p=0.003, n1 (f)=14, n2 (m)=10) (fig. 5.174). When testing age versus sex, there was no statistically significant difference for EC of the supinator (ulna) for males (x^2=1.817, df=1, p=0.178, n=8) and for females (x^2=4.667, df=2, p=0.097, n=14). There was no statistically significant difference in EC of the supinator (ulna) between left (l) and right (r) (U=65, p=0.657, n1 (l)=12, n2 (r)=12).

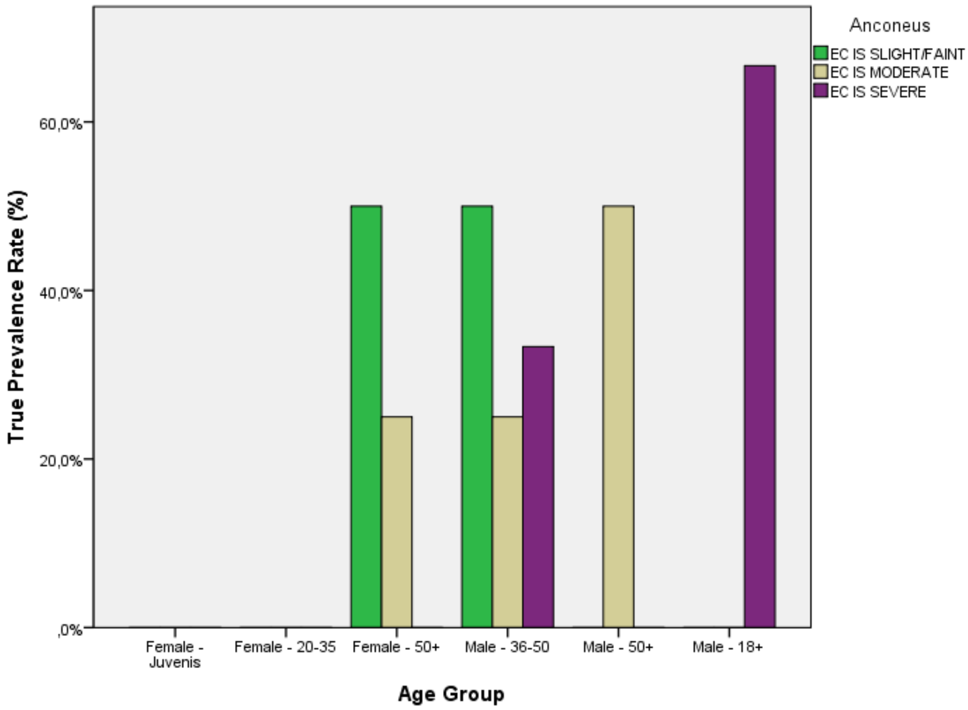

Fig. 5.175: TPR (True Prevalence Rate) in percentages of the anconeus scores for each sex and age group of the Moorsel skeletal assemblage.

There was a statistically significant difference between males and females for the anconeus (U=21.5, p=0.003, n1 (f)=13, n2 (m)=10) (fig. 5.175). When testing age versus sex, there was no statistically significant difference for EC of the anconeus for males (x^2=0.808, df=1, p=0.369, n=8) and for females (x^2=5.673, df=2, p=0.059, n=13).There was no statistically significant difference in EC of the anconeus between left (l) and right (r) (U=65, p=0.947, n1 (l)=12, n2 (r)=11).

** Lower Limb EC*

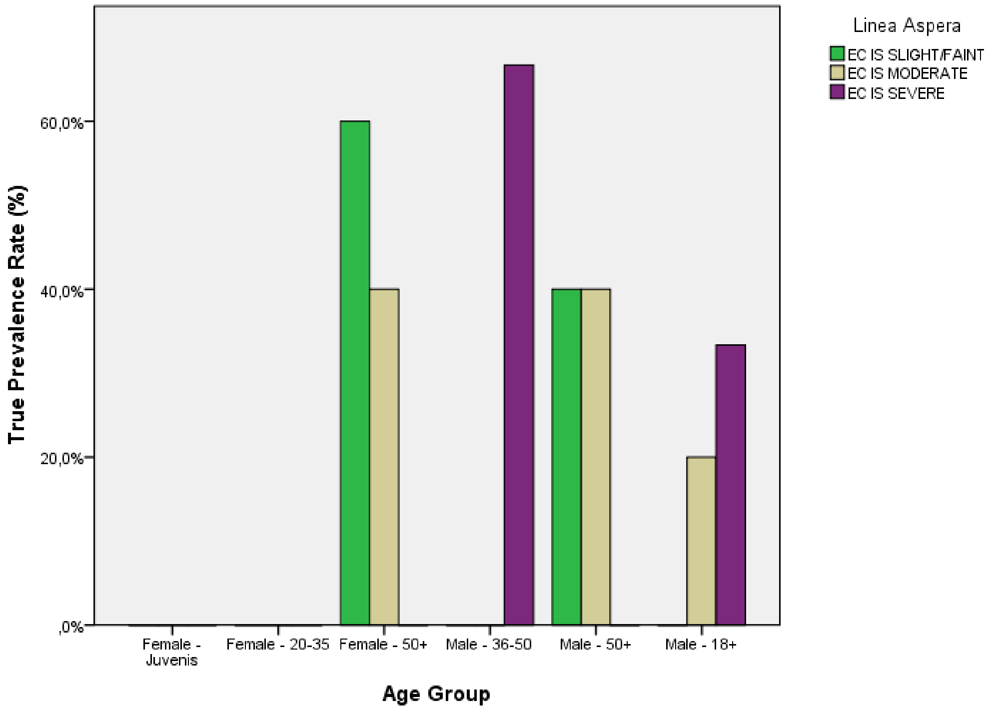

Fig. 5.176: TPR (True Prevalence Rate) in percentages of the linea aspera scores for each sex and age group of the Moorsel skeletal assemblage.

There was a statistically significant difference between males and females for the linea aspera (U=25, p=0.049, n1 (f)=10, n2 (m)=10) (fig. 5.176). When testing age versus sex, there was a statistically significant difference for EC of the linea aspera for females (x^2=8.036, df=2, p=0.018, n=10), but not for males (x^2=0.000, df=1, p=1.000, n=8).There was no statistically significant difference in EC of the linea aspera between left (l) and right (r) (U=44, p=0.664, n1 (l)=11, n2 (r)=9).

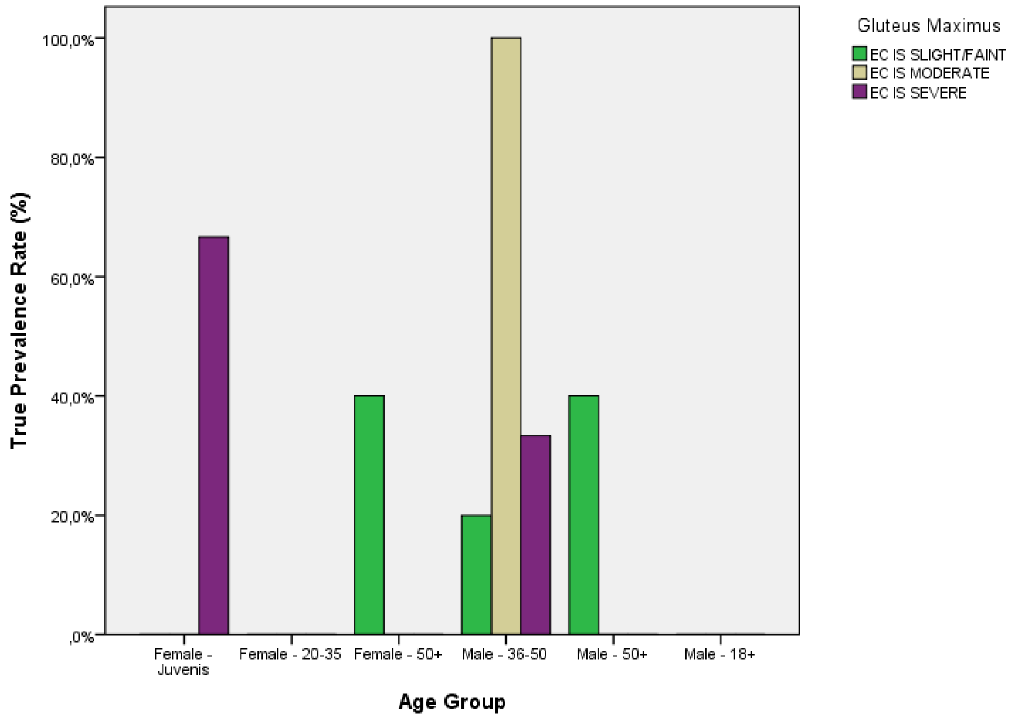

Fig. 5.177: TPR (True Prevalence Rate) in percentages of the gluteus maximus scores for each sex and age group of the Moorsel skeletal assemblage.

There was no statistically significant difference between males and females for the gluteus maximus (U=40, p=0.662, n1 (f)=9, n2 (m)=10) (fig. 5.177). When testing age versus sex, there was a statistically significant difference for EC of the gluteus maximus for males (x^2=4.397, df=1, p=0.036, n=8), but not for females (x^2=2.707, df=2, p=0.258, n=9). There was no statistically significant difference in EC of the gluteus maximus between left (l) and right (r) (U=37, p=0.536, n1 (l)=11, n2 (r)=8).

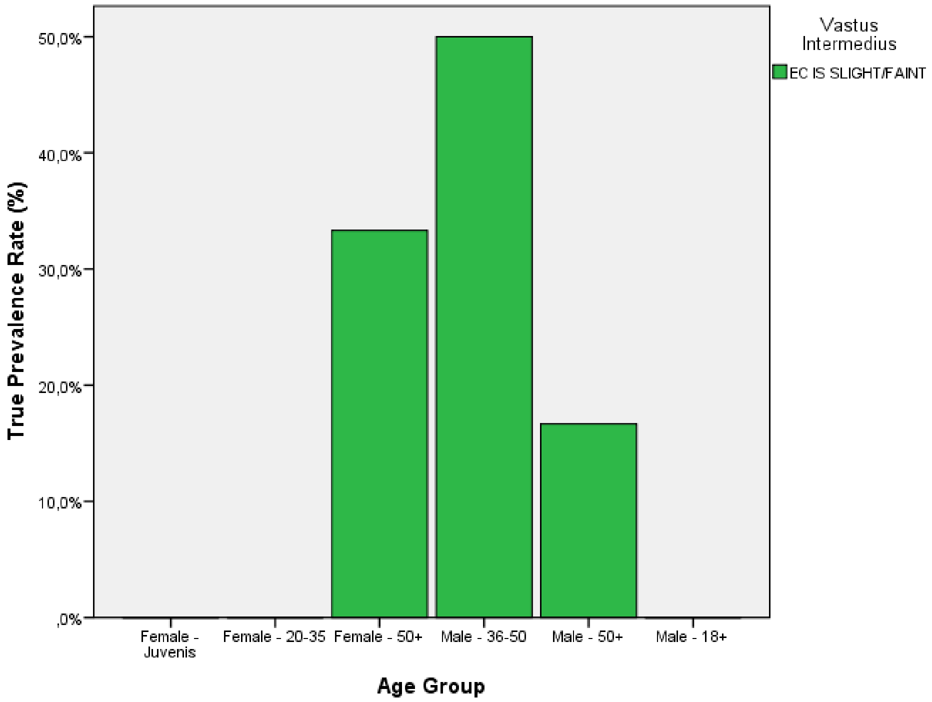

Fig. 5.178: TPR (True Prevalence Rate) in percentages of the vastus intermedius scores for each sex and age group of the Moorsel skeletal assemblage.

There was no statistically significant difference between males and females for the vastus intermedius (U=37, p=0.418, n1 (f)=9, n2 (m)=10) (fig. 5.178). When testing age versus sex, there was no statistically significant difference for EC of the vastus intermedius for males (x^2=1.750, df=1, p=0.186, n=8) and for females (x^2=2.857, df=2, p=0.240, n=9). There was no statistically significant difference in EC of the vastus intermedius between left (l) and right (r) (U=30, p=0.152, n1 (l)=11, n2 (r)=8).

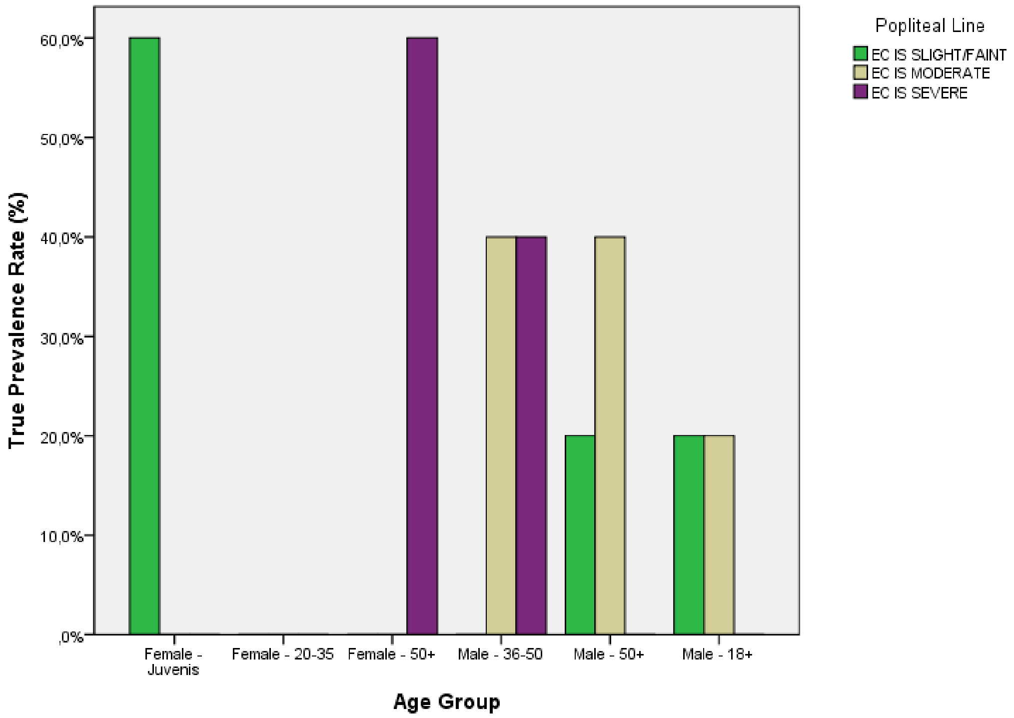

Fig. 5.179: TPR (True Prevalence Rate) in percentages of the popliteal line scores for each sex and age group of the Moorsel skeletal assemblage.

There was no statistically significant difference between males and females for EC of the popliteal (U=34.5, p=0.376, n1 (f)=9, n2 (m)=10) (fig. 5.179). When testing age versus sex, there was a statistically significant difference for EC of the popliteal line for females (x^2=7.000, df=2, p=0.030, n=9), but not for males (x^2=3.452, df=1, p=0.063, n=8). There was no statistically significant difference in EC of the popliteal line between left (l) and right (r) (U=41.5, p=0.768, n1 (l)=10, n2 (r)=9).

5.6.6. Oosterweel

** Upper Limb EC*

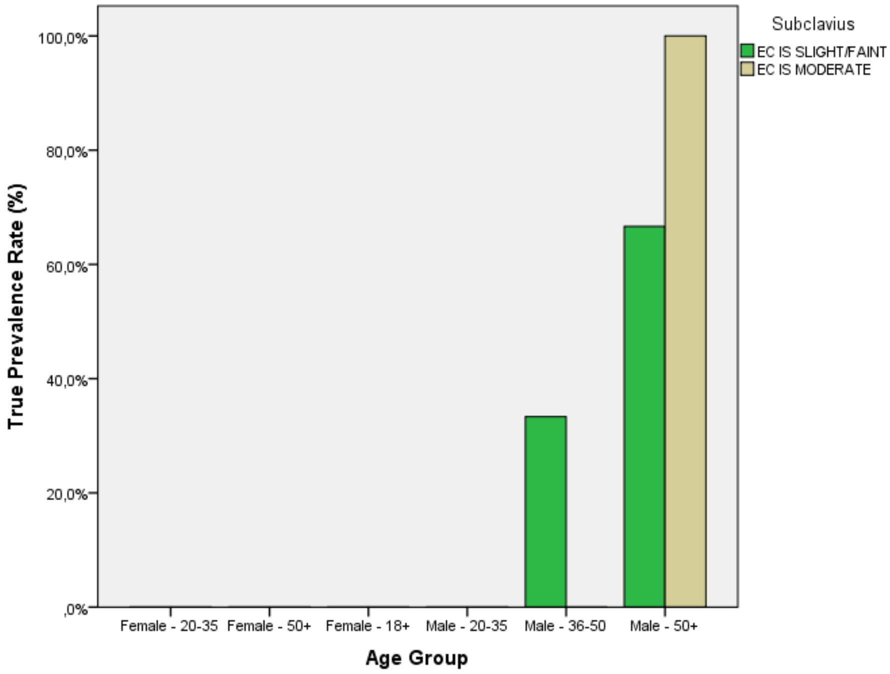

Fig. 5.180: TPR (True Prevalence Rate) in percentages of the subclavius scores for each sex and age group of the Oosterweel skeletal assemblage.

The extent of EC of the subclavius was not statistically significant between males and females of the Oosterweel skeletal assemblage (U=91, p=0.056, n1 (f)=14, n2 (m)=17) (fig. 5.180). When testing age versus sex, there was no statistically significant difference for EC of the subclavius for males (x^2=3.184, df=2, p=0.204, n=17). No EC was identified in females (n=14). There was no statistically significant difference in EC of the subclavius between left (l) and right (r) (U=136 p=1.000, n1 (l)=17, n2 (r)=16). No EC was identified in females (n=14).

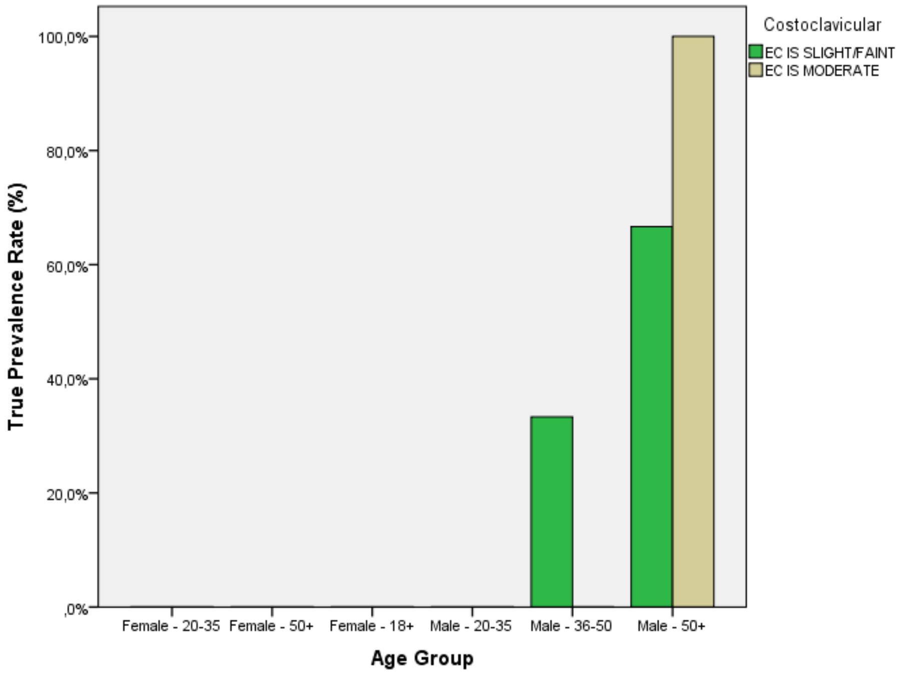

Fig. 5.181: TPR (True Prevalence Rate) in percentages of the costoclavicular scores for each sex and age group of the Oosterweel skeletal assemblage.

There was no statistically significant difference between males and females for the costoclavicular ligament (U=91, p=0.056, n1 (f)=14, n2 (m)=17) (fig. 5.181). When testing age versus sex, there was no statistically significant difference for EC of the costoclavicular ligament for males (x^2=3.184, df=2, p=0.204, n=17). No EC was identified in females (n=14). There was no statistically significant difference in EC of the costoclavicular ligament between left (l) and right (r) (U=136 p=1.000, n1 (l)=17, n2 (r)=16).

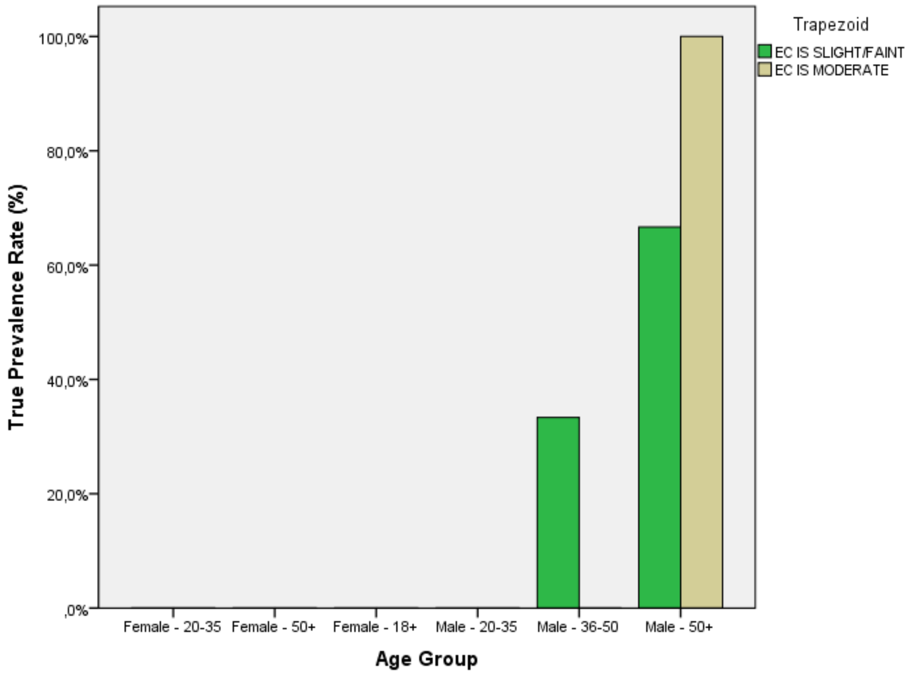

Fig. 5.182: TPR (True Prevalence Rate) in percentages of the trapezoid scores for each sex and age group of the Oosterweel skeletal assemblage.

For EC of the trapezoid, the difference between males and females is not statistically significant (U=91, p=0.056, n1 (f)=14, n2 (m)=17) (fig. 5.182). When testing age versus sex, there was no statistically significant difference for EC of the trapezoid for males (x^2=3.184, df=2, p=0.204, n=17). No EC was identified in females (n=14). There was no statistically significant difference in EC of the trapezoid between left (l) and right (r) (U=136 p=1.000, n1 (l)=17, n2 (r)=16).

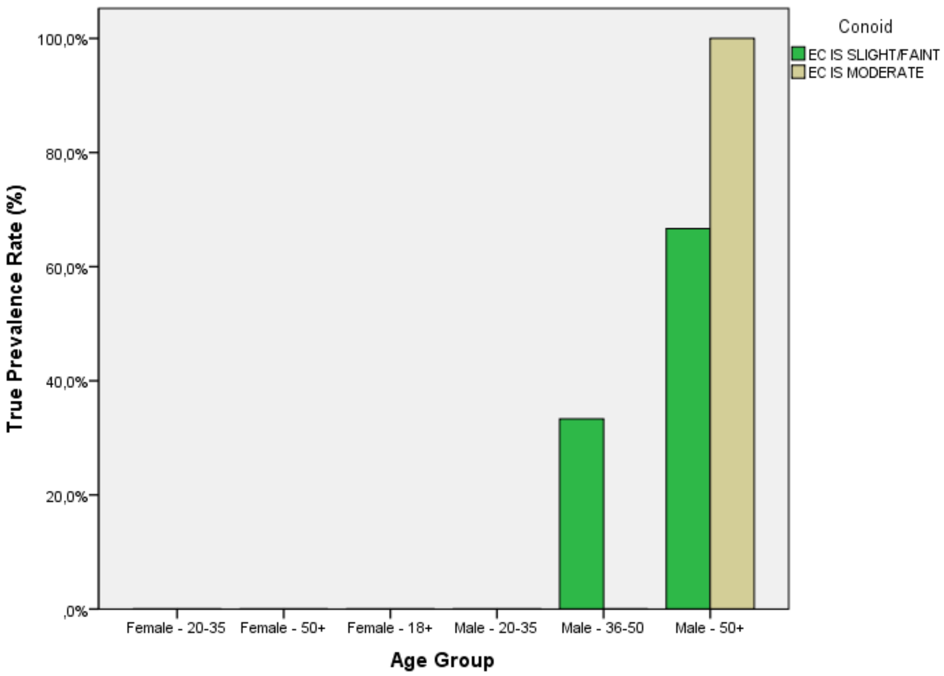

Fig. 5.183: TPR (True Prevalence Rate) in percentages of the conoid scores for each sex and age group of the Oosterweel skeletal assemblage.

There was no statistically significant difference between males and females for the conoid (U=91, p=0.056, n1 (f)=14, n2 (m)=17) (fig. 5.183). When testing age versus sex, there was no statistically significant difference for EC of the conoid for males (x^2=3.184, df=2, p=0.204, n=17). No EC was identified in females (n=14). There was no statistically significant difference in EC of the conoid between left (l) and right (r) (U=136 p=1.000, n1 (l)=17, n2 (r)=16).

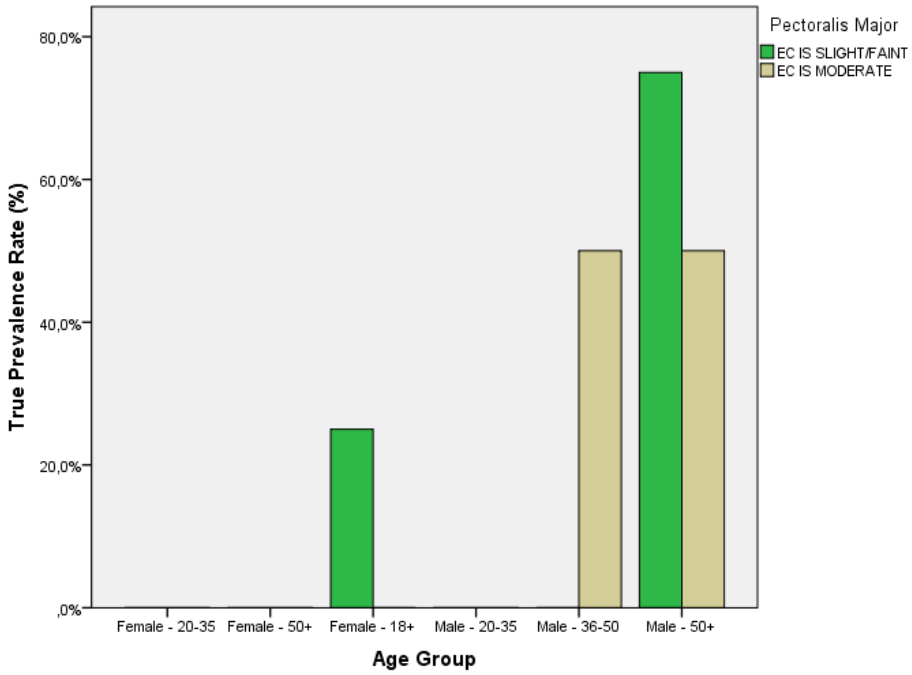

Fig. 5.184: TPR (True Prevalence Rate) in percentages of the pectoralis major scores for each sex and age group of the Oosterweel skeletal assemblage.

There was a statistically significant difference between males and females for EC of the pectoralis major (U=81.5, p=0.022, n1 (f)=15, n2 (m)=17) (fig. 5.184). When testing age versus sex, there was no statistically significant difference for EC of the pectoralis major for males (x^2=5.759, df=2, p=0.056, n=17) and for females (x^2=0.000, df=1, p=1.000, n=11). There was no statistically significant difference in EC of the pectoralis major between left (l) and right (r) (U=140, p=0.852, n1 (l)=18, n2 (r)=16).

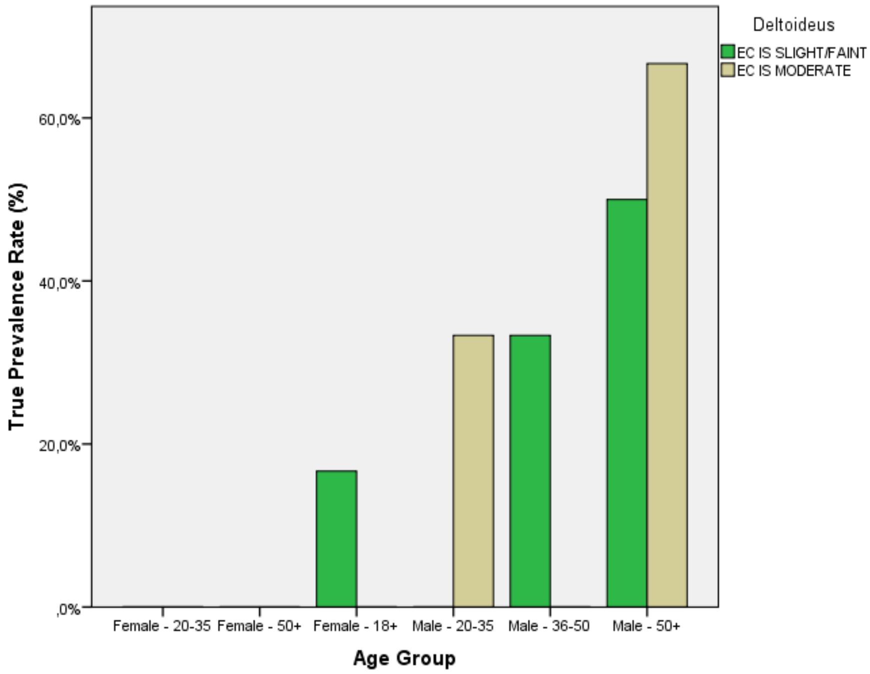

Fig. 5.185: TPR (True Prevalence Rate) in percentages of the deltoideus scores for each sex and age group of the Oosterweel skeletal assemblage.

There was a statistically significant difference between males and females for the deltoideus (U=82.5, p=0.015, n1 (f)=15, n2 (m)=18) (fig. 5.185). When testing age versus sex, there was no statistically significant difference for EC of the deltoideus for males (x^2=3.613, df=2, p=0.164, n=18) and for females (x^2=0.000, df=1, p=1.000, n=11). There was no statistically significant difference in EC of the deltoideus between left (l) and right (r) (U=148.5, p=0.880, n1 (l)=19, n2 (r)=16).

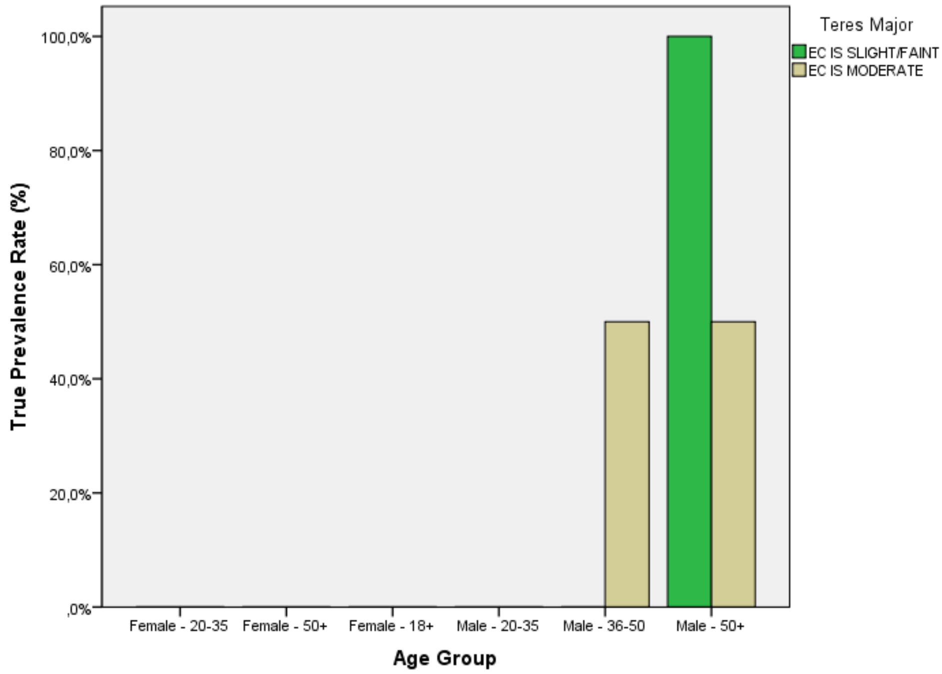

Fig. 5.186: TPR (True Prevalence Rate) in percentages of the teres major scores for each sex and age group of the Oosterweel skeletal assemblage.

There was a statistically significant difference between males and females for the teres major (U=97.5, p=0.049, n1 (f)=15, n2 (m)=17) (fig. 5.186). When testing age versus sex, there was no statistically significant difference for EC of the teres major for males (x^2=2.867, df=2, p=0.239, n=17). No EC was identified in females (n=15). There was no statistically significant difference in EC of the teres major between left (l) and right (r) (U=142, p=0.902, n1 (l)=18, n2 (r)=16).

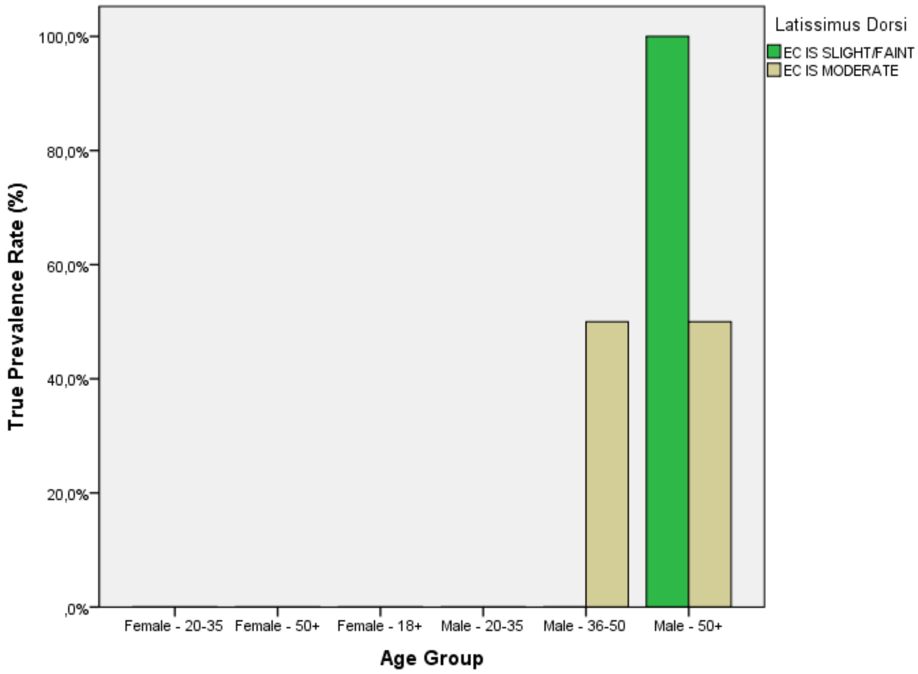

Fig. 5.187: TPR (True Prevalence Rate) in percentages of the latissimus dorsi scores for each sex and age group of the Oosterweel skeletal assemblage.

There was a statistically significant difference between males and females for the latissimus dorsi (U=97.5, p=0.049, n1 (f)=30, n2 (m)=39) (fig. 5.187). When testing age versus sex, there was no statistically significant difference for EC of the latissimus dorsi for males (x^2=2.867, df=2, p=0.239, n=17). No EC was identified in females (n=15). There was no statistically significant difference in EC of the latissimus dorsi between left (l) and right (r) (U=142, p=0.902, n1 (l)=18, n2 (r)=16).

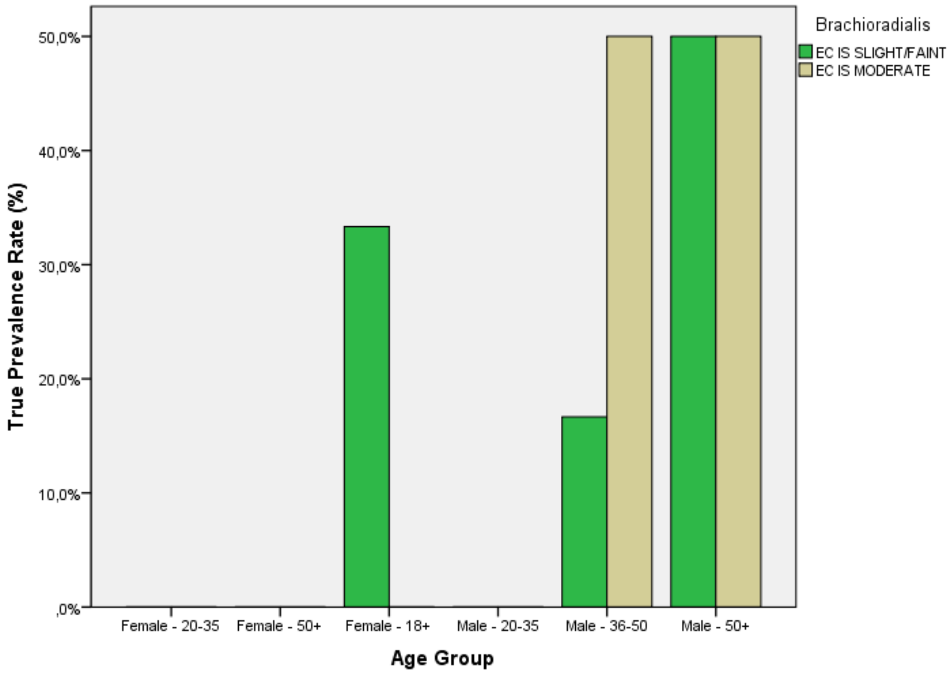

Fig. 5.188: TPR (True Prevalence Rate) in percentages of the brachioradialis scores for each sex and age group of the Oosterweel skeletal assemblage.

There was no statistically significant difference between males and females for the brachioradialis (U=97.5, p=0.134, n1 (f)=15, n2 (m)=17) (fig. 5.188). When testing age versus sex, there was no statistically significant difference for EC of the brachioradialis for males (x^2=4.571, df=2, p=0.102, n=17) and for females (x^2=0.000, df=1, p=1.000, n=11). There was no statistically significant difference in EC of the brachioradialis between left (l) and right (r) (U=144, p=1.000, n1 (l)=18, n2 (r)=16).

