An osteoarchaeological reconstruction of the medieval population from the Hospital of St James at Thornton Abbey, Lincolnshire.

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A thesis submitted for the degree of Doctor of Philosophy

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April 2021

Acknowledgment

There are so many people who deserve thanks for the support they have given me while writing this thesis. Firstly, I must thank Hugh Willmott and Peter Townend who included me in the excavations at Thornton Abbey and provided me with the opportunity to undertake this research.

Secondly, to Hugh Willmott and Elizabeth Craig-Atkins, my supervisors, who had the patience and enthusiasm to read and re-read drafts of this thesis. Your advice, guidance and encouragement have been paramount to its completion.

Thirdly, to Sharon DeWitte who took time out of her hectic schedule to teach me statistical methods of analysis at the forefront of our field.

I would especially like to thank Francesca Breeden for her IT skills and proof reading abilities. But more importantly for your friendship and support.

Finally, a big thank you goes to my parents, Ian Hook and Carrol Green, and my friends for their unwavering support and for reminding me to take a break once in a while.

This work was supported by the Arts Humanities Research Council (grant number AH/L503848/1) through the White Rose College of the Arts Humanities.

Abstract

This thesis examines the Hospital of St James at Thornton Abbey, Lincolnshire, looking at funerary practice and the hospital's population. This is the first examination of the hospital since excavations at the site closed in 2016. The primary objective of the thesis is to characterise the Hospital of St James. This is achieved through a multidisciplinary approach, incorporating osteology, population demography and archaeological research methods which provide a broad and reaching approach to the archaeological assemblage enabling a comprehensive study to take place.

The thesis begins with an introduction to the role of a hospital in later medieval society, commenting on the principals upon which they were founded, their contribution to charity and their position on the edge of monastic and lay communities. Having established the background to the role hospitals fulfilled in later medieval England, the aim of characterising the Hospital of St James is first addressed through an exploration of the burial practices carried out at the hospital. The thesis goes on to address this objective through the establishment and exploration of the population's demographic profile which reveals a dominantly male population with a large proportion of non-adults. This demographic profile is compared to nine contemporary hospital sites to integrate the Hospital of St James into current literature concerning medieval hospitals of England, as well as monastic and lay populations as a means to explore the extent to which the hospital represented the monastic communities from which they were established. Following this an exploration of the palaeopathologies present in the cemetery is undertaken and also compared to the nine contemporary hospitals. Through this, the type of care being offered at the Hospital of St James can be measured against that being offered at other hospitals. The penultimate chapter presents a discussion surrounding the large number of non-adults present within the hospital's assemblage, calling for a discussion of the position of children in medieval society and their relationship with the religious communities of later medieval England. This draws upon the involvement of religious communities in caring for sick and abandoned children, their role as a primary educator and their training children for a life of monasticism. The discussion also examines the location of the Hospital of St James within the outer precinct of Thornton Abbey, and how this position may have had an influence upon the large presence of non-adults and the role the hospital fulfilled. The final chapter discusses the characterisation of the Hospital of St James established from the thesis research findings. These finding conclude that the Hospital of St James may not have followed the convention of the four hospital types referenced throughout academic literature, instead it displays a complex blend of children, the sick poor and corrodians. Following these, suggestions for future research is presented regarding the further study of late medieval hospital demographic profiles and the research potential of the skeletal assemblage from the Hospital of St James.

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Introduction

"The study of medieval English hospitals is now recognised as an important interdisciplinary activity of interest to historians working in many fields. Much of the credit of our greater understanding of these institutions goes to archaeologists, whose findings help to compensate for the loss of building and archives at the Dissolution, and who can also teach us to interpret what has survived in very different ways."

(Rawcliffe 1999)

This thesis offers the first examination of the later medieval Hospital of St James through an osteoarchaeological approach. The Hospital of St James is located within the wider precinct of Thornton Abbey, Lincolnshire, which was one of the wealthiest religious institutions of later medieval England. This hospital represents the charitable acts and almsgiving of the Abbey, yet its history and existence has been lost over time. With no surviving historical evidence to elucidate the function of the hospital and the cemetery, the archaeological, and particularly the osteological remains are the sources of evidence available to explore. The osteological investigation of the skeletal remains is the means through which this thesis aims to reveal the function of the hospital through the analysis of the individual burials and the population as a whole.

For the purpose of this thesis the later medieval period refers to the time from the Norman Conquest in 1066 up to the Dissolution of the Monasteries between

1536 and 1541AD . The following gives a brief overview of the social and political circumstances of England. The onset of the twelfth century saw a population that had doubled in the last 500 years; the twelfth and thirteenth centuries saw England's economy and population expand. This continued growth was possible as the centuries were free from major epidemic disease, catastrophic crop failure and natural or man-made disaster (Dyer 2005, 9). This freedom from adversity resulted in a growing population and prospering economy. Throughout the thirteenth century England's exportation of raw materials such as wool and tin to the European continent continued to grow; the population at Thornton Abbey benefited greatly from the flourishing wool trade (as discussed in section 1.3 of this thesis) (Dyer 2005, 13). The number of towns being established rose, as did their wealth and size. In rural settings a large proportion of the population held a few acres of land to work and depended largely on the wage labour to make their living (Dyer 2005, 9). The confidence people held in their economic situation is reflected in the peasants resistance to demands made by their lords for rents and services and the migration of serf's from community to community despite legal restriction on the 'unfree' (Dyer 2000, xiii). However, the continued growth over these two centuries turned into an explosion of population expansion and by the end of the thirteenth century the population had doubled again (Boswell 1988, 269). This rapid growth resulted in the inevitable overcrowding of growing urban centres and life-threatening food shortages.

The struggles of society were further exacerbated by the outbreak of plagues and famines throughout the fourteenth century; namely the great famine of 1315-17 and the Black Death of 1348-9 (Bolton 1980, 72). By the fourteenth century all classes of society felt the impact of overpopulation, high inflation and harvest failure but it was the lower classes that often went without basic provisions (Roberts and Cox 2003, 225). The Black Death caused a significant decline in the population; between one-third and half of the population died from the initial 1348-9 epidemic, and throughout the fourteenth century outbreaks of less devastating plague continued to occur and impact the population and economy of England (Horrox 1994, 3–4). The impact of the Black Death at the Hospital of St James has been evidenced in the mass burial of plague victims within the hospital's cemetery. Willmott *et al.* (2020) recorded a total of 48 men, women and children interred in a single event at the hospital with the positive identification of *Yersinia pestis*. These burials represent England's first Black Death mass grave found in a rural context, and provides a unique insight into the overwhelming impact of the plague on small rural communities (Willmott *et al.*, 2020, 1790). The aftermath of the plague aided economic growth, due to an increase in the availability of work, wages and food supply (Clark 2007, 115; Bailey 1996, 9; Bolton 1980, 46; McKintosh 1988, 219). However, this newfound prosperity was not to last, and the lower classes of society soon found themselves in poverty once again as lower demands for food caused an increase in prices which were not met by the stagnant state of wages.

Population size remained low until after 1500, due to the high rate of mortality throughout the fourteenth century (Hatcher 1986, 19-38), after which wages and the standard of living in fifteenth-century England steadily improved (Dyer 1998, 306-11). The sixteenth century saw the Dissolution of the Monasteries, which was the administrative and legal process to disband the monasteries and friaries of England, Wales and Ireland by Henry VIII between 1536 and 1541 (Bernard 2011, 390; Mottram 2019, 1). Lincolnshire, and more specifically the town of Louth, was a centre for resistance against the Dissolution (Everson and Stocker 2003, 145), and a spontaneous protest, known as the Lincolnshire Rising, commenced on 2 October 1536. The protesters opposed the closing of monasteries as well as the impact on all traditional religious practices; however, the stand did not last long and by the following Friday the rebels had abandoned their cause and in less than two weeks the rebellion has ceased completely (Hoyle 2001, 93; Everson and Stocker 2003, 145). The Dissolution ultimately led to the abandonment of religious houses and their subsidiaries which included hospitals.

1.1 An introduction to the study of late medieval hospitals

Extensive works of research and excavation have been carried out within the grounds of Thornton Abbey (Willmott *et al.* 2020). Of particular note to this thesis are the excavations within the grounds of the Abbey taking place form 2013-2016, which uncovered the remains of a late medieval building and surrounding cemetery. The building was orientated on an east – west alignment, as one would expect of a Christian place of worship. This, combined with a reference to an indulgence granted for 'repairs made to the chapel of St James, without the walls of Thornton' made in 1322 (Page 1906, 235), led to the building being initially identified as the Hospital of St James. A comprehensive identification of these remains as the documented hospital is published in Willmott *et al.* (2020).