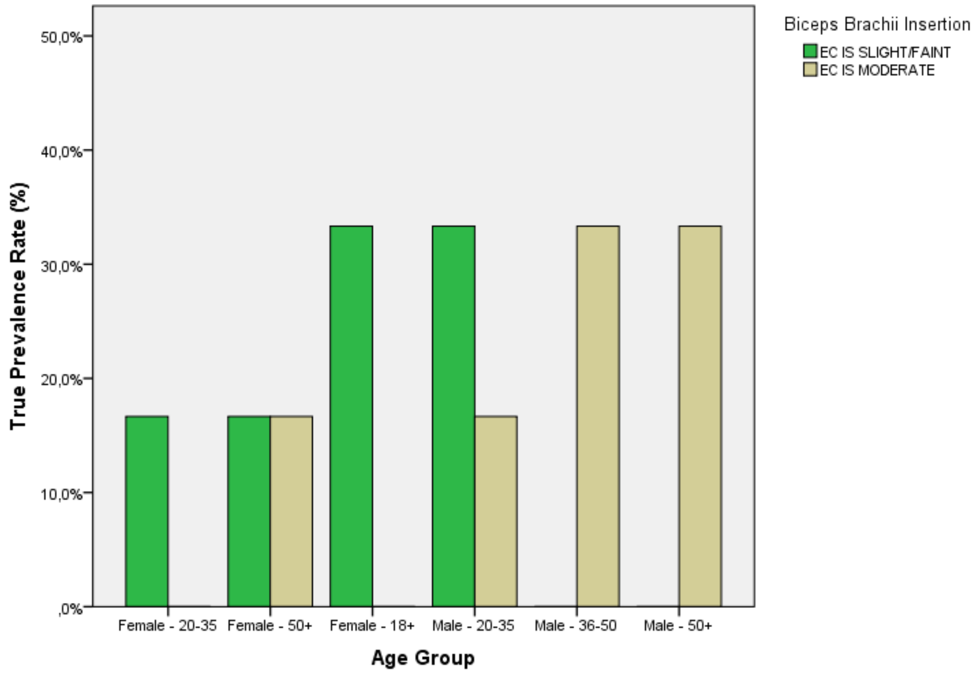

Fig. 5.189: TPR (True Prevalence Rate) in percentages of the biceps brachii insertion scores for each sex and age group of the Oosterweel skeletal assemblage.

There was no statistically significant difference between males and females for the biceps brachii insertion (U=80.5, p=0.380, n1 (f)=13, n2 (m)=15) (fig. 5.189). When testing age versus sex, there was a statistically significant difference for EC of the biceps brachii insertion for females (x^2=5.859, df=1, p=0.015, n=10), but not for males (x^2=0.206, df=2, p=0.902, n=15). There was no statistically significant difference in EC of the biceps brachii insertion between left (l) and right (r) (U=76, p=0.088, n1 (l)=14, n2 (r)=16).

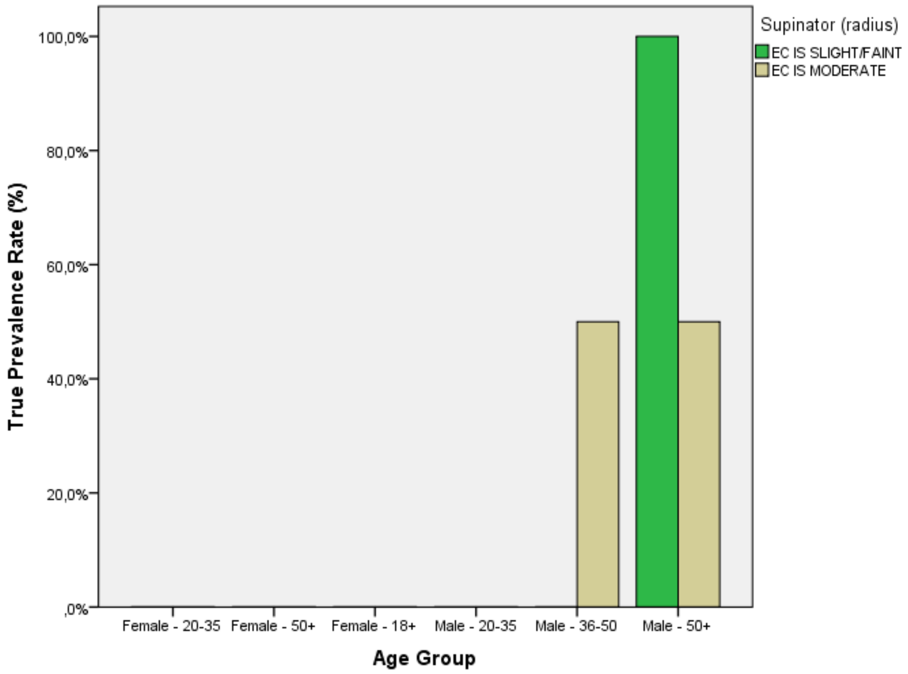

Fig. 5.190: TPR (True Prevalence Rate) in percentages of the supinator (radius) scores for each sex and age group of the Oosterweel skeletal assemblage.

The supinator (radius) did not show a statistically significant difference between both sexes of the Oosterweel skeletal collection (U=78, p=0.094, n1 (f)=13, n2 (m)=15) (fig. 5.190). When testing age versus sex, there was no statistically significant difference for EC of the supinator (radius) for males (x^2=2.492, df=2, p=0.288, n=15). No EC was identified in females (n=13). There was no statistically significant difference in EC of the supinator (radius) between left (l) and right (r) (U=103.5, p=0.497, n1 (l)=14, n2 (r)=16).

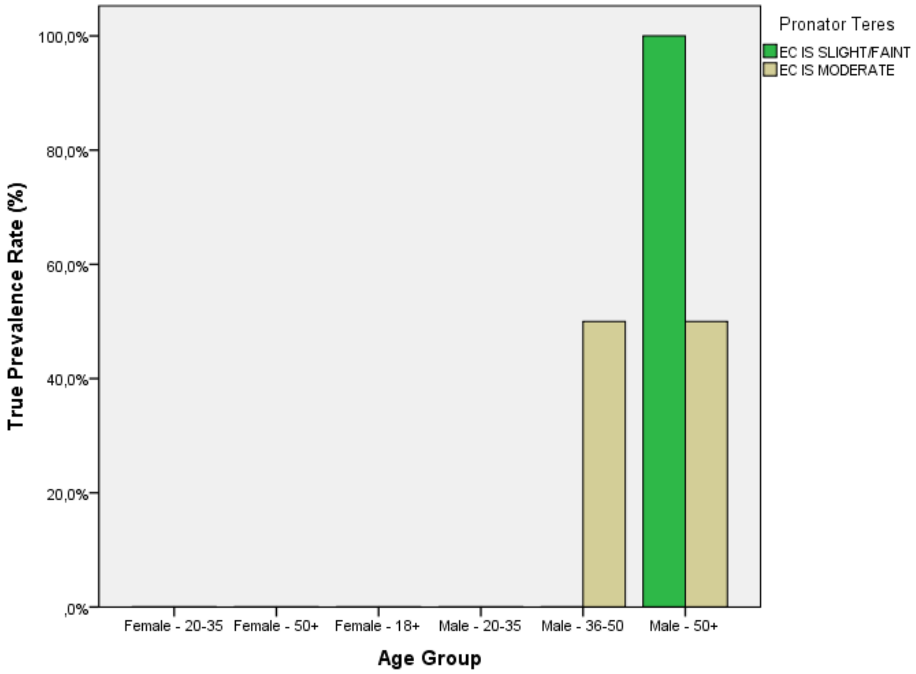

Fig. 5.191: TPR (True Prevalence Rate) in percentages of the pronator teres scores for each sex and age group of the Oosterweel skeletal assemblage.

EC of the pronator teres did not display a statistically significant difference between males and females (U=78, p=0.094, n1 (f)=13, n2 (m)=15) (fig. 5.191). When testing age versus sex, there was no statistically significant difference for EC of the pronator teres for males (x^2=2.492, df=2, p=0.288, n=15). No EC was identified in females (n=13). There was no statistically significant difference in EC of the pronator teres between left (l) and right (r) (U=103.5, p=0.497, n1 (l)=14, n2 (r)=16).

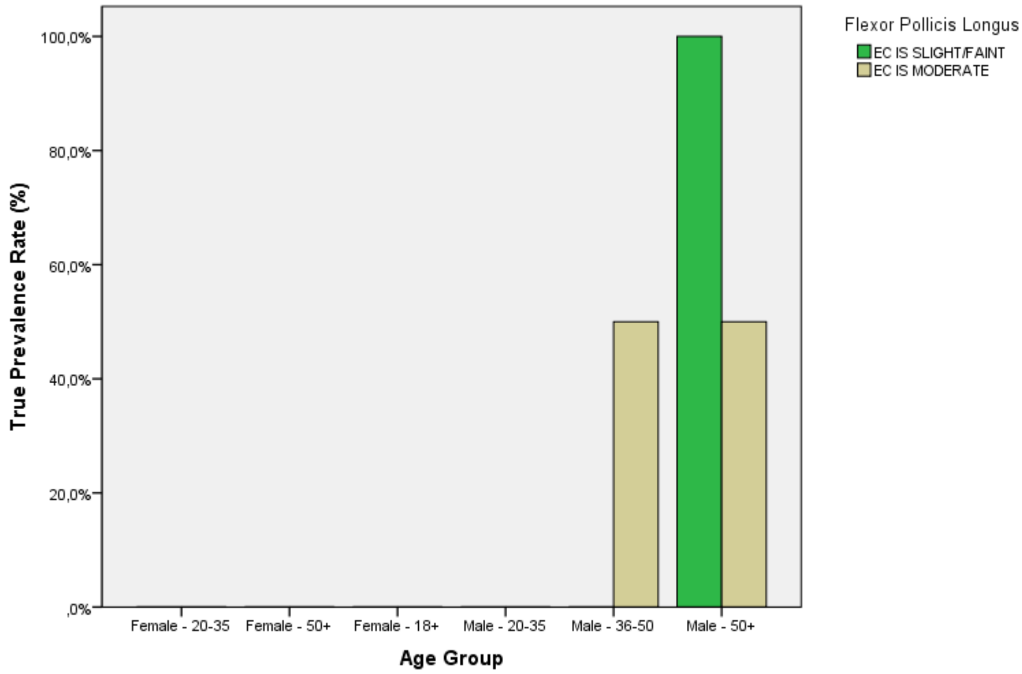

Fig. 5.192: TPR (True Prevalence Rate) in percentages of the flexor pollicis longus scores for each sex and age group of the Oosterweel skeletal assemblage.

There was no statistically significant difference between males and females for the flexor pollicis longus (U=78, p=0.094, n1 (f)=13, n2 (m)=15) (fig. 5.192). When testing age versus sex, there was no statistically significant difference for EC of the flexor pollicis longus for males (x^2=2.492, df=2, p=0.288, n=15). No EC was identified in females (n=13). There was no statistically significant difference in EC of the flexor pollicis longus between left (l) and right (r) (U=103.5, p=0.497, n1 (l)=14, n2 (r)=16).

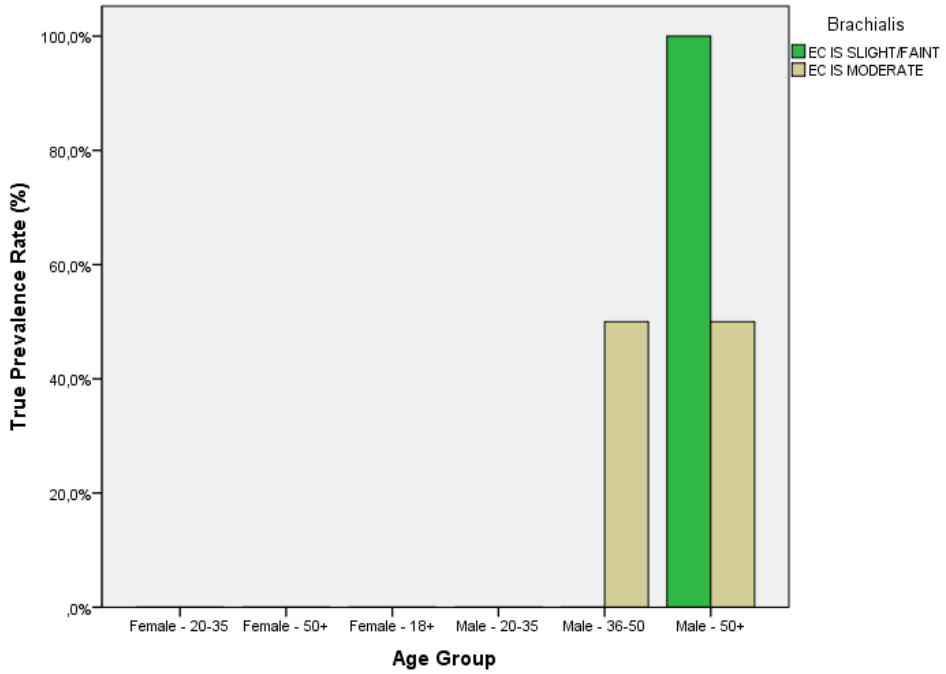

Fig. 5.193: TPR (True Prevalence Rate) in percentages of the brachialis scores for each sex and age group of the Oosterweel skeletal assemblage.

There was no statistically significant difference between males and females for the brachialis (U=60.5, p=0.069, n1 (f)=11, n2 (m)=15) (fig. 5.193). When testing age versus sex, there was no statistically significant difference for EC of the brachialis for males (x^2=1.996, df=2, p=0.369, n=15). No EC was identified in females (n=11). There was no statistically significant difference in EC of the brachialis between left (l) and right (r) (U=98, p=1.000, n1 (l)=14, n2 (r)=14).

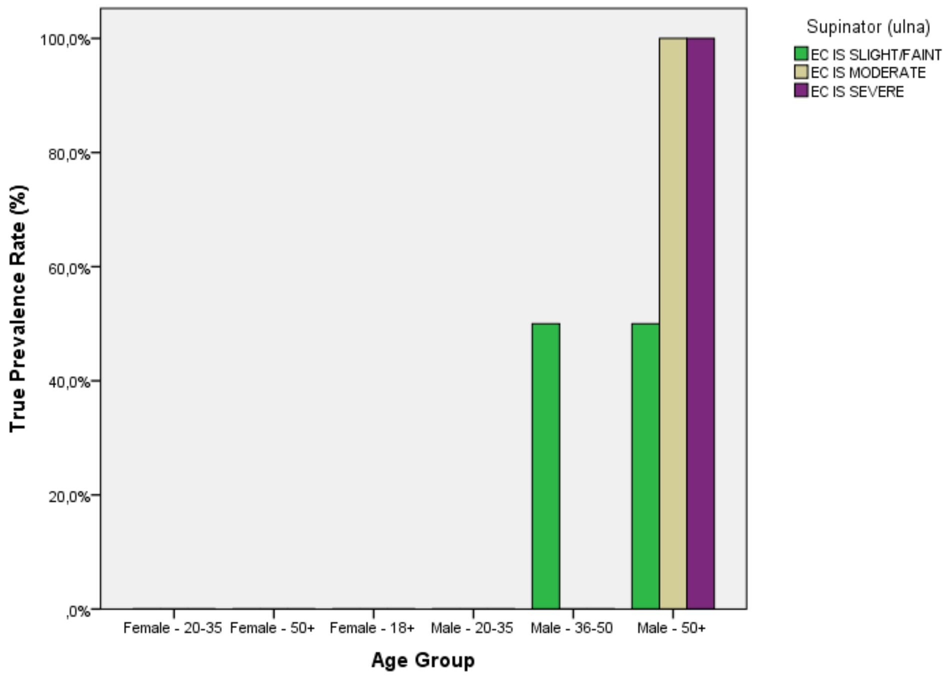

Fig. 5.194: TPR (True Prevalence Rate) in percentages of the supinator (ulna) scores for each sex and age group of the Oosterweel skeletal assemblage.

There was a statistically significant difference between males and females for the supinator (ulna) (U=44, p=0.010, n1 (f)=11, n2 (m)=15) (fig. 5.194). When testing age versus sex, there was no statistically significant difference for EC of the supinator (ulna) for males (x^2=5.213, df=2, p=0.074, n=15). No EC was identified in females (n=11). There was no statistically significant difference in EC of the supinator (ulna) between left (l) and right (r) (U=91, p=0.672, n1 (l)=14, n2 (r)=14).

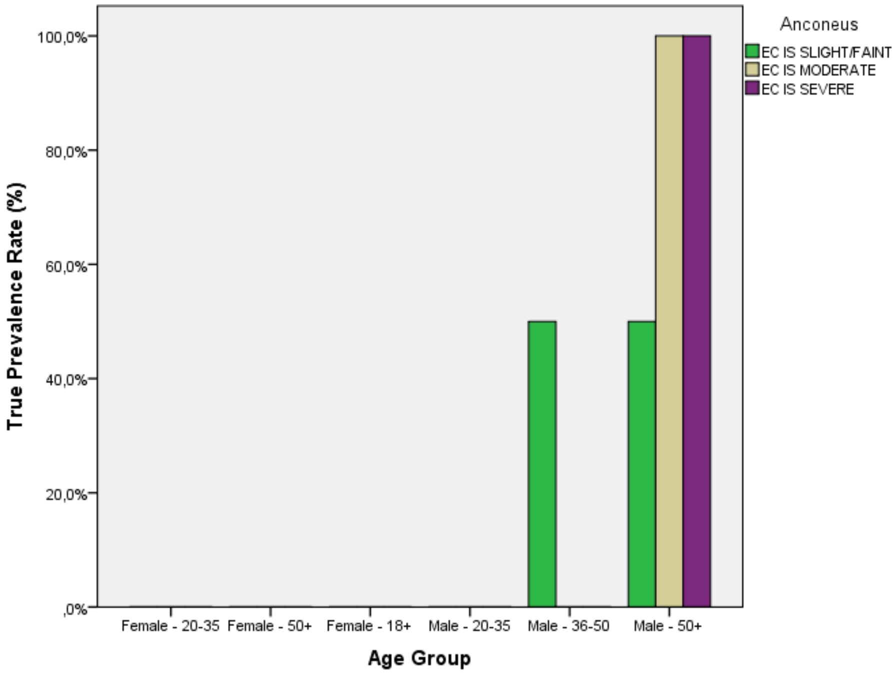

Fig. 5.195: TPR (True Prevalence Rate) in percentages of the anconeus scores for each sex and age group of the Oosterweel skeletal assemblage.

There was a statistically significant difference between males and females for the anconeus (U=44, p=0.010, n1 (f)=11, n2 (m)=15) (fig. 5.195). When testing age versus sex, there was no statistically significant difference for EC of the anconeus for males (x^2=5.213, df=2, p=0.074, n=15). No EC was identified in females (n=11). There was no statistically significant difference in EC of the anconeus between left (l) and right (r) (U=91, p=0.672, n1 (l)=14, n2 (r)=14).

** Lower Limb EC*

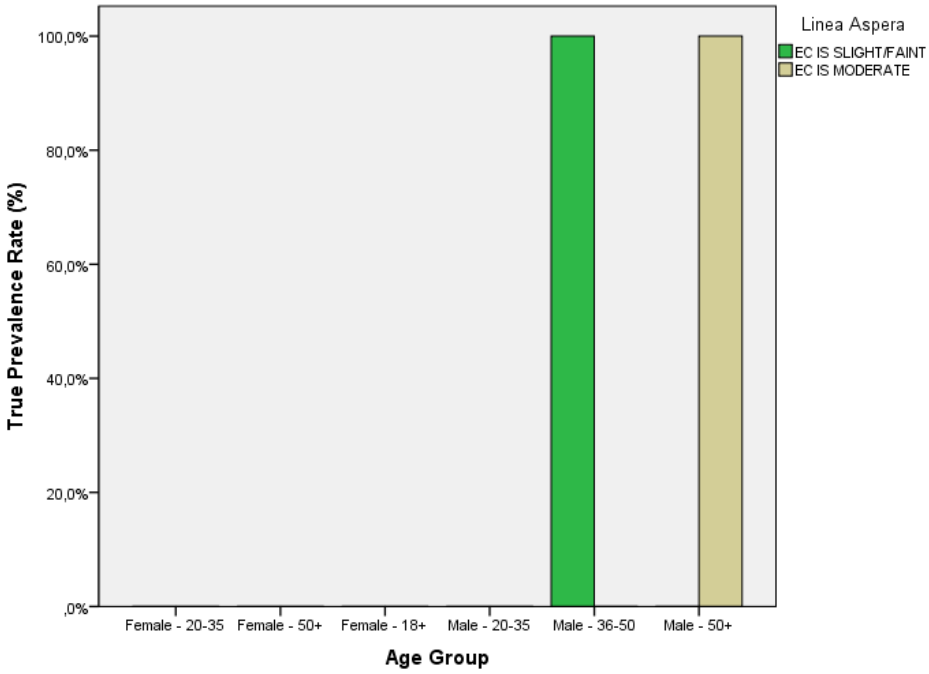

Fig. 5.196: TPR (True Prevalence Rate) in percentages of the linea aspera scores for each sex and age group of the Oosterweel skeletal assemblage.

There was no statistically significant difference between males and females for the linea aspera ($U=97.5$, $p=0.083$, n1 (f)=15, n2 (m)=16) (fig. 5.196). When testing age versus sex, there was no statistically significant difference for EC of the linea aspera for males ($x^2=2.325$, $df=2$, $p=0.313$, $n=16$). No EC was identified in females ($n=15$).There was no statistically significant difference in EC of the linea aspera between left (l) and right (r) ($U=129$, $p=0.623$, n1 (l)=16, n2 (r)=17).

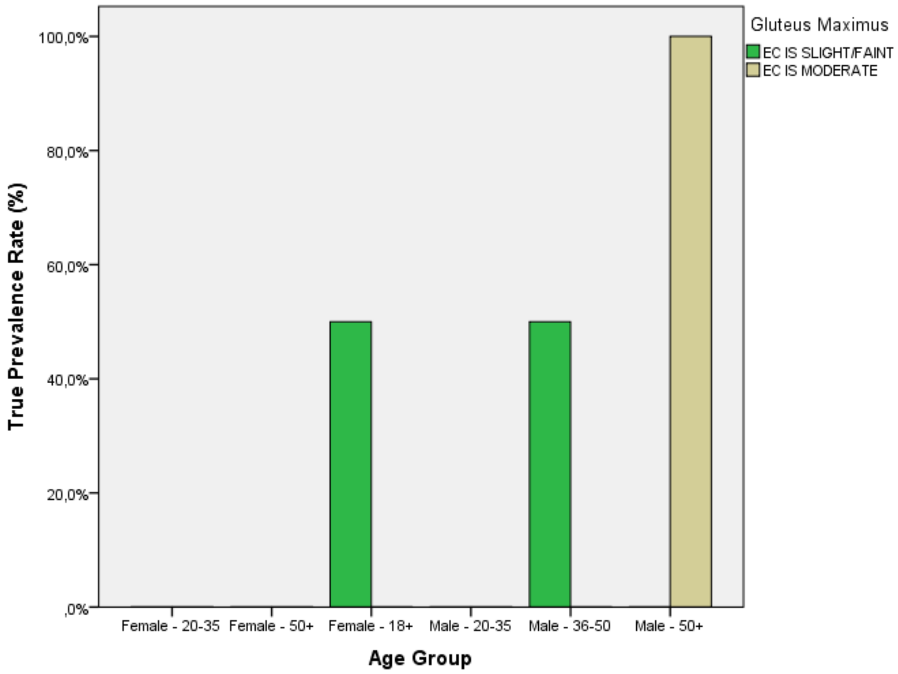

Fig. 5.197: TPR (True Prevalence Rate) in percentages of the gluteus maximus scores for each sex and age group of the Oosterweel skeletal assemblage.

There was no statistically significant difference between males and females for the gluteus maximus (U=104.5, p=0.293, n1 (f)=15, n2 (m)=16) (fig. 5.197). When testing age versus sex, there was no statistically significant difference for EC of the gluteus maximus for males (x^2=2.325, df=2, p=0.313, n=16) and for females (x^2=0.000, df=1, p=1.000, n=11). There was no statistically significant difference in EC of the gluteus maximus between left (l) and right (r) (U=121.5, p=0.357, n1 (l)=16, n2 (r)=17).

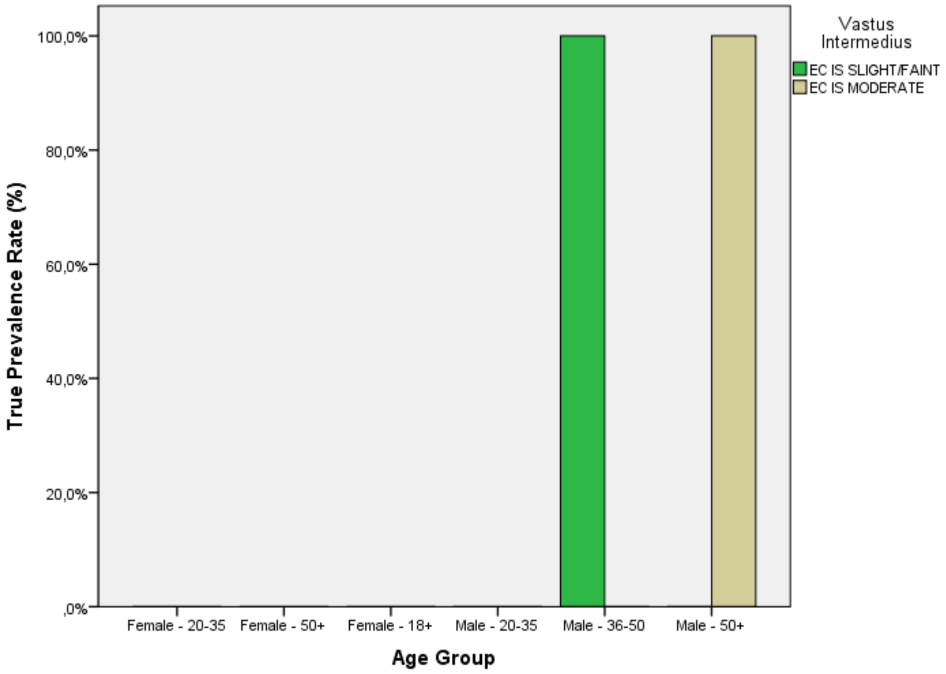

Fig. 5.198: TPR (True Prevalence Rate) in percentages of the vastus intermedius scores for each sex and age group of the Oosterweel skeletal assemblage.

There was no statistically significant difference between males and females for the vastus intermedius (U=97.5, p=0.083, n1 (f)=15, n2 (m)=16) (fig. 5.198). When testing age versus sex, there was no statistically significant difference for EC of the vastus intermedius for males (x^2=2.325, df=2, p=0.313, n=16). No EC was identified in females (n=15). There was no statistically significant difference in EC of the vastus intermedius between left (l) and right (r) (U=129, p=0.613, n1 (l)=16, n2 (r)=17).

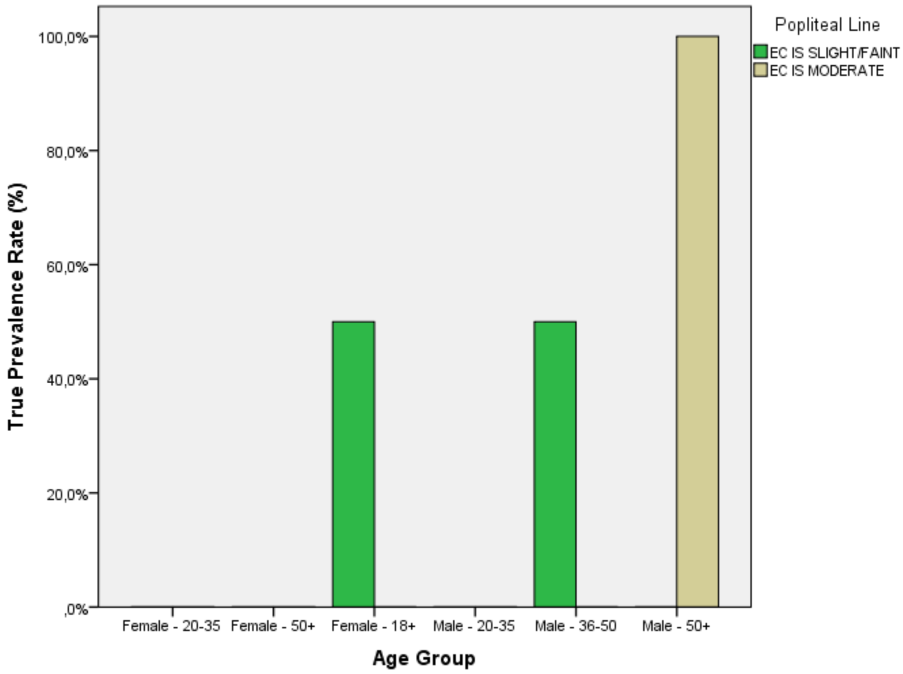

Fig. 5.199: TPR (True Prevalence Rate) in percentages of the popliteal line scores for each sex and age group of the Oosterweel skeletal assemblage.

There was no statistically significant difference between males and females for EC of the popliteal (U=91.5, p=0.138, n1 (f)=13, n2 (m)=18) (fig. 5.199). When testing age versus sex, there was a statistically significant difference for EC of the popliteal line for males (x^2=8.024, df=2, p=0.018, n=18), but not for females (x^2=0.000, df=1, p=1.000, n=9). There was no statistically significant difference in EC of the popliteal line between left (l) and right (r) (U=134.5, p=0.936, n1 (l)=16, n2 (r)=17). Severe EC of the popliteal line was not observed.

5.7. Summary

This chapter presented the results of the bioarchaeological analysis of the six skeletal assemblages: mortality profile, the distribution of age according to biological sex, average stature, palaeopathological lesions and the analysis of the twenty muscle attachment sites, or entheseal changes (EC), within each skeletal collection. These data will be further discussed in the following chapter to indicate inter- and intra-population variability in health status, and to demonstrate the effects of diet, lifestyle, environment and occupational activities on people across status groups. The use of historical sources will aid in the discussion regarding regional and social differentiation and gendered labour division.

CHAPTER 6

DISCUSSION OF THE BIOARCHAEOLOGICAL DATA OF THE SIX SITES

This chapter will discuss the results of the bioarchaeological analysis as demonstrated in Chapter 5. The main focus of this research is to identify the impact of occupational activities and the environment on skeletal individuals from six late-medieval to early modern archaeological populations in Flanders, from different socio-economic status groups and geographical locations. Skeletal markers were examined to investigate patterns of diet, disease and activities, both on inter- and intra-population level, and intend to reveal gender and age related differences within the small urban and rural communities. Besides the discussion of mortality, average stature, dental lesions and pathologies, one section is dedicated to the history of occupational diseases among textile and flax workers, following a brief notion of their occupational risks in the modern era, in order to build a bridge to the historical socioeconomic data of the six sites. At the end, the data analysis of entheseal changes (EC) is considered, and its influence on age, sex and status to elucidate social differentiation and rural-urban discrepancies.

6.1. Mortality Profile

As illustrated in figure 5.1 in Chapter 5, the majority of deaths for all case study sites apart from Deinze and post-medieval Moorsel are in the young adult age category (20-35 years). Deinze and post-medieval Moorsel, however, have more recorded deaths in the old adult age group (Deinze: 27%; post-medieval Moorsel: 31%) compared to the group of young adults (Deinze: 23%; post-medieval Moorsel: 24%). Sex distribution of mortality numbers indicate that most female deaths occurred in the young adult age group while male deaths were recorded in the middle and old adult groups (fig. 5.3 to 5.9). Other osteological studies from the Low Countries on medieval to early modern skeletons demonstate a similar pattern in the sex distribution of mortality data with a female preponderance between the age of 20-40 years and males who mainly died after the age 36 years (e.g. De Groote *et al.* 2011; Maat *et al.* 1998, 2005; Schats 2017: 95). The fact that more women died at a younger age might be explained by increasing health risks during pregnancy and childbirth (De Groote *et al.* 2018: 231).

All six skeletal assemblages assessed in this thesis included burials from the following age categories: Infans I (1-6 years), Juvenis (13-19 years), and all adult age groups. Only the rural site of Moorsel and the nineteenth-century population of Vichte did not have newborns. The skeletal collection of Zottegem did not contain human remains from children aged 7-12 years (Infans II), in contrast to the other rural sites, although inhumations from this age category were represented by a small number (as also shown in fig. 5.1 and 5.2 in Chapter 5): Oosterweel (3%), Moorsel (6%), post-medieval group of Moorsel (7%), Slijpe (8%) and Vichte (2%). There are several possible explanations for these patterns, including divergent burial practices for newborns or the extent of the excavated area as discussed in Chapter 3, while an explanation for a dearth of individuals in the Infans II category at Zottegem may be that, apart from the likelihood of a different burial area, older children are not represented because they survived into adulthood. Lewis (2016) related a paucity of children's burials to working practices. Her osteological study on the working life of children in medieval England demonstrated a decline in the deaths of children aged 6-10 years from rural sites after the Black Death, and she suggested that this pattern might be suggestive of younger children migrating to nearby towns for work. Although the majority of young labourers were aged between 12-16 years, English parish records illustrated that, besides the example of 'a girl signed to a weaver at the age of 12', there were even younger children who started to work at the age of six years (Lewis 2016). In Flanders, migration to nearby bigger towns to work as apprentices was historically documented. For example, a large proportion of weavers were active during the Late Middle Ages in Ghent, and a historical study on late medieval apprentice lists from the same city by Nicholas (1995: 1112, 1115 and 1130) demonstrated that the weaver's trade was not necessarily 'passed from father to son', but that there was 'still plenty of room for new persons', often apprentice migrants who moved to a town for employment. The exact age of the apprentices in Ghent is not, however, specified. Although migration to bigger towns may have happened in light of economic reasons, this certainly does not clarify the dearth of burials of older children in Zottegem.

It was not only major cities such as Ghent that attracted migrant workers during the late Middle Ages and beyond, as even a smaller town such as Deinze must have welcomed young labourers from the countryside to work as apprentices or servants (as discussed in Chapter 2). The latter category has been investigated by Stabel and Dambruyne (2003a: 151) whose study of the census of 1695 and 1796 revealed that a large percentage of 9.6% in 1695 and 11.3% in 1796 of the total Deinze population worked as a domestic servant. With an average of 8.2% of household servants in the province of East-Flanders in 1796, Deinze clearly outnumbered the regional towns with even a preponderance of male domestic helpers (124 men: 100 women), mostly under the age of 30 (Stabel and Dambruyne 2003a: 151). Historical data (e.g. *communicantencijfers* or *communicant figures*) from the seventeenth-eighteenth centuries indicate an overall young population in Deinze, with 42% of the total population under the age of eighteen in 1695 (Stabel and Dambruyne 2003b: 192-194). Such a large proportion of a young, and likely working group in Deinze, might explain the higher number of juvenile deaths between 13-19 years of age (16%) that were identified during the osteological analysis, compared to the lower numbers of the other non-urban case studies of Oosterweel (8%), Slijpe (7%), Vichte (2%) and Zottegem (13%). Only post-medieval Moorsel included a higher number of juvenile deaths (17%), but this number may be affected by the smaller sample size of individuals with determined age at death (n=29) compared to the larger Deinze group (n=85) (see fig. 5.1 and 5.2).

6.2. The Effects of Environmental Stress

Larsen (2015: 54) enumerated several archaeological and modern clinical studies of the effects of environmental stress, and pointed out that individuals who were exposed to extended childhood stressors were susceptible to dying earlier. For Deinze, historical demographic sources revealed a high mortality rate for infants in Deinze between 1760-1779, with more than 50% of the buried individuals in the O.L.V.-churchyard not older than being twelve years of age (Devos 2003: 236). However, mortality data of the younger age categories of Deinze (13% of combined categories of neonatus, infans I and II) do not particularly indicate a peak in infant death compared to the mortality numbers of the other age groups (juvenis: 16%; young adults: 23%; old adults: 27%) as presented in fig. 5.1. On the other hand, the archaeological data as illustrated in chapter 2 showed an intensification of burials in the eastern excavated area of the churchyard. Since the trench in that part of the cemetery was not fully excavated, the number of child (and juvenile) burials might, thus, be even higher (Laisnez and Vandecatsye 2011: 101, *KLAD Archaeological Report 24*). Further, it is possible that this high level of childhood mortality as suggested by historical sources may even occur before and after the period 1760-1779. Indeed, infectious diseases were often caused by contaminated water and/or food, which were principal causative agents, and poor sanitation and insufficient medical care often hastened the spread of epidemics (Devos 2003: 239; Hays 2000: 35; Stabel and Dambruyne 2003b: 194). Demographic data for Deinze suggest an average mortality rate of sixteen deaths a year throughout the seventeenth century, with a population size mostly varying between 800 and 1000 inhabitants, but the plague in 1667-1668 increased the number of deaths to 62 a year (Stabel and Dambruyne 2003b: 192 and 196). Moreover, death registers of Our Lady's parish in Deinze revealed a similar high average of 60 deaths a year in 1694, mainly caused by epidemics and famine during the Nine Years' War (1688-1697). Fluctuations in mortality numbers are noticed too for Deinze in the eighteenth century, with an average of 40 deaths every year, but with a peak of 154 deceased persons due to dysentery in 1794 (Devos 2003: 238-240).

The late-medieval site of Slijpe showed the highest percentage of burials of children less than twelve years old (20% of combined categories of neonatus, infans I and II) compared to the other sites. One explanation may be the excavated area as these infant burials were particularly clustered to the north of the church, and might indicate a preferred burial zone for children in the churchyard of Slijpe (see also 3.3.1.). Dobson (1997), however, drew an association between topographical characteristics, such as altitude, draining and soil and mortality, and suggested that infant mortality rates appeared to be higher in societies living near to wetlands or marshlands than parishes from more inward areas (Dobson 1997: 167). It could be argued that the location of Slijpe in the coastal polder area in the proximity of wetlands may indeed have contributed to an increased vulnerability to develop diseases and to die at a younger age.