Characterising the physical structure, function and religious practice of medieval hospitals has been the subject of academic research for over half a century (Carlin 1989; Gilchrist 1995; Godfrey 1955; Leistikow 1967; Orme and Webster 1995; Prescott 1992; Rawcliffe 2006; Rubin 1989; Watson 2006; Ziegler 2011; Huggon 2018). However, greater consideration is required of the broad demographic profile of people that the hospitals supported, and the composition of these hospital communities which consisted of religious staff, lay staff and the inmates. However, providing a generalised characterisation of medieval hospitals is complex, as these sites are broadly idiosyncratic and not built to a common template, resulting in vastly different archaeological remains (Gilchrist 1995, 4). These differences represent the diverse approaches each hospital took to care for their inmates and their role as an institution. It is commonly agreed across the scholarly literature that medieval hospitals throughout Europe were run in accordance to monastic practices of charity and spiritual well-being, yet there is little coherence as to which elements of monastic practice were embraced and which were not (Carlin 1989; Gilchrist 1995; Godfrey 1955; Leistikow 1967; Orme and Webster 1995; Prescott 1992; Rawcliffe

2006; Rubin 1989; Watson 2006; Ziegler 2011; Huggon 2018). Nonetheless, medieval hospitals are considered a distinct form of monastic institution and not a subdivision of other religious houses. Instead, hospitals were a direct response to society's need for a system of health care, delivered via the religious ideals of a healthy soul and managed by an institution founded by religious communities.

Despite the hospital's importance in late medieval society, just five percent of the approximate 1,146 hospitals of medieval England and Wales have been subject to archaeological investigation, leaving a substantial opportunity to expand our understanding of this important social institution (Huggon 2018, 18). One potential reason for this under-examination of hospitals is their complicated and ever changing form. While hospitals took on the responsibility for providing care and alms to those in need, they were also very particular in which social groups they catered for and specific in the types of care they administered. These unique characteristics are arguably a result of the hospital's uncertain position between the monastic, religious and secular worlds, a position which sets hospitals aside as a unique and individual institution within late medieval society (Carlin 1989; Gilchrist 1995; Godfrey 1955; Orme and Webster 1995; Prescott 1992; Rawcliffe 2006; Rubin 1989; Watson 2006; Ziegler 2011). The introduction of medieval hospitals has taken place here to provide a basis on which the aims of this thesis can be discussed, a more detailed discussion of hospital establishment, their background and their place in society is carried out in Chapter 2.

Evaluating the role of the medieval hospital is no small feat given the aforementioned complexities. Many studies have been produced in an attempt to define the role of medieval hospitals, and many of these works did so based solely on the documentary evidence (Clay 1909; Godfrey 1955; Carlin 1989; Rubin 1989; Prescott 1992; Orme and Webster 1995). In contrast, more recent work has placed a greater emphasis on the excavation of hospitals and their cemeteries (Thomas *et al.* 1997; Gilchrist and Sloane 2005; Rawcliffe 2006; Watson 2006; Bowers 2007; Ziegler 2011; Connell *et al.* 2012; McIntosh 2012; Cessford 2015). While such research offers a new perspective, they often present a discussion limited to just one hospital, and therefore a broader understanding of institutions across England has not been explored on to the same depth. Thus, part of the challenge of making a novel contribution to the study of medieval hospitals lies in the integration of this diverse and variable body of work.

The first summary of medieval hospitals in England was undertaken by Mary Clay in 1909, in which a general survey of hospitals, arranged by county, was undertaken. Clay's work comments on the various types of hospital and their role in Medieval England by drawing upon records including *The Victoria History of the Counties of England* and the publications of various antiquarian societies. Clay's synthesis of the medieval hospital was ground-breaking and was later followed by the works of Carlin in 1989 and Orme and Webster's 'The English Hospital: 1070-1570' in 1995. Since then the scholarly exploration of hospitals has grown with research interests in social welfare, urbanization, political and social evolution (Biller and Ziegler 2001; Bowers 2007; Brodman 2007; McIntosh 2012;DeWitte 2013, 2016).