The least percentage of children's burials was observed in the nineteenth century site of Vichte (6% of combined categories of neonatus, infans I and II). This may be related to the excavated area which was carried out to the west and south area of the church instead of the north part which may have included more graves of children (see also 3.3.1.). The typhoid epidemics that occurred in Belgium in the 1840's had a major impact on life expectancy as demonstrated by Devos (2006: 28-30 and 113). Mortality numbers in the Belgian provinces were employed by Devos (2006: 30 and 113) to assess the life expectancy at birth between 1841-1850, and indicate the lowest life expectancy of 32.1 years in the province of West Flanders (in comparison: the province of Namur suggests a life expectancy at birth of 47.3 years). Indeed, among all Belgian provinces, West Flanders, and especially the regions of Kortrijk, Roeselare and Tielt (which is near Vichte), was worst affected by the typhoid fever, with mainly children aged 1-10 years old among the casualties (Devos 2006: 113).

Despite the prevalence of infectious diseases and environmental stress in Deinze and Vichte, both sites include most recorded deaths in the old adult category of 50+ years (respectively 27% and 31%) compared to the rural groups of Slijpe (23%), Oosterweel (24%) and Zottegem (11%). Moreover, if comparing intra-populational numbers of young with old adult females, then old adult females were particularly noticed in Deinze and Vichte (both 10%), but also in post-medieval Moorsel (12%). For Deinze and Vichte, this difference might be explained by a strong immune response of women to infectious diseases because of their experiences during childbirth and gender related hormonal differences, showing an increased risk of mortality during child-bearing years, but a decrease in the older years (Ortner 1998). An enhanced female immune response to infections resulting in a longevity of more than 40 years was also demonstrated in a study by Minsky-Rowland (2016) who analysed 374 Native American skeletal individuals dating to 1600-1832 AD, and revealed that women, with evidence of a biological stress marker such as dental enamel hypoplasia, cribra orbitalia or short stature, had an increased survivorship over men after the age of 40 years. The fact that they had experienced a stress factor during childhood might have contributed to their enhanced immune system and life expectancy of more than 40 years old (Minsky-Rowland 2016). Moreover, also Blondiaux *et al.* (2015) have demonstrated an increased survivorship with females after the age of 40 by analysing skeletons with evidence of TB from a French site dated to between 200-1500 AD, and their conclusion supports the 'theory of female hormonal protection'. When considering the prevalence rates of environmental stress markers such as cribra orbitalia and dental enamel hypoplasia within the six case studies (see table 6.1), the only other identified infectious diseases such as ear infections and sinusitis were mostly recorded in Deinze (11.0%) and Vichte (6.4%), and evidence for respiratory infections particularly in Deinze (15.4%), thus underpinning the hypothesis of female hormonal protection compared to the other case study sites. Danneel (1986: 62, 66 and 72), for example, mentions a specific category of, most likely single, women servants between the fifteenth and seventeenth centuries in Ghent, who were solely occupied with disinfecting the house and clothes of those who had died from the pest or *'smettelicke siecte'*, next to female caretakers of the afflicted patients, and which may indicate an enhanced adaptability of the female immune system over time to recognise specific pathogens. In post-medieval Moorsel, however, evidence for infectious disease was rather uncommon, with no evidence at all for respiratory or other infections. Demographic data from 1605 to 1800 AD for Moorsel presented by Verleyen (1985: 186-189) show that mortality numbers never exceeded birth rates per decade. Only several years between 1661 and 1680 AD indicated a higher mortality, especially in 1667 and 1668, due to the plague (Verleyen 1985: 147, 205 and 379). As discussed earlier in 4.3.1. on the 'osteological paradox', acute diseases mainly affect the soft tissues and do not show alterations in human bones. A decrease in mortality numbers in Moorsel during the nineteenth century might be explained by an improvement in health care such as an increase in skilled medical practitioners in the village (Verleyen 1985: 189, 207).

Skeletal evidence of environmental stress markers such as cribra orbitalia and dental enamel hypoplasia observed in the six skeletal assemblages will be discussed below in 6.3.

6.3. Environmental Stress Markers

6.3.1. Cribra Orbitalia

Cribra orbitalia (CO) was only observed in three sites: Deinze (4.0%), Slijpe (22.9%) and Vichte (4.2%), and did not reveal statistically significant differences between males and females (as presented in 5.4.4.1.). TPR data, however, demonstrated a statistically significant difference between adults and subadults for Slijpe (p=0.033, one tailed Fisher's exact test) and Deinze (p=0.006, one tailed Fisher's exact test).

CO is usually associated with anaemia, and especially with contributing factors that prevent the intake of iron such as a diet poor in iron, infections, inadequate hygiene, or even extreme blood loss due to trauma (Roberts and Manchester 2010: 227-228; Waldron 2009: 136-137). It is likely that nutrient losses have been provoked by gastrointestinal infections and diarrheal diseases as a result of crowded, unsanitary living conditions (Stuart-Macadam 1992; Walker *et al.* 1992). It has been recognized that bone alterations identified in adults originated during childhood (Stuart-Macadam 1985: 391 and 396). Apart from nutrition, anaemia has indeed a myriad of causes as stated in a study by Walker *et al.* (2009) who advocate the need to reconsider the aetiologies of pathological conditions seen in the cranial roof (porotic hyperostosis) and orbits (cribra orbitalia). Walker *et al.* (2009: 116 and 120) argued that iron deficiency is not the principal cause of these skeletal lesions, but rather a vitamin B12 deficiency. Vitamin B12 is mostly found in animal foods, and a deficiency in adults develops very slowly since they usually have adequate amounts of vitamin B12 in their livers. Infants, however, have low vitamin B12 reserves and symptoms of a deficiency could be visible within months, with a higher risk for nursing infants from mothers with depleted vitamin B12 reserves (Walker *et al*. 2009: 114). Moreover, insufficient vitamin B12 levels may be exacerbated by poor sanitation that is 'conducive to additional nutrient losses from gastrointestinal infections around the time of weaning' (Walker *et al*. 2009: 119). CO and porotic hyperostosis share the same pathogens and both pathological lesions are sometimes found in the same individual (Walker *et al.* 2009: 115). For Slijpe, porotic hyperostis was identified in two individuals, a young adult female and a child of c.4-5 years. Only the young child had CO too.

Skeletal Stress Marker	Site					
	Deinze	**Oosterweel**	**Moorsel**	**Slijpe**	**Vichte**	**Zottegem**
Cribra Orbitalia	4.0	0.0	0.0	22.9	4.2	0.0
Porotic Hyperostosis	1.2	0.0	0.0	3.0	2.4	3.0
Non-specific Infections						
Periosteal Reaction	19.4	0.0	10.5	22.9	23.3	11.6
Osteomyelitis	3.2	0.0	2.6	1.4	2.3	0.0
Respiratory Infections	15.4	0.0	0.0	4.1	2.2	0.0
Other Infections	11.0	0.0	0.0	4.1	6.4	4.4
Dental Enamel Hypoplasia	18.7	21.5	0.0	22.9	15.2	15.2

Table 6.1: CPR's (Crude Prevalence Rates) and TPR's (True Prevalence Rates, of cribra orbitalia, porotic hyperostosis and dental enamel hypoplasia) in percentages for skeletal stress markers within the total population of each site.

While some studies attribute the prevalence of CO and porotic hyperostosis within medieval populations to overpopulation resulting in poor sanitation (Novak *et al.* 2012), or other childhood stress factors such as malnutrition and gastro-intestinal infections (Gilchrist 2012: 51-52), research by Schats (2015) on medieval groups in the Netherlands raised the possibility of malaria as a principal explanation. She examined thirteen Dutch urban and rural skeletal populations dating to 1000-1652 AD, and revealed a high statistically significant difference between the prevalence of CO and individuals living in marshy areas, such as the province of Zeeland (10.1 %), compared to those who lived in non-malarial regions (1.5%) (Schats 2015: 137). Percentage rates in her study, however, are crude prevalence numbers, as acknowledged by Schats (2015: 136, 147), and thus reflect all individuals, including those without observed orbits, while true prevalence rates, which consider individuals with recorded orbits only, would have been more suitable for comparative analysis. Therefore, to provide comparable data with Schats' study, the CPR data for CO from this research demonstrate similar patterns when comparing the wet polder region of Slijpe, with a higher prevalence of 26.7%, to the non-malarial context of urban Deinze with a CPR of 3.6%. Also, the CPR data of Slijpe for CO is similar to the CPR of late-medieval Klaaskinderkerke (25.9%) (Schats 2017: 147). The use of CPR data in Schats' osteological analysis may provide insight into the geographic divergence between malarial and non-malarial regions in medieval and early modern Holland, and is able to demonstrate a possible link with CO. Moreover, Schats (2015: 138 citing Baetsen 2008: 74) advocates considering malaria as a likely cause of CO, and especially when skeletons from marshy areas are involved; for example, she refers to a previous study of the skeletal collection from Wijk aan Zee, situated in a 'region with high malaria endemicity', in which the high rate of cribra orbitalia is attributed to nutritional stress instead of malaria. The high frequency of CO in Slijpe in contrast to the other case study sites may be indicative of the influence of malaria on individuals from marshy areas.

The incorporation of geographic and environmental conditions in interpretations of CO does not relate to the high-status group of Oosterweel, in which CO was not observed. However, the region of this polder village dealt with 'polder fever', referring to the intermittent fevers of the patient, and a popular name to describe malaria (Wagemans 2015). An indication for the presence of malaria in the region of Oosterweel, for example, can be observed in the seventeenth century *Bist* chapel, or *Bistkapelle(ke)*, in the nearby village of Ekeren. It is suggested by Stephanus Schoutens (1878), in his work *Maria's Antwerpen*, (and not the author 'P.C.Boutens' as misspelled by Wagemans (2015), that the chapel was mainly used by the villagers to pray for protection from a certain fever, most likely polder fever (Kennes *et al.* 1992; Wagemans 2015). One of its main characteristics for distinguishing malaria from regular fevers is indeed its seasonal appearance. Although indirect evidence for malaria before the nineteenth century consists of the diagnosis of re-occurring fevers, caution should be made since not every fever means an indication of malaria (Devos 2001: 200-202). Several outbreaks of the disease were reported throughout the eighteenth and nineteenth centuries. Even in the twentieth century, *Austrueel*, the alternative spelling of Oosterweel, is depicted on a map that illustrates the spread of the *Anopheles* mosquito (see below) *Atroparvus* in 1937, responsible for malaria (Devos 2001: 212 citing Rodhain and Van Hoof 1943: 217).

The consequences of contracting malaria include anemia and disorders of the digestive system, leading to physical frailty and disability, and hence producing a socioeconomic and demographic impact. For example, eighteenth-century mortality numbers in the polder area were higher compared to mortality rates of inland populations in Flanders. This divergence in mortality was especially noted in the autumn season after a dense concentration of mosquitoes, and could indicate the prevalence of malaria in the polder region (Devos 2001: 219).

Although the skeletal assemblage of Oosterweel involves socially higher ranked individuals with no osteological indication of CO, the disease clearly affected all socioeconomic groups as suggested by historical documents. For example, the French king Louis XIV, who was in Flanders in 1680, was reported to be affected by the disease that time, when many Flemish inhabitants suffered from symptoms including 'sweating, insomnia and tiredness' (Kohn 2008: 118). Moreover, the disease occurred earlier since other historical sources, such as the chronicle of the Gembloux abbey, located near Brussels, documented outbreaks of quartan fever, which is evoked by malarial parasites, in the twelfth century. Even in the fifteenth century, endemic malaria was reported abroad, in for example East Anglian coastal parishes, resulting in many deaths (Knottnerus 2002: 345).

Malaria is caused by parasites of the genus *Plasmodium*, and one of its six species that is transmitted to humans through female *Anopheles* mosquitoes, *vivax*, is 'thought to have a deep European history' (Newfield 2017: 255). Indeed, Newfield (2017: 260-261) lists several scholars who tentatively depict the occurrence of malaria in the early Middle Ages in the North Sea region, coming from the Mediterranean, and which has spread further inland through waterways and marshy areas. Despite the minimal historical references to malaria in Europe, such as reports of intermittent fevers in malarial regions, archaeology and palaeopathology can provide a better understanding of the disease. For example, a palaeo-microbiological and -immunological analysis of a fifth-century Umbrian child demonstrated the existence of malaria by the successful isolation of the *plasmodium falciparum* parasite through the use of aDNA (Sallares and Gomzi 2001). Even more, high levels of cribra orbitalia are reported in early medieval individuals from the 'high Rhine region, at Schleitheim (Switzerland) along the Wutach river', and this might be indicative of malaria too, although the association with enamel hypoplasia (*cf. infra*) here could be indicative of nutritional stress (Newfield 2017: 254, 263 and 292). The probability of malaria as a result of living near marshes was also put forward as a second possible cause of a similar high occurrence of cribra orbitalia (25.5%) within the late medieval population of Nin (Croatia), after the aforementioned poor sanitation and overcrowding (Novak *et al.* 2012).

The earliest indirect evidence for malaria was demonstrated by Gowland and Western (2012: 308-309) in their study on the skeletal remains from 47 sites in eastern Anglo-Saxon England (410-1050 AD), which used GIS to discuss spatial distribution of cribra orbitalia. They suggest that the pattern of orbital lesions is the result of endemic malaria, and this is, as the authors state, consistent with the conclusions of Gowland and Garnsey (2010), who demonstrated that Roman Italian sites with the highest rates of cribra orbitalia 'coincided with marshy areas where malaria is believed to have been endemic', and hence results in cases of severe anemia. Changes in climate as increasing temperatures during the Anglo-Saxon period would have been an ideal setting for mosquitoes, but also unhygienic living standards as observed in present-day 'marginalized fishing communities' (Gowland and Western 2012: 309 citing Verduijn 2000 and Westaway *et al.* 2009).

Although the commonly named Medieval Warm Period took place between the tenth and thirteenth centuries in the North Sea area, and thus created favorable circumstances for mosquitoes, Knottnerus (2002) argues there is little relationship between the rise and fall of malaria and long-term climatic changes, but that the disease is dependent on local conditions. The fact that malaria was mostly prominent in coastal and polder areas is related to the proximity of brackish water, an optimal breeding site for the *Anopheles atroparvus*, the mosquito species that chiefly hastened the spread of malaria in Western Europe (Deschutter and Seys 2014). Moreover, it is suggested that this species was even able to survive long winters when hibernating indoors, and with a predominant preference for breeding places of 60 meters below sea level, the lower situated marshes of the North Sea region offered favourable circumstances (Devos 2001: 211).

With the creation of embankments, canals and ditches from the eleventh century in the brackish environment of the North Sea, the reclamation of land by the coastal and polder inhabitants provided even more breeding-places for all kinds of insects, including malaria mosquitoes (Knottnerus 2002: 345). In the coastal region of Slijpe, it is suggested that embankment of the tidal landscape happened before the end of the tenth century (Tys 2013: 217). For example, 'oval enclosures or nuclear embankments' were identified in Slijpe, and these nucleated practices are regarded as the earliest evidence of embankments in the coastal region of North-West Europe (Tys 2013: 215 citing Allen 1997: 16; 2000: 1212). Despite the environmental risk factors for the coastal inhabitants, the salt marshes provided many natural resources such as fish, salt, arable land for livestock, sheep farms for wool production, and peat as a source of fuel as an alternative to wood to ensure survival of the peasants (Soens 2013a: 148-149 and 172; Tys 2013: 208). Knottnerus (2002: 345) suggests that 'the inhabitants of the coastal marshes must have acquired a certain degree of immunity against malaria' by the eleventh century, but that on the other hand, 'the crusaders and pilgrims coming back from Rome and Jerusalem must have brought many novel infections with them'. That many pilgrims did not survive the perilous journey was documented by the son of *Anselmus Adornes*, who traveled from Bruges to Jerusalem, passing through Genoa, and who advised to drink wine instead of water, since the water may be contaminated and cause dysentery and fever (Boelaert 2011: 159 citing Viaene 1982).

The presence of the Knights Templar in the coastal site of Slijpe has been historically and archaeologically documented (Hosten 2006; Zeebroek *et al.* 2006). Pilgrims on their way to Jerusalem were protected by the order of the Knights Templar, which was founded there in c. 1119, and abolished in 1312 by Pope Clemens V, with their goods transmitted to the Hospitallers (Barber 2012; Nicholson 2010). In the West, the templars founded local administrative quarters, a preceptory or commandery. A templar commandery was a place with many activities: agrarian, industrial and religious (Nicholson 2010). Slijpe also owned a templar commandery. This preceptory, *Groot-Tempelhof*, was established in the first quarter of the thirteenth century, and was one of the most important community centers of the Knights Templar in Flanders (Hosten 2006: 88-89). Also referred to as *Commanderie de Flandres*, the building complex included a hospital, a mill, a chapel, and archaeological surveys, as illustrated in Chapter 3, demonstrated that the preceptory in Slijpe was 'not an ordinary agrarian exploitation but an important centre of an international organisation' (Zeebroek *et al.* 2006: 159, 162 and 180). Although Nicholson (2010) states that 'most of the people living in a commandery in the West would never have fought the Muslims and were not expected to do so', the international military, politic and economic character of the Slijpe preceptory suggests the residence of retired knights, and their acquisition of tenements in the region of Slijpe (Zeebroek *et al.* 2006: 162 and 176). For example, Zeebroek *et al* (2006: 162) mention church records of 1557 that record the allocation of the estate *Koudeschuur Hof* (near Slijpe) to the knight '*Jehan de Ereulx, chevalier de l'ordre de Saint Jehan en Jherusalem*'.

Although this remains highly speculative, if several knights returned to Slijpe, they may have carried infectious diseases. Mitchell (2004: 2 and 23), who specifically focuses on battlefield injuries and surgery in the crusades, also reports outbreaks of quartian and tertian fevers as a manifestation of malaria, especially when armies were stationed nearby marshes for a certain period. Moreover, another endemic disease that was likely known in the eastern Mediterranean is trachoma, an infection of the eyes, which can result in blindness (Mitchell 2004: 2). The palaeopathological record, however, does not involve many case studies on the prevalence and distribution of this orbital lesion. Reference works on ancient diseases such as those from Ortner (2003), Waldron (2009) and Roberts and Manchester (2010) do not report trachoma and its manifestation in the skeleton. Aufderheide and Rodríguez-Martin (2008: 251), on the other hand, describe trachoma as a chronic eye infection which is spread by human contact, and mainly prevalent in dry, arid regions as noticed in ancient Rome and in documentary sources from medieval Europe and the Middle East. Osseous indications so far have been demonstrated by Webb (1990) in his study of the orbits of prehistoric Australian Aborigines, but the orbital lesions he specifies, reveal a different morphology than those typical of CO, seen in large, oval lesions, usually in the lateral part in the orbit and situated antero-medial of the lacrimal fossa (Webb 1990: 92-94). Further, in Webb's study (1990: 94), the disease was not identified in children younger than fourteen years. In contrast, our study showed small foramina in the orbits within all age categories, apart from one juvenile and one newborn. Thus, it is more likely that an ophthalmic condition and ancient infectious disease as trachoma did not occur in the Slijpe population.

The high prevalence of CO in the Slijpe collection may thus be associated with the possibility of malaria endemicity as a result of living in the proximity of brackish water and coastal environments, and is consistent with other studies who reported a high prevalence of CO in late medieval populations from marshy areas compared to urban samples (Novak *et al.* 2012; Schats 2015, 2017). Modern clinical literature described the impact of urbanization on African populations that showed a decrease in malaria cases compared to rural areas near permanent water (Govoetchan *et al*. 2014; Hay *et al*. 2005), which may explain the lower frequency of CO in urban Deinze. CO will be further discussed in 6.3.3. on its association with linear enamel hypoplasia (EH) as well as on its prevalence within age categories.

6.3.2. The Prevalence of Dental Enamel Hypoplasia (EH) in the Six Case Studies

Apart from CO, another indicator of childhood stress is observed in the defect of the dental enamel, attributed to nutritional deficiency and disease during the formation of the crown of the tooth. This stress lesion known as dental or linear enamel hypoplasia (EH) is manifested by linear, parallel grooves on the crown's surface (Larsen 2015; Ortner 2003: 34). The prevalence of hypoplastic defects in adult individuals implies that they had experienced episodes of physiological stress endured during childhood when the formation of the tooth occurs, and is thus considered as an indicator of this stress since teeth do not remodel once formed (Goodman and Martin 2002: 27) (fig. 6.1).

Five case studies exhibited a true prevalence rate of EH between 15.2% and 22.9% (fig. 6.2). Only the post-medieval cluster of Moorsel did not show EH. The highest frequencies were noted in the late-medieval coastal site of Slijpe (22.9%) and in the high-status group of Oosterweel (21.5%), although the grade of EH in the latter group was recorded as 'slight' in more than half of the cases.

Fig. 6.1: Dental enamel hypoplasia in the mandibular teeth of a juvenile of c.12-14 years old (white arrows) (Deinze, skeletal individual nr. WP2 L25).

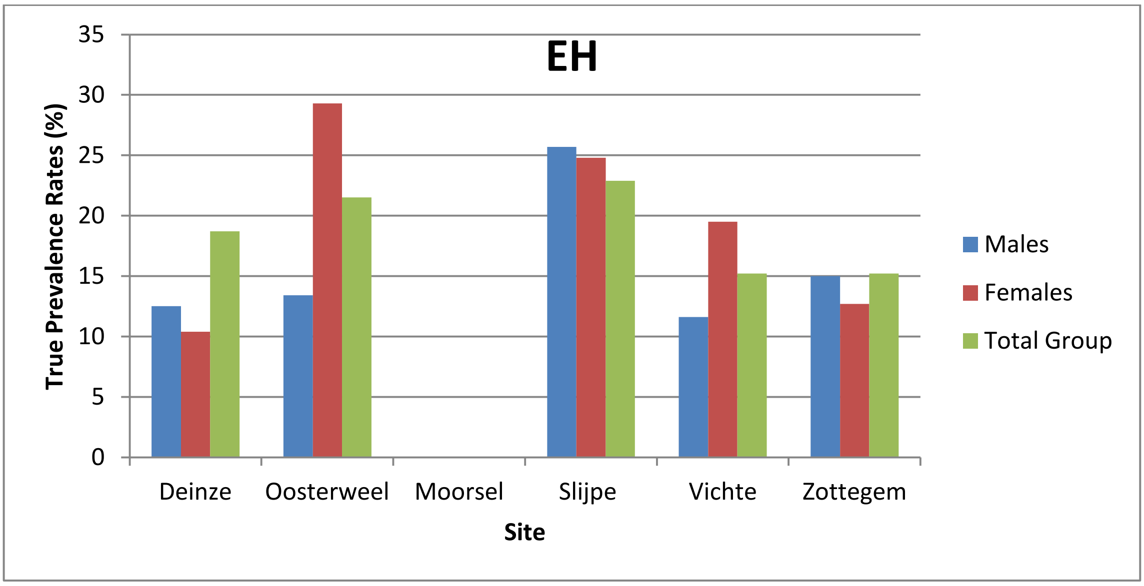

Fig. 6.2: Summary of the TPR's of dental enamel hypoplasia (EH) across the six case studies. The total group includes all skeletal individuals with teeth available for analysis based on the TPR data of table 5.35.

Some authors have linked socioeconomic status to EH, as for example Larsen (2015: 55), Polet (2010: 68) and Goodman and Martin (2002: 25-26), who all discuss the study of the medieval Swedish population of Westerhus which revealed a low prevalence of EH in high-status landowners, and adversely, more EH within the social groups of slaves and peasants. In contrast, other studies of high-status groups such as the monks from the Carmelite monastery in Aalst have shown a large frequency of EH (De Groote *et al.* 2011: 191). EH has also been applied to indicate a relationship between age and enamel defects, with more hypoplasias in younger individuals (for an overview of papers see Larsen 2015: 54), and to point out discrepancies between rural and urban contexts (Primeau 2014). Primeau focuses on childhood's skeletal stress markers including not only EH, but also Harris lines and middle ear infections, and from which modifications can still be observed in adult skeletons. Her study on medieval Danish skeletons suggests a higher prevalence of these three lesions in the urban population compared to its rural counterpart (Primeau: 2014). Primeau (2014) addresses the discussion of 'the osteological paradox' (see 4.3.1.) by arguing that the high-status citizens were in better health than the rural peasants since the stress lesions seen in the adult group implied they had survived childhood's diseases because they had a better resistance to malnutrition. However, she does not mention the average age at death, stature or demographic composition of the two populations which could be additional indicators to define the health status. EH was observed in both adults and the juvenile within the high-status group of Oosterweel and the difference was not statistically significant. The presence of EH in the high-status adults may indicate that they were prone to fevers or infections during childhood but survived into adulthood. However, as indicated in 5.4.1., the small sample size should be taken into account when interpreting the results.

Further, as also explained in 4.3.1. on the 'osteological paradox', every individual from a population responds differently to disease, and thus showing a variation in risk of dying at that age, a paradox described by Wood *et al.* (1992: 344-345) as hidden heterogeneity in risks. The hypoplastic lesions seen in individuals from different age groups as a response during periods of stress are related to their immune system, indicating survival of a disease process and suggests that these individuals may be the healthier ones than those without lesions. The homogenous group of Oosterweel, however, excludes differences in socioeconomic status and environmental conditions, two factors that are responsible for a variation in risk for dying at a certain age.

The relationship of EH to the environment and the geographical position of settlements was investigated by Garcin *et al.* (2010: 430, 435) on four early medieval Moravian and Frankish juvenile skeletal populations from various contexts: urban, rural, coastal and inland. They concluded that a high proportion of EH relates more to the environment than to socio-economic status. In particular, the prevalence of EH among children from the early medieval coastal site of Cherbourg (northwestern France) was remarkably low, and could be related to its location near the sea, and consequently, to a different diet consisting of mainly marine resources (Garcin *et al.* 2010: 436). The only site in the present study with a comparable topography, the late medieval coastal population of Slijpe, revealed a statistically significant difference for the prevalence of EH between adults and subadults (x^2=1.991, df=1, $p<0.001$) (see also 5.4.1.). Similar to Garcin *et al.*'s (2010) analysis, EH within the subadult group of Slijpe was less common: only two children aged 7-12 years were observed with the dental defects, and the majority of examples of EH was observed with young adult males and middle adult females. Unfortunately, the study sample of Cherbourg in Garcin *et al.*'s (2010) paper did not include adult individuals, nor did it focus on cribra orbitalia as well to outline a more comprehensive picture of environmental conditions (see section below). Apart from coastal versus inland contexts, other findings by Garcin *et al.* (2010: 433-434) concentrate on rural-urban discrepancies with more EH in two medieval adult urban populations from southern France, which is likely attributed to an extended exposure to malnutrition and diseases, whereas the lower values of EH seen in the four early medieval juvenile populations from Eastern Europe are suggested to be related to relatively good environmental conditions ruling out a prolonged susceptibility to malnutrition and nonspecific childhood diseases as proposed by Garcin *et al.* (2010: 436). Certainly, the osteological paradox should be considered when interpreting the results, as well as the possibilities of future pathological analysis of the four adult groups in the aforementioned study, however, environmental conditions should be definitely incorporated to clarify EH. For instance, the dental analysis of the 22 individuals with recordable dentition from the rural medieval group of Moorsel, including both adults and juveniles, revealed a significant low value of EH, with only 4 individuals (4/22; 18%) affected (1 male of 50+, 1 young adult female, 1 infans II and 1 adult of unknown sex aged 30-39 years) (Van Cant 2011: 76)[4]. Moreover, the twenty skeletal individuals from the post-medieval cohort of Moorsel with teeth available for analysis and whose total palaeopathological analysis was addressed in this thesis based on completeness and preservation, did not even exhibit EH. Although the villagers of Moorsel and its surroundings were often threatened by religious wars, forced labour and looting in the post-medieval era (Reyntens 1892: 125-129; Verleyen 1985: 69-71), death rates between 1605 and 1800 do not particularly exceed birth rates. As illustrated in 6.2, the only increase in mortality was reported c. 1667-1668, when the plague killed several families in Moorsel (Verleyen 1985: 147, 205 and 379). The low prevalence of EH could indicate that the rural inhabitants of Moorsel were not notably susceptible to prolonged malnutrition or infectious diseases during childhood, and that its location in a transitional alluvial environment (outside of the marshes) provided sufficient natural resources to outbalance intense nonspecific environmental stress.

When considering CPR's of EH, no sites from our study revealed statistically significant differences between males and females. However, when considering TPR's of EH, there was a statistically significant difference between males and females in Oosterweel and Vichte (see table 5.38). In the

[4] Re-evaluation of the skeletal reports of the Moorsel individuals by the author of this thesis indicated four individuals with EH instead of the initially reported five (thus excluding skeletal individual nr. IV/S1/24 or 165, who showed discoloration (and not EH) on the labial, mesial and distal surface of five teeth).

latter two sites, the frequency of EH was higher in females (Oosterweel: 29.3%; Vichte: 19.5%) than in males (Oosterweel: 13.4%; Vichte: 11.6%). Previous studies that found higher rates of EH in females suggest that this is related to different cultural practices where preferential treatment of sick males was preferred over females resulting in a growth delay among females (May *et al.* 1993: 45). The difference in the high-status group of Oosterweel, however, may be explained by the smaller number of teeth available for analysis compared to the other case study sites. Apart from the aforementioned observed statistically significance between adults and subadults in Slijpe, the only other site with an age-related statistically significance is Vichte (see 5.4.1.), with a majority of EH for both sexes in the young adult age groups.

6.3.3. CO and its Association with EH

A few studies have investigated the relationship between EH and CO and revealed contrasting results. Some did not demonstrate a positive correlation (e.g. Kozak and Krenz-Niedbala 2002, on the fourteenth to eighteenth centuries population from the Polish town of Kołobrzeg; Liebe-Harkort 2012, on Swedish Roman Iron Age adults; Novak *et al.* 2010, on medieval to early modern skeletons from several continental Croatian sites). Although Kozak and Krenz-Niedbala (2002: 77-81) concluded that the frequency rate of 27.6% of CO was average compared to nine other medieval eastern European groups in their study, it may be worth noting that Kołobrzeg is located near the Baltic Sea, and that the authors fall short in addressing possible causes of its prevalence within this coastal population, such as evaluating geographic and climatic conditions. Also, the latter study demonstrated a frequency of 22.4% for EH with a similar prevalence between males (22.6%) and females (22.2%) (Kozak and Krenz-Niedbala 2002: 77-81), and show comparable data with Oosterweel (21.5%) and Slijpe (22.9%), both located in marshy and/or coastal areas. Furthermore, in the Croatian late medieval skeletal assemblage of Nin, no statistical association was calculated, despite the 'relatively high frequencies' as stated by Novak *et al.* (2012: 447-448) of both EH (44.2%) and cribra orbitalia (25.5%).

Other studies showed a positive correlation between CO and EH (e.g. as listed by Novak *et al.* 2010: 265). Stuart-Macadam's (1985, 395, Pl. 4), on the other hand, observed a higher frequency of EH in individuals with CO at the Roman Poundbury Camp in England, even though there is no direct interdependence between these pathological changes, she further argued that 'children with inadequate diet and weakened immune system were much more readily affected by the causes of these disorders'. The relationship between CO and EH, however, remains unclear as pointed out by Novak *et al.* (2010: 265), citing Turbón *et al.*'s (1991/1992) conclusion that the two disorders 'reflect different dietary aspects: cribra orbitalia is more connected to iron deficiency, while EH is linked with the calcium level in the organism'. In contrast, some studies have associated EH with recurrent, seasonal fevers, rather than a calcium shortage, and with malaria as a possible causative agent (Brunet *et al.* 2002; Kinaston *et al.* 2016). Therefore, it should be noted that the highest frequencies of EH within both Oosterweel (21.5%) and Slijpe (22.9%) (table 6.1) could be explained by their environmental and geographical setting, and may demonstrate the dispersion of the malarial anopheles vector. Because of the low TPR of CO in Deinze and Vichte, an association between CO and EH was performed for Slijpe only and was not statistically significant ($x^2=0.000$, $p=0.494$).

More associations between the two skeletal stress markers and age, sex, and burial type, were undertaken by Yaussy *et al.* (2016), who investigated the difference in life stressors in individuals who died during famine periods and from those living during non-famine circumstances in medieval London. Only age was a factor found to be statistically significant for both EH and cribra orbitalia (Yaussy *et al.* 2016: 277). In this thesis, an association between all age groups and CO is identified in Deinze ($p=0.002$) when using CPR data (highest frequency in young children aged 1-6 years), and in Deinze ($p=0.006$) and Slijpe ($p=0.033$) between adults and subadults when using TPR data (see 5.3.4.1.). For EH, there was a statistically significant difference between adult and subadult groups in Deinze ($p<0.001$), Slijpe ($p<0.001$), and between all age groups with EH in Vichte ($p=0.003$) (with a majority in juveniles in Deinze and for Slijpe and Vichte mostly in young adult males) (see 5.4.1.). With also a highest frequency of EH in the age group of 18-25 years, Yaussy *et al.* (2016: 278-279) suggest that a regular exposure to environmental stress could have caused a disruption in their childhood growth, and which could have led to an earlier mortality. The possibility of malaria for the site of Slijpe, and the documented outbreak of typhoid and cholera, and in general, poor sanitation in Vichte, could have disrupted the growth of the tooth enamel. Early childhood stresses could also explain the presence of CO within the younger age categories of both Deinze and Slijpe. Several studies have demonstrated that CO is a childhood disease and that the lesions observed in adults represent unremodelled changes acquired during childhood (Kozak and Krenz-Niedbala 2002: 77; Stuart-Macadam 1985). Similarities with Yaussy *et al.*'s (2016: 279) analysis, who mostly found CO in those below the age of 46 years, were mainly consistent with our findings, apart from Slijpe. Here, CO was, after the group of older children, principally observed with both sexes from the age of 36 years. The older age might thus suggest certain immunity against malaria with people living in endemic regions as illustrated in 6.3.1., but elderly individuals may still exhibit pathological conditions as iron deficiency. For example, modern clinical studies on malaria among geriatrics in endemic areas of Nigeria report complications as respiratory disorders and anemia (Chukwuocha *et al.* 2016). Frequent exposure to the disease will increase the susceptibility to noncommunicable diseases and induce metabolic disorders such as anemia and diabetes in older adults: 'Therefore it is plausible to suppose that changes resulting from constant exposure to infectious diseases such as malaria without adequate management and control could therefore have pathophysiological impacts associated with non-communicable disease conditions and outcomes' (Chukwuocha *et al.* 2016). Schats (2017: 147) found CO in both young and old adults only from the late-medieval coastal population of Klaaskinderkerke, with no statistically significant difference between males and females, suggesting that both sexes were equally affected by CO, but does not expound further on its presence in adults only. Porotic hyperostosis, however, another skeletal manifestation of anaemia, was not commonly recorded in this study, but the low frequency seen in Slijpe (two individuals, one young adult female and one young child) is similar to Schats' (2017: 147) analysis of Klaaskinderkerke, who found porotic hyperostosis in two individuals (here two adult females) with no evidence of CO.

Immunity to diseases such as malaria was postulated by Devos (2001: 214-217) to clarify differences in mortality numbers in the province of East Flanders in the early nineteenth century. She pointed out that communities who were living near stagnant pools were more susceptible to a higher mortality than those living near rivers and streams, and, more importantly, that divergences in death rates were also observed regarding the size of the marsh. Villages with the largest wetlands (in size and in number), thus leaving their inhabitants more exposed to infection, show a lower mortality than those located nearby smaller marshes. This could indicate that the polder inhabitants from the largest marshy areas acquired certain immunity (Devos 2001: 214-216).

6.3.4. Rare Dental Anomalies

Skeletal individuals from Oosterweel , Vichte and Zottegem did not exhibit any other unusual dental lesions. However, a dental pathology observed in males only, all older than 30 years of age, in Deinze (4 males), Moorsel (2 males) and Slijpe (1 male) involved a defect of the *cementum*, a tissue that is a part of the root. Calcium, trace elements, phosphate, protein and vitamins A, C and D are all important during growth, and a shortage of these fundamental nutritional components may provoke anomalous teeth (Ortner and Putschar 1985: 28). For Deinze, three of the four skeletons with a lesion of the cementum have been radiocarbon dated to between AD 1220-1280 (one individual) and between AD 1630-1670 (two individuals). Noteworthy events that occurred in Deinze in the thirteenth century include its urban development, the onset of its linen industry, and the existence of the hospital in 1232 as described in its earliest historical evidence (Prevenier 2003a: 12; Prevenier and Huys 2003: 232; Stabel and Dambruyne 2003a: 144-145). Other pathologies that were observed with this thirteenth-century adult male from Deinze concern mainly degenerative diseases of the lower vertebral column, osteoarthritis of both the left and right first carpo-metacarpal joint, and moreover, severe entheseal changes of the right upper limbs and hand bones, which might indicate strenuous repetitive activities (skeletal individual nr. WP2 L58). In the second half of the seventeenth century, or at least until 1670, infectious diseases such as the plague, and diseases caused by contaminated water and food, were reported in Deinze (Devos 2003: 238-239; Huys 2003: 242). Lesions that were identified with the two adult males from the seventeenth century also involve the lower spine and osteoarthritis of the hand bones, but mainly faint entheseal changes of the upper extremities (skeletal individuals nr. WP2 L59 and WP2 L71). A nonspecific infection such as periosteal reaction was noted in one individual. Hence, an insufficient diet or an infection may have inhibited the absorption of essential nutrients which led to the defect of the cementum.

The most idiosyncratic dental deformations were identified in the Deinze collection as well. Two juveniles of c. 12-15 years were observed with a severe deterioration of the cusp and crown anomalies of several teeth (skeletal individuals nr. WP2 L25 and WP3 L74). Apart from EH observed in both adolescents, one individual displayed evidence of mastoiditis and rickets, and the other one was identified with a possible indication of TB and meningitis. This is suggested by the new bone formation on the endocranial surface of the left parietal bone, which indicates a bacterial or viral infection, 'and can be a complication of infections such as tuberculosis' (Roberts and Manchester 2010: 176-178). Meningitis TB was, for example, reported as the main cause of death for 92 children in a London hospital between 1948-1950 in a clinical study by Bentley *et al.* (1954: 64-67), as well as identified in an American juvenile skeleton from the first half of the twentieth century because of the parietal endocranial lesions (Pálfi *et al.* 2012), which are comparable to the Deinze subadult. Moreover, albeit rare, modern clinical studies have demonstrated the involvement of the parietal bone with skeletal tuberculosis. For example, two case studies were reported in India, in a nineteen year old male (Kupta *et al.* 1998), and a girl aged ten, and it is suggested that TB involving the skull mostly affects individuals less than twenty years old (Singh and Dutta 2006). Further evidence for TB in the Deinze subadult was suggested by the new bone formation on the visceral surface of the ribs, and other signs of TB within the total skeletal sample from Deinze could imply a general presence of the disease among the population. Moreover, it could be possible that the adolescent from Deinze, besides having (meningitis) TB, suffered from multiple conditions, including syphilis. For example, the probability of both congenital syphilis, a bacterial infection disease transmitted through the placenta from the mother to the foetus, and TB, was suggested by Ioannou *et al*. (2015) in their study of a nineteenth-century child of c. 8-10 years old, from European colonists in Australia. Apart from the similar periosteal reaction on the left parietal bone, more resemblances with the Deinze juvenile were observed in the dentition, seen by the dysplastic occlusal enamel in the permanent mandibular and maxillary first molars (Ioannou *et al*. 2015).

A typical characteristic of congenital syphilis is mulberry molars, which are manifested by malformations such as small nodules on the cusps, and in the Deinze subadult, on both the upper and lower permanent first molars (Roberts and Manchester 2010: 77-78). Similar irregularities in the occlusal surface of molars were observed in an eight year old modern child, and are associated with congenital syphilis (Aufderheide and Rodríguez-Martin 2008: 164-166 and 406). Hillson *et al.* (1998: 31-35), however, have described dental defects in a nine year old documented child with congenital syphilis, and noted that the mulberry lesions seen in the permanent first molars may be 'related to the subject's congenital syphilis condition, although there is no direct proof of this because there is no evidence of any major growth disruption either before or after the main defect' (Hillson *et al.* 1998: 35). When surviving birth and early childhood, skeletal changes that are characteristic for congenital syphilis involve periosteal reaction and osteomyelitis (Aufderheide and Rodríguez-Martin 2008: 165), and these lesions were not noticed in the Deinze juvenile. Furthermore, another specific characteristic of congenital syphilis are Hutchinson's incisors, and the presentation of syphilitic incisors includes a peg-like or screwdriver appearance (Ioannou *et al.* 2016: 619), which was not identified in the remaining incisors of the Deinze subadult. However, the diagnosis of congenital syphilis in the Deinze juvenile should not be entirely ruled out. The survival into adolescence with congenital syphilis was indicated by Ioannou *et al.* (2016: 626 citing Erdal 2006) who described the case of a thirteenth-century fifteen year old juvenile from Turkey, who was, apart from the 'typical dental abnormalities' also diagnosed with compatible criteria and skeletal pathological lesions such as sabre tibia and osteomyelitis on several bones.

Despite distinctive skeletal lesions such as sabre shin (bowing of the tibia), caries sicca, and the characteristic shape of the incisors, Ioannou *et al*. (2015) argued that even in the absence of these afflictions, it would be possible to recognise congenital syphilis by enamel deficiencies, and furthermore, through the effects the enamel shows as a result of a treatment used for syphilis. Mercury, for instance, was often employed to treat venereal diseases in Western Europe before the introduction of modern medicine (Wong *et al.* 2016). However, the mercurial cure led to malformations of the enamel, and especially affecting first molars, which was also observed in the European settler child of Ioannou *et al*.'s study (2015), with 'the occlusal surface exposing multiple tubercles, appearing rugged, pitted and dirty' (Ioannou *et al*. 2015: 6). Apart from the comparable tubercles and pitting, the Deinze adolescent displays strong discoloration on the occlusal and lingual surface of the present maxillary teeth, and on the protoconid, hypoconid and hypoconulid and buccal side of the right mandibular second molar (fig. 6.3).

Fig. 6.3: Left maxillary fragment showing multiple tubercles on the occlusal surface of the first molar (arrowed), as well as severe discoloration on other dental elements, which may indicate mercury treatment for syphilis. This juvenile of c. 15 years old was also observed with possible evidence of meningitis TB (Deinze, skeletal individual nr. WP3 L74).

These stains could be evoked by mercury as a treatment for syphilis, since its use for other diseases has not been extensively described. The employment of mercury as a cure for TB was yet brought to attention by the surgeon Wright (1908a and b) at the beginning of the twentieth century, who examined patients at a naval hospital in the USA, some of them with both TB and syphilis, and who reported that 'it was while treating tuberculo-syphilitics in 1905 that I first realized the value of mercury in tuberculosis' (Wright 1908b: 27). Since the churchyard in Deinze was in use until 1860, it is less likely that the use of mercury in order to cure TB would have provoked the dental alterations in the Deinze juvenile. A similar explanation was put forward by Ioannou *et al.* (2015: 7), whose aforementioned nineteenth-century infant probably suffered from TB since childhood, but was most likely not treated with mercury for this condition.

Similarities were noticed when comparing the nineteenth-century illustrations from Hutchinson of the mercurial dentition of congenital syphilitic patients treated with mercury (Ioannou *et al.* 2016: 620-622 citing Hutchinson 1878 and 1888). After all, the diagnostic criteria for congenital syphilis of the Deinze juvenile may not be entirely corroborated because of the absent pathologies of the limb bones, the evidence seen in the dentition, on the other hand, could be suggestive, as Ioannou *et al.* (2016: 626) conclude that 'signs of treatment with mercury might be considered indicative of syphilis in those individuals who do not display classical signs of this disease, as besides syphilis, mercury has been very rarely used to treat any other disease with desirable effects'.

Similar dental alterations of the first permanent molars are rare in the archaeological and palaeopathological record, and only a few were reported by Ogden *et al.* (2007), who propose the term cuspal enamel hypoplasia, referring to the abnormal disrupted cusp patterns seen in post-medieval subadults from London, possibly indicating malnutrition, poor living standards and infection, and by Radu and Soficaru (2016), on a post-medieval/early modern Romanian infant of c. seven years old. Moreover, the latter study also considered the practice of using mercury as a treatment for congenital syphilis, and more importantly, in this case of the Romanian child, co-morbidities such as anemia and respiratory diseases are not excluded (Radu and Soficaru 2016: 37). The fact that the first molars are mainly involved is illustrated by Ogden *et al.* (2007: 962), who mention that ‘first molar crowns form in 3.8 years, i.e. half the time that canines take, and so are more vulnerable to short systemic disturbances'. The influence of respiratory disorders was noted too, as Ogden *et al*. (2007: 962 citing van Amerongen and Kreulen 1995) describe Dutch medical records that report children with developmental defects of their first molars, and from which a high number of 67% suffered from respiratory disease.

6.3.5. The Effects of Socioeconomic and Environmental Factors on Human Growth: Discussion of the Average Stature

It has been widely hypothesised that the average height of an individual reflects both their genetic predisposition and personal health status, with the latter influenced by socioeconomic conditions such as food supplies, environmental factors, population density, hygienic and sanitary standards (e.g. Cardoso and Garcia 2009; Holden and Mace 1999; Maat 2005; Mays *et al.* 2008: 85). The first years of an individual’s life are critical for attaining final adult height since malnutrition and exposure to infectious diseases during childhood may cause a detrimental effect on the growth of children (Cardoso and Garcia 2009: 143-145). Gowland (2015) discussed the importance of the in utero environment and early infant health and its impact on long-term adult health as well as the fact that poor health may be inherited across generations. Maternal well-being prior to and during pregnancy is a crucial factor since, for example, poor nutrition by the mothers demonstrated a decline in the consumption of breast milk by their infants leading to early childhood malnourishment and growth stunting (Gowland 2015: 533).

Clinical geneticists have pointed out that the genetic impact to explain differences in stature is less significant compared to nutritional and environmental aspects of a community, and especially when 'nutrients or toxins are present during important growth phases' (Maher 2008). Thus, the assessment of adult stature from past communities could shed light on their living conditions, and could elucidate both inter- and intra-population differences when individuals from comparable socioeconomic and/or environmental contexts are involved (Swales 2012: 119). Further, a sexual dichotomy in stature could express a different experience in physiological stress between males and females during growth, or could indicate a differential access to food.

The use of stature as a proxy to investigate nutrition and health in archaeological remains has been indeed on multiple levels: first, to question socioeconomic status within populations from one specific geographic area (e.g. Maat 2005) and second, to outline sexual stature dimorphism (SSD) in order to infer sexual differences between cultural groups (e.g. Holden and Mace 1999; Wolfe and Gray 1982), or between sexes from one topographical context (e.g. Gustaffson *et al*. 2007). Tassenaar and Karel (2016b: 132) argue for considering the first approach, i.e. to compare the average stature of historical communities living in a similar geographical region, in order to eliminate unstable determinants like climatic factors. The impact of climate on stature was indeed questioned by Gustafsson and Lindenfors (2004: 260), who reported significant differences in height between two Central African populations living close to each other. An illustration of the first approach is, for example, Maat's (2005) comparative study of the development of male stature in the Low Countries between 50-1997 AD, which demonstrated a higher height for the canons in Maastricht (1070-1521 AD), likely because of their 'excessive life-style' involving a rich diet, in contrast to the socially lower ranked males from the city of 's-Hertogenbosch, who lived in less favourable circumstances during the nineteenth century. Maat's study, however, solely focuses on male stature since he integrates historical evidence such as military records, which specifically concerns males (Maat 2005: 277). A diachronic study also related to one geographic area, but which includes both sexes, has been undertaken by Gustaffson *et al.* (2007), here relying on mean stature data from Swedish populations from the tenth to the twentieth century, which did not reveal a significant allometric association between male and female stature throughout time. The only notable contrast was the increase in male and female stature in the twentieth century, compared to the stature data from the previous centuries, and the authors suggest not an improvement in living conditions, but a plausible methodological bias 'between the recordings of in vivo standing height, and the stature estimations based on archaeological remains' to explain the difference in height (Gustaffson *et al*. 2007: 868). Although a growth in stature since the two last centuries in industrialized regions was mainly attributed to improved living conditions such as enhanced nutrition and medical provision, the economic historian Steckel (2009), however, illustrates the counter effects of industrialization especially during the early industrial period, by analyzing 44 papers on global anthropometric data.

The data show a decline in height, or the so called 'antebellum paradox', indicating thus a decrease in stature 'and life expectancy in the midst of vigorous economic growth' (Steckel 2009: 12-13). Likely causes are suggested to involve migration, population density, urbanization and diseases, until investments in public health and technological innovations in e.g. food transport have chiefly instigated beneficial effects on physical growth (Steckel 2009).

Anthropometric data from archaeological skeletal collections from Flanders mainly involve socially higher ranked individuals, and show for example an average male stature of 170 cm for the Carmelite friary in Aalst (De Groote *et al.* 2011), and 171.5 cm for the post-medieval male church burials in Meldert (Vander Ginst and Vandenbruaene 2006). As presented in table 5.8 in Chapter 5, a minimum average height of 170 cm was only recorded in the male groups of Vichte (170.2 cm) and Zottegem (171.8 cm). It should be noted that, from the latter site, male stature measurements were only obtained for seven individuals as a result of poor completeness and preservation of the long bones. Deinze, Oosterweel, Slijpe and Moorsel, on the other hand, show a similar range in male stature of c. 168-169.6 cm, and could indicate a correlative response to environmental or nutritional stress factors between the male groups of the four sites (fig. 6.4).

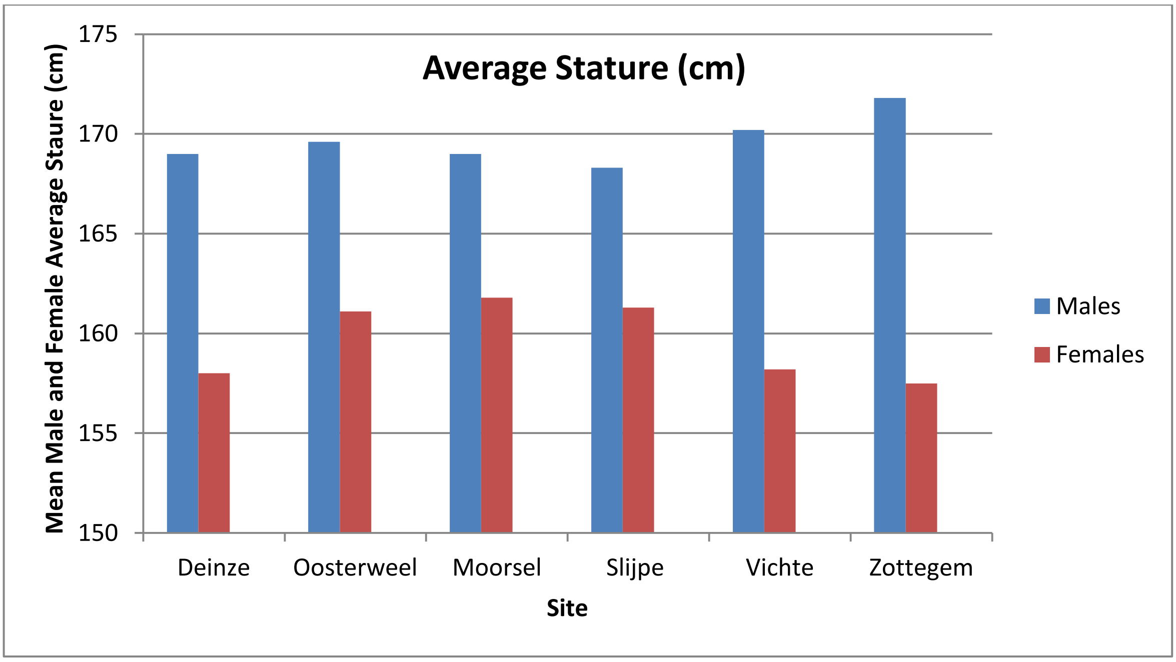

Fig. 6.4: Summary graph of the mean male and female average stature of each site (in cm). Data are derived from table 5.8.

Contemporary male stature data for Vichte come from nineteenth-century historical sources that were, for example, applied by Alter *et al.* (2014), who investigated the height of young men from seven communities in the eastern part of Belgium to illustrate the effects on growth arising from 'mechanization in rapidly growing cities'. The mechanisation of textile manufacturing in Vichte, however, was only initiated in the last quarter of the nineteenth century as occupational activities were previously mainly concentrated on agriculture and weaving (Blockeel 1975: 18-19). Thus, it is likely that most mean stature data from Vichte reflect the rural, agrarian context before the onset of industrialisation in the parish. Two of the seven case studies presented in Alter *et al*.'s paper, Limbourg and Verviers, with principal activities focused on textiles, show a life expectancy at birth of 40 and 32 years old respectively, circa 1846 (Alter *et al*. 2004: 234). The conscription lists of the young adult males reveal further a relatively short stature of between 161.6 and 166.9 cm for Limbourg and Verviers (Alter *et al*. 2004: 240), which is, without considering the average standard deviation of 3.39 cm, and taking into account that stature was measured from all adult age categories, slightly shorter than the average male stature of 170.2 cm for Vichte. The difference in stature could be interpreted as resulting from the discrepancy between estimations of archaeological remains and of the aforementioned in-vivo standing height or they could express the detrimental effects of the industrialisation process during the transition period in the early nineteenth century as observed in the historical data. On the other hand, differences were also noticed in occupations before and after 1850, especially between the shorter rural and urban labourers, and the taller skilled industrial workers, and students and other white-collar occupations, but demonstrated an inverse growth after 1850 among the poorest workers (Alter *et al.* 2004). Alter *et al.* (2004) suggested that the differences in stature between the occupational groups are likely to reflect income and wealth, rather than being the consequence of diseases. Thus, it can also be assumed that the average higher male stature of Vichte may indicate changes in hygienic standards that occurred in the course of the nineteenth century in the village (Blockeel 1975: 19). However, the mean average female stature of 158.2 cm in Vichte is among the lowest of the six sites, and this could demonstrate a variation between male and female responses to environmental and nutritional stress during childhood, which is also reflected in the statistically significant difference between male and female frequencies of EH as illustrated in 6.3.2.

The nineteenth-century female stature data from the West-Flemish village of Vichte nevertheless correspond to the historical demographic study of Devos (2006), which demonstrates the evolution of the average height of males and females in Flanders since the eighteenth century, but further notes a lower stature in the western areas compared to that of the peasants in the province of East Flanders. Devos (2006: 136) supports Komlos' (1998) hypothesis that the average stature of peasants shows a negative correlation when being not self-sufficient, but instead market-oriented, resulting to a decline in food consumption, and hence nutritional status. The fact that the majority of peasant farms in West Flanders were market-oriented, and the higher intake of potatoes and lower consumption of dairy products might indeed have led to a shorter average height of the peasants in West Flanders in the nineteenth century (Devos 2006: 134). However, the male Vichte data do not corroborate this as the male average height of c. 170.0 cm is higher compared to the male average of c. 165.0 cm described in Devos' (2006: 118 and 129) study, but does show similarities with eighteenth-century stature data from adult men in East-Flanders. Of course, in-vivo height measurements taken from conscripts at the age of nineteen years old may, in most of the cases, not reflect the final attained height, as sometimes males grow until the age of twenty-three (Devos 2006: 124). Moreover, if skeletal anthropometric data of earlier periods were available for Vichte, then more conclusions could be drawn whether or not a decline in height happened in the nineteenth century. Conversely, this applies as well for nineteenth-century skeletal stature data for the sites in the other provinces: Deinze, Moorsel and Zottegem in East-Flanders and Oosterweel in Antwerp. It is most likely that the coalescence of multiple causative agents such as long periods of malnourishment in combination with poor sanitation and chronic infectious diseases do have a long-lasting effect on the final attained height rather than just one singular factor such as diet (Devos 2006: 127, 129-131 and 133).

Gustaffson *et al.* (2007: 862 and 868) remark on the ambiguous results of several archaeological and clinical studies concerning whether or not male stature is more sensitive to environmental and nutritional fluctuations, and that 'female growth is more buffered against hardship'. Their findings do not underline the hypothesis of a prevailing plasticity of male stature over female stature. In general, men are, on average, taller than women and the evaluation of SSD (sexual stature dimorphism), or the male to female stature ratio within one cultural group, ranges around a mean of 1.07 as shown by several 'cross-cultural studies' (Gustaffson *et al*. 2007: 862). Only Deinze displays a similar mean SSD of 1.07, and the other sites show a range between a lower SSD of 1.04 (Moorsel and Slijpe) and 1.05 (Oosterweel), and a higher ratio of 1.08 (Vichte) and 1.09 (Zottegem). The SSD's of Vichte and Zottegem corroborate the reasonable assumption that 'populations with above average mean stature should be more likely to display a high SSD', and a lower SSD in populations could suggest a 'substandard nutritional level' (Gustafsson and Lindenfors 2004: 255 and 259). On the other hand, the female groups of Slijpe and Moorsel show the tallest average height of the six sites of 161.3 cm and 161.8 cm respectively, which is similar to the high-status females of, for instance, Meldert (161.0 cm) (Vander Ginst and Vandenbruaene 2006), to the post-medieval rural females from Elst (162.0 cm) (Baetsen 2008), and to those of the monastery of Aalst (160.0 cm) (De Groote *et al.* 2011). These results may indicate a similar response to environmental stress between both sexes during childhood, perhaps also illustrated by the fact that were no statistically significant differences for the prevalence of stress indicators like EH and CO between males and females in Slijpe. Despite the highest frequency of CO in Slijpe, it did not affect the final attained height of most adult males and females identified with CO, which could indicate that catch-up growth occurred, and thus demonstrates the possibility of full recovery from malnourishment during childhood (Singh *et al*. 2014). Schats (2017: 129-130, 151, 161) revealed no significant differences in mean stature of both sexes from the late-medieval coastal site of Klaaskinderkerke, which had the highest CPR for CO, compared to the late-medieval urban site of Alkmaar, with a lower CPR for CO, suggesting that the observed differences in stress did not impact adult stature.

The high-status female group of Oosterweel had, compared to Slijpe, a similar average stature of 161.1 cm, however, TPR data of EH was observed as statistically significant between males and females (see table 5.38). CO and EH were further not reported in post-medieval Moorsel. Activities at the rural sites of Slijpe, Moorsel and Oosterweel involved cattle (Limberger 2000; Meys 1981; Pieters 1986; Smet 2012), and the production and consumption of milk and beef may have a positive effect on growth as suggested by Koepke and Baten (2008: 143).

Disease susceptibility in early life and a greater exposure to pathogens due to urbanization are also causal factors of growth disruption (Gowland 2015; Steckel 2004). Urban Deinze exhibited the highest CPR's of evidence of respiratory infections of the six case studies. Whilst there was no statistically significant difference between males and females for the prevalence of respiratory conditions, Carey *et al.* (2007) pointed out that the development, severity and vulnerability to lung diseases is presumably gender related. Sex hormones could indeed influence both the development of pulmonary afflictions or 'serve as protective factors'. During growth, males tend to have larger lungs than females, and 'minor changes in lung structure and development can have a major impact on respiratory health in later life' (Carey *et al.* (2007). Female sex hormones tend to have a strong impact on, for example, the prevalence and gravity of a lung disorder such as asthma, especially during pregnancy, which can exacerbate the situation with several asthma-afflicted women, as demonstrated by clinical reports (Carey *et al*. 2007). Moreover, a recent cross-sectional study that involved medical records from over a million adults in the UK, concluded that 'people (both men and women) who develop chronic lung disease are more likely to be shorter in height than the general population', particularly affecting those from deprived social groups during early life stages (Ward and Hubbard 2011). Thus, it could be assumed that the prevalence of respiratory diseases for both sexes within Deinze might have contributed to their observed shorter mean average stature. In Vichte, only one young adult male showed evidence of a pulmonary infection, therefore, there might be another reason to explain the difference in height. Exposure to inferior socio-economic conditions (e.g. disease and nutritional) during infancy seems to affect the maximum attained female height much more than the height of males, which could be explained by the fact that 'boys were shielded from variation in these conditions by their parents' (Baten and Murray 2000: 368). The TPR's for CO and EH were lower compared to the sites of Oosterweel (EH) and Slijpe (CO and EH), and conversely, the mean average height, especially of the female adults, was at least c. 3.0 cm taller. With the likelihood of malaria, or polder fever, in Oosterweel and Slijpe, it would be worth knowing other stature data of historically documented malaria infected regions such as those from, for example, Schatz's (2015) or Gowland and Western's (2012) studies, as one would also expect a low height amongst those populations when susceptibility to environmental stress factors is noticed. Alternatively, exposure to malarial parasites during childhood was not statistically significantly associated with a delayed physical development or major differences in height and weight as revealed by a modern clinical study (Fink *et al.* 2013). Therefore, other factors with a deteriorating effect during growth, e.g. a different quality of nutrition, a divergence in sanitation and living conditions, might have caused this imbalance in stature in Vichte.

Certainly, reduced height does not imply a reduced life expectancy, as Tassenaar and Karel (2016a) have demonstrated a positive relationship between the shorter Jewish young adult male conscripts, who achieved a higher life expectancy, and the taller farmers in the Dutch rural province of Drenthe in the nineteenth century, and they suggest that the difference in longevity may be related to 'religious rules concerning physical hygiene and preparation of food' within the Jewish community. Meanwhile, it is suggested that the potato crisis which affected the Netherlands between 1845 and 1847 led to a 'decrease in mean height of 2.2 centimeters over the years 1847–1860' (Tassenaar and Karel 2016a: 668). Differences between the sexes were noted by Baten and Murray (2000), who concluded that, apart from the potato crisis, the prevalence of TB contributed to a decline in the height of women. These two factors did not significantly influence the height of men, or they must have encountered catch-up growth in adult life (Hauspie 1976: 261), but rather economic conditions in the first years of life were crucial for adult height. Although the Jewish male conscripts were less dependent on the cultivation of potatoes, and consumed fewer animal proteins, Tassenaar and Karel (2016a: 669; 2016b: 140) propose that the reduced height may indeed be the result of their more vulnerable socioeconomic position and large 'sibships', or, even more, of higher food prices and restricted access to nutrition. On the other hand, stature data of the male conscripts were taken at the age of nineteen years old, and it should be noted that men could still grow after this age, as noted above (Devos 2006: 124).

Also, it could be that more and better food was distributed in favor of male family members since they were regarded as the principal wage earners of the family, and hence needed to be in good physical shape to be able to deal with any arduous work (de Beer 2007: 110 citing Johnson and Nicholas 1997). If the final attained adult stature of women is indeed considered to be more affected by socioeconomic, nutritional, and disease circumstances in early childhood than the stature of men (Baten and Murray 2000: 368), this could explain the lower mean average stature of women in Deinze and Vichte.

6.4. Diet and Dental Pathologies: Skeletal, Historical and Archaeological Evidence

Evidence for dietary habits of past populations is mostly found in historical documents, bioarchaeological remains, and archaeological findings from, for example, cesspits, rubbish pits, or even by the unearthing of a single oven at a site (Sloane and Malcolm 2004: 208). In human skeletons, the prevalence of dental pathologies such as ante mortem tooth loss (AMTL), carious lesions, periodontal disease and dental abscesses are usually an indication of the diet and oral hygiene of a population (Waldron 2009: 236). Patterns of dental wear may even demonstrate socio-cultural behaviour (e.g. clay pipe smoking, artificial deformation, the use of teeth for activities) (Harvey *et al.* 2014: 55; Roberts and Manchester 2010: 79-82; van Dijk *et al.* 2014), or from calculus, which may contain non-dietary microdebris like bast fibres, micro charcoal and wood dust used to interpret occupational crafts such as pottery making, weaving or spinning (Radini *et al.* 2016).

6.4.1. The Skeletal Evidence

Results of the other dental pathologies, next to the above discussed EH, analysed in this study (AMTL, caries, periodontal disease and abscesses) are presented in 5.4.

In general, there were no statistically significant differences between both sexes for the prevalence of periodontal disease and abscesses in the six sites. Abscesses were not recorded in the high-status group of Oosterweel, in post-medieval Moorsel and in all subadults with teeth available for analysis. Most abscesses were recorded in Slijpe (1.8%), opposed to Deinze (1.0%), Vichte (0.7%) and Zottegem (1.1%). The prevalence of abscesses may be the consequence of poor oral hygiene, and can lead to an increase in plaque formation. TPR data of dental caries, on the other hand, was reported as statistically significant between males and females in Deinze, Moorsel, Oosterweel and Slijpe. The consumption of cariogenic foods such as sugar and fine white flour resulted in an increase in the rate of dental caries since the post-medieval period (Hillson 1996; Roberts and Manchester 2010: 68-69), and its higher frequencies are often attributed to the rising import of cane sugar from overseas regions or enhanced milling techniques to refine flour (Lewis 2017: 70; Polet 2010: 55-66). However, the TPR of caries in the late-medieval males of Slijpe (12.2%) was higher than those from the nineteenth century parish of Vichte (8.9%). When considering the TPR data for caries of the complete skeletal collections, then the result of Slijpe (9.0%) was lower than Vichte (9.7%). Also, it should be noted that the sample size of male teeth of Slijpe (n=402) was much larger than those from Vichte (n=146). Furthermore, carious lesions were identified in both sexes from all sites, and observed the most within the high-status females of Oosterweel (17.2%) and within post-medieval Moorsel males (23.2%). When comparing intrasite variability of caries frequencies, only females of Vichte and Oosterweel showed a higher frequency of caries compared to their male groups, with a minimal difference in Vichte (males: 8.9%; females: 10.6%) (fig. 6.5).

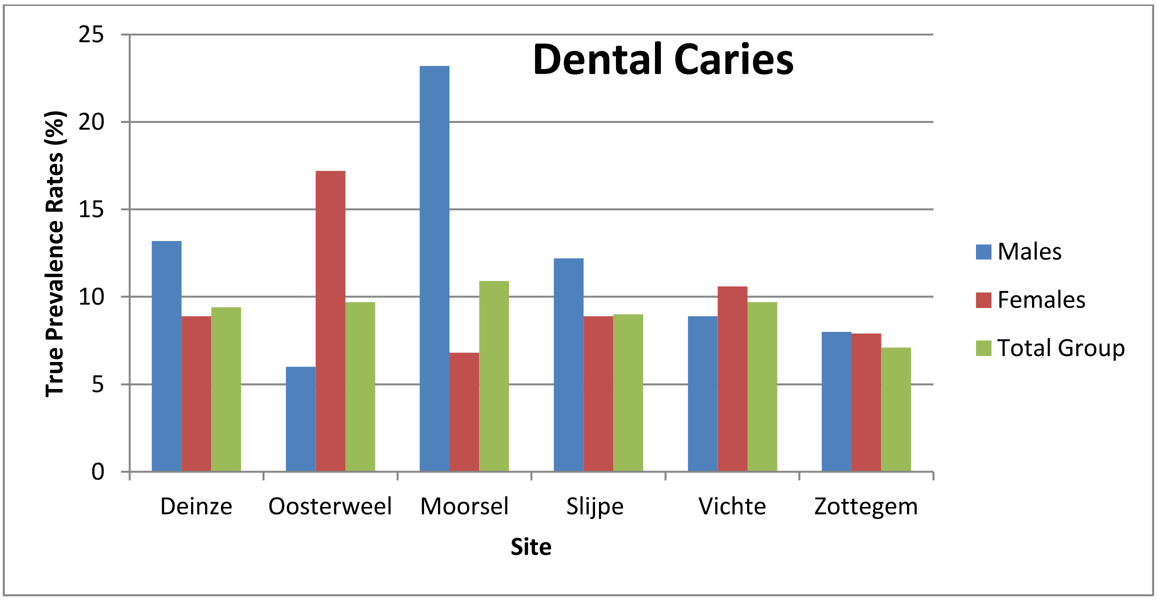

Fig. 6.5: Summary of the TPR's of dental caries across the six case studies. The total group includes all skeletal individuals with teeth available for analysis based on the TPR data of table 5.35.

Caries, whether minimal or large, are commonly reported in archaeological populations, even regardless of social status or sex as demonstrated by Mant and Roberts (2015) in their study on both a post-medieval working-class and middle-class population from London. The prevalence of caries in diverse social classes may indicate a similar consumption of cariogenic (and even non-cariogenic) foods, and could therefore be an illustration of 'downward diffusion'. Dyer (2005: 134-135) referred to fifteenth-century historical sources in which, for instance, artisans shared a similar high protein diet with priests during the Late Middle Ages, with a preference for white bread, meat and fish, and this may be an imitation of the aristocratic diet by individuals with a lower status.

A few other studies have shown similar frequencies between males and females in the prevalence of dental caries within medieval and post-medieval groups (Mays 2007: 133), and this could indicate comparable dietary behavior or behavioral resemblances in oral hygiene. Other dental studies, covering both various geographic locations and time periods, however, reveal more carious lesions with females than males, suggesting factors such as earlier eruption of the teeth in girls, and therefore allowing longer exposure to the cariogenic influences, nutritional differences, limited or distinct access to food during famine, hormonal fluctuations and a weakened immune system during pregnancy as plausible explanations (Larsen 1995: 189; Lewis 2017: 68; Mant and Roberts 2015: 199; Walter *et al.* 2016). In most historical societies, and certainly in medieval households, women were responsible for the preparation of meals, and thus allowing them a greater intake of carbohydrates during cooking, the main source for oral bacteria and caries development (Larsen *et al.* 1991: 198). Despite the possibility of gender differences in cultural or social behaviour to explain the usual greater prevalence of dental caries with women, Walter *et al.* (2016: 37-38) stress the importance of including biological factors such as increasing estrogen levels, which may have a more significant impact on the frequency of caries. The statistically significant results in this study may illustrate differences in oral hygiene or consumption seeing the fewer carious lesions in females of Deinze, Moorsel and Slijpe and in males of Oosterweel. A similar pattern of a higher caries prevalence in males was demonstrated by Schats (2007: 174) in the late medieval coastal population of Klaaskinderkerke. Schats (2007: 174) drew an association between a high frequency of caries and an increase in alcohol consumption since beverages high in alcohol may affect the salivary glands leading to tooth decay and a higher risk of cavities. Thus, it is possible that the higher prevalence of caries observed in the Deinze, Moorsel and Slijpe males may be related to the consumption of alcohol since the importance of local beer brewing in Flanders from the late medieval period (Segers 2001; Unger 2007). Another possible explanation for the difference between males and females in the prevalence of caries may be that females consumed less cariogenic foods or starchy foods containing carbohydrates such as bread and grains, or consumed more dairy products and milk since they contain cariostatic and protective properties against caries (Hillson 2008: 313; Tanaka *et al*. 2010).

Caries and periodontal disease may cause AMTL (Hillson 1996), and seeing the higher true prevalence rates of AMTL compared to caries frequencies for both male and females at all sites, it may be argued that caries, or any other dental disease, would be the underlying source of AMTL. In addition, AMTL was mainly recorded in Oosterweel females (29.4%), and in both sexes of Moorsel (males: 43.6%; females: 28.7%) and of Vichte (males: 51.4%; females: 38.8%). Apart from Oosterweel, the TPR of AMTL was higher in males than in females in all other case study sites. Differences between males and females for AMTL were statistically insignificant in Zottegem only. Within all sites, males exhibited a higher prevalence of periodontal disease than females, and this disease was observed mainly from the age of 36 years for both sexes. Periodontal diseases often lead to AMTL, and are usually observed with older adults (Hillson 2005).

Subadults from all sites with teeth available for analysis (Deinze, Moorsel, Oosterweel, Slijpe and Zottegem) did not exhibit abcsesses, AMTL and periodontal disease. Caries, in contrast, were noticed in subadults from Deinze (2.0%), Moorsel (3.8%), Slijpe (1.3%) and Zottegem (6.5%), but were not observed in the Oosterweel subadult. The difference between adults and subadults for caries was statistically significant in Deinze, Moorsel and Slijpe (as illustrated in 5.4.1.). An association between age and AMTL was also observed as statistically significant in all sites apart from Oosterweel, wherein AMTL was recorded in all adult individuals. Many dental diseases are commonly reported in skeletal collections to be associated with an increase in age since they may reflect an accumulation of years of being susceptible to oral pathogens, and thus resulting in an increased risk of obtaining dental afflictions at an older age (Walter *et al.* 2016: 35). Consequently, a population consisting predominantly of older adults would have higher frequencies of dental lesions than a younger assemblage, and therefore dental data should consider the age of the analysed population (Roberts and Manchester 2010: 83).

6.4.2. Historical and Archaeological Evidence of Diet

A historiography of food consumption in Belgium was published by Van den Eeckhout in 2002, who, similarly to Devos (2006: 144), criticizes the initial dearth of a historical socio-cultural approach in food studies until the end of the 1980's, when the theme was mainly studied by the historian Peter Scholliers, who added a socio-cultural perspective in the debate with the inclusion of the concept of 'identity' (Scholliers 2001; Van den Eeckhout 2002: 373-374 and 383). Schollier's (2001) assembly of papers in 'Food, Drink and Identity: Cooking, Eating and Drinking in Europe since the Middle Ages' explores several notions of identity regarding food matters such as social differentiation, or questioning national or regional identities, but unfortunately, does not include any scholarly articles on Belgium, as also remarked by Van den Eeckhout (2002: 383). Van den Eeckhout's critical paper, however, is particularly focused on food studies addressing the nineteenth and twentieth centuries.

Apart from the work by Scholliers, Van den Eeckhout (2002: 383) further notes a new class of scholarly papers by authors such as Segers and Beyers.

Indeed, since 2000, studies of food consumption in Flanders throughout the nineteenth century have been thoroughly assessed by the historian Segers (2001), building on the extensive earlier studies from other scholars such as Lis and Soly (1977) on Antwerp, Vandenbroeke (1973) on mainly Ghent and Brussels, and Van den Eeckhout and Scholliers (1983, 1986) on living standards of Belgian working-class households in general. Segers (2001) used the *octroi* tax, a charge levied on consumer goods, and revealed a general decline, mainly due to higher retail prices, in the consumption of meat, fish, rye, wine, beer and gin in eight Flemish cities, whereas a rise in the intake of potatoes and wheat indicates that the average diet became considerably less varied between 1800 and 1860. Next to a growing polarisation between poor and rich in urban areas, similar patterns were observed in the countryside, with a decline in purchasing power until at least 1895, when the ‘caloric intake of the average Belgian' was surpassed above the minimum standard. From then on, the diet showed more variety to enable adequate nutrition with less potatoes and bread, but more meat and dairy products (Segers 2005: 520 and 532).

Rural areas in the provinces of East and West Flanders witnessed poor living conditions between for example 1846-1849, primarily because day labourers and those engaged in spinning and weaving activities became unemployed because of the crisis in the rural linen industry (Devos 2006: 110-111). The raise of textile products that were developed mechanically generated cheaper textiles, provoking a decline in wages and thus purchasing power. Food consumption *per capita* was low, and 'the nutritional value of the average Belgian remained under the minimum caloric limit' of the daily c. 2.500 calories (Segers 2005: 525 and 529). Unsurprisingly, the consumption of beer continued to be the 'no. 1 national beverage' because of the deficient water quality, especially in towns, and was also considered as a cheap substitute for large calorie intake. Even more, regional differences in beer consumption have been noticed since the late medieval period, with less drinking of beer in Bruges and Ghent compared to the cities of, for example, Antwerp and Brussels (Segers 2001: 315-316). Although Flanders was indeed an important centre for both local production and consumption of beer, it relied chiefly on imports from Germany and Holland (Unger 2007: 96). A spirit such as gin, on the other hand, is considered as a typical working-class drink, and was particularly consumed in Ghent, based on annual numbers of gin consumption per head between 1800-1844 (Segers 2001: 318 citing Stevens 1847: 418-433). Although Segers does not report on Deinze in his paper, the production of gin was a significant economic activity in this small town by the end of the eighteenth century (Stabel and Dambruyne 2003a: 152) (see also Chapter 2).

Food and drink consumption in Flanders before the eighteenth century has been investigated as well by some of the aforementioned scholars such as Vandenbroeke (for example, wine and the cultivation of potatoes), and Van den Eeckhout, but these studies clearly represent a minority compared to the abundance of studies focusing on the last 200 years. Although Schollier's (2012) latest collection of papers that adds a worldwide perspective on the history of food, from the Ottoman Empire and the Far East to Africa and the Iberian world, does, again, not include a study involving Belgium, more attention is given to the interdisciplinary scope of integrating natural sciences, and how this approach and incorporation of new trends may inspire food historians (Scholliers 2012: 59 and 65). In this volume, Freedman (2012: 27) for instance, refers to the progress made in stable isotope analyses, archaeozoology and palaeobotany, to enhance our understanding of medieval cuisine among different social groups.