A common research theme in the study of medieval hospitals is categorisation of hospitals by function, as well as trying to establish how many of each type were in existence. One of the most widely referenced of these sources is the work of David Knowles and Richard Hadcock (1971) entitled 'Medieval Religious Houses: England and Wales'. This provided a gazetteer of 1,103 hospitals and influenced many later works, most evidently Carlin's (1989) account of 'Medieval English Hospitals'. This work was also based on historical accounts of hospital use, documenting the proportion of hospitals belonging to four classifications: hospitals for the leprous sick, the sick-poor, almshouses and hostels for the poor wayfarer and pilgrim. However, Rawcliffe (2013) instead chose to employ categories based on the length of time inmates would be housed, as well as those for the leprous sick. This study resulted in the characterisation of three types of hospital: for pre-leprosy sufferers, for long-term care for the elderly and disabled, and for short-term care for individuals near death, with acute disease, and for the hospitality of travellers (Rawcliffe 2013).

Authors such as Orme and Webster (1995), Sweetinburgh (2004) and McIntosh (2012) focused on the hospital's history, charting the establishment of hospitals through to their dissolution in the sixteenth century. Rawcliffe (2013) diversified her approach to the medieval hospital, producing several works on health, the practice of medicine and the relationship between religion and healing. Scholarly attention has also rested on the cemeteries that accompany many medieval hospitals. Gilchrist and Sloane (2005) produced a gazetteer of the medieval monastic cemeteries of Britain, in which they synthesised demographic profile data from previous excavations and cemetery reports to comment on the different mortuary practices encountered in monastic cemeteries, including those of hospitals. This work divided hospitals into Carlin's (1989) four widely-used categories based on documentary resources and cemetery populations. However, this approach to classification does not allow for the potential diversity in hospital function; it is now recognises that many of these evolved and changed through time (Huggon 2018). More recently, Huggon's (2018) thesis provides a synthesis of the archaeology of the medieval hospitals of England and Wales from AD 1066-1546.

Arguably the most significant archaeological study of a single late medieval hospital in England is that of St Mary Spital, London. Excavations carried out by the Museum of London Archaeology Service from 1976 to 1989 resulted in a cemetery assemblage of over 10,500 skeletons (Connell *et al.* 2012, xix). The hospital was established in 1197 and run by an order of Augustinian canons (Thomas *et al.* 1997, 19–20, 48-9). As Rawcliffe (1999, 419) noted, the site report makes impressive reference to comparative documentary and topographical material, presenting the fullest chronological and archaeological survey of an English hospital at the time. More recent research has seen the excavation of the Hospital of St John, Cambridge by the Cambridge Archaeological Unit (CAU) over a series of interventions from 2005-2012. This investigation revealed the majority of the urban hospital's cemetery comprising 404 skeletons. The hospital buildings were less accessible than St Mary Spital, being located beneath the current St John's College, and thus has been subject to limited investigations. However, relatively extensive documentary records referring to the hospital's establishment and management enabled excavators to elucidate form and function of the buildings (Cessford 2015, 57-63, 76, 113). Therefore, while the archaeological evidence for medieval hospitals and their cemeteries is growing, the number of sites comprehensively excavated remains small, and their analysis has often relied heavily on detailed historical records in place of missing archaeological data. However, in the case of the Hospital of St James this is not possible, due to the limited historical records pertaining to the hospital, and instead the investigation rests on the archaeological material excavated and demonstrates the potential of archaeological material to illuminate the complex history of past institutions.

1.2 Research aims and objectives

The research objectives of this thesis are simplified into five aims, these aims are often interrelated and therefore there is scope for overlap between them. The first aim of this thesis is to provide a broader contextualization of the Hospital of St James. This thesis will undertake a brief overview of the institution of medieval hospitals and its inhabitants, providing a general discussion of the hospital's role in medieval society, examining the principles upon which they were founded and their general management. This characterisation will make comparisons to other contemporary hospital populations and hospital practices. The four categories of hospital defined by Knowles and Hadcock (1971) and Carlin (1989) and usually adopted by others are used in this analysis of the Hospital of St James, not necessarily because they are ideal, but so meaningful comparisons can be made with the wider archaeological literature. However, as will be established in C hapter 2, hospitals were fluid institutions which do not conform to some of the more traditional historical narratives. Consequentially, the overarching objective of this thesis is concerned with the characterisation of the Hospital of St James, and the categorisation of hospitals is employed for comparative means only.

The second aim of the thesis is to characterise the burial practices employed at the Hospital of St James. This will be achieved via an examination of grave form, skeletal placement and analysis of the phases of cemetery use. This will form a picture of hospital interaction with the dead through their burial treatment. Furthermore, any observable patterning within the cemetery will be used to further interpret possible differences in treatment in the various populations buried there such as the lay and the religious communities, who are both known to have been buried at hospitals. This approach follows similar studies already successfully undertaken at the Hospital of St Bartholomew, London (Moor 1918, 159-60), the Hospital of St John, Ely (Daniell 1997, 91), the Hospital of St Mary Magdalen, Partney (Atkins and Popescu 2010) and the Hospital of St Nicholas, Lewes (Barber and Sibun 1998).