In Belgium, modern techniques such as stable isotope analysis in studies of diet among past populations have been applied by Polet and Katzenberg (2003), on the medieval monastic community of the Dunes abbey in Koksijde, and by Quintelier *et al.* (2014), on the post-medieval Carmelite friary at Aalst. Another application of stable isotope analysis was carried out by Müldner *et al.* (2014), who used herbivore bones to explore animal husbandry until the fifteenth century in the Flemish coastal plain. Zooarchaeological data on the other hand were applied to present Flemish sea-fish consumption in the Middle Ages (Van Neer and Ervynck 2016), or the consumption of meat in medieval to post-medieval towns (Ervynck and Van Neer 2017).

Among the sites addressed in this study, only stable isotope data from nineteen skeletal individuals from Slijpe were available, and these were analysed by the Royal Institute for Cultural Heritage (KIK) in 2012 and listed by Smet *et al.* (2012: 153). The analysis suggests, perhaps surprisingly, as stated in the archaeological report by Smet *et al.* (2012: 133 and 153), a carnivore diet, and not marine consumption, as one would assume for a coastal population. Despite an evolution in fish consumption as indicated by archaeozoological information (see e.g. Ervynck *et al.* 2014 for a list of papers), the isotope diagrams in the latter study on Roman to post-medieval Belgian sites (including Slijpe) show different results, which lead Ervynck *et al.* (2014: 786) to the conclusion 'that freshwater or marine fish have never played a dominant role in human protein uptake throughout the last 2 millennia' in the Belgian case studies of their overview, and the meat of terrestrial animals, or the edible seeds of plants (pulses) must have been a primary source of proteins. On the other hand, consumption of marine products in monastic sites was revealed through stable isotope analysis with a preponderance of high-status male burials inside the church from the Carmelites in Aalst (Quintelier *et al.* 2014), and with the monks from the Dunes abbey in Koksijde (Polet and Katzenberg

2003), and is supported by archaeozoological evidence from several Flemish monastic communities that indicates the importance of fish as a food product within the abbeys (Ervynck 1997: 78). If fish consumption was indeed mainly reserved for the elite (Woolgar 2010), it would explain the consumption of meat by the low-status individuals from coastal Slijpe as suggested by the stable isotope analysis. Mutton or lamb, for instance, could have been a main source of protein, as stable isotope data taken from sheep bones from the nearby medieval site of Leffinge indicate husbandry strategies such as sheep herding in the salt-marshes in the newly acclaimed polder area (Müldner *et al.* 2014). A diet consistent of meat, here containing sheep, but also pigs, cattle, goose, duck, chicken, and sporadically rabbit and red deer, was nevertheless demonstrated by archaeozoological analyses from another adjacent site, the late medieval fishermen's village of Raversijde (Pieters 1997: 175). Here, the consumption of shellfish and marine fish such as plaice and herring by the villagers was also suggested, although the finding of a pit with a high concentration of fish bones from at least 130 plaice with specific cut marks behind the head and caudal fin, may indicate residues of 'plaice processed for future consumption and export inland' (Pieters 1997: 175).

The recovery of, for example, herring and cod bones and shell fragments of oysters and mussels at several inland medieval sites (as for example observed at the tenth-century *portus* site of Ghent), probably indicates transport of marine fish species in a processed form (i.e. beheading and/or splitting the fish to facilitate preservation methods such as salting and drying, a development which was accelerated by the raise of urban markets (Van Neer and Ervynck 2016). An increase in marine fish consumption and trade was stimulated by innovation in fishing techniques, a development that was also noticed during the tenth and eleventh centuries in Britain, and was defined by Barrett *et al.* (2004: 623) as the 'fish event horizon'. The consumption of freshwater fish, however, showed a decline at several Flemish towns during the late medieval period, and is explained by 'a decrease in inland fish stocks due to the pollution of waters in and near towns, due to over-fishing, and due to the negative effects of water management works' (Ervynck and Van Neer 1998: 89; Van Neer and Ervynck 2016).

6.5. Occupational Diseases

Weaving and spinning activities were commonly undertaken inside the farms of the peasants and a paste that was usually made of starch (from e.g. potatoes), sugar, alum and water was used to strengthen the yarn (Butterworth 1822: 128-131). Linen production is associated with a humid environment as the thread for spinning and weaving must be moist (van Gorp 1984: 58; Wincott

Heckett 2003: 57). This fluid dressing, however, left dust behind on the weaving-loom which in turn may have led to pulmonary diseases like 'asthma, chronic bronchitis and tuberculosis' (De Wilde 1997: 154). Moreover, the monotonous, repetitive tasks of handling the loom and mastering the pedals in a mostly bent position of the spine must have caused lower back pain (De Wilde 1997: 154). Women, in contrast, had at least the opportunity to take the spinning wheel outside from the dark, unhealthy space in order to work in the open air (De Wilde 1997: 154-155). The possibility of spinning outdoors was shown in a study by Evans (1985) on the East Anglian linen industry where women engaged in spinning in the sixteenth century in Ipswich (UK) were noticed 'at their wheeles out in the streete (sic) and lanes as one passes' (Evans 1985: 111). However, Standley (2016: 289, 291 and 293) argues that spinning does not necessarily imply a demarcation between an industrial process and domestic task in the growing textile industry since 'the portable nature of the spindle' indeed indicated that spinning could be conveniently undertaken anywhere. She suggests that spinning and weaving were carried out by both sexes on both urban and rural sites based on historical and iconographic sources that listed either a combination of male occupations such as brewer and spinner, or illustrated that women were weaving too (see Chapter 2).

The Italian physician, Bernardo Ramazzini (1633-1714) (also cited in Chapter 2, section 2.7.6.), is considered as the father of occupational and environmental medicine since his influential publication 'De Morbis Artificum Diatriba' ('Diseases of Workers') from 1700, which described the health risks of 52 occupations, including the exposure of workers to chemicals or dust in textile and flax production such as silk carders and bleachers. Ramazzini depicted the carders as 'pale looking' and 'breathing like asthma patients', especially during winter, when the work is carried out in closed and unventilated rooms, which thus exacerbated the respiratory system due to heavy coughs and difficulties breathing which are life-shortening threats (Ramazzini 1777). Moreover, Ramazzini (1777: 341-347) outlines the particular pulmonary health damaging effects of using silkworms, and assigns the occupational death of a whole family, whose members all worked in the silk industry, to *phtisie*, or a contagious disease nowadays defined as TB. The autopsy on five other individuals working in flax and hemp cultivation also revealed pulmonary lesions by their suppurated and inflamed lungs, which were attributed to dust exposure (Ramazzini 1777: 346).

Another substantial work on the causative agents of diseases observed in professions was written by Thackrah in 1832 (also cited in 2.7.6.), who described health hazards in 120 crafts such as among bleachers inhaling chlorine, and who further remarked on a difference in the health status of the tanners compared to Ramazzini's eighteenth-century study, of which the latter observed a faltered breath among tanners. Thackrah (1832: 61-62), however, recorded tanners as being in a better shape, which might be due to the fact that there were hardly any older men working in the tanyards, but that the activity instead was undertaken by healthy, younger male adults. He has further observed that mature individuals, who had been working as tanners for several successive years, did not even experience illnesses, and queries these discrepancies with Ramazzini's (1777) study as either being subjective observations, or as the result of other processes, or working conditions (Thackrah 1832: 61). Notwithstanding Thackrah's pioneering work on occupational health, especially on the implications of child labour in the industrial environment, Kirby (2013: 5 and 33) argues that 'Thackrah's opinions about factory work were, in fact, quite theoretical', noting that Thackrah's statement that strenuous labour 'shortened the lives of workers' was not formed by 'personal observation but from medical reading'.

Both studies laid the foundations for clinical recognition of occupational diseases, and similarities were noticed with the weavers who endured respiratory complications because of the dust, as a result of which 'they do not commonly live beyond the age of 50' (Thackrah 1832: 55, 61-62, 68). More severe exposure to dust was reported during the manual process of flax heckling in the mills, with not only men, but also children carrying out the task, and those 'in the most injurious to health' occupation are generally depicted as being unhealthy and exposed to pulmonary exhaustion, and even documented to die chiefly at a young age, mostly between the ages of eighteen and 30 years old (Thackrah 1832: 70-71 and 78). Thackrah (1832: 72-81) medically examined several flax workers of both sexes, with many of them having started work in childhood, and thus have been working for more than a decade in flax manufacture. They were indeed predominantly diagnosed with a chronic bronchitis, severe coughs and difficulties in breathing. Other pulmonary infections such as TB were commonly noticed among silk weavers in England (and females enduring a 'distortion of the pelvis'), and by the prevalence of rickets, (or deformed lower legs), spinal diseases, low stature, varicose ulcers of the legs, cervical TB (scrophula) and muscular pain amongst the silk workers in the French city of Lyons (Thackrah 1832: 38).

Hence, pulmonary afflictions might have been common among the flax and textiles workers in the region of the Leie-river. The process of retting flax, for instance, was preferably undertaken in streaming water, and the high standard quality of the retted flax was not only attributed to the excellent water condition of the Leie (and likely because of the color it obtained after the retting activity), but also to the expertise and the arduous work of the labourers, by which the Leie became internationally acclaimed as the *Golden River* (Demasure 2012: 27; Dewilde 1983: 387; Schrooten 2004: 94). Because retting involved a high risk of water pollution and fish mortality, one of the earliest bans on retting in the Leie was imposed in 1406, but labourers continued soaking the flax stems in its tributaries, which often culminated in disputes since the water was also used for other activities such as fishing and beer brewing (Dewilde 1983: 21; Schrooten 2004: 100-101; Slicher van

Bath 1976: 297). Other ways to circumvent the law were noticed in sixteenth-century historical accounts that alluded to the prosecution of labourers who, despite the prohibition of retting flax in streaming water, persisted in employing the Leie for this task. Moreover, in 1725, the mayor of Kortrijk expressed his concerns over the polluted Leie-water that had not only caused fish and livestock death, but also implied risks for contagious diseases among the inhabitants (Warlop and Wyffels 1968).

It appears that malnourishment, a frequently reported low stature, and mainly pulmonary and respiratory diseases were common afflictions among many weavers (especially of silk), and labourers in general working in textiles and flax cultivation, and thus with a high exposure to dust from textile fibers, certainly between 1700 and 1832, the publication dates of the studies on the effects of professions of respectively Ramazzini and Thackrah. Ramazzini described occupational diseases in 1700, but it is undoubtedly the case that these health risks existed before, and seeing the production of linen and flax in earlier centuries, it is likely that respiratory infections were prevalent among the workers.

The respiratory diseases noticed among the flax and cotton workers have been further clinically scrutinized, particularly during the first half of the nineteenth century, and in the 1950's and 1960's when several papers were published on byssinosis, the new term of the pulmonary affliction after the Greek *βύσσος*, indicating fine linen or flax (Bouhuys 1976; Bouhuys *et al.* 1963; Elwood *et al.* 1982; Schilling 1950; Tuypens 1961; Verbeke and Tasson 1966). Since 1948, byssinosis has been acknowledged as an industrial disease in the UK, seeing a higher occurrence compared to other countries like Belgium, the Netherlands and the US (Schilling 1950: 52; Tuypens 1961: 118; Verbeke and Tasson 1966: 305). In Belgium, byssinosis, although described by the government as a 'lung disease caused by the inhalation of cotton, flax, hemp, jute, sisal and bagasse dust', has been officially recognized as an occupational disease since July 1st, 1973 (listed under code 2.306.02)(Federal Agency for Occupational Risks [FEDRIS], 2017). Verbeke and Tasson (1966: 306) argue that the low prevalence of byssinosis in Belgium (at the time of their publication in 1966) compared to the UK, is related to much older factories and a scarcity in preventive regulations in the latter. Prevention measures such as regular medical examinations of the workers, adequate ventilated rooms and allocation to dust free departments if bronchitis or an asthmatic affection were diagnosed, were introduced (Verbeke and Tasson 1966: 294 and 303).

To date, the modern working facilities, involvement of unions, and dust control procedures have curbed the prevalence of chronic respiratory diseases in the developed countries, while developing countries such as Egypt, Ethiopia, Sudan and India, however, show a significant rate of byssinosis and pulmonary affections, similar to those in the United States and the United Kingdom in the 1950s and 1960s. Therefore, it should be noted that 'lessons learned from the past can be used to speed up the process of occupational risk reduction in these countries' as prompted by Harrison (2007: 492-493). Indeed, even recent medical examinations have revealed predominant occupational symptoms such as 'dry cough, chest tightness and general weakness' in the flax cultivation caused by an allergic reaction to bacteria and fungi as shown in a clinical study from 2000 between 51 Polish flax farmers, who were highly esposed to dust during activities such as scutching and harvesting, and 50 office workers (including smokers, ex- and non-smokers in both the study and control group) (Skórska et al. 2000). Even in the modern era, occupational risks in flax cultivation and textiles production seem still prevalent in certain countries, and therefore regulations and the consolidation of unions in developing countries should be deemed a high priority.

Section 6.6. below presents and discusses the prevalence of joint disease, trauma, infections and other pathologies observed in the skeletal collections of the six case study sites to demonstrate the possible consequences of occupational activities of the inhabitants on their physical condition. The data seek to demonstrate inter- and intrapopulation variation in health and disease patterns that may be characteristic for each case study site.

6.6. Health and Disease Patterns in the Rural and Small Urban Case Studies

6.6.1. Joint Diseases

The data analysis of joint disease within the six sites was presented in Chapter 5 in 5.3.1. Table 6.2 provides an overview of the statistically significant differences for the joint diseases (DDD, vOA, pOA and SIJI) noticed within the six sites between the sexes and/or if a statistically significant association with age of individuals of known sex was demonstrated. For DDD and vOA, TPR data are shown according to both total count of vertebrae (cervical, thoracic and lumbar) and total count of spines. There were no statistically significant differences recorded for DISH.

Joint Diseases	Site											
	Deinze		Oosterweel		Moorsel		Slijpe		Vichte		Zottegem	
	Sex	Age	Sex	Age	Sex	Age	Sex	Age	Sex	Age	Sex	Age
DDD		**0.001**		0.076		0.166		**0.001**		**<0.001**		0.211
C+T+L	**0.002**		**0.002**		**<0.001**		**<0.001**		NA	NA	**<0.001**	
Spine	**0.046**		**0.020**		0.073		**<0.001**		0.342		**0.032**	
vOA		**0.038**		0.352		0.839		**0.012**		**0.003**		**0.034**
C+T+L	**0.002**		0.068		0.227		**0.003**		NA	NA	0.055	
Spine	**0.048**		0.231		0.463		**0.043**		0.385		**0.015**	
pOA	0.163	**0.028**	0.275	0.103	0.537	0.497	0.233	0.178	0.147	**0.018**	0.199	0.178
SIJI	**0.038**	**<0.001**	NP	NP	0.058	0.966	0.620	0.394	0.756	0.192	0.731	0.261

Table 6.2: Overview of the statistically significant differences (p-value; in bold when result was statistically significant) between males and females and between individuals of known sex and age for joint diseases observed within the six case studies. DDD=degenerative disc disease; vOA= vertebral osteoarthritis; pOA=peripheral osteoarthritis; SIJI=sacroiliac joint inflammation; NP=not present; NA=data not available; C=cervical vertebrae; T=thoracic vertebrae; L=lumbar vertebrae.

6.6.1.1. OA of the Spine and Hip Bone

Statistically significant differences between males and females for joint diseases were mostly observed in Deinze, Slijpe and Zottegem. The majority of observed statistically significant differences for joint diseases indicating an association with age are mostly noticed in Deinze, Slijpe and Vichte. The high-status group of Oosterweel exhibited solely a statistically significant difference for DDD between the sexes, with all middle and old adult males affected. Statistically significant differences between males and females were not reported in Vichte, and only for DDD in Moorsel. When considering the count of spines, however, the result of the latter group was statistically insignificant, although the calculated probability of p=0.073 is close to the threshold of significance (p=0.05). The majority of joint diseases were identified with middle and old adult males in all sites. Only SIJI was more common with females from Slijpe, Vichte and Zottegem, and showed an equal distribution between the sexes in Moorsel. Pregnancy is indeed one of the causes of inflammation of the sacroiliac joint, located between the sacrum and the ilium bones of the hip, which may explain that SIJI is the only joint disease observed with more adult females than males from all sites. With females, the disease was mostly identified from the age of 36 years, apart from the rural groups of Moorsel and Slijpe, where SIJI was seen within younger age categories. On the other hand, SIJI was not observed with either sex in Oosterweel, and its absence within the female cohort may be illustrated because of the smaller sample size, or because of less repetitive motion of the hip joint, and thus not because of the mainly younger age group of the skeletal sample. Deinze was the only site wherein SIJI was statistically significant between males and females and where an association with age was observed. It was also the only case study with more males affected from an earlier age of 36 years, than females with whom the disease was noted from the age of 50 years. Another source of SIJI is incorrect lifting of objects, or bending the spine, and is mostly observed in combination with degenerative diseases of the (lower) spinal column with the affected individuals from the case studies. Apart from age as a for the development of SIJI, excess weight and repetitive activities affect the cartilage of the sacroiliac joints, and may eventually lead to osteoarthritis of the hip bone (Hansen and Helm 2003). The different occupational activities between an urban and rural context may explain the statistically significant difference for SIJI for both sex and age in Deinze. Lewis (2016: 161) for instance, reported higher frequencies of lesions of the joints and spine in urban adolescents than in subadults from rural areas in medieval England. Osteoarthritis in the spine was the most commonly affected joint amongst both males and females from the urban population of Alkmaar in Holland (AD 1448-1572), but was also highly frequent in both sexes from the late medieval coastal site of Klaaskinderkerke (Schats 2017: 102, 104, 107). Schats (2017: 167) remarked on the difficulties of interpreting spinal OA and noted that differences in its prevalence may be related to the curvature of the spine rather than reflecting occupational variety. In this study, TPR's of spinal OA (vOA and DDD) indicated a higher prevalence in males than in females in all case study sites, and the spinal degeneration may be related to excessive mechanical loading on the spine, morphological differences, or to the fact that, in general, the groups of middle and old adult males were larger than those of females.

When considering TPR data of the hip joint as shown in 5.3.1.1., males demonstrated more OA than females in Deinze (3.3%), Slijpe (2.4%) and Oosterweel (6.7%). OA of the hip bone was not recorded in females from Slijpe and Oosterweel, males from Moorsel and Zottegem or in both sexes from Vichte. Also, OA of the hip bone was not observed in young adults of all sites.

For a rural context, joint diseases of the hip bone such as OA were specifically associated with farmers, and especially those dealing with a large number of animals (Croft *et al.* 1992; Thelin *et al.* 2004; Thelin and Holmberg 2007). Whilst the environment of the farm is an external risk factor to generate osteoarthritis of the hip, other occupations such as abattoir and construction work, and moreover, activities involving frequent manual handling of loads of over 20kg for more than a decade also develop an increased risk (Juhakoski 2013: 7). Clinical studies have pointed out that hip OA mainly occurs from the age of 40, and researchers seek to clarify this by its long development, or by the fact that 'young people do not generally choose to work in physically demanding occupations'

(Juhakoski 2013: 7-8). On the other hand, in medieval peasant households, children were assigned with chores on the fields or in and around the farm, including more strenuous tasks for older children such as working with larger animals and farming tools, and thus making them prone to both joint diseases and injuries (Lewis 2016: 163). If repetitive motions carried out from a young age do indeed influence the development of degenerative joint diseases of the hip bone and the sacroiliac joint, this might indicate that younger females from the rural sites of Moorsel and Slijpe were involved in farming activities since young adulthood or even since childhood. The lack of hip OA in males from the rural villages of Moorsel, Zottegem and Vichte is rather surprising, and may be explained by the small group of old adults (Zottegem) or by less mechanical loading of the hip joint because of a variety in labour. In post-medieval Moorsel and in nineteenth century Vichte, activities in the countryside involved apart from the cultivation of crops weaving as an additional resource. Inter- and intrasite variation of EC of the lower limb will be further discussed in 6.7.2.

6.6.1.2. OA of the Appendicular Skeleton

Results of OA of the appendicular skeleton (pOA) are presented in 5.3.1.1. in Chapter 5. In the small urban site of Deinze, males are more affected than females for every joint type, with the right side more affected than the left for both sexes. The right sterno-clavicular joint (SCJ) showed the highest TPR for pOA in both sexes (males: 17.6%; females: 8.8%). In the coastal site of late-medieval Slijpe, the pattern is different. Here, the most affected joint in males is the left SCJ (14.3%), while females exhibited most pOA of the right shoulder (6.7%). In Slijpe in general, females demonstrated more OA of the shoulder, elbow, wrist and hand than males. In Vichte, OA of the acromio-clavicular joint (ACJ) was mostly recorded in both males (left side: 33.3%) and females (right side: 26.7%). Only the right and left elbow showed more OA in females (6.2%) than in males (2.6%). TPR data of the hand and carpal bones were unfortunately not available. A similar pattern was observed in Zottegem with the right ACJ as the most affected joint (females: 23.1%; males: 11.1%). Females were more affected with OA than males, and this was specifically noticed in the SCJ, ACJ, metacarpals, hip and knee joint. Females were more affected with OA than males, and this was specifically noticed in the SCJ, ACJ, hand bones (metacarpals), hip and knee joint. In Moorsel, in contrast, OA of the SCJ and ACJ was not observed in both sexes. OA of the left knee was particularly noticed in males (28.6%). Females demonstrated more OA of the elbow (16.0%) and hip bone (7.1%) than males (respectively 10.7% and 0.0%). TPR data of pOA in the high-status males of Oosterweel were mostly seen in the left SCJ (11.1%). The knee (both left and right) was the only affected joint in the female group (14.3%). Here, males showed more pOA than females. In general, pOA of the SCJ and ACJ was particularly common in Deinze, Slijpe, Vichte and Zottegem. In Moorsel, pOA was mostly observed in the elbow and knee and in the knee as well in Oosterweel. Since females outnumber males in the skeletal samples of Slijpe and Zottegem, and males outnumber females in Oosterweel and Vichte, caution is needed in the interpretation of sex related differences in the affected joints.

The CPR data of pOA which is the number of affected individuals varies between 16.7% (Oosterweel) and 42.1% (Moorsel). The percentage of males with pOA was higher than females in all case studies, but the difference was not statistically significant. An association with age was only statistically significant in Deinze and Vichte wherein pOA was mainly observed in middle and old adult individuals. Similar observations regarding the distribution of pOA within adult age groups was noticed in Oosterweel, but here without a statistically significant difference. Further, although minimal, pOA in the young adult group was seen in females only in all low-status rural sites (Moorsel, Slijpe, Vichte and Zottegem), with the left and right elbow and shoulder as the most affected joint. The overall frequency of upper limb pOA in females is consistent with historical studies on female activities in rural villages such as milking cows, washing clothes and churning of butter which all required more strain from the upper limbs as pointed out by Schats (2017: 166). This would explain the particular involvement of shoulder and elbow OA in females from the rural sites.

Inter-and intrasite variation of upper- and lower limb EC and occupational behavior of the six case studies will be further discussed in 6.7.

6.6.2. Trauma

6.6.2.1. Overview of Trauma in the Six Sites

The CPR’s for trauma and the location of traumatic injuries of the skeletal individuals are described in 5.3.2. Fig. 6.6 shows a summary of the CPR's for traumatic injuries of the complete skeletal populations of each site. Trauma distribution according to sex is demonstrated in fig. 6.7.

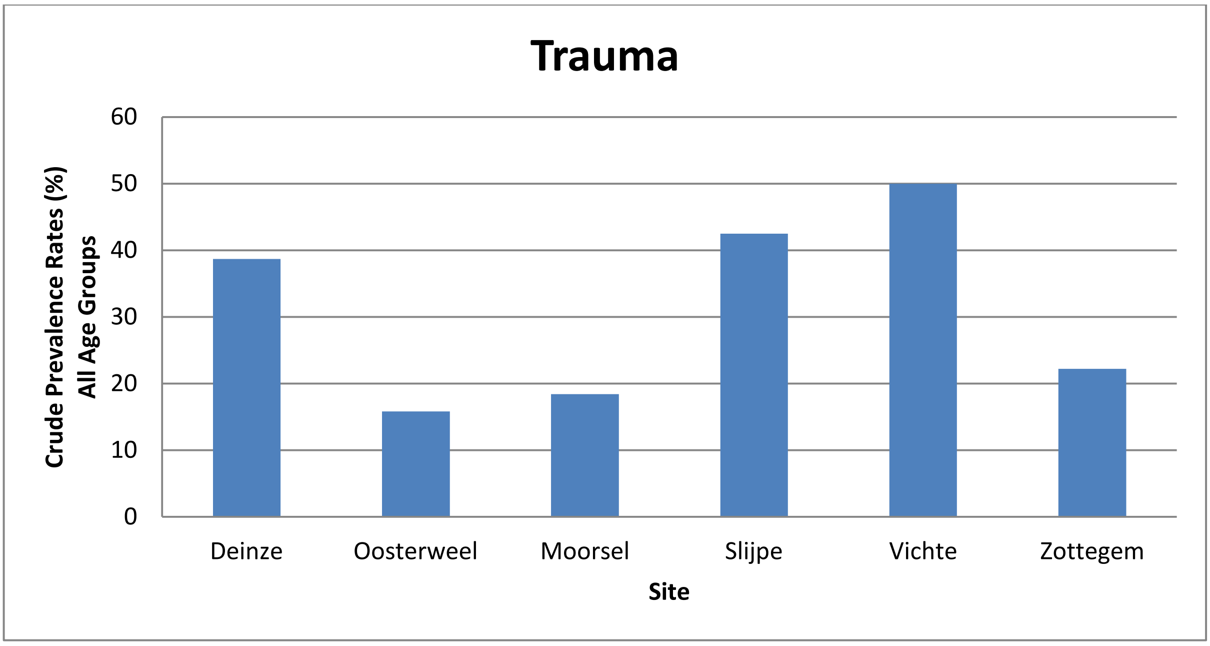

Fig. 6.6: CPR's (Crude Prevalence Rates) in percentages for traumatic lesions within the six sites.

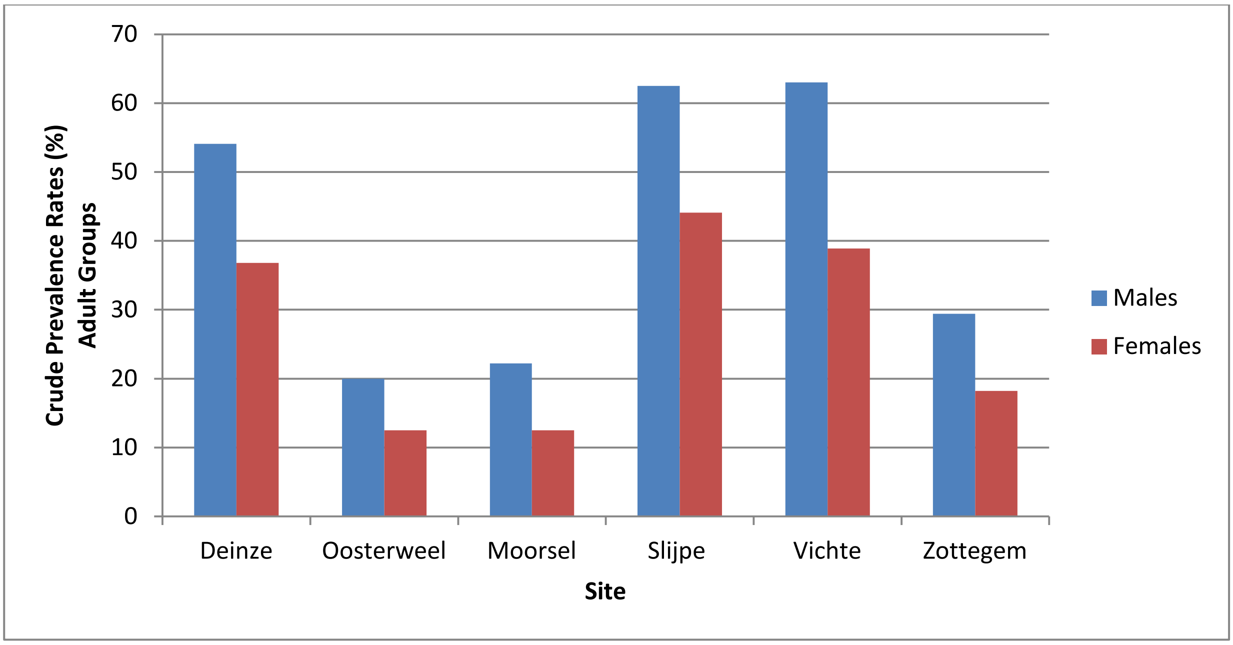

Fig. 6.7: CPR's (Crude Prevalence Rates) in percentages for the distribution of traumatic injuries according to sex within the six sites.

Although CPR data indicate that males were observed with more traumatic injuries than females, there were no statistically significant differences between both sexes. An association with age was only statistically significant in the complete skeletal collection of Slijpe. Trauma in the subadult groups was uncommon. One older child (Infans II group) from Slijpe was observed with an avulsion fracture of both clavicles.Traumatic lesions in juveniles were further noticed in Deinze (three individuals with respectively O.C.D, a possible impacted fracture and an avulsion fracture of lower limbs) and in Zottegem (one individual with a stress or secondary fracture of the left fibula). Sections 5.3.2.1 to 5.3.2.6 list all individuals with traumatic lesions and type of injury.

When considering TPR's of affected bone elements, however, the difference between males and females was only statistically significant in Deinze for fractures of the left femur (p=0.011, one tailed Fisher's exact test). Table 6.3 shows TPR's and CPR of rib fractures in percentages of the observed left and right bone elements of each sex to demonstrate gender specific differences for traumatic injuries within the six sites. Statistically significant results between males and females are indicated in bold.

Location of Trauma						**Site**						
	Deinze		Oosterweel		Moorsel		Slijpe		Vichte		Zottegem	
	M	F	M	F	M	F	M	F	M	F	M	F
Clavicula												
Right	15.6	2.9	12.5	0.0	0.0	0.0	15.0	9.4	9.1	0.0	0.0	0.0
Left	3.4	5.7	11.1	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0
Scapula												
Right	3.0	3.1	0.0	0.0	0.0	0.0	8.3	3.0	4.8	0.0	0.0	0.0
Left	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Humerus												
Right	6.1	6.1	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0
Left	6.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ulna												
Right	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.7	6.3	0.0	0.0
Left	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.5	13.3	0.0	0.0
Radius												
Right	6.9	0.0	0.0	0.0	0.0	7.1	0.0	0.0	9.1	6.3	0.0	0.0
Left	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.7	7.1	0.0	0.0
Femur												
Right	9.4	3.1	0.0	0.0	0.0	0.0	6.3	4.8	0.0	11.8	0.0	0.0

Left	**18.7**	**0.0**	0.0	0.0	0.0	0.0	11.1	7.1	16.7	5.9	0.0	0.0
Tibia												
Right	9.7	0.0	0.0	0.0	13.3	0.0	16.7	0.0	8.7	0.0	11.1	0.0
Left	3.0	0.0	0.0	0.0	13.3	0.0	0.0	0.0	9.1	0.0	0.0	0.0
Fibula												
Right	17.2	6.7	0.0	0.0	6.7	0.0	0.0	10.0	0.0	13.3	11.1	0.0
Left	9.4	6.2	0.0	0.0	0.0	0.0	22.2	0.0	10.0	15.4	25.0	7.7
Cranium	3.4	3.1	0.0	0.0	22.2	9.1	8.3	3.0	9.1	0.0	0.0	0.0
Rib	19.4	6.1	0.0	0.0	0.0	0.0	12.5	5.9	4.3	5.6	8.3	0.0

Table 6.3: TPR's (only rib fractures show crude prevalence rates or CPR's) in percentages for trauma location for both males and females within the six study sites. Statistically significant differences observed between sexes are shown in bold.

6.6.2.2. Trauma in Subadults

Evidence of healing is absent when a fracture happens shortly before or around the time of death, and peri-mortem damage is usually difficult to discern from post-mortem bone cracks (Moraitis *et al*. 2009). Hence most fractures that are identified in an archaeological context are healed (Roberts and Manchester 2010: 89 and 114-115). This might explain the dearth of trauma within the immature individuals of the six sites if a traumatic injury would have directly led to the child's death. Only one older child from the Infans II group (7-12 years old) from Slijpe was identified with a likely avulsion fracture of both clavicles. In general, there is minimal evidence of childhood trauma in the palaeopathological literature (Lewis 2007: 183). Apart from the difficulty in identifying peri-mortem trauma from post-mortem breaks, the identification of injured bones in children may be complicated as well because of their bone plasticity and its rapid healing may obscure previous traumatic lesions (Lewis 2017: 91). The age of an individual certainly determines the healing of broken bones as younger persons seem to recover much faster than older individuals (Roberts 2000: 340). Another explanation of infrequent childhood trauma in archaeological populations may be that 'the child survived and entered the sample as an adult' (Judd and Redfern 2012: 369). Further, it should be considered that many fatal traumatic accidents with children such as ‘drowning, burns, fatal stings and poison ingestion' are not identifiable on the skeleton (Judd and Redfern 2012: 369 citing Baker *et al.* 1984).

Traumatic injuries in adolescents were noticed in Deinze in the right femur (OCD) of a juvenile, in a female juvenis (avulsion fracture of both fibulae) and in a male juvenis of c. eighteen years old, who exhibited a shortening of the right femur and fibula. The shortening of a limb within an adult for example might have been the result of an accident during childhood (Glencross 2011: 395; Lewis 2017: 91; Roberts 2000: 346). Trauma in juveniles from the other case study sites was uncommon and was further observed in the left fibula of a Zottegem female of c. eighteen years old.

6.6.2.3. Gender Differences in Trauma

Fig.6.4 illustrates that males were observed with more traumatic lesions than females in all case study sites. Previous studies of trauma in past populations revealed that fracture rates were in fact higher among males than females, with the suggestion that males are more susceptible to trauma because of their involvement in higher risk occupations, warfare or interpersonal violence (Mant 2019: 10; Roberts and Manchester 2010: 98 and 101-103). Differences in trauma between males and females could be socio-culturally determined as Lovell (2008: 377-378) suggests that, in traditional communities, female fractures mostly happen inside the house, while fractures in males are often the result of outdoor activities or occupations, but acknowledges that a variation is determined by country, age and employment. Specific male occupations such as 'mining, logging and construction' may provoke an increased risk for injuries whereas domestic tasks such as 'carrying water and firewood' could be risk factors for women and children. Other activities such as milking, harvesting and herding of animals may have been carried out by both men and women from different age groups, which may make them prone to accidents due to animal kicks or to falls from ladders (Lovell 2008: 378). In medieval rural samples from English sites, Judd and Roberts (1999) demonstrate different fracture patterns with only males displaying fractures of the humerus and femur, whereas females were mostly observed with fractures of the forearm, the latter suggested because of 'being kicked by cows while milking' (Gilchrist 2012: 61). In the rural sites of this study, humeral fractures were only noticed in the male group of Slijpe (a displacement and avulsion fracture of the right humerus in a respectively young and middle adult), but fractures of the forearm and femur, however, were identified in both sexes of Slijpe and Vichte. Although no males but only females from Vichte were observed with fractures of the right femur (11.8%; 2/17), the difference is not statistically significant (p=0.158, one tailed Fisher’s exact test). In Deinze as noted previously, however, left femoral fractures were seen in six males only and the difference between the sexes was statistically significant. These fracture types of the left femur involve OCD (3), spiral (1), oblique (1) and mysositis ossificans (1) and were seen in all adult age groups. One Deinze female aged 18+ was seen with a dislocation of the left hip. In Vichte, the right femoral fractures in one young and in one old adult female involved solely OCD. Four Vichte males, two young and two middle adults, in contrast, displayed a variety in fracture types of the left femur: OCD (1), oblique (1) and a crack fracture of the knee (2). Although OCD is often observed in males according to Roberts and Manchester (2010: 121), the lesions seen in the medial femoral condyles of the Vichte females are consistent with other studies that report OCD in the same location and are caused by acute macro-trauma or repetitive micro-trauma (Schindler 2007). However, Vikatou *et al.* (2017) investigated OCD in a nineteenth century rural skeletal collection from The Netherlands and revealed that OCD was only diagnosed in the foot of both males and females, and not in other body parts, suggesting this is related to the use of wooden footwear such as clogs since movements of the foot are limited. It is likely that the nineteenth century Vichte farmers would have worn similar footwear, however the Vichte skeletal sample did not exhibit OCD lesions in the pedal elements. Female occupations in nineteenth century Vichte were mainly centered around the house, but rural women often assisted their husbands on the fields and were engaged in dairy farming (Blockeel 1975). Also one Slijpe female was observed with OCD in the right femur. Daily rural activities may have led to repetitive micro-trauma of the knee compared to the small urban females of Deinze and the high-status group of Oosterweel. Traumatic injuries in the other rural sites of Moorsel and Zottegem were less frequent and included mainly avulsion fractures of the spine (Zottegem) and lesions of the cranium (Moorsel). Males from both sites were also observed with stress fractures of the lower limb (also listed in 5.3.2.4. and 5.3.2.5.). Cranial trauma was the highest in the rural male group of Moorsel (22.2%), and facial fractures are often caused by interpersonal violence or falls (Lovell 2008: 353). Principal activities in Moorsel and Zottegem from the late medieval era until the eighteenth century involved the cultivation of crops and cattle in particular. Lamarcq (1989) noted that in Zottegem nearly every villager (such as carpenters, brewers and millers) were involved in agriculture as well. Also in post-medieval Moorsel, the labour-intensive cultivation of crops such as flax, wheat and hop must have placed much strain on the lower legs (Verleyen 1985). The strong urban need and the commercialisation of labour during this era have certainly impacted the physical bodies, and especially the lower extremities, of the rural villagers (Dyer 2005; Stabel 2001; Thoen 2001).

Fractures of the forearm were particularly noted in both males and females from Vichte and may illustrate that certain activities such as milking cows may have been undertaken by both sexes. However, variations within rural populations regarding the distribution of fracture patterns are certainly plausible as suggested by Redfern (2016).

6.6.2.4. Rural-Urban Differences in Trauma

Prevalence rates of fractures by bone elements have thus indicated differences, not only between males and females, but also between urban and rural populations. Redfern (2016) mentions bioarchaeological analyses that have investigated differences between urban and rural groups, and notices that the majority of traumatic lesions with the latter are the result of accidents, rather than interpersonal violence. In their trauma chapter, Roberts and Manchester (2010: 98) have summarised several spatiotemporal studies that demonstrated a high frequency of radius and ulna fractures in rural groups, and lower rates amongst urban populations. In the present study, fracture rates of the ulna and radius in urban Deinze, although only observed in males, were, in general, indeed lower than the rural sites of Vichte and the female group of Moorsel, but were, on the other hand, not identified in the other rural groups of Oosterweel, Slijpe and Zottegem (table 6.3). In fact, in the high-status group of Oosterweel, only male individuals exhibited trauma of both clavicles while no injuries of the upper and lower extremities were identified in females. A small number of malformed fractures in high-status groups might be explained by an increased access to medical care as suggested by Amato (2014: 68), who identified a low prevalence of unhealed and malformed trauma in the monastic population of the Dunes Abbey in Koksijde (Amato 2014: 68). When considering the prevalence rates of injured bone elements, apart from traumatic lesions of the ribs and left clavicle bone, females from Deinze showed less injuries of both upper and lower limbs compared to females from the rural groups. The activities related to agriculture and involving animals may explain the higher frequency of trauma among rural females (Judd 2006; Judd and Roberts 1999).

All rural male groups from the medieval to post-medieval sites (Moorsel, Slijpe and Zottegem) exhibited the most tibial fracture rates of 13.3%, 16.7% and 11.1% respectively, and included mainly avulsion and stress fractures. One individual of unknown sex and age from Zottegem exhibited a spiral fracture (fig. 6.8). Avulsion of a tendon can be caused by acute overloading but can also be considered as a stress fracture as the result of prolonged muscle tension that has weakened the bone at the muscle attachment site (Bargfeldt *et al.* 2011). Similar lesions generally occur in male athletes as reported by clinical case studies (Arredondo-Gómez *et al.* 2007; Vega and De La Mora García 2016). Judd (2006) noted a high frequency of tibial trauma among rural populations in Nubia which is attributed to 'continued stress on the knee joint' or 'sudden impaction of the joint' (Judd 2006: 328).

Fig. 6.8: A spiral fracture in the right tibial midshaft observed in an individual of unknown age and sex from the Zottegem collection (skeletal individual nr. 55).

A spiral fracture is a common fracture type of the tibial shaft with the highest incidence reported in the clinical literature among young adult men as a result of high energy mechanisms such as falls, during walking and sports (Larsen *et al.* 2015; Taki *et al.* 2017). Complications of a tibial diaphyseal fracture are mainly malunion, muscle loss and reduced mobility (Rudge *et al.* 2014: 245). Because of difficulties of immobilizing the lower leg, malunion of a shaft fracture is therefore often diagnosed in the archaeological record (Lovell 2008: 364-365). The tibial fractures observed in the middle and old adult rural males from Moorsel, Slijpe and Zottegem may be induced by the labour-intensive work on the fields accompanied by long distance walking since most of their work must have been performed at a distance from home. In Deinze and Vichte, TPR data of tibial fractures were less noticed and concerned mostly stress and avulsion fractures too.

Femoral fractures were mostly observed in the sites of Deinze and Vichte, and are usually common among older adults due to osteoporosis (Roberts and Manchester 2010: 100). Although both sites do include a high proportion of old adults, femoral fractures were not particularly identified within the latter age category, but were noticed among young adults and mostly included OCD lesions as a likely result of repeated micro-trauma. Fractures of the clavicle were particularly present in males from Deinze and Slijpe and in two high-status males from Oosterweel. Burrell *et al.* (2018) investigated patterns of fractures on a medieval rural farm in Poulton (Cheshire, UK) and found that fractures to the clavicle were most common, likely as the result of a fall. In Slijpe and Deinze, trauma type of the clavicle demonstrated a diverse pattern in both sites and involved mainly breaks in the middle and distal parts. Several lesions of the clavicle resulted in deformity and malunion. However, this does not imply a shortcoming in treatment or care since broken clavicles are difficult to support unlike arm bones, which can be healed by using a splint or sling (Burrell *et al.* 2018: 87). Two young adult females from Slijpe exhibited an avulsion fracture of the clavicle while a greenstick fracture was seen in a young adult female from Deinze. These fractures are likely caused by a fall or a direct blow to the chest, shoulder or hand (Yates 1976: 191). The pattern in fracture type of the clavicle suggests that both sexes from the small urban and late medieval coastal sites were equally susceptible to accidents of the chest or shoulder likely related to daily chores in a small town and in and around the farm respectively. Moreover, the lesions in the clavicle of the two Oosterweel males suggest that even high-status individuals were at risk of a fall.

The highest fracture rate that was noticed in the small urban population of Deinze, and which could indicate differences between a rural and urban context, were those involving the ribs, especially in males (19.4%). Brickley (2006) has investigated rib fractures in early modern working-class individuals from an English urban site, and found a similar crude prevalence rate of 15.6% for the total assemblage (Deinze: 9/69; 13.0%), with also a majority of rib lesions in males. A variety of reasons may lead to rib trauma, such as crushing injuries because of machinery, osteoporosis, falls, but also chronic coughing or sneezing may result in breakage of the ribs (Brickley 2006; Roberts and Manchester 2010: 105). Interpersonal violence may account as well for rib fractures since ribs, the cranium and hand bones are mostly affected (Lovell 2008: 376). However, trauma of the hand bones within the Deinze skeletal collection was less frequent (individual count rate of 2.9%; 1/34) compared to the other sites with observed hand injuries at Slijpe (13.7%; 7/51), Vichte (4.9%; 2/41) and Zottegem (3.2%; 1/31).

Ribs that are mostly fractured involve the fourth to eighth, while trauma of the first to third ribs is basically rare, since these ribs are protected by the thoracic cage, and lesions are most often provoked by high-velocity trauma (Lovell 2008: 353). Most rib fractures in the Deinze skeletal collection include the sixth to eight ribs, and were mainly healed. A direct blow, however, would damage the surrounding soft tissues, and its serious impact would often lead to the sudden death of the individual, which means that these rib fractures should be discernible as peri-mortem trauma instead of healed injuries, and thus could be easily overlooked while analysing human skeletal remains (Brickley 2006: 62-63). Healed rib fractures on the other hand would thus most likely illustrate 'non-life-threatening trauma' (Lovell 2008: 357). Although not statistically significant, rib fractures between males and females of the Deinze collection indicate a prevalence with females from the age of twenty years, and with males from the age of 36. Many individuals who showed evidence of rib trauma, were also observed with other injuries, for instance, of the scapula or clavicle, however, it is not clear whether or not lesions of both ribs and other bone elements occurred in a similar incident. The involvement of multiple fractured ribs in one side of the rib cage of a person, on the other hand, was observed in four individuals, and is possibly associated with the same accident. Brickley (2006: 73) refers to TB in her aforementioned nineteenth century case study, which was endemic at that time in Birmingham, and poor respiratory because of the debilitated lung function may lead to an increased vulnerability to acquire complications following rib fractures. Although historical sources dating to before the eighteenth-century documented outbreaks of typhoid, cholera, dysentery and the plague in Deinze (Devos 2003: 238; Huys 2003: 242-243), but do not report specifically on TB, it does not imply its absence, or a lack of any other pulmonary afflictions in the small town. One indication might be the St Blasius hospital near the church (discussed in 3.2.1.1. in Chapter 3) that was re-named in the fifteenth century after the patron saint of both the wool combers and patients with throat ailments. Other evidence of the likelihood of pulmonary diseases in Deinze may be situated in the textile related activities of the citizens. Roberts (2012: 443) acknowledged a relationship between TB and specific occupations that involve a higher risk of being infected with TB bacilli. For example, not only food-handlers and people who work in an environment with an increased susceptibility to TB such as in hospitals, farmsteads and prisons, but it has also been suggested that TB was a common infectious disease among e.g. weavers, leather tanners and silk carders, and especially if working in an insufficiently ventilated environment, which involved an increased vulnerability to acquire TB bacilli (Barnes 1995; Roberts and Buikstra 2008: 69-73). The association of pulmonary diseases with occupations is further explored in section 6.5.

The pattern of traumatic lesions observed among both rural and urban males and females suggests that all groups were susceptible to accidental or repeated micro-trauma. However, minimal variation in traumatic lesions as observed in fractures of long bones and ribs likely indicate different activities associated with a rural and urban context. Jongma (2016) investigated long bone fractures in four post-medieval sites in the Netherlands and found more long bone fractures in urban Eindhoven compared to rural Middenbeemster and no significant difference between high- and low-status groups. Trauma of the left femur was only observed as statistically significant between males and females from Deinze. However, interpretation of trauma should be deemed as a complex, personal, or perhaps multi-etiological situation as multiple aspects such as domestic or interpersonal violence, age, occupation, the socio-cultural environment or even susceptibility to poor health may all contribute to the interpretation of skeletal trauma.

6.6.3. Diseases as a Consequence of Exposure to Trauma and Pollutants

Evidence of the mostly identified infectious diseases (non-specific infections such as periosteal reaction and osteomyelitis and specific infections such as respiratory infections and others including for example, mastoiditis and sinusitis) within the total skeletal assemblages of each site are shown in fig. 6.9. Figures 6.10 to 6.13 demonstrate the distribution of periosteal reaction, osteomyelitis, respiratory infections and other infections according to sex within the six sites. As presented in 5.3.3., statistically significant differences between males and females were only noticed for periosteal reaction in Slijpe and Zottegem. Further, an association with age was only statistically significant for the prevalence of other infections in Deinze, where there was a majority of ear infections within the younger age categories.

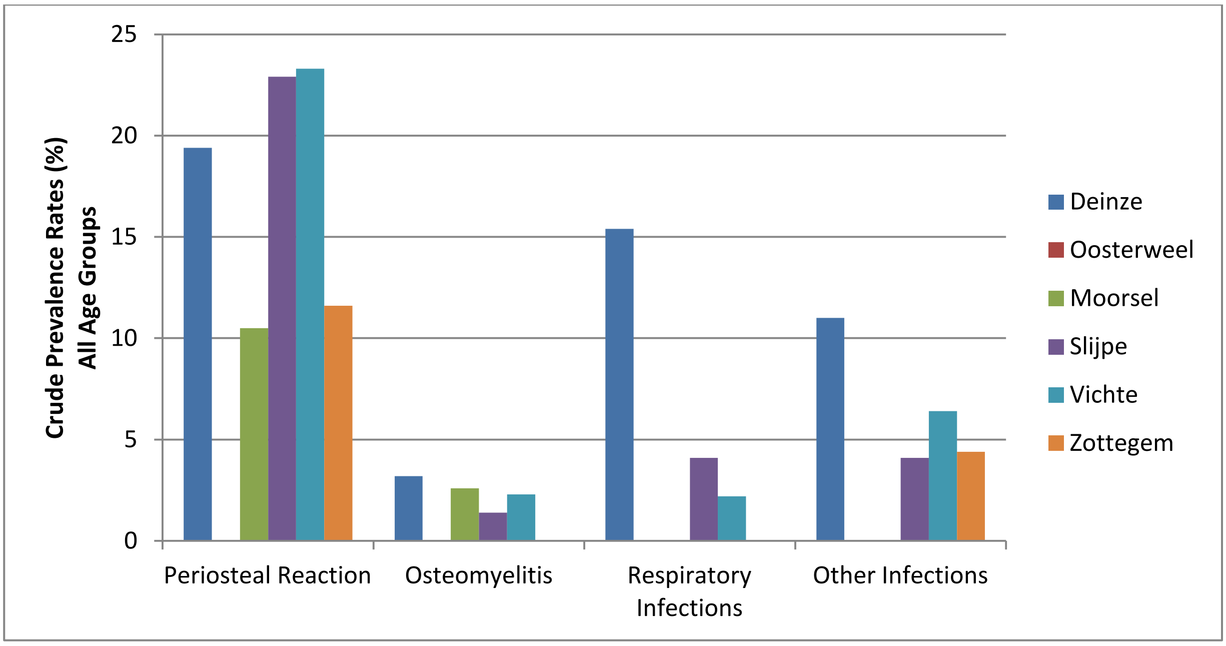

Fig. 6.9: CPR's (Crude Prevalence Rates) in percentages for evidence of infectious diseases (periosteal reaction, osteomyelitis, respiratory infections and other infections) identified in the total skeletal assemblages of each site.

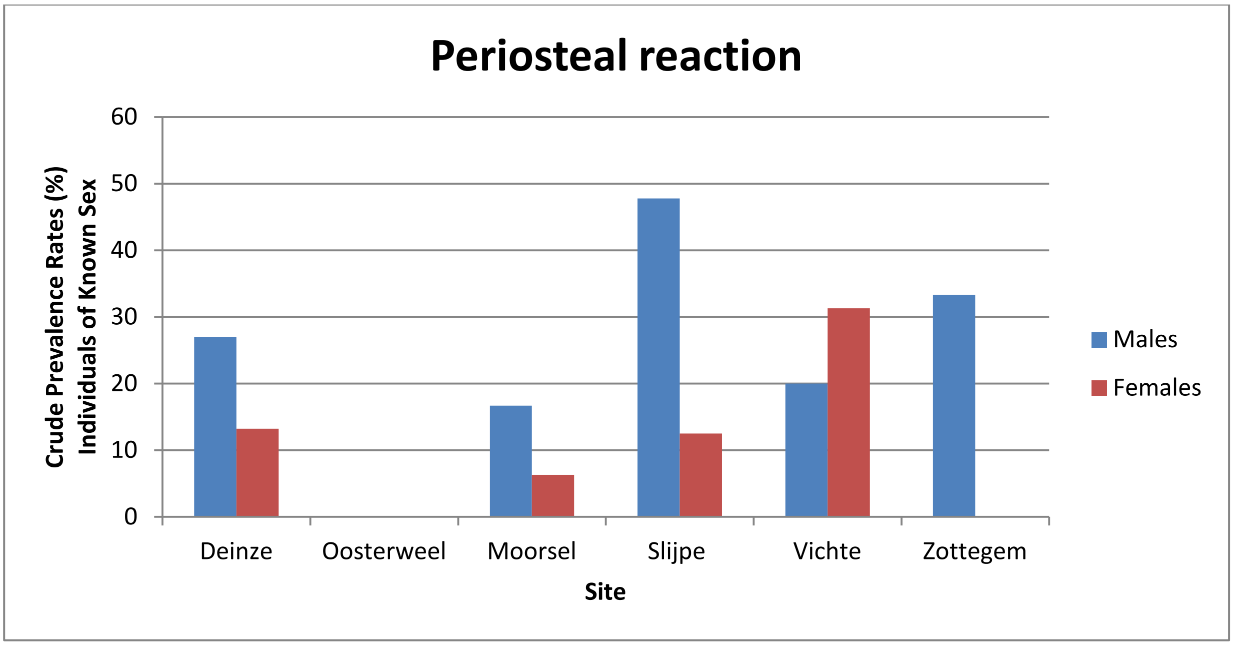

Fig. 6.10: CPR's (Crude Prevalence Rates) in percentages for the distribution of periosteal reaction according to sex within the six sites.

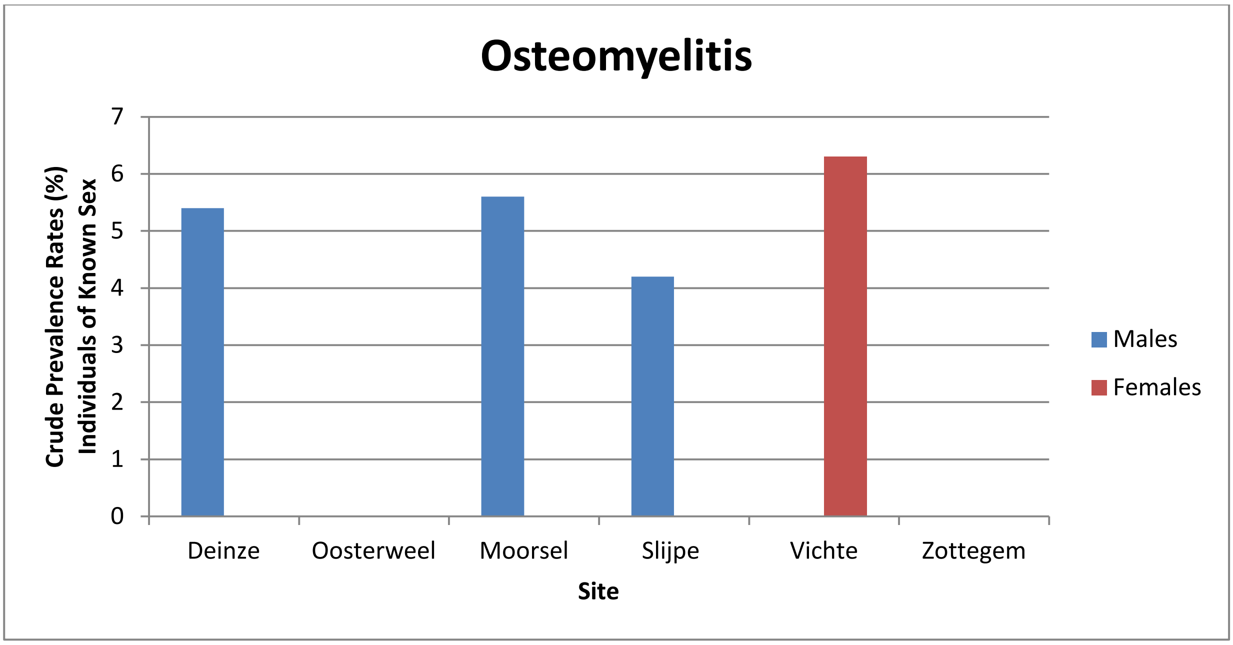

Fig. 6.11: CPR's (Crude Prevalence Rates) in percentages for the distribution of osteomyelitis according to sex within the six sites.

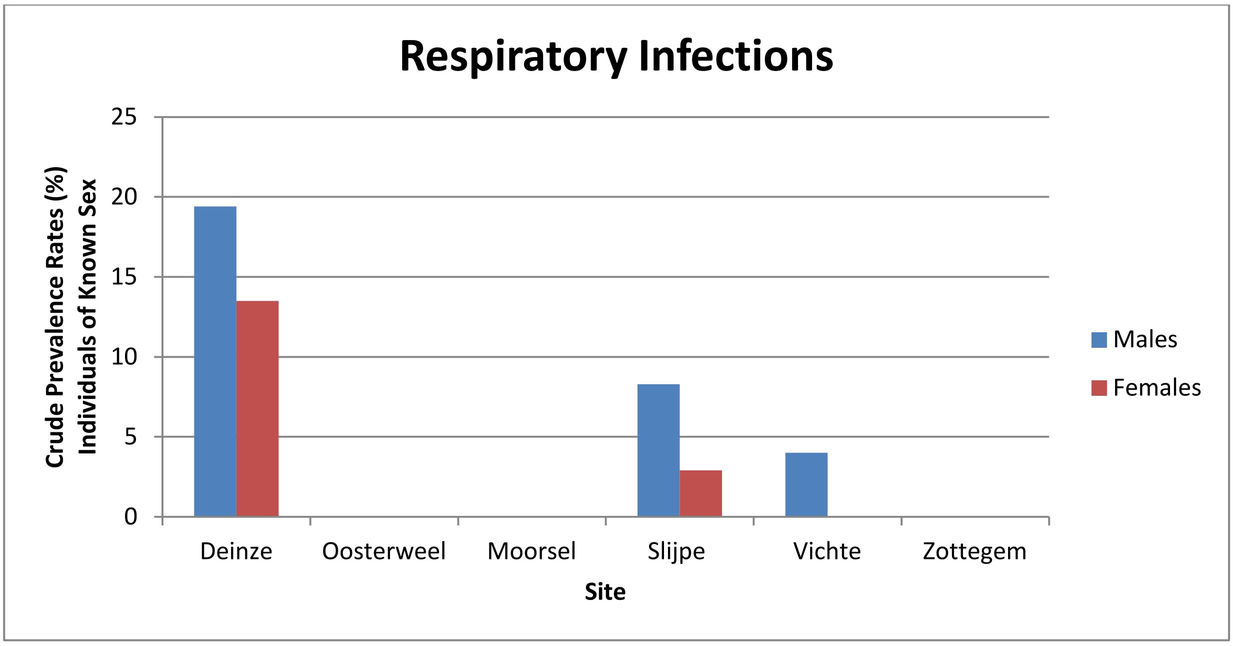

Fig. 6.12: CPR's (Crude Prevalence Rates) in percentages for the distribution of evidence of respiratory infections according to sex within the six sites.

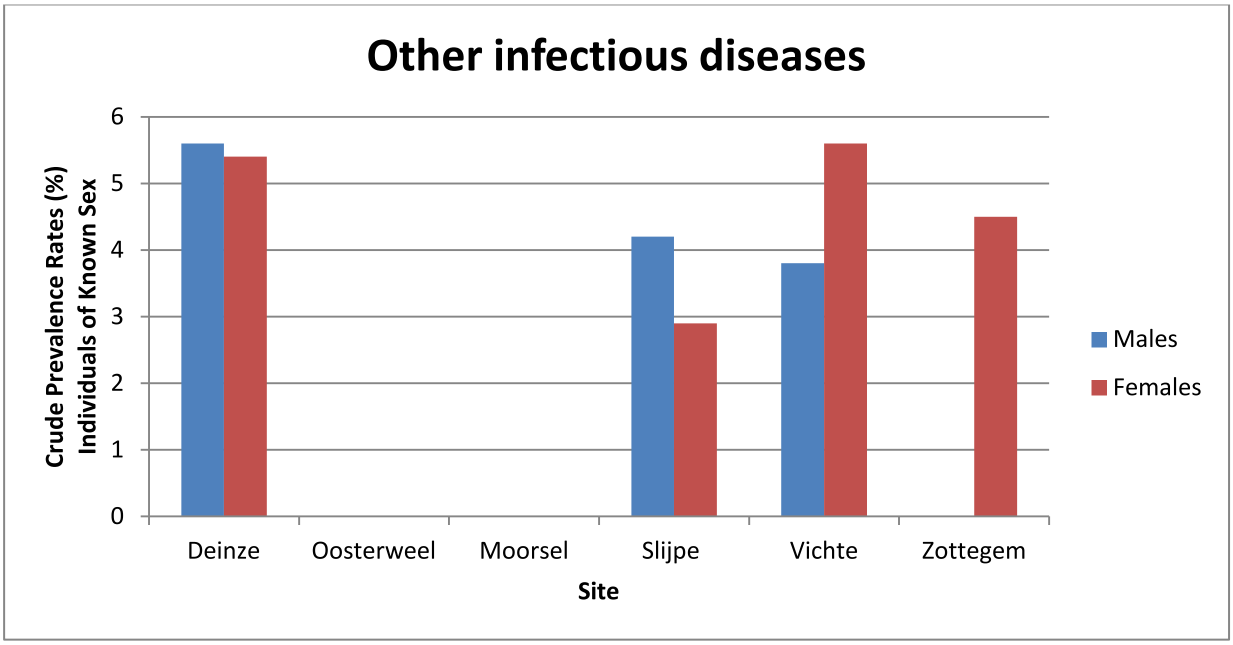

Fig. 6.13: CPR's (Crude Prevalence Rates) in percentages for the distribution of other infectious diseases according to sex within the six sites.

Periosteal reaction, osteomyelitis, evidence of respiratory infections and other infections such as mastoiditis were not identified with the high-status individuals from Oosterweel, and these data are chiefly consistent with the palaeopathological analysis of high-status medieval and post-medieval burials from Flemish rural sites such as Hofstade and Meldert, which revealed no infections in Meldert, and one case of osteomyelitis in Hofstade (Moens and Quintelier 2010: 58; Vander Ginst and Vandenbruaene 2006: 148). Other studies of medieval high-status individuals from English sites have also reported low frequencies of infections of, for example, facial sinuses suggesting that wealthy individuals were more protected from polluted (working) areas than labourers from especially an urban environment (Roberts and Manchester 2010: 174). Indeed, most evidence of infections affecting the ears and sinuses were observed within the citizens of Deinze (11.0%) in contrast to lower rates in the rural sites of Vichte (6.4%), Slijpe (4.1%) and Zottegem (4.4%) (fig. 6.6). For Deinze, there was no statistically significant difference between the sexes (fig. 6.10) for other infections, suggesting that both males and females were equally exposed to pollutants in the air, or other causative agents that provoke infectious diseases. The statistically significant association between the prevalence of other infections and age in Deinze, however, may explain a high vulnerability to pollution with younger individuals. Ear infections were mostly recorded in subadults (6) while only two adults were observed with similar lesions. Aufderheide and Rodríguez-Martin (2008: 253) noted that infections of the middle ear are common in children under the age of four. Krenz-Niedbala (2017) demonstrated as well a significantly higher number of ear infections in subadults from a medieval to late-medieval urban sample in Central-Europe compared to contemporary rural sites in the same region. Even more, the same study by Krenz-Niedbala (2017) demonstrated poor respiratory health in the urban sample. The frequency of infections of the respiratory system and maxillary sinusitis has indeed revealed differences between the countryside and the urban environment. Other bioarchaeological studies covering different geographical locations found a higher frequency of sinusitis and respiratory infections in urban sites (Lewis *et al.* 1995; Roberts 2007). Water contamination, low air quality, exposure to smoke and dust both at home and at work are several factors which have been attributed to explain this divergence in data distribution (Lewis *et al.* 1995; Roberts 2007). The lower frequency noted in agricultural groups may be related to the fact that peasants mainly worked outdoors and were less exposed to polluted air (Krenz-Niedbala 2017: 18; Roberts 2007: 793). Although the prevalence of sinusitis was low in both urban and rural sites in this study, a higher frequency of respiratory infections was recorded in urban Deinze and might highlight a variation in work and environmental conditions in a town compared to the countryside.

Exposure to pollution arising from occupations may shed light on the prevalence of infectious diseases between sexes and cultural groups. Connell *et al.* (2012: 159) described both textual sources from the fourteenth and fifteenth centuries indicating that also women were involved in textile crafts such as dyeing and fulling and archaeological evidence of 'bases of large vats used for brewing or for dyeing cloths' that were unearthed nearby the site of St Mary Spital (London) (Connell *et al.* 2012: 159). Archaeological evidence of similar vats has not been determined for Deinze, but palynological analysis of macro-remains of fibre plants (yellow weed) that were retrieved from a thirteenth century watering place at the *Markt* site (see also Chapter 3) suggests a textile activity such as dyeing was taking place. Further archaeological investigation of the pond in Deinze revealed material waste such as animal bones, pottery and leather (Laisnez and Vandecatsye 2011: 38, *KLAD Archaeological Report 24*), and disposal of waste dyestuffs of craftsmen may involve a risk factor to contaminate watercourses. It is indeed likely that waste products from these activities entered the pond and would have contaminated the water wich in turn exposed the Deinze population to diseases.

Other hazardous conditions that would expose urban citizens to pollution include occupations that demand heat and indoor combustion of fuel since susceptibility to burning coal and sulphur dioxide could aggravate pulmonary lesions in individuals with poor respiratory function (Capasso 2000; Connell *et al.* 2012: 159). Blacksmiths, for example, who were historically recorded in Deinze (Stabel 1985: 145), worked mainly in a very warm environment while being exposed to air pollutants such as the charcoal from the furnaces, but also brewing activities which were also undertaken in Deinze, were conducive of air pollution (Dyer 2002). Furthermore, an exposure to lead implicates various disorders such as developmental defects, brain damage, miscarriage and stillbirth (Redfern 2016). Osteological evidence of stillbirth, however, was not confirmed in the six sites of this study, but this is probably related to preferential burial practices and/or the extent of the excavated churchyard area as discussed in 3.3.1. Lead was frequently used to glaze pottery, and would have made urban dwellers susceptible to lead poisoning as argued by Rasmussen *et al*. (2015: 366), because when the vessel contains 'acidic or salty foods then the lead in the surface can be dissolved and leak into the foodstuff'. Chemical analysis on medieval urban and rural Danish and German skeletons have indeed demonstrated higher levels of lead in the citizens, and it is suggested that glazed ceramics were less used in the countryside (Rasmussen *et al*. 2015: 366). The presence of pottery manufacturing in the fifteenth century in Deinze was pointed out by Stabel (1985: 98), and the archaeological findings of medieval glazed kitchenware at the *Markt* by Laisnez and Vandecatsye (2011, *KLAD Archaeological Report 24*), may support a vulnerability to lead exposure. In contrast, in rural Moorsel, glazed pottery was only documented by a minimal number of sherds of glazed Andenne ware (0.4%), and the majority of ceramics consisted of local greyware (88%) as revealed during archaeological research of the twelfth- to thirteenth-century outer ditch in the village (Pieters *et al.* 1999). Chemical analyses to demonstrate levels of lead in the urban and rural skeletons of this study might provide more details on exposure to pollutants in a different environment.

As mentioned in this section, evidence of respiratory infections in this study may shed light on urban-rural discrepancies. CPR data demonstrate that most respiratory infections were found in both males (19.4%) and females (13.5%) from urban Deinze compared to the other rural sites (fig. 6.12). The lack of statistically significance between both sexes suggests that males and females were equally exposed to causative agents leading to infections of the respiratory system (fig. 6.14 and 6.15)[5].

Along with the urban dwellers from Deinze, the late medieval male farmers of Slijpe exhibited the highest frequency of periosteal reaction (47.8%) and the second highest evidence of pulmonary lesions (8.3%) and other infections such as mastoiditis (4.2%) after the Deinze males (figures 6.7, 6.9 and 6.10). Only the difference between males and females (12.5%) for periosteal reaction was statistically significant. A non-specific infectious disease such as periosteal reaction is often found in the long bones of the lower limbs, especially in the tibiae, and is suggested to be trauma or infection related (Ortner 2003: 209). Periosteal reaction was indeed mostly observed in the tibiae and fibulae of the Slijpe males. Moreover, TPR data as shown in table 6.3 demonstrate that trauma of the right tibia was mostly recorded in the Slijpe males. In late-medieval coastal Slijpe, activities were particularly focused on cattle farming, arable fieldwork, peat extraction and fishing, but also labour concomitant with an increase in flood and inundation risk in the region must have attributed to an increase in vulnerability to trauma and infections in the lower limb of the Slijpe males (Pieters 2013b; van Bavel and Thoen 2013; van Cruyningen 2013; Zeebroek *et al.* 2006). Also, labourers handling meat and animals have a high susceptibility to acquire other diseases such as bovine TB and brucellosis (Roberts and Cox 2003: 229). However, macroscopic differentiation between human and bovine TB during osteological research is not always straightforward since both diseases involve destructive lesions of the vertebrae, nonetheless specific characteristics of human TB such as vertebral collapse and kyphosis do not occur in brucellosis (Waldron 2009: 96-97). In her study on medieval rural and urban populations in the Netherlands, Schats (2017: 156) did not find skeletal evidence for bovine TB or brucellosis, although a DNA study by de Jong and Houwers (2008) on late-medieval cattle remains demonstrated the presence of brucellosis in The Netherlands, and therefore,

[5] Although the presence of extra cortical new bone formation seen in individual nr. WP1 L43 on (fig. 6.14 and 6.15) several bone elements such as the internal surface of the iliac fossa may be indicative of TB, the differential diagnosis of a metastatic carcinoma can not be completely ruled out seeing the concomitant lytic lesions which may be related to a bronchogenetic carcinoma or a malignant carcinoma of the lung (Grupe 1988; Marques 2019).

its prevalence is likely underestimated in the archaeological record (Schats 2017: 156-157). In Belgium, DNA studies to gain insight in bovine TB or brucellosis in the past have not been applied to date. In Slijpe and in Vichte, there was no vertebral involvement in the individuals observed with respiratory infections. In Deinze, however, severe osteolitic lesions of the lower vertebrae were observed in one young adult female (see also table 5.30). As likewise suggested by Connell *et al.* (2012: 159) of their data from medieval London, cattle would have been held within the walls of Deinze (Verwee 1941). It may be that livestock in Deinze was maintained by a small number of individuals, or that minor accidents with cattle occurred seeing the general lower frequencies of trauma of the long bones in the urban dwellers compared to those seen in the rural inhabitants. Therefore, the lesions of the vertebrae in the Deinze young adult female may be indicative of pulmonary TB, rather than brucellosis, since the presence or absence of kyphosis in her spinal column was not identified. Although skeletal involvement of the spine has been noticed in brucellosis, lytic lesions of the vertebral bodies are rarely severe and are commonly located on the anterior, superior margins (Ortner 2003: 216) whereas the lytic lesions of the Deinze female occurred on the lateral side of the lower thoracic and lumbar vertebral bodies. As illustrated in 6.5., the retting of flax in the Leie-river caused pollution of the water and would have contributed to a higher risk to acquire contagious diseases among the urban inhabitants of Deinze. Clinical studies have indeed reported an increase in pulmonary TB and infections of the respiratory system if populations or individuals were exposed to contaminated water, the ingestion of polluted water and food and unsanitary living conditions (e.g. Cardoso *et al.* 2017; Greenberg and Kupka 1957; Miller and Anderson 1954). Workshops such as tanneries, metal smelting spots and butcheries must have produced smoke, dust and waste and contributed to an increased susceptibility to pathogens resulting in respiratory infections (Krenz-Niedbala 2017: 17). As noted in 6.5, working in the flax industry and weaving was also a risk factor for acquiring pulmonary infections. However, infections of the respiratory system were not observed in post-medieval rural Moorsel. Located on the boundary of the flax cultivation and linen production, the tillage of flax was highly performed in the area from 1350 AD. From c 1750 AD, however, the villagers became involved in the production of other crops such as wheat, oats, rye and hop (Verleyen 1985: 222 and 226). This may suggest that the Moorsel inhabitants were less exposed to the hazards of the manual process of flax heckling. Moreover, next to agricultural labour, weaving was an important additional resource for the farmers in the Moorsel area and household inventories has shown that many peasant families owned a weaving loom (Schelstraete *et al*. 1986: 47; Thoen 2001: 121). The dearth of respiratory infections in Moorsel may be related to the fact that people had passed away before lesions became macroscopically identifiable on the human skeletal remains, considering that a high number of deaths was recorded in the young adult age group (as presented in fig. 5.2).

It is certainly the case that exposure to pollution on a personal level relies on the working and living circumstances of an individual, while 'some risks would have applied to urban populations in general, while others would have been more localised' when, for instance, artisans with similar crafts were concentrated in a specific area of a town (Connell *et al.* 2012: 161).

Fig. 6.14: Erosive and proliferative lesions of the left ilium (posterior side is pictured) of a middle adult female, aged 36-50 years, may be suggestive of TB (differential diagnosis: malignant carcinoma of the lung) (Deinze, skeletal individual nr. WP1 L43).

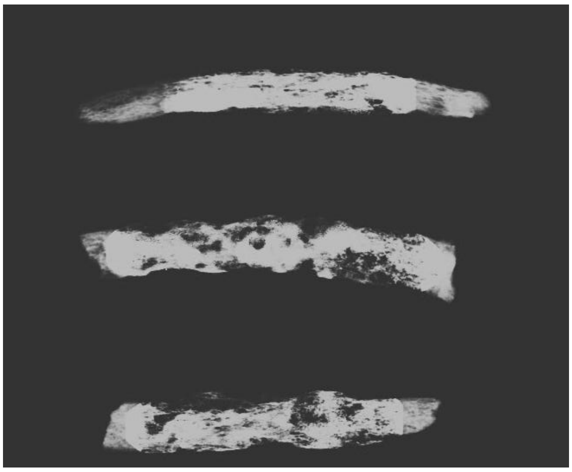

Fig. 6.15: Similar erosive lesions were identified in unspecified rib fragments in the same individual shown in fig. 6.14 (differential diagnosis: malignant carcinoma of the lung) (CAT-scans provided by Radiology, UZ Jette, Belgium, 19 Jan. 2015).

6.6.4. Other Palaeopathologies: Rickets/Osteomalacia and Enthesopathies of the Hand Bones

Apart from the commonly identified pathologies such as joint disease, cribra orbitalia, trauma and infections within the six sites, other pathological conditions such as rickets or osteomalacia were less frequent. Since there were no statistically significant differences between the sexes or a statistically significant association with age for the latter palaeopathologies, a summary of their prevalence will be presented below.

A metabolic disease such as rickets (in subadults), or osteomalacia (in adults), which is caused by vitamin D deficiency, and leads to the bowing of the weight-bearing limbs, was identified in the total skeletal assemblages of Deinze (5.4%), Vichte (7.0%) and Moorsel (2.6%). Adults were mostly involved as this was noted in Vichte, with left and right femora affected of one old adult male and female. One young adult female from Vichte was diagnosed with bending of both tibiae and fibulae. The healed deformities seen in adults as a result from vitamin D deficiency in childhood do not demonstrate active osteomalacia. Juveniles were only affected in Deinze (one individual). In Moorsel, the likelihood of healed rickets was suggested by the slight bending of both femora in an adult male aged 18+. Furthermore, in Deinze, deformities were seen in the femora, tibiae and fibulae, although affected separately, of one young adult female, with slight bowing of both femora and further observed in two young and one old adult male.

Foods such as oily fish contain vitamin D, but its principal source is direct exposure to sunlight. Therefore, a lack of vitamin D is commonly associated with urbanization and industrialization since less sunlight would restrain its intake, and this would explain the scarce evidence in the archaeological record before the seventeenth century (Brickley and Ives 2008; Roberts and Manchester 2010: 238). However, rickets was as well osteologically identified in nine children of the wealthy Italian the Medici family (sixteenth-seventeenth centuries), which demonstrates that even children from earlier Renaissance elite classes were susceptible to rickets (Giuffra *et al.* 2015). Lewis (2007) described a difference between the form that the condition manifests as and whether it was caused by malnutrition or lack of sunlight. For example, 'plump bones' indicates a lack of sunlight in well-nourished children, whilst low density bones can indicate malnutrition as well. In an 'undernourished rachitic child', cortices are less dense, and other lesions, such as scurvy, may be noticed (Lewis 2007: 122). In general, it is suggested that rural populations are less likely to suffer from rickets or osteomalacia compared to people who live in air polluted and overcrowded urban centres (Lewis 2007: 121; Ortner 2003: 393). The prevalence of rickets and osteomalacia in Deinze and Vichte may be attributed to several reasons: it could indicate that these individuals were particularly restrained from direct sunlight exposure, perhaps through occupational activities indoors (such as weaving and spinning at home), or because these individuals were bedridden due to illness, or even in some cases, by wearing specific clothing that covers most of the skin; all factors that might attribute to develop a vitamin D deficiency (Roberts and Manchester 2010: 239). For example, the diagnosis of osteomalacia and degenerative cervical spine disease in a late-medieval young adult Christian woman (25-35 years), who was buried in the periphery of the churchyard of the medieval priory of Coldingham (Scotland), was supported by the decorated lead-alloy spindle whorl that was found in the grave. Since spindle whorls are usually made of stone or ceramic, Stronach (2005: 406, 408 and 412) argued that, as spinning was undertaken from an early age, and considered as an important activity for girls, this spindle whorl would have likely been 'one of their most familiar possessions', and thus may have been regarded as a 'treasured piece, placed in the grave for sentimental reasons'. Her condition likely arose due to insufficient sunlight, whilst the bowing of her legs may also indicate an immobile state (Stronach 2005: 410). Hence, it can be assumed that spinning inside the home might have been her primary chore.