The third aim of this thesis is to compare and contrast the demographic profile of the population of the Hospital of St James to those from other well-excavated hospital sites. This demographic profile is established through osteological analysis of the excavated skeletal remains. An important purpose of this aim is to address the large proportion of children present in the population at the Hospital of St James, to determine how significant the number of non-adults is and what this could reveal about the hospital's use. To achieve this aim, the demographic data will be compared and contrasted to nine sites which have been the subject of analysis and publication in the archaeological record, and each have been categorised as one of the four hospital types defined by Knowles and Hadcock (1971) and Carlin (1989). This will provide a thorough contextualisation of the Hospital of St James assemblage. The demographic profile will also be statistically measured against the demographic profile of populations from both monastic and lay populations of later medieval England. This will reveal the extent to which the hospital followed monastic rules on the housing of their communities (such as the separation of sexes) versus the inclusion of lay people.

The fourth aim is to explore the paleopathologies present in the population, to investigate the ailments of inmates and to establish the type of care being provided by the hospital. This will include discussion of whether the evidence for pathologies can be used to indicate whether the hospital was providing short- or long-term care for its inmates, or any other indication of its general status. However, it is important to note that the purpose of this aim is to build a record of the pathologies present and not to establish the overall health of the population. The profile of pathologies present at the Hospital of St James will be compared to the same 9 hospitals used for demographic analysis to maintain consistency. However, additional sites will be introduced for analysis of specific conditions and instances of trauma where appropriate.

The final aim is to explore the large proportion of non-adults present at the Hospital of St James. As will be discussed, the hospital held an unexpectedly large number of non-adults. This anomaly requires exploration as their presence heavily influences any interpretation of the hospital's use and how the hospital interacted with its monastic environment. This aim will be addressed through a discussion of the housing and education of non-adults in monastic institutions, and the role the hospital played in this context in particular. In particular the placement of the hospital both physically and spiritually within the precinct will be explored to explain why so many non-adults were present in its population.

These complementary aims represent a multidisciplinary approach, integrating osteological analysis, palaeopathology and broader archaeological research methods, to provide a comprehensive and contextualized undertaking of the site. By adopting this approach, which often crosses narrow specialist boundaries, a more comprehensive discussion of the hospital demographics and ailments cared for can be made. Furthermore, an examination of the non-adult population will move beyond discussion of the hospital's basic function and provide a more developed discussion on the quasi-monastic status of hospitals in later medieval society that moves beyond many traditional narratives.

1.3 The medieval Hospital of St James at Thornton Abbey

The archaeological remains of the Hospital of St James at Thornton Abbey was discovered during a programme of research and excavation carried out between 2011-2016 by Dr Hugh Willmott and Dr Peter Townend from the Department of Archaeology at the University of Sheffield (figure 1.3.1), and was located within the outer precinct of the Abbey (figure 1.3.2). Prior to these excavations very little was known of the hospital beyond a single mention in 1322 which references an indulgence granted for the 'repairs made to the chapel of St James, without the walls of Thornton' as documented by Page (1906, 235) (as discussed in section 1.1). It is not uncommon for medieval hospitals to have such little surviving documentary evidence, this is largely because foundations were poorly endowed, small in size and lasted only a few generations (Cullum 1989, 21).

The site of Thornton Abbey was founded as an Augustinian house in 1139 by William le Gros, first Earl of Albemarle (Minns 1898, 492-3; Clapham and Ballie Reynolds 1956). The Abbey prospered and became one of England's wealthiest houses in the later medieval period, with an annual revenue of £591 0*s.* $2\frac{3}{4}$*d.*, by the Dissolution, largely due to its involvement in the flourishing wool trade (Page 1906, 165-6). An important primary documentary source for Thornton Abbey is the *Thornton Chronicle* (Bodleian Library, Tanner MS 166), and this documents the history of the Abbey from the thirteenth to the fifteenth century, recording the abbots, the names of all principal officers, building works and accounts. The Abbey thrived until the house was surrendered on 12th December 1539 to Henry VIII's royal commissioners. The 23 incumbent canons left the Abbey in return for pensions of £5-£7, while their Abbot William Hobson received a pension of £40 (Minns 1898). Thornton Abbey was initially one of a select few monasteries in England to survive destruction after closure through conversion to a secular college for priests. However, this new phase of life was short-lived, when in 1547 it was finally dissolved under Edward VI (Oswald *et al.* 2010, 2).