As presented in 5.3.9., enthesopathies of the hand bones revealed no statistically significant differences between males and females within the six skeletal collections. An association with adult age was only observed as statistically significant in urban Deinze.

	Site											
	Deinze		Oosterweel		Moorsel		Slijpe		Vichte		Zottegem	
	M	F	M	F	M	F	M	F	M	F	M	F
Hand Bone Enthesopathy	36.1	21.2	0.0	12.5	35.3	6.7	59.1	48.3	40.0	37.5	21.4	11.8
CPR Adult Assemblage	24.6		7.1		16.7		52.9		35.9		13.0	

Table 6.4: CPR's (Crude Prevalence Rates) in percentages for hand bone enthesopathies for males (M) and females (F) within the skeletal assemblages of known sex and age of the six sites.

Table 6.4 presents the CPR's in percentages of the ossification exostosis, or bony spur, that was observed in the proximal and intermediate hand phalanges in both males and females within the six sites. Each hand has five proximal phalanges and four intermediate phalanges (excluding the thumb), and their shafts consist of a medial and a lateral border. In contrast to the soft dorsal surface, the convex shaft of the palmar surface involves rough sides, with sharp ridges indicating attachment of the fibrous tendon sheaths of the flexor muscles (White and Folkens: 2005: 240). Not surprisingly, ossification exostosis of the hand phalanges was more prominent in middle and old adults. Only in Slijpe and Vichte, enthesopathies of the hand phalanges were as well identified in young adult age categories: in Slijpe in young adult males and females and in Vichte in young adult females. The lack of statistically significant differences between the sexes of all sites suggests an equal susceptibility for both males and females. The association with adult age in Deinze only indicated that middle and old urban adults were more susceptible to the lesions of the hand phalanges compared to the dearth seen in young adults. Similar results were demonstrated in a clinical study by Meng *et al.* (2014) who evaluated these bony palmar ridges of the proximal and intermediate hand phalanges by 270 radiographs and 33 CT scans and demonstrated no differences between males and females. Moreover, their analysis showed that the bony excrescences were not seen in the hands of children and indicated further a correlation with advancing age when the ridges become more prominent (Meng *et al.* 2014). However, Kalichman *et al.* (2007) found a higher proportion of enthesophytes of the hand bones in males than females, and suggested that a combination of factors such as physical load and genetic predisposition may be a plausible explanation. The appearance of bony palmar ridges within younger age groups in Slijpe and Vichte may demonstrate the involvement of strenuous rural activities from childhood, in which hands, and especially the fingers, may have been frequently and repeatedly employed. A correlation between palmar ridges and OA of the hand was not assessed in this study, but a study of hand OA in an identified archaeological population from Spitalfields (London), dated to between 1729 and 1869, and from which 29 male individuals were registered as handloom weavers, rejected the hypothesis that weaving developed hand OA, but that 'the disease in the hands was related more to aging than to occupation' (Waldron and Cox 1989: 421-422).

6.7. The Effects of Age, Sex and Social Status on Entheseal Changes (EC)

6.7.1. An Introduction to EC and its Association with Age, Sex and Activities

The study of EC to infer activity patterns within past populations has been often employed to demonstrate gender and social differentiation, both on skeletal collections with known and unknown occupations (e.g. Alves Cardoso and Henderson 2010; Havelková *et al.* 2011, 2013; Henderson *et al.* 2013b; Palmer *et al.* 2016; Perry 2004; Santana-Cabrera *et al.* 2015). In Belgium, EC as a proxy for demonstrating social differentiation has been recently published by Palmer and Waters-Rist (2019). Three different socio-economic groups including low-status, middle-class and high-status individuals from a post-medieval skeletal collection from Aalst (Flanders) have been analysed for sixteen entheses to identify a correlation between status, age and sex, and they revealed no consistent correlation between EC and status.

Although some studies have found a positive correlation between EC and activities such as male occupations involving heavy manual tasks (for example Villotte *et al.* 2010b), many other studies, however, indicate the strongest association with age, rather than with activity, and therefore suggest that EC 'cannot be immediately interpreted as markers of physical activity in osteological samples' (e.g. Alves Cardoso and Henderson 2013; Henderson *et al.* 2017; Mariotti *et al.* 2004; Michopoulou *et al.* 2016; Milella *et al.* 2012: 386; Molnar *et al.* 2011). But even age as a factor shows variation in entheses as observed by Henderson et al. (2012) in a study on a skeletal sample of 31 manual male workers. These ambiguous results clearly show that the study of EC incorporates many confounding factors. For example, the involvement of certain pathological conditions has been questioned by Henderson (2013), who noticed in the clinical literature an association between calcific tendinitis and cortical defects, periosteal reaction or new bone formation at both fibrous and fibrocartilaginous entheses, mainly in the rotator cuff, and suggested the need to consider a possible differential diagnosis, 'especially if these changes affect only one enthesis or an endocrine disease is suspected' (Henderson 2013: 68). On the other hand, since EC do not indicate specific activities, statistical patterns of musculature may reveal the social organization of work within a cultural group as postulated by Robb (1998), who further notes that 'variability in musculature within a single skeleton

and between individuals provide particularly important clues to task specialization and to homogeneity in the level of stressful activities' (Robb 1998: 375). It is indeed surmised that repetitive, habitual activities affect the musculo-skeletal system of an individual (Larsen 2015: 232), which is considered by Perry (2004: 94) as an elemental aspect of research of the skeletal musculature since it 'contributes to a measurable range of skeletal variation within a population' Building on the former statement by Robb (1998), Perry (2004: 94-95) argued that the social and economic organization of historical cultural groups 'will influence the ease with which activity patterns can be inferred from the skeleton', and may indicate differences between societies 'characterized by specialized production strategies involving full-time craftspeople', and societies without a specialised production, but who have demonstrated a broad spectrum of activities. Therefore, Perry (2004: 94), whose doctoral dissertation on sexual labor division in pre-Hispanic archaeological populations in the American Southwest yielded differential male and female engagement in activities, further suggested that 'the primary task in any investigation of the impact of activity on the skeleton, then, is sorting out those factors contributing to skeletal variation'.
In this regard, and apart from the age factor, the study of EC as outlined in Chapter 4, has been integrated to elucidate gender related patterns of activity within the six historical populations from different contexts and social status. It is certainly important to note that the effects of physical activities on the musculoskeletal system must be considered within a 'particular context of a particular individual and population before drawing conclusions based on a given marker' (Perry 2004: 96).

In the same study, Perry (2004: 87-93) lists male and female activities that were undertaken in the historical communities, in association with the primary muscles involved in the upper limbs. Such actions related to non-locomotor movements of the upper body include lifting, raising, extending, bending, flexing and twisting while being stationary. Table 6.5 presents the analysed attachment sites in this thesis, and suggested related activities concomitant with the principal muscles of the upper limbs.

Muscle	Insertion	Origin	Function	Associated Activities
Trapezoid (TRZ) (ligament)	Posterior surface of lateral third of clavicle; acromion process; spine of scapula	External occipital protuberance; nuchal ligament; spinous process of C7-T12; medial superior nuchal line	Prevents medial movement of clavicle; adducts (retracts) scapula	Carrying water in jars; carrying grain corn; house plastering; sieving grain or clay; weaving on an upright loom; stringing the warp on an upright loom; planting; house construction; hunting with nets and sticks; climbing up and down ladders; harvest crops; collecting wood
Conoid (CO) (ligament)	Located superomedially from the base of the coracoid to conoid tubercle (near acromial end) on the under surface of the clavicle		Limits anterior movement at the scapula	
Subclavius (SC)	Groove on the inferior surface of the clavicle	Junction of first rib with its costal cartilage	Depresses clavicle; brings shoulder forward and downward; steadies clavicle during shoulder motions; **assists with breathing**	
Costoclavicular (ligament) (CC)	Connects the inferior medial clavicle (through the rhomboid fossa) to the first costal cartilage and adjacent end of the first rib		Stabilises sternoclavicular joint	Picking up and carrying children; house plastering; sieving grain or clay; weaving on an upright loom; stringing the warp on an upright loom; climbing up and down ladders
Biceps Brachii (BBI)	Radial tuberosity; bicipital aponeurosis to the fascia on the medial side of the forearm	Supraglenoid tubercle of the scapula; coracoid process of the scapula	Flexes the arm at the shoulder; flexes forearm at elbow; supinates forearm at elbow	Gardening; husking corn; washing wool; sieving grain or clay; firing pottery; grinding pigment; using a sickle; weaving and stringing the warp on an upright loom; planting; hunting with sticks and nets; butchering large and

				small game; house construction; lifting of heavy objects; collecting wood; climbing up and down ladders; flax scutching
Supinator (Radius+Ulna) (SU_RA+SU_UL)	Dorsal and lateral sides of upper third of radius	Lateral epicondyle of humerus; supinator crest of ulna; radial collateral ligament; annular ligament of superior radioulnar joint	Supinates forearm	Basket weaving; gardening; husking corn; cutting meat; firing pottery; decorating and polishing vessels; spinning cotton with a spindle whorl; rope making; washing wool; butchering large and small game
Pronator Teres (PT)	Middle of lateral surface of radius	Medial supracondylar ridge of humerus; medial border of coronoid process of ulna	Pronates forearm; flexes elbow	Gardening; husking corn; cutting meat; firing pottery; spinning cotton with a spindle whorl; butchering large and small game; basket weaving; rope making
Flexor Pollicis Longus (FPL)	Base of distal phalanx of the first metacarpal	Middle of anterior side of radial shaft; medial epicondyle of humerus	Flexes the thumb	Basket weaving; gardening; husking corn; cutting meat; firing pottery; decorating and polishing vessels; rope making; butchering large and small game
Brachialis (BA)	Coronoid process and tuberosity of ulna	Anterior part of lower half of humerus	Flexes forearm	Gardening; husking corn; washing wool; firing pottery; butchering large and small game; flax scutching
Anconeus (AN)	Lateral surface of olecranon process and posterior side of ulna	Posterior part of lateral epicondyle of humerus	Extends forearm (assists triceps)	Gardening; husking corn; washing wool
Deltoideus (DT)	Deltoid tuberosity on the middle of the lateral side of the humeral shaft	Anterior border and superior side of lateral third of clavicle; lateral border of acromion	Flexes and medially rotates arm; abducts arm; extends and laterally rotates	Gardening; picking up and carrying children; house plastering; sieving grain or clay; firing

		process; lower lip of the crest of the spine of scapula	arm	pottery; spinning cotton with a spindle whorl; weaving and stringing the warp on an upright loom; planting; construction; using a sickle; hunting with nets and sticks; climbing up and down ladders; collecting wood; butchering large game; harvest crops
Teres Major (TM)	Medial lip of the bicipital groove of humerus	Lower third of the posterior surface of lateral border of scapula, near inferior angle	Medially rotates, adducts and extends arm	Picking up and carrying children; house plastering; spinning cotton with a spindle whorl; weaving and stringing the warp on an upright loom; using a sickle; climbing up and down ladders; butchering large game
Pectoralis Major (PM)	Lateral lip of bicipital groove of humerus	Medial half of clavicle; sternocostal part	Adduction, medially rotation of arm; clavicular part flexes arm from full extension; sternocostal part extends the flexed arm	Gardening; picking up and carrying children; washing wool; house plastering; sieving grain or clay; spinning cotton with a spindle whorl; weaving and stringing the warp on an upright loom; planting; construction; using a sickle; hunting with nets and sticks; climbing up and down ladders; collecting wood; butchering large game; harvest crops
Latissimus Dorsi (LD)	Bottom of bicipital groove	Inferior angle of the scapula; spinous processes of lower six	Extends, adducts and medially rotates the arm; moves shoulder	House plastering; sieving grain or clay; weaving and stringing the warp on

		thoracic vertebrae, lumbar and sacral vertebrae; supraspinal ligament; posterior part of iliac crest; lower three or four ribs	downward and backward; **accessory muscle of respiration**; keeps inferior angle of scapula against the chest wall; also used for crawl stroke in swimming	an upright loom; planting; construction; using a sickle; hunting with nets and sticks; climbing up and down ladders
Brachioradialis (BR)	Base of styloid process and lateral surface of radius	Lateral supracondylar ridge of humerus	Flexes forearm	Gardening; husking corn; washing wool; firing pottery; flax scutching
Linea Aspera (LA)	Involves attachment of several muscles such as insertions for *adductor magnus*, *adductor brevis* and *adductor longus*; longitudinal ridge or crest on the posterior surface of the femoral shaft		Adduction of the femur at the hip	
Gluteus Maximus (GM)	Gluteal tuberosity of femur and iliotibial tract (or band)	Surface of ilium posterior to posterior gluteal line and posterior inferior surface of sacrum and coccyx	Extends, abducts and laterally rotates the thigh at the hip; ***weaver's bottom***	
Vastus Intermedius (VI)	Quadriceps tendon to base of patella and onto tibial tuberosity via the patellar ligament	Anterior and lateral surfaces of femoral shaft	Extends the leg at the knee joint	
Popliteal Line (PL)	Proximal posterior surface of tibia; just above the soleal (popliteal) line	Lateral surface of lateral condyle of femur	Rotates leg medially; flexing of the lower leg at the knee	

Table 6.5: Summary of analysed muscle attachment sites: insertion, origin, function and related activities (Information mainly derived from Perry 2004: 87-93; Stone and Stone 2003).

6.7.2. Lower Limb EC

Studies to point out associations between EC and stress patterns are mainly concentrated on the upper extremities as argued by Niinimäki and Baiges Sotos (2013), who therefore analysed lower limb entheses from early twentieth century males with known occupations, and which were separated into heavy and light activity groups. The results showed surprisingly no differences between the two labour groups, and suggested further that the age factor did not affect all entheses, but was only significant for entheses such as gluteus maximus and linea aspera (Niinimäki and Baiges Sotos (2013: 224). These findings are in agreement with this study, which shows a mainly statistically significant difference for age distribution for particularly the linea aspera in all low-status sites (tables 6.6 and 6.7). Statistically significant differences between the sexes were demonstrated for linea aspera in Deinze, Vichte, Zottegem and Moorsel. Oosterweel and Slijpe did not show a statistically significant difference regarding sex for all lower limb EC. Deinze was the only site with most statistically significant differences between males and females for lower limb EC (linea aspera, gluteus maximus and popliteal line). Effects of size on EC were not tested in this thesis, but this was demonstrated to be a minimal causal factor in the sample size of Niinimäki and Baiges Sotos (2013: 226), which might be explained by the diversities in movements between the lower and upper limbs. Niinimäki and Baiges Sotos (2013: 226) further pointed out that 'in the lower limb, activity patterns are not likely to differ as much between individuals as in the upper limb due to bilateral asymmetry and larger range of movement possible in the upper limb'. However, the effects of size on the biceps brachii enthesis in the upper limbs from a mixed adult skeletal sample were positively tested by Nolte and Wilczak (2013).

EC Lower Limb				**Site**					
	Deinze			**Oosterweel**			**Moorsel**		
	Sex	Age M	Age F	Sex	Age M	Age F	Sex	Age M	Age F
Femur									
Linea Aspera (LA)	**<0.001**	**0.038**	**0.002**	0.083	0.313	n/o	**0.049**	1.000	**0.018**
Gluteus Maximus (GM)	**0.005**	0.304	n/o	0.293	0.313	1.000	0.662	**0.036**	0.258
Vastus Intermedius (VI)	0.879	0.617	**0.014**	0.083	0.313	n/o	0.418	0.186	0.240
Tibia									
Popliteal Line (PL)	**0.004**	0.071	0.644	0.138	**0.018**	1.000	0.376	0.063	**0.030**

Table 6.6: Summary of statistically significant differences (showing p-value; in bold when statistically significant) between males and females and between male (M) and female (F) age of individuals of known sex and age for entheseal changes of the analysed muscle attachment sites of the lower limb within Deinze, Oosterweel and Moorsel. n/o=no EC observed.

EC Lower Limb				Site					
	Slijpe			Vichte			Zottegem		
	Sex	Age M	Age F	Sex	Age M	Age F	Sex	Age M	Age F
Femur									
Linea Aspera (LA)	0.106	**0.006**	0.474	**0.010**	**0.003**	0.359	**0.026**	0.086	**0.002**
Gluteus Maximus (GM)	0.385	0.495	0.247	0.195	0.053	0.319	0.068	0.170	0.110
Vastus Intermedius (VI)	0.506	0.984	**0.010**	0.060	0.886	0.151	0.083	0.086	n/o
Tibia									
Popliteal Line (PL)	0.890	0.475	0.122	**0.042**	0.459	0.155	0.647	**0.015**	**0.030**

Table 6.7: Summary of statistically significant differences (showing p-value; in bold when statistically significant) between males and females and between male (M) and female (F) age of individuals of known sex and age for entheseal changes of the analysed muscle attachment sites of the lower limb within Slijpe, Vichte and Zottegem. n/o=no EC observed.

Defining specific actions involving entheses of the lower limbs is more complex since they mostly relate to motions of the knee and the hip such as standing up from a seated position, and lesions of these attachment sites have been linked to activities such as horseback riding, cart driving, and jogging with heavy loads in rough terrain or 'balancing the body's weight over the stance leg during walking' (Havelková *et al.* 2011: 501). Palmer *et al.* (2016), who investigated EC in a rural post-medieval population in the Netherlands (Middenbeemster), focused for this reason only on muscle attachment sites of the upper body, stating that locomotor movements involving lower limbs such as walking, running and jumping 'can obscure detection of other activities, a complication which is absent in the upper limb' (Palmer *et al.* 2016: 79). Because of the importance of locomotion, there are indeed difficulties to determine physical activities associated with lower limb EC. However, gender and social status differences were demonstrated by Havelková *et al.* (2013), who found a higher prevalence of lower limb EC in early medieval male individuals from warrior and deep graves compared to females and males who were buried in shallow graves, and who represented a lower socioeconomic status.

Age was also demonstrated as one of the most significant contributors to the presence of lower limb EC by Weiss (2004). Apart from the age factor, Weiss (2004: 235) found as well a significant correlation when controlling for sex, which is in agreement with this thesis. Indeed, especially EC of the linea aspera showed a correlation with age in males of Deinze, Slijpe and Vichte and in females of Deinze, Zottegem and Moorsel. EC of the linea aspera was not observed in the high-status females of Oosterweel. However, Weiss (2004: 236-237) demonstrated that the association between sex and size is highly correlated, and thus supports the hypothesis that higher muscle marker scores with males are mainly attributed to their general greater muscle mass, and their average larger height and weight than females, rather than the result of activity patterns. In sum, sex difference in lower limb EC 'seems to be partly a result of sex differences in body size' (Weiss 2004: 237). In all sites of this study, older male individuals were mainly observed with moderate and severe scores for lower limb EC than younger males and female individuals from all age categories, who were chiefly identified with slight EC. Severe scores in female lower limb EC were only found in the linea aspera and popliteal line in post-medieval rural Moorsel, even in the younger age group (fig. 6.16).

Fig. 6.16: Popliteal line on the right tibia (posterior surface) showing grade 4 (severe), identified in an old adult rural female from Moorsel (skeletal individual nr. IV/S3/181).

The gluteus maximus (GM) was the only enthesis that did not exhibit EC in the female group of Deinze and was observed as statistically significant between both sexes. In contrast, EC of the GM was noticed in females of younger age categories in the rural sites of Moorsel, Vichte and Zottegem and in females from the age of 36 years in Slijpe. The GM is the largest muscle in the gluteal area, and because of its function as the main hip extensor, the GM is considered as the most important muscle related to the hip. It consists of three bursae, or fluid- filled sacs around a joint to assist in movement of the bones and to reduce friction between adjacent fibrous tissues. One of them, the ischiogluteal bursa, is located at the base of the pelvis, between the ischial tuberosity and the GM, and may be subjected to recurrent irritation or stress (Schuh *et al.* 2011). When sitting for a long time occurs, especially on hard surfaces, this can cause inflammation of the bursa, or *ischiogluteal bursitis*, because 'the muscle slides up so that there is only fibrous tissue and sometimes a bursa between the bone and the skin' (Swartout and Compere 1974: 551). Because of the intermittent friction on the ischial tuberosity during prolonged sitting, the disease has been documented among weavers, and is therefore also known as 'weaver's bottom' (Anderson 1974: 565). This type of bursitis, however, is a disorder that has only been reported in the clinical literature, and not in the palaeopathological record. EC studies of the pelvic region, on the other hand, are less frequent, and revealed no association between osteophytic changes on the ischial tuberosity and occupation (Campanacho and Santos 2013). When considering the GM in hip movements, such as moving the upper leg up and down repeatedly, differences in its robusticity between male and female groups may be related to certain physical activities that put strain on the thigh muscle. This action is for example employed during weaving on a treadle loom, where the threads of the warp are lifted by manipulating the foot pedals (Øye 2016: 36, 42-43, see also fig. 2.3 in Chapter 2). In an urban context, weaving was considered as a predominant male profession organised by the guilds, although female participation in handling the loom cannot be totally excluded (Øye 2016). However, as previously mentioned in Chapter 2, operating the heavier horizontal loom required a strong musculoskeletal system, and was therefore mostly handled by men (van Bavel 2010: 155). Weaving was indeed one of the primary activities during the medieval period in Deinze, and historical accounts indicated a local cloth production (Stabel and Dambruyne 2003a: 144 and 150-153). Stabel (1985: 97) specified for example the names of *Jan de Suttere* and *Gillis den Heect*, who were both male tapestry weavers in Deinze during the fifteenth century. The dearth of female GM EC in Deinze may suggest that the urban women were less involved in repetitive activities that implied extension movements of the hip, compared to the rural females. Other activities that place strain on the ischiogluteal bursa and which cause injuries to the GM include repetitive running, kicking, weight lifting, walking uphill or jumping.

6.7.3. Upper Limb EC

An overview of the statistically significant differences found between both sexes and with advancing age of the upper limb EC is shown in tables 6.8 and 6.9 and is, similar as tables 6.6 and 6.7, based on the data which are more detailed in Chapter 5. In general, and more specified below: the small urban population of Deinze exhibited less statistically significant differences between males and females and a correlation with both male and female age for EC seen in the entheses of the arms compared to all rural groups. Slijpe and Moorsel include the most statistically significant differences between the sexes of upper limb EC. Increasing age was not observed as statistically significant for all upper limb EC in the female groups of Deinze and Slijpe and hardly noticed in Zottegem females and in those from the high-status group of Oosterweel. An association between EC and age for both males and females was particularly recorded in Vichte.

EC Upper Limb			**Site**						
	Deinze			**Oosterweel**			**Moorsel**		
	Sex	Age M	Age F	Sex	Age M	Age F	Sex	Age M	Age F
Clavicula									
Trapezoid (TRZ)	0.784	**0.017**	0.545	0.056	0.204	n/o	0.902	0.057	0.325
Conoid (CO)	0.902	0.699	0.103	0.056	0.204	n/o	0.702	1.000	0.186
Subclavius (SC)	**0.006**	0.054	0.138	0.056	0.204	n/o	1.000	0.114	0.249
Costoclavicular (CC)	**<0.001**	0.296	0.375	0.056	0.204	n/o	0.938	0.057	0.353
Radius									
Biceps Brachii Insertion (BBI)	**<0.001**	**0.019**	0.122	0.380	0.902	**0.015**	**0.003**	0.554	0.092
Supinator (SU_RA)	0.347	0.229	0.368	0.094	0.288	n/o	**0.008**	0.096	0.166
Pronator Teres (PT)	**0.045**	0.662	n/o	0.094	0.288	n/o	**0.037**	**0.008**	**0.027**
Flexor Pollicis Longus (FPL)	0.971	0.851	0.147	0.094	0.288	n/o	0.064	**0.011**	0.075
Ulna									
Brachialis (BA)	0.593	0.233	0.501	0.069	0.369	n/o	**0.028**	0.533	**0.007**
Anconeus (AN)	0.095	0.088	0.365	**0.010**	0.074	n/o	**0.003**	0.369	0.059
Supinator (SU_UL)	0.089	0.289	n/o	**0.010**	0.074	n/o	**0.003**	0.178	0.097
Humerus									
Deltoideus (DT)	**0.017**	0.140	0.883	**0.015**	0.164	1.000	0.432	1.000	0.394
Teres Major (TM)	0.274	0.482	0.513	**0.049**	0.239	n/o	**0.019**	0.264	0.076

Pectoralis Major	**0.011**	0.434	0.880	**0.022**	0.056	1.000	**0.005**	1.000	0.076
(PM)	0.337	0.100	0.373	**0.049**	0.239	n/o	**0.019**	0.264	0.076
Latissimus Dorsi	0.572	0.427	0.278	0.134	0.102	1.000	0.131	0.693	0.121
(LD)									
Brachioradialis (BR)									

Table 6.8: Summary of statistically significant differences (showing p-value; in bold when statistically significant) between males and females and between male (M) and female (F) age of individuals of known sex and age for entheseal changes of the analysed muscle attachment sites of the upper limb within Deinze, Oosterweel and Moorsel. n/o=no EC observed.

EC Upper Limb				**Site**					
	Slijpe			**Vichte**			**Zottegem**		
	Sex	Age M	Age F	Sex	Age M	Age F	Sex	Age M	Age F
Clavicula									
Trapezoid (TRZ)	0.058	0.333	0.866	0.323	**0.001**	**0.030**	0.246	0.565	0.474
Conoid (CO)	0.130	0.903	0.884	0.553	**0.015**	0.353	**0.027**	0.804	0.336
Subclavius (SC)	0.082	0.118	0.877	0.285	0.088	0.274	0.419	0.118	0.858
Costoclavicular	**0.024**	**0.011**	0.536	0.068	0.437	0.295	0.512	0.225	0.089
(CC)									
Radius									
Biceps Brachii	0.074	**0.016**	0.081	0.051	**0.005**	**0.010**	0.145	0.144	0.133
Insertion (BBI)									
Supinator (SU_RA)	**<0.001**	0.961	0.252	**0.003**	**0.040**	0.139	0.055	0.067	**0.025**
Pronator Teres	**<0.001**	0.700	0.151	**<0.001**	**0.040**	**0.003**	0.236	0.472	0.659
(PT)	**0.045**	0.277	0.062	**0.006**	0.746	**0.001**	0.274	0.122	0.636
Flexor Pollicis									
Longus (FPL)									
Ulna									
Brachialis (BA)	**<0.001**	0.949	0.067	0.443	**0.002**	**0.001**	0.312	0.191	0.129
Anconeus (AN)	**0.026**	0.609	0.455	**0.049**	**0.001**	**0.039**	0.094	**0.006**	0.151
Supinator (SU_UL)	**<0.001**	0.977	0.405	**0.022**	**0.003**	**0.006**	0.051	**0.006**	0.437

Humerus									
Deltoideus (DT)	**0.014**	1.000	0.249	0.807	0.823	0.111	0.710	**0.016**	0.316
Teres Major (TM)	0.556	0.608	0.758	0.587	0.498	0.595	0.226	0.090	0.287
Pectoralis Major	**0.001**	0.289	0.794	0.168	0.910	0.109	0.912	0.083	0.186
(PM)	**0.030**	0.425	0.825	0.974	0.795	**0.019**	0.379	**0.029**	0.201
Latissimus Dorsi	0.210	0.249	0.620	0.155	**0.031**	0.077	0.517	**0.047**	0.527
(LD)									
Brachioradialis									
(BR)									

Table 6.9: Summary of statistically significant differences (showing p-value; in bold when statistically significant) between males and females and between male (M) and female (F) age of individuals of known sex and age for entheseal changes of the analysed muscle attachment sites of the upper limb within Slijpe, Vichte and Zottegem. n/o=no EC observed.

The insertion of the biceps brachii (BBI), which is mainly responsible for flexion and supination of the forearm and elbow during for instance lifting of objects, was only reported as statistically significant between males and females at Moorsel and Deinze. An association with increasing age in males was recorded at Deinze, Slijpe and Vichte, and in females at Oosterweel and Vichte.

A similar sexual dimorphism of the BBI was also identified in the aforementioned study by Palmer *et al*. (2016) of the post-medieval village of Middenbeemster. Most individuals from the latter skeletal assemblage date to the nineteenth century, and since they were not affected by the industrial revolution (Palmer *et al.* 2016: 79), the data could be comparable with the nineteenth century villagers of Vichte. Occupational activities in Middenbeemster were also mainly concentrated on farming as at Vichte, although the parish records revealed heterogeneity of professions that included preachers, saddle makers, merchants, tailors and carpenters and hence represent a variety in activity markers. Social differentiation, however, was not distinguished in the Middenbeemster population which might be explained by a small number of elite individuals or by performing an equal number of tasks by the elite group (Palmer *et al*. 2016: 85-86). Nevertheless, the overall results of the upper limb EC suggested a gendered labour division. Males were particularly observed with EC in the biceps brachii which implies movements such as 'lifting of heavy objects', while females on the other hand had higher EC scores in the triceps brachii which is responsible for 'extension of the lower arm, the adduction and extension of the arm, and the bracing of the elbow joint, for instance when pushing an object', and may indicate that women were employed in repetitive and strenuous tasks such as milking cows or 'using a scrubbing board on laundry' (Palmer *et al.* 2016: 85). In this thesis, severe scores of the BBI were only observed with males from Deinze and Vichte, while the late-medieval group of Slijpe showed the opposite pattern. Here, severe scores were even noticed in young adult females and might suggest that labour is required from the whole community, including men and women from all age groups. As explained in 2.1., labour in the coastal region during the late medieval period was both characterised by a combination of farming and small-scale proto-industrial production such as textiles (e.g. wool processing), sheep and cattle husbandry, fishing and peat digging (Soens *et al.* 2014: 142-144; Soens *et al.* 2015) as well as by a strict distinction in the coastal households in which most activities for women included domestic tasks alongside milking, butter making, gardening, weeding and looking after smaller animals such as sheep (Karel *et al*. 2011: 193). Although Devos *et al.* (2011: 157, 165) stated that the commercial agricultural market economy in the North Sea region required a significant input of a young and male working population, the Slijpe data of the BBI, but also of several other muscle attachment sites showing severe scores in young adult females, may suggest a significant contribution of young adult females too; nonetheless it is not possible to attribute specific activities to an individual since muscular hypertrophy reflects multiple motions.

Because of its location in the coastal area, the region of Slijpe endured several consecutive flood disasters in the late medieval period, especially in the fifteenth century (Soens 2013b: 226). By reconstruction financial investments in flood protection and dike repair works in coastal Flanders, Soens (2013b) was able to demonstrate the reciprocation between warfare, an abandoned maintenance of the dikes and successive flood disasters. Soens (2013b: 221) further remarked that ‘only in the course of the fifteenth century, did some coastal areas (like coastal Flanders or Romney Marsh) seem to embark on a long-run road to depopulation, turning lack of manpower into a structural problem'. The lack of manpower in the vulnerable coastal region might indeed explain a hindrance in the organisation of flood protection as suggested by Soens (2013b: 231), it can be assumed that the late-medieval coastal inhabitants of Slijpe were affected by the consequences of the frequent flood disasters on multiple levels, not only economically because of failed harvests, but also being subjected to health risks. Moreover, the same period witnessed a rural economic recession and the coastal landholders 'actively compensated for the depressed agricultural prices through scale enlargement and saved on labour costs by turning from arable farming to animal husbandry' (Soens 2013b: 224). de Kraker (2006: 928) noted the human response to floods in terms of ‘(in)sufficient dike maintenance, carrying out fast repairs, local surface levels of polders, and the quality and size of polder management and administrative units’. Thus, it may be suggested that, if dike repairs would have occurred occasionally and would have been employed, it would have required muscle power as stated by Muscolino (2015: 124), and dealing with the consequences of flooding must have demanded additional labour because of economic losses, damage to the property and its impact on the work organisation (Leiter *et al*. 2009).

A muscle that flexes the arm at the shoulder joint like the BBI, but acts more powerful when lifting the arm, is the *m. deltoideus*, or deltoid muscle, with its insertion located on the humeral shaft. The results in this thesis indicate that in the rural sites of Moorsel, Slijpe, Vichte and Zottegem and in urban Deinze, mostly young and middle adult females were observed with moderate to mainly severe scores of the deltoid compared to their male counterparts with severe deltoid EC from the age of 36 years. Unfortunately, comparison with the Middenbeemster group for the deltoid muscle is not possible since this enthesis yielded remarkably no pronounced results in the Dutch analysis, despite its multifunctionality (Palmer *et al.* 2016: 84). A correlation with age for deltoid EC was only recorded as statistically significant in Zottegem males. Although age was demonstrated as not statistically significant in the female groups, the severe scores identified in the younger age categories may indicate a labour-intensive input of a young female adult working population. This is in agreement with, for example, Eshed *et al*. (2004: 312) who found a similar higher score of the deltoid muscle in Natufian hunter-gatherer females, and concluded that 'females, therefore, generally utilized forearm muscles reinforced by arm muscles (e.g. the teres major and deltoideus) for labor-intensive activities'.

One of the muscles that assists in breathing is the *latissimus dorsi* (LD). When forced breathing occurs, for example during coughing with asthma patients, it is suggested that the LD has an 'inspiratory action' in chronic asthmatics (Gutiérrez *et al.* 2014: 802 and 806), and in whom the muscle fibers often display hypertrophy (Orozco-Levi *et al*. 1995). Clinical studies have demonstrated an association between pulmonary function and the neural activation of muscles related to respiration such as the LD (Terson De Paleville and Lorenz 2015). Thus, it can be conjectured that the case studies with the highest frequencies of pulmonary afflictions, Deinze and Slijpe, may demonstrate a correlation between LD EC and pulmonary or other infections. Although four of the five skeletal individuals with moderate to severe LD EC were also observed with bone spur or exostosis on several ribs, and one skeleton with possible evidence of pulmonary TB in Slijpe, there was no statistically significant association between LD and TB and other infections ($p > 0.05$) (skeletal individuals nr. 8-2-48: male, aged 40+; 37-9-34: male, aged 36-50; 60-12-9: female aged 50+; 74-7-10: female, aged 40+). In Deinze, none of the skeletal individuals with moderate to severe LD EC exhibited any evidence of respiratory infections. In the high-status group of Oosterweel, statistically significant differences between males and females were found in several entheses of the ulna and humerus. This may be due to the fact that EC was mostly faint or hardly present in Oosterweel females and this pattern can be explained by the small female sample size of a mainly young age group compared to the larger group of older males.

The brachialis (BA), a muscle that is responsible for flexion of the forearm was observed as statistically significant between males and females in the rural populations of Slijpe and Moorsel. When controlling for age, EC of the BA was significant in both sexes of Vichte and in Moorsel females. In Oosterweel, slight to moderate BA EC was only observed in males, while severe scores were observed in males from Slijpe, Vichte and Zottegem and in both sexes from Moorsel. Santana-Cabrera *et al.* (2015: 133) note a high frequency of BA EC in females as a result of daily activities that concern flexion and pronation of the arm. A moderate to high development of muscle robusticity in the BA is also reported in hunter-gatherer societies, where this increase has been associated with bow hunting, chopping and gathering wood, food processing, production of pottery and load bearing (Wakefield-Murphy 2017: 171). Activities such as wood collection and chopping, soil preparation and lifting are similar to those performed by agricultural groups. Within the rural context in this study, the production of flax and its various stages (e.g. breaking, scutching, heckling) imply a biomechanical loading that is likely responsible for an increased strain on the forearm and elbow. The sexual dimorphism in the data for BA EC in Moorsel, but also in Slijpe, indicate that the male group was particularly involved in activities that produce flexion and pronation of the arm. However, the severe scores for BA EC noticed in Moorsel old females may indicate similar strenuous tasks carried out by the whole community. From the seventeenth century, many rural households in the area of Moorsel, were engaged in the demanding cultivation of flax, oats, rye and production of linen (Thoen 2001: 121; Vermoesen 2010: 5-6). As illustrated in Chapter 2, the whole family worked intensively by digging the land with spades, weeding and sowing, and the results for Moorsel corroborate the probate inventories that were incorporated by Thoen and Soens (2015: 244-245 and 249) to demonstrate 'the high physical productivity' in the Land of Aalst. In Deinze, scores for BA EC were rather small, with no differences between males and females and between male and female age categories for BA EC, suggesting that both sexes from all age classes were involved in minimal activities that flex the forearm at the elbow joint. Low values were noticed as well for the flexor pollicis longus (FPL) which is required for flexion of the thumb, and yielded no statistically significant differences for sex and age in Deinze, Zottegem and Oosterweel, in contrast to Moorsel, Slijpe and Vichte. Moreover, when examining sexual dimorphism, only Vichte showed a statistically significant difference for FPL EC and a correlation with female age. Mainly males from all adult age categories exhibiting faint to moderate scores. Severe scores were recorded in Slijpe females (18+) and in Moorsel middle adult males. Repetitive employment of the hand was previously demonstrated by the frequency of bony excrescences in the hand bones, especially in Vichte and Slijpe, although in both sites also observed in females below 36 years old, suggesting a repeated use of hands and fingers. Spinning and weaving at home were carried out by the villagers of Vichte in the nineteenth century as well as other documented activities such as a basket weaver who had employed six basket plaiters in the village (Blockeel 1975: 18-19). Muscles that are associated with these activities, i.e. basket weaving and spinning cotton with a spindle whorl, but also gardening, cutting meat and husking corn (from the sixteenth century) are the FPL, pronator teres (PT), supinator radius (SUP_RA) and supinator ulna (SUP_UL), and were more prominently recorded in males and females from Slijpe and Vichte, and to a lesser extent in Moorsel and Zottegem. In Deinze and Oosterweel, EC of these entheses were scarcely observed. Differences between males and females for the pectoralis major (PM) were statistically significant in Deinze, Moorsel and Slijpe, where severe PM EC was mainly observed in both younger and older males. In Slijpe as well as in Zottegem although not statistically significant in the latter, young adult females exhibited severe scores as well (fig. 6.17). In Oosterweel, females hardly exhibit PM EC which may clarify the statistically significant difference between the sexes. This muscle is responsible for medial rotation and extension of the arm, and adducts the arm at the shoulder joint. As a large pectoral muscle, the PM is related to an array of activities.