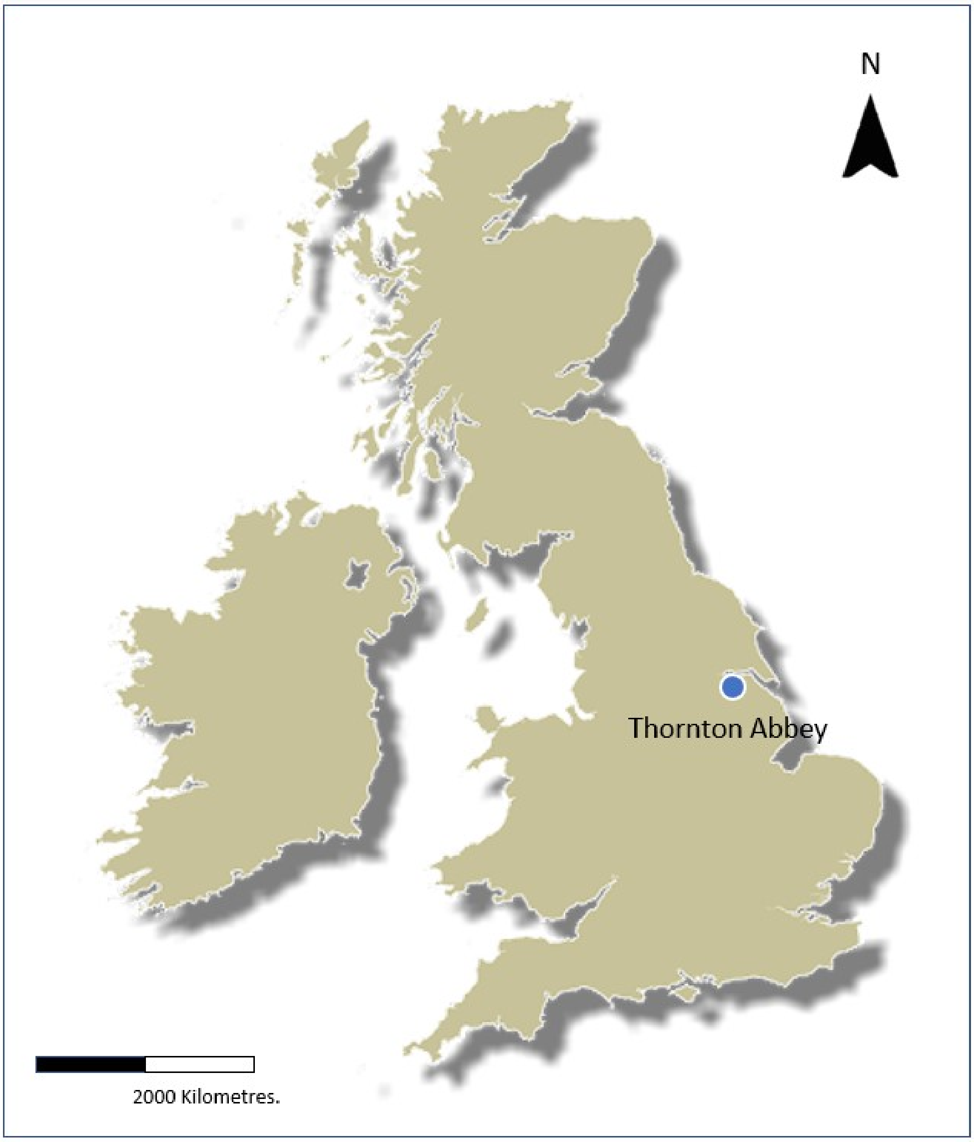

Figure 1.3.1: The location of Thornton Abbey, Lincolnshire, England.

Excavation has shown that from the 12th century at least, a chapel stood on the site of the later hospital, and it has been hypothesised that this either was a pre-existing structure that formed part of the original grant to the canons in 1129, or was a simple church built for their use while the first phase of the major monastic buildings were being constructed to the east (Hugh Willmott pers. comm.). By the late twelfth century, the chapel appears to have been given over for use as a hospital, again evidenced by the 1322 indulgence reference to the hospital (Page 1906, 235). During its time as a hospital several extensions and outbuildings were added to the chapel building. The hospital seems to have remained in use for the remainder of the life of the abbey, when it would have closed.

The excavations at Thornton Abbey uncovered the hospital's chapel and surrounding building, as well as the cemetery and 175 skeletons. The hospital's chapel measured 11 metres wide by 21 metres and was on an east-west alignment. Excavation confirmed it consisted of a single-cell stone chapel and a brick-built extension to the west; this extension would most probably have provided residential facilities to the hospital complex. As stated in the 1322 reference to an indulgence granted for the repair of the chapel of St James 'in the hospital' (Page 1906, 235), several phases of repair had been made to the hospital's building, the most substantial of which was the addition of the buttress to hold up the north-east corner of the chapel. The addition of the stone buttress (figures 1.3.3 and 1.3.4) is of particular note as it cut through the remains of several non-adults as will be discussed in Chapter 3. Surrounding the east and north of the hospital building was the hospital cemetery, consisting of 175 articulated burials which are the subject of this thesis, as well as the single mass grave which does not form part of this current study (see below). Considering the limited reference to the hospital it is not possible to decipher its use, management or demographic profile of the population through historic documentation alone. However, the archaeological evidence obtained through excavation offers an opportunity to further our knowledge of the hospital.

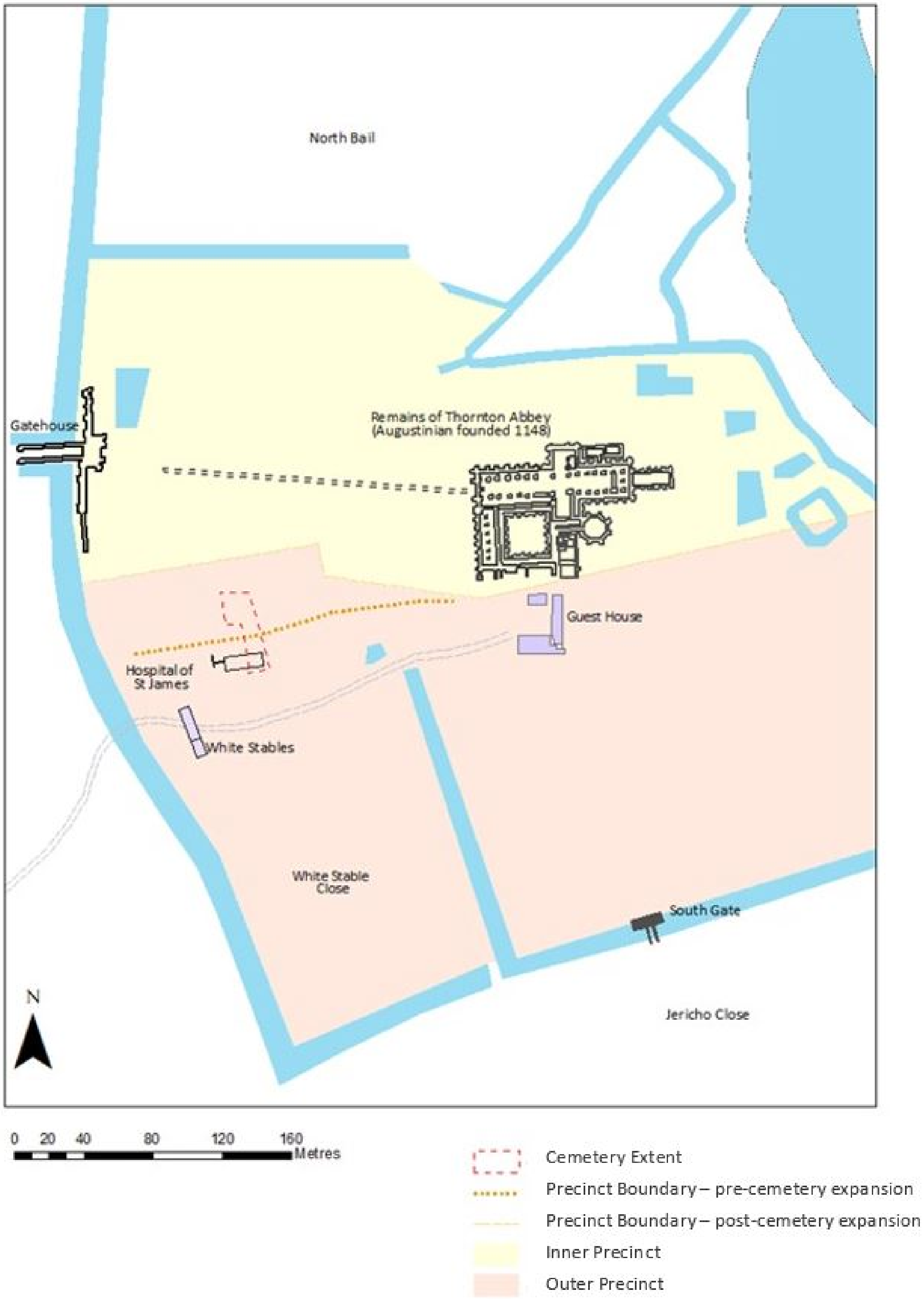

Figure 1.3.2: A schematic plan of Thornton Abbey and its wider complex, including the Hospital of St James and the known extent of the associated cemetery.

Figure 1.3.3: The buttress can be seen as a supporting structure for the northern wall of the chapel, with grave cuts evident to the north and east. Photo looking east-south-east.

Figure 1.3.4: The buttress constructed on the northeast corner of the hospital chapel, the structure cut through several non-adult burials. Photo looking south-west.

As will be established in C hapter 2, medieval hospitals provided burial of their lay inmates and there is no reason to question that the burials at St James do not follow the same practice. However, it seems unlikely that St James provided burial to the local parochial community as they were served by the nearby parish church of St Laurence in the village of Thornton Curtis, which was already well established by the date of the foundation of Thornton Abbey in 1139 (Clapham and Ballie Reynolds 1956). While their burial in the hospital cemetery is a possibility, the main cemetery for the burial of the religious at Thornton was located in the traditional position within the inner precinct to the east of the church and monastic infirmary. Through the analysis of the osteological material and demographic profiles, this thesis aims to investigate whether the hospital population is representative of a monastic community, the hospital inmates or a mixed population containing both the monastic and the hospital's inmates.