Fig. 6.17: Severe EC scores in the pectoralis major (below) and teres major (above) of the right humerus in a Slijpe young adult female (skeletal individual nr. 48-7-27).

The various tasks involved in agricultural and urban labour are represented by repetitious flexion/extension and adduction/abduction movements of the arm and the shoulder girdle. Handling tools such as sickles and small scythes, also used by females in the coastal region, most likely during busy harvest times (see Chapter 2), will exert force on the prime movers of the arm, and compel stabilisation of the shoulder joint (Perry 2004: 364). Muscles that are related to shoulder flexion (DT, TM, PM and LD) are, for example, applied during harvesting and while using a sickle, and these patterns are particularly indicated by moderate to severe scores in both sexes in the rural sites of Moorsel, Slijpe, Vichte and Zottegem, and are even noticed in age groups below 36 years. Although rural males across age categories in general exhibited mainly moderate to severe markers for supination, while rural females were observed with faint to moderate scores, it does not imply a more strenuous male participation in activities which exert supination forces such as gardening, cutting meat, spinning cotton or washing wool, but indicate that females were also participating in tasks which required physical strength. In Deinze and Oosterweel, however, EC scores for supination were rarely seen in females, but most frequently in males.

In general, sexual dimorphism of upper limb EC in the humerus, radius and ulna was mostly significant in the rural groups of Moorsel, Slijpe, Vichte and Zottegem, with moderate to severe EC particularly observed in males. Some entheses, however, showed severe scores in the young adult working females too, especially in those from Deinze, Slijpe and Zottegem. Other archaeological samples have demonstrated greater robusticity of several entheses in females than in males (e.g. Eshed *et al*. 2004; Robb 1998; Santana-Cabrera *et al.* 2015; Wilczak 1998). However, it should be noted that this pattern is not universal since the differences between the sexes could reflect functional variations as Mariotti *et al.* (2007: 296) argue that 'some entheses present higher development in one sex while others are more developed in the other'.

The late-medieval coastal population of Slijpe is the group with the most recorded EC that exhibited statistically significant differences between males and females (CC, PM, DT, LD, SUP_RA+UL, FPL, PT, BA and AN, as indicated in table 6.9). For Slijpe, these EC are mostly related to movements of the forearm, such as pronation, supination and flexion of the elbow. A gender division of labour in coastal households (see Chapter 2) was indeed postulated by Devos *et al.* (2011: 157 and 165) and Karel *et al.* (2011: 192-193), with men mostly involved in agricultural labour and farm work, and women in domestic tasks and farm activities (e.g. wool washing, milking cows). However, it should be noted that to interpret sexual dimorphism as a result of different intensity levels within physical activities, motions related to flexion-extension of the elbow, supination of the forearm and function/articulation of the shoulder girdle, may be related to biomechanical processes, characteristic for strenuous activities that put strain on the upper limb (Kapandji and Kauer 2009a; Santana-Cabrera *et al.* 2015: 134). Farm activities such as preparing the fields, harvesting crops, woodland clearance but also building constructions would obviously demand physical strength of the upper body, and is consistent with the hypertrophy of upper limb EC observed in male skeletons from an agricultural eleventh to fifteenth century population (Santana-Cabrera *et al.* 2015). Males exhibiting greater robusticity than females in the upper limb have been acknowledged in several EC studies from spatiotemporal archaeological populations and are, apart from activity patterns, mainly attributed to divergent bone responses to biomechanical stress, body size and to the influence of hormones (e.g. Milella *et al.* 2012; Santana-Cabrera *et al.* 2015; Schlecht 2012; Steen and Lane 1998). Increasing levels of testosterone with boys may be responsible for the difference in the development of muscle mass during puberty, especially in the upper limb (Round *et al.* 2009).

Differences between left and right EC were minimal, and were only identified as statistically significant in two entheses in Vichte individuals (with a predominance of the right subclavius and left teres major in males) and in one enthesis within the Zottegem population (with a predominance of the right trapezoid in females). The overall dearth of statistically significant differences in the laterality of entheses may be explained by the fact that stress patterns on the principal extremity are being obscured by 'the complementary role of the non-dominant extremity in labors of assistance. In this sense, unilateral and bilateral use of the extremities may mask the signs of a lateral preference, if one existed' (Santana-Cabrera 2015: 131). This pattern is in agreement with other studies that reported a minimal difference between sides in populations engaged in strenuous activities in which both limbs are used (e.g. Al-Oumaoui *et al.* 2004; Eshed *et al.* 2004; Myszka and Piontek 2012; Santana-Cabrera *et al.* 2015).

When comparing similar analysed EC from this study with the aforementioned analysis by Palmer and Waters-Rist (2019) on the post-medieval Aalst assemblage representing different socioeconomic groups, divergences were noticed in the correlation with sex for the brachioradialis in the low-status groups which was statistically significant whereas the present study did not identify a correlation with sex. Although the lowest class population from Aalst showed a statistically significant correlation between sex and EC whereas the middle-class and high-status individuals showed none, Palmer and Water-Rist (2019: 310) emphasize that this does not necessarily imply a different division of labour between the sexes of the low-status group since this was observed in only two entheses. Also, the small sample size of the high-status individuals (n=13) may bias the interpretation of the results (Palmer and Waters-Rist 2019: 310). In this study, sexual dimorphism was observed in minimum five entheses of each skeletal population and may be related to the total number and selection of muscle attachment sites. Similarities, on the other hand, demonstrated that age was not particularly correlated to EC since a few entheses showed a positive correlation in most sites. Palmer and Waters-Rist (2019: 310) advocate that aetiological factors other than age possibly influence EC and support the multi-variation of the effects of age on different tendons as illustrated in 6.7.1.

6.8. Summary

The lives of peasants in contrast to their urban counterparts in medieval to early-modern societies have been often investigated by historians. Living in a town has been commonly deemed as a place that induced detrimental effects on the health of the citizens due to e.g. overpopulation, poor sanitation, and a lack of sewage structures, thus creating an environment which made people vulnerable to infectious diseases. The image of the countryside, in contrast, has been usually depicted as the opposite with respect to health issues, although peasants were involved in physical demanding agricultural labour (Saers *et al.* 2017: 132). Hence it would be assumed that the lives of individuals from urban centers would demonstrate discrepancies in various aspects such as occupational activities, lifestyle, diet and health with those from a rural context. A valuable method to reveal the effects of socioeconomic conditions on past populations is the integration of bioarchaeological analyses of skeletal individuals. Several osteological studies have indeed demonstrated differences between urban and rural populations, albeit with contrasting results, and some studies, on the other hand, showed no marked dichotomy between town and country (Schats 2016). This thesis aimed to elucidate the impact of socioeconomic conditions from a bioarchaeological perspective on six skeletal assemblages from different regions in Flanders, dating between the twelfth and nineteenth centuries: Deinze, Moorsel, Oosterweel, Slijpe, Vichte and Zottegem. Economic developments in the later medieval period instigated a dynamic phase in both urban and rural industries, imbued with a regional differentiation between the coastal area, with a principal production of woollen cloth and inland Flanders, with its focus on flax and linen. The economic growth created smaller towns such as Deinze, for which the thirteenth century meant a transformation from a rural village towards an urban centre with an initial concentration of textile related activities performed by the inhabitants (e.g. dying, fulling, tapestry manufacturing).

Historical data suggested a close interaction between town and countryside, and distinguishing between the two settlement types should certainly overcome a strict dichotomy. The data in this chapter demonstrated that in terms of diseases, the environment should be incorporated as a crucial factor that might have affected the lives of the rural and urban inhabitants. For example, how past populations, and moreover, the local authorities, managed the organisation of water supply, since the consumption of polluted water often accounts for the spread of infectious diseases. Vulnerability to flood disasters and malaria was suggested by the most recorded prevalence of cribra orbitalia in the late-medieval coastal population of Slijpe and supports the historical data that documented outbreaks of quartan fever or malaria in Flanders (and other locations in Europe). Moreover, linear enamel hypoplasia was also mostly prevalent in Slijpe and in the medieval to post-medieval socially higher ranked individuals from Oosterweel, a former polder village situated in the province of

Antwerp, and indicates the prevalence of the lesions across socioeconomic status groups. Palaeopathological analysis revealed further a high exposure to pulmonary lesions and possible evidence of pulmonary tuberculosis in the small urban working group of Deinze, and corroborates the general findings of a higher susceptibility to developing respiratory ailments in citizens compared to rural dwellers. Rather than population density, since Deinze is a small town, other factors might have been responsible for the high prevalence of respiratory infections. Here, the variety in textile occupations may have caused an increase in lung diseases, consistent with clinical studies who found a high risk of acquiring pulmonary diseases, respiratory infections and chronic lung afflictions among textile workers. Moreover, the process of retting flax in the Leie-river, which runs through Deinze, has likely contributed to its pollution, as historical sources refer to the contaminated Leie water and the ensuing exposure to contagions for both inhabitants and animals. Moreover, there was no statistically significant difference between the Deinze males and females for the prevalence of respiratory infections and other infectious diseases, indicating that both sexes were equally exposed to the hazardous and polluted living environment of the small town.

Although traumatic injuries were common in both rural and urban individuals, differences between town and country were observed in the affected bone elements. For example, rural females showed more fractures in the upper and lower limbs than the Deinze females, while rib injuries were mostly recorded in both Deinze males and females, leaving the suggestion that this type of lesion may be the result of chronic coughing, but not ruling out other causes such as falls and crushing trauma.

Larger variations, however, were identified in the analysis of entheseal changes (EC), for which twenty muscle attachment sites in both upper and lower limb of adult individuals were scored for robusticity and cortical defect. The upper limb EC was shown to be statistically significant in terms of severity between males and females in all working rural communities, for which adults from Slijpe exhibited the most sexual dimorphism. Age was not observed to be a significant factor for many upper limbs compared to lower limb EC. Only Vichte showed the highest frequency considering a correlation with age for both males and females. This notable lack of association with age in most sites may point to the multi-aetiological nature of EC. It may also indicate that strenuous labour was carried out from a young age to late adulthood accounting for the severe scores of EC in younger age categories. Indeed, moderate to severe scores were even noticed in female and male younger age categories of the agricultural labourers of Moorsel, Slijpe, Vichte and Zottegem. In general, it was expected that males would exhibit greater robusticity in upper and lower limb EC. The variety of tasks in an urban context opposed to the mainly gender-delineated labour roles in the rural sites would suppose a sexual division of labour seen in the latter. In this study, however, lower limb EC were shown to be statistically significant between males and females, whether urban or rural. Sex differences for lower limb EC are likely related to the greater muscle mass of males rather than activity patterns. However, although males demonstrate greater robusticity in lower limb EC, probably as a result of higher levels of lower limb loading, the differentiation between the sexes may be related to the intensity of activities performed by males.

The bioarchaeological approach to investigating the impact of occupational activities and environmental conditions through the integration of skeletal stress markers, palaeopathologies and EC identified on the skeletal assemblages from six Flemish archaeological sites has demonstrated that the lives of medieval to early modern individuals in this region were significantly affected by their local habitat, irrespective of social class, gender, an urban or rural context. The incorporation of historical and archaeological evidence along with the osteological data has demonstrated the importance of a multi-dimensional approach to addressing research questions around the impact of socioeconomic and environmental conditions affecting late medieval to early-modern populations from Flanders, consisting of human beings who played an active role in a vigorous society.

CHAPTER 7

CONCLUSIONS

This doctoral thesis intended to apply a bioarchaeological approach to investigate the health status of six skeletal assemblages from archaeological sites in Flanders (Belgium), dating between the late twelfth and nineteenth centuries: Deinze, Moorsel, Oosterweel, Slijpe, Vichte and Zottegem. The main focus was to elucidate inter- and intra-population variability by analysing osteological markers to study the impact of activities and the environment on the skeletal individuals from various contexts. Patterns of mortality, palaeopathologies, dental lesions and entheseal changes (EC) were analysed and discussed to reveal social and regional differentiation and discrepancies between living in a (small) town and the countryside. The comparative analysis of the six sites demonstrated the consequences of a strenuous lifestyle in a vulnerable coastal area and inland Flanders, but also the raise of a small town in a period that was essential for the formation of the rural market economy, and the effects of occupational activities on the working populations whose socioeconomic significance was exposed through historical sources.

This chapter will evaluate the main research questions that were introduced in the first chapter, and will further explore future possibilities in the bioarchaeological research of historical communities.

7.1. First Research Question

What can we learn about the rural and urban health status at both inter- and intra-population levels? Are there any specific demographic, pathological and dental lesions that reveal the consequences of a rural lifestyle compared to living in an urban environment in Flanders between the twelfth and nineteenth centuries?

Five skeletal populations in this study were derived from rural sites: one high-status group, Oosterweel (prov. of Antwerp), and four representing agricultural labourers, which are late-medieval Slijpe in the coastal area, Moorsel and Zottegem (prov. of East Flanders), and the nineteenth century villagers of Vichte (prov. of West Flanders). Only Deinze concerned a small urban working population. Besides the more specific time period archaeologically assigned to Slijpe and Vichte, the four other skeletal collections represent a broader time period, and were unearthed from churchyards ranging from 800 to 1923 AD. Skeletal preservation and completion of the oldest bone material, however, was in a poor condition, and thus osteological analysis was carried out on skeletons dating from the late twelfth century from the four latter sites. Differences in funerary practices between the rural and urban sites were minimal. The prevailing W-E grave alignment was mostly recorded in five sites, with only at Moorsel a common NW-SE orientation which might be related to the construction of the churchyard wall. More variation was seen in the provision of grave goods with a Christian connotation, such as rosaries and crucifixes, that were notably found in post-medieval Moorsel and Vichte. However, discrepancies in mortuary practices may reflect regional customs as observed by the scapulars in Deinze, and the iron shears that were found in two burials in Oosterweel, and demonstrate that the final decision to supply the deceased with a personal object, whether religious or not, will be made by the surviving relatives.

More important is that regional differentiation between the six sites certainly affected socioeconomic conditions. Topographical and environmental circumstances have led to the adaptation of different economic strategies which contrasted notably between coastal and inland Flanders. Activities that were undertaken in the peasant small-holdings in the North Sea area were mainly focused on peat extraction, fishing, cultivation of salt marshes for sheep grazing, animal husbandry, and the production of wool and grain, while the tillage of labour-intensive crops such as flax and the production of linen were dominant in inland Flanders. The frailty of the coastal wetlands was further reported by successive flood disasters, for example during the fifteenth century, and demonstrates the interconnection between environmental and economic history, as a shortfall of financial resources in dike maintenance may have imbalanced rural economy. Depopulation and a lack of manpower may have hindered the organisation of flood protection, which, in turn, may have left the late-medieval coastal inhabitants of Slijpe vulnerable to a weak economic position and to health risks. The wet and cold climate of the coastal polder region and marshlands may have produced and intensified diseases that are less common in inland Flanders such as colds, arthritis and endemic malaria, or 'Polder fever', and may result in a higher mortality rate because of the detrimental water circumstances.

As shown in Chapter 5, comparing mortality between the six sites if both sexes are clustered together revealed that the majority of deaths for Oosterweel, Slijpe, Vichte and Zottegem are situated in the young adult category between the ages of 20-35 years. Compared to the latter age group, old adults aged 50 years and over were mostly recorded in Deinze and post-medieval Moorsel. When looking at the age distribution according to biological sex, female death occurred mostly between the ages of 20-35 years in Deinze, Oosterweel, Slijpe, Vichte and Zottegem, while for post-medieval Moorsel, most female deaths were recorded in the old adult age category. Male mortality, however, indicated that men in general reached an older age than women, and mainly died after the age of 36. These mortality data support the general suggestion of an increased risk of mortality for women during child-bearing years, but a decrease in the older years. An explanation for the larger group of low-status old adult females compared to the age category of middle adult females at Deinze, Slijpe, and Vichte could be related to the experience of childhood stress factors which may enhance immunity and result in an older life expectancy. Evidence of biological stress markers were principally recorded in the aforementioned three sites, and involve a short stature (Deinze and Vichte), cribra orbitalia (Slijpe), non-specific infections such as periosteal reaction (Deinze, Slijpe and Vichte) and other identified infections such as ear infections and sinusitis (mostly in Deinze and Vichte, followed by Slijpe). The prevalence of dental enamel hypoplasia (EH), another environmental stress marker, was mostly found in the coastal site of Slijpe and in the high-status individuals of Oosterweel, although in the latter group mainly recorded as slight, but was further particularly present in Deinze, with no statistically significant difference between males and females in Deinze and Slijpe. In Oosterweel, there was a statistically significant difference between males and females for EH, with more females than males displaying EH, but this may be explained by the smaller number of teeth available for analysis. On the other hand, the presence of EH in the high-status individuals indicates its prevalence regardless of social status.

Interestingly, post-medieval Moorsel was the only site in which EH was absent, and may indicate that the villagers were not prone to prolonged malnourishment or infectious diseases during childhood, which may also be demonstrated by the highest mean female average stature of 161.8 cm and by the fact that for both sexes, most deaths were recorded in the old adult age category. The minimal presence of children under the age of thirteen in most rural sites may be due to the scope of the excavated area, or to survival into adulthood. Another possible explanation may be that children migrated to nearby towns for apprentice or servant work. Not only major cities attracted young labourers. Historical census data of the seventeenth and eighteenth century of Deinze, revealed a large proportion of domestic servants, mostly young adults of both sexes. Moreover, *communicant figures* from the same era revealed an overall young population in Deinze. For example: 42% of its total population was younger than eighteen in 1695, and may corroborate the higher frequency of juvenile deaths aged 13-19 years (16%) in the skeletal assemblage, in contrast to the other non-urban skeletal collections of Oosterweel (8%), the complete assemblage of Moorsel (15%), Slijpe (7%), Vichte (2%) and Zottegem (13%).The described poor sanitation, epidemics, famine, dysentery, and infections because of contaminated water and foodstuffs in Deinze may have caused an increase in mortality, which most likely has affected the vulnerable younger age groups in the small town in the seventeenth and eighteenth century.

Patterns of pathologies in the six sites indicated that the natural habitat of the inhabitants played a crucial role in the development of diseases, but also how working conditions must have been regulated in the past. An important factor to inhibit the spread of endemics and infections is the management of water supply since for example the consumption of contaminated water often hastens the expansion of contagions. The sites with the most recorded infectious diseases (Deinze, Slijpe and Vichte) are those with evidence of polluted water, or high exposure to flood disasters. Vichte, with the outbreak of typhoid and cholera in the nineteenth century, had poor sanitation in the village. The nearby small stream *Vichtebeek* or *Kasselrijbeek* was applied as driving force for the local mill, and became an open sewer in the landscape by which the pollution of this water was noted as extremely high.

More vulnerability to the effects of water and a high risk to flood disasters was observed in the coastal polder area of Slijpe. Exposure to malaria was suggested by the highest rates of cribra orbitalia (CO), and is supported by historically documented outbreaks of quartan fever or malaria in polder regions. Although Oosterweel is situated in a polder region too, and inundations and malaria were historically documented in the area, even in socially higher ranked individuals, there was no osteological evidence of CO. If not considering the small sample size, it may be suggested that the high-status individuals from Oosterweel were buffered against nutritional deficiencies and chronic infections by a combination of better hygiene, medical care and a vitamin rich diet.

Most respiratory afflictions and likely evidence of tuberculosis (TB) were identified in the urban working individuals of Deinze. A higher susceptibility to developing pulmonary diseases and TB is usually reported in citizens compared to rural inhabitants, and is often attributed to poor sanitation and overpopulation. Seeing its small urban context, other factors might have been responsible for the high prevalence of respiratory infections in Deinze. For example, the Leie (or Lys)-river, running through Deinze, has been historically documented as being contaminated, with a high risk for both residents and animals. The high pollution of the river was apparently due to the process of retting flax. Although bans for this reason on retting flax in the streaming Leie-water were introduced in the fifteenth century, historical accounts revealed that in the sixteenth century, labourers were prosecuted for retting flax in the Leie, despite the prohibition. Also, the various textile-related activities may have caused an increase in respiratory diseases, consistent with clinical studies who found a high risk to acquire TB and chronic lung afflictions among textile workers.

Even more, there were overall no statistically significant differences in the prevalence of infectious disease and CO between males and females in the aforementioned sites, demonstrating that both sexes were equally affected by the polluted and vulnerable conditions and consequences of residing in the proximity of inferior water quality.

As previously mentioned for Deinze, occupational diseases were common among textile and flax workers due to exposure to dust from textile fibers, and have been reported in both historical and modern clinical studies. For example, the paste used to strengthen the yarn of the weaving loom in the peasant's farm needed to be moist, leaving dust behind, which in turn may have caused asthma, chronic bronchitis and tuberculosis. However, in post-medieval Moorsel, the only site situated on the boundary of the flax cultivation and linen production, infections were less prevalent compared to all other working populations. Although the cultivation of flax was highly performed in the area from 1350 AD, from c 1750 AD, an increase was noticed in the production of other crops such as wheat, oats, rye and hop (Verleyen 1985: 222 and 226), suggesting that the villagers were less subject to the disadvantages of the manual process of flax heckling. On the other hand, besides the agricultural labour, weaving was an important additional resource for the villagers in the Moorsel region (Schelstraete *et al*. 1986: 47), and household inventories has shown that many peasant families owned a weaving loom (Thoen 2001: 121). The absence of infections of the respiratory system in Moorsel can also be explained by the fact that people had passed away before lesions became macroscopically identifiable on the human skeletal remains.

Also trauma was generally less prevalent in Moorsel compared to the other working groups, degenerative joint diseases of the hip bone, however, were, next to Slijpe, frequently recorded in younger Moorsel females, suggesting their involvement in agricultural labour since young adulthood or even since childhood. The majority of joint diseases were mostly observed in middle and old adult males from all sites, which can be explained by the overall larger group of older males and by age as an influential factor on joint disease. All rural working females, however, and moreover in the young adult age group, showed pOA in the left and right elbow and shoulder as the most affected joint. The frequency of upper limb pOA in females is consistent with historical studies on female activities in rural villages such as milking cows, washing clothes and churning of butter which all required more strain from the upper limbs, and this pattern may explain the particular involvement of shoulder and elbow OA in females from the rural sites. In urban Deinze, males were more affected than females for every joint type, with more involvement of the right than the left side for both sexes, and this was mainly observed in the shoulder. In general, pOA of the shoulder was particularly common in Deinze, Slijpe, Vichte and Zottegem. In Moorsel, pOA was mostly observed in the elbow in females and in the knee in males. In the high-status group of Oosterweel, pOA was less common and was only observed in the shoulder of an old adult male and in the knee of a middle adult male and old adult female.

Even though traumatic injuries were noticed in both rural and urban individuals, differences between town and country were shown in the affected bone elements. The distribution of traumatic injuries revealed that rural females showed more fractures in the upper and lower limbs than the urban Deinze females, likely because of the agricultural work including handling cattle, while rib injuries were mostly recorded in both Deinze males and females, leaving the suggestion that this type of lesion may be the result of chronic coughing, or other reasons such as falls or crushing trauma. Other trauma patterns indicated that cranial trauma was the highest in the rural male group of Moorsel, which may be induced by interpersonal violence or falls. Furthermore, and also documented in other rural populations (Judd 2006: 328), all rural medieval to post-medieval males from Moorsel, Slijpe and Zottegem displayed the most tibial fractures, which mainly involved stress and avulsion fractures. In nineteenth century Vichte, however, femoral fractures were mainly recorded in both males and females, and mostly concerned OCD as a result of repetitive micro-trauma or acute macro-trauma. Although more males displayed traumatic injuries than females in all case study sites, the CPR's for trauma between the sexes were not statistically significant. The diversity of the affected bone elements within the rural and urban sites outlines the variation of fracture patterns within diverse past societies.

Dental health did not significantly differ between the urban and rural sites, and between the social status groups. Carious lesions were mostly observed in the high-status females of Oosterweel, and in the post-medieval rural males from Moorsel, and support the common findings of caries in archaeological populations across social status groups. A severe increase in dental caries is often associated with the intake of cariogenic foods, such as sugar and fine white flour, since the post-medieval period, especially due to the import of cane sugar from overseas colonies. However, the TPR of caries in late-medieval Slijpe was higher than the nineteenth century parish of Vichte, and this may be indicative of poor oral hygiene, since both sexes were also observed with the highest rate of abscesses, which is often the result of an increase in plaque formation due to deficient dental care. Differences in oral hygiene or consumption within the case study sites are suggested by the fewer carious lesions in females of Deinze, Moorsel and Slijpe and in males of Oosterweel, and may be related to the consumption of alcohol, which can induce tooth decay and a higher risk of cavities, since the importance of local beer brewing in Flanders from the late medieval period. It could also be that females consumed less cariogenic foods or more dairy products and milk since they contain cariostatic and protective elements against caries. Data on diet for Slijpe were for example retrieved from a stable isotope analysis of nineteen skeletal individuals, and revealed a primary consumption of meat, rather than of fish. More isotopic studies from several Roman to post-medieval skeletal individuals in Belgium suggested the intake of proteins through meat or through plants such as pulses as main source above freshwater or marine fish.

In sum, the palaeopathological and demographic data of the six skeletal assemblages from different contexts may have shown the effects of the environment on human health, and the possible consequences of the long, arduous and repetitive activities undertaken by the working populations in this study. Being subject to the contamination of water, malaria endemics and flood risks for the inhabitants residing nearby a river, stream, coastal or polder area, was historically documented, and likely affected many individuals, regardless of sex, age, status, rural or urban context. Despite of the small sample size, the high-status group of Oosterweel showed overall fewer evidence of trauma, non-specific infections and joint diseases than those of the urban and rural labourers (apart from DISH), and may indicate that these individuals were restrained from severe, daily repetitious duties. At the end, as previously noted in Chapter 6 regarding the heterogeneous trauma pattern in both rural and urban societies, this applies as well for mortality and palaeopathologies in general, as multiple variables within the socio-cultural and socioeconomic environment of an individual and his community are conducive to the interpretation of health and diseases.

7.2. Second Research Question

Will the impact of occupational activities, the role of rural labour supply, the strong urban need, and the commercialisation of labour as illustrated by historical sources suggest a regional economic differentiation between the skeletal assemblages, since the medieval era was essential for the formation of the rural market economy in the Low Countries? Could therefore the approach of entheseal changes (EC) reveal a sexual division of labour within each group and/or indicate variations between the groups? Will it enhance our understanding of inter- and intra-population variability if EC will relate to the different economic activities of the Flemish regions?

The significance of Flanders in the production and trade of wool, linen, cloth, and the labour-intensive cultivation of flax and other crops implicated a major impact on the working lives of both citizens and peasants since the medieval period. Alongside the historical socioeconomic data that point to not only regional differentiation in the social agrosystem between the coastal area and inland Flanders, but also to gender labour discrepancies between the two areas, the study of EC or occupational activity markers was integrated to explore this inter- and intra-population variability. However, since recent methodologies to employ a standardized system in EC analysis are still being tested and in development, a limited section of this research was therefore attributed to the implementation of EC. Twenty muscle attachment sites or entheses of upper and lower extremities of male and female adult individuals from six Flemish archaeologically derived populations were scored for morphological alterations in order to determine inter- and intra-population variability of muscle strength. Variations between the labourers of the rural (Moorsel, Slijpe, Vichte and Zottegem) and urban (Deinze) sites of this study were particularly noted in upper limb EC. When controlling for age and sex, the small urban population of Deinze showed fewer statistically significances compared to the rural farmers of Moorsel, Slijpe, Vichte and Zottegem, indicating that a gendered division of labour was less explicit in the small town, or that males and females were involved in activities that put strain on similar entheses. Sexual dimorphism was mostly observed in late-medieval coastal Slijpe, and may demonstrate that men and women were occupied with different tasks, as suggested by historical data on gendered labour division in coastal households, where men were predominantly engaged in farming, and women in domestic tasks. However, in busy harvest times, women were also needed on the field, and the severe scores of muscles that are responsible for e.g. medial rotation and extension of the arm, and lifting heavy objects identified in the Slijpe females from younger age categories illustrate that repetitive, strenuous activities were undertaken from childhood or adolescence. The data demonstrate that rural females in particular were more prone to repetitious, habitual behaviour from a younger age compared to urban females. Muscles that rotate the wrist and flex the forearm were shown to be more robust in rural than urban females, and suggests intense movements of the wrist at a young age which are associated with for example spinning and domestic chores such as washing, gardening and food preparation. Heavy use of the forearm and shoulder was as well suggested by the moderate to severe scores in female and male younger age categories of the agricultural communities of Slijpe, Moorsel, Vichte and Zottegem, indicating the frequent use of the upper extremities during the multiple stages of farm work such as soil preparation, digging and harvesting, and may be indicative for the need of females, and thus the whole family, on the fields of the inland and coastal peasant holdings. EC in the high-status females of Oosterweel, on the other hand, were minimal, and were mostly slight to moderate in males, which is likely related to their role in the community that required no strenuous activities. However, the small sample size and the younger age at death of the Oosterweel females might be a confounding factor, and may clarify the general absence of EC. The overall absence of a statistically significant asymmetry indicates that both left and right extremities of the body are employed during repetitive activities.

It was expected that males in general would exhibit greater robusticity than females in the upper and lower limb, which supports the data from other EC analyses of archaeological populations, and is likely associated with body size, different bone responses to biomechanical stress and hormonal factors that affect muscle mass growth. Surprisingly, age was not observed to be a significant factor for many upper limbs compared to lower limb EC. Only Vichte showed the highest frequency considering a correlation with age for both males and females. This notable lack of association with age in most sites reflects the multi-aetiological nature of EC. It may also support the fact that strenuous labour was carried out from a young age to late adulthood accounting for the severe scores of EC in younger age categories. The commercial agricultural market economy in the North Sea region required a significant input of a young working population, both males and females, and is further supported by the increase of proto-industrial activities in rural groups in inland Flanders from the sixteenth century as well as in the late-medieval coastal group.

In conclusion, the integration of EC analysis has demonstrated to be a valuable complement to the historical and socioeconomic sources of past societies, and supports the historical data that indicated a harsh burden of the physical environment (see Chapter 2) for the late-medieval coastal inhabitants of Slijpe, who were also possibly affected by the consequences of flood risks, and a lesser burden of the physical environment for the peasants of inland Flanders. However, the performance of diverse, repetitive tasks by all rural labourers of both sexes must have begun since childhood, which corroborates the involvement of children and adolescents in farm work and/or textile preparation chores. It would certainly be a benefit to continue studying the impact of activity markers on past working populations when recent EC methodologies such as the new Coimbra method will be refined and tested. Therefore, the need for large samples of known context, but also the inclusion of modern clinical studies will definitely enhance our understanding of working conditions in the past.

To finally quote Sébastien Villotte, who was the keynote speaker with a paper about prehistoric populations at the interdisciplinary conference on identifying occupation from the skeleton: 'The main result is to deduct a division of labour, and not particularly to find out or to tell WHAT they did', and is undoubtedly in agreement with the present study on late-medieval to pre-industrial societies.[6]

7.3. Prospective Opportunities in Bioarchaeological Research

The study of human skeletal remains from archaeological populations will, apart from macroscopic investigation, certainly be enhanced by the application of biomolecular methods. Recent developments in palaeomicrobiology, for example, will increase our understanding in the identification and interpretation of ancient pathogens that were responsible for past pandemics such as the plague (Fornaciari 2017), as several lethal infectious diseases are not discernible on bones. Investigations by ancient DNA (aDNA) have been proven successful in not only exploring the plague, but also other consequential contagious diseases such as tuberculosis (TB), malaria, cholera and leprosy (e.g. Bos *et al.* 2016; Brown 2000: 470; Donoghue *et al.* 2017; Fornaciari 2017; Mays *et al.* 2001; 2002: 31-32, TB localised in one individual; for a critical overview see Wilbur and Stone 2012). The combination of osteological analysis with biomolecular methods will contribute to an improved

[6] His paper entitled *Division of Labour in European Prehistory* was presented at Working Your Fingers to the Bone. An Interdisciplinary Conference on Identifying Occupation from the Skeleton, in Coimbra (Portugal, July 7 2016).

diagnosis of ancient diseases in individual case studies (Mays *et al.* 2002: 35). The tentative presence of pulmonary TB and malaria that was osteologically indicated in several individuals from Deinze and Slijpe would be an ideal test case for the identification of possible ancient pathogens. Moreover, the interdisciplinary nature of palaeomicrobiological analyses with historical and archaeological data, for example, funerary treatment of victims of pestilences, will improve our knowledge in the identification of pathogenic agents that cause infectious diseases. Schreg (2014: 109 and 111) as well emphasises the importance of interdisciplinary research, by further remarking , in his paper, the intermediate position of medieval archaeology between natural sciences and humanities, when many significant social, economic and ecological processes occurred in Europe.

The issue of migration from the rural hinterland to towns has been slightly touched upon as motivations to move were for example poverty and work opportunities as a servant, but often involves a temporal situation. Long term and distance migration, however, may be explored by stable isotope analysis to demonstrate mobility through oxygen isotopes (see e.g. Redfern *et al*. 2016), or by combining oxygen with strontium isotopes (see e.g. Hemer *et al.* 2013). Even more, historical and topographical data note the immigration of Flemish weavers to the English town of Beverley in the fourteenth century, or even before (see Chapter 2). If skeletal remains of the original parish churchyard in Beverley would be available for osteological analysis, then the inclusion of stable isotope analysis could support the historical evidence.

Other applications of stable isotope techniques include the investigation of diet through carbon and nitrogen isotopes. A pilot study in collaboration with Dr Julia Beaumont (University of Bradford, lab analysis undertaken at the University of Bradford on 7-8 December 2015), was carried out on bone collagen from ten late medieval to post-medieval adults and subadults from the age of twelve of the Deinze skeletal population, and indicates the consumption of freshwater fish above marine species, suggested by the high nitrogen isotope ratios (fig. 7.1). However, this diet of the inland population does not corroborate the zooarchaeological study by Van Neer and Ervynck (2016: 8) that demonstrates a decline in the production of freshwater fish in the late Medieval Period, and which is likely related to the pollution of waters in and nearby towns (Ervynck and Van Neer 1998: 89). Although the study by Van Neer and Ervynck (2016) particularly focuses on the consumption of marine fish (cod), and their dataset did not include Deinze, but nearby sites such as Ghent, the authors suggest to expand the dataset involving different social status groups in order to achieve a more comprehensive picture of the food economy and trade. In general, our preliminary results show clearly a difference in food consumption with the high-status monks of Aalst, which is indicative of a diet rich in marine fish (Quintelier *et al.* 2014). Moreover, the assumption could be made that, if the inhabitants of Deinze continued the consumption of freshwater fish from nearby polluted rivers, this may support the high prevalence of infectious diseases and nutritional stress identified in the skeletal remains. Therefore, continued stable isotope analysis and/or other novel methods, such as MALT screening using DNA extracts, on the same and other skeletal individuals could further investigate, respectively, nutrition, and may reveal for example bacterial causes of enteric fever, due to contaminated water (Vågene *et al.* 2018).

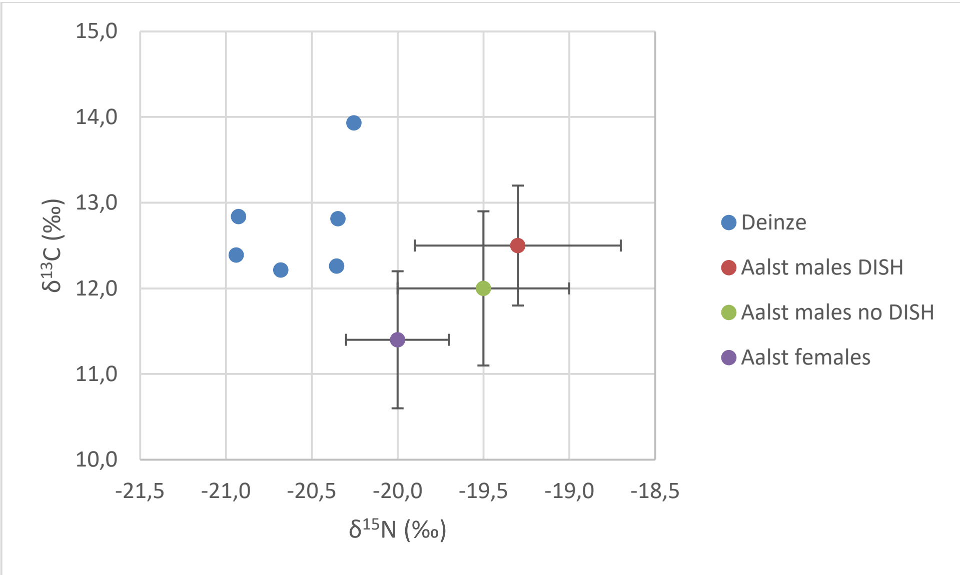

Fig. 7.1: Carbon versus nitrogen data in human bone collagen, indicating variation in fish consumption between low-status individuals from Deinze and the high-status Carmelites of Aalst (data from Aalst retrieved from Quintelier *et al.* 2014).

Thus, the use of biomolecular techniques on samples from Belgian archaeological sites is at present, indeed, rather scarce, and especially on individuals from late medieval to early modern rural and small urban populations. The few analyses that have been carried out to date mostly concentrate on dietary habits, as for example, the aforementioned stable isotope analysis on individuals from the post-medieval Carmelite friary at Aalst (Quintelier *et al.* 2014), or, on exploring animal husbandry using herbivore bones (Müldner *et al.* 2014), but none have ever published patterns of ancient diseases through palaeomicrobiology. Above all, functioning as an orientating instrument, it can also inform us on current and future epidemics, gain insight on how palaeopathological events emerge over time and on the resilience of populations towards these epidemics (DeWitte 2016). DeWitte (2016: 71), for example, argues that by investigating mortality patterns associated with diseases, this could reveal who was more vulnerable during epidemics as for instance a higher mortality risk was observed among casualties of the Black Death who were already ill or malnourished. Therefore, the study of past epidemics can instigate current operations 'in advance of crises to ameliorate their potential devastating effects'. Other aspects such as economic, political conditions and diet should be incorporated to obtain a holistic view of human health in the past that could be beneficial for modern working populations (DeWitte 2016: 71 and 73). For example, the respiratory diseases that were noticed among the flax and textile workers in this study (see Chapter 6, 6.5), are still widespread today in developing countries, and modern clinical data have shown that improvement of working conditions (e.g. dust control regulations, ventilated rooms, involvement of unions) have mitigated the effects of occupational risks in the western world.

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