Within the cemetery of the hospital there were five zones of use which could be observed in the archaeological record (table 1.3.1). First were the five individuals afforded intramural burial within the hospital's chapel. Second were the burials surrounding the chapel. The third was a distinct final phase of burial in which coterminous burials of either two or three individuals took place among the cemetery extension (the fifth zone). The fourth was the mass interment of fourteenth-century plague victims, likely dating to the outbreak of 1349. As a discrete event, the mass burial is not a subject of analysis in this thesis and has recently been published by Willmott *et al.* (2020). The fifth and final distinction is the extension of the cemetery marked by the original precinct boundary (figure 1.3.5). All of these burials, excluding the mass burial, are included in the analysis and interpretation throughout this thesis. For clarity, the different areas of burial are referred to throughout this thesis as areas A, B and C (figure 1.3.5). Area A contains the burials which took place within the original precinct boundary wall, which lay to the north. Area B contains burials that lie north of the original precinct boundary wall which represent an extension to the cemetery. This area also contains the final phase and mass burial of Black Death victims. Area C comprises the intramural burials, which have been categorised separately to facilitate later interpretation on the grounds that they represent an alternative and arguably superior burial treatment (Finucane 1981, 43-4; Harding 1992; Daniel 2005, 86; Crabtree 2013, 48).

Zone	Description	Area referred to in this thesis
1	Intramural burials within the hospital's chapel.	B
2	Burials surrounding the hospital's chapel.	A
3	The final phase of burial in which coterminous burials of either two or three individuals took place.	C
4	Mass interment of the fourteenth-century plague victims, likely dating to the outbreak of 1348-9 (not subject to analysis in this thesis).	n/a
5	Burials in the extension of the cemetery marked by the original precinct boundary	C

Table 1.3.1: Description of the Hospital of St James cemetery zones and area references.

It is apparent that the Hospital of St James does not have the strong historic documentation which some, but by no means all, contemporary and primarily urban hospitals boast, such as that relating to St Mary Spital, London and St John's, Cambridge. Nonetheless, the hospital's rich osteological assemblage presents an opportunity for human skeletal remains to reveal previously unknown information about funerary practice, socio-cultural behaviours and the function of a hospital on the border of a monastic community. Therefore, this thesis not only presents a rural medieval hospital with a substantial multiphase cemetery, it does so via an osteological and paleodemographic approach. Furthermore, it investigates a rural medieval community where research has tended to focus on hospitals among the development of urban centres.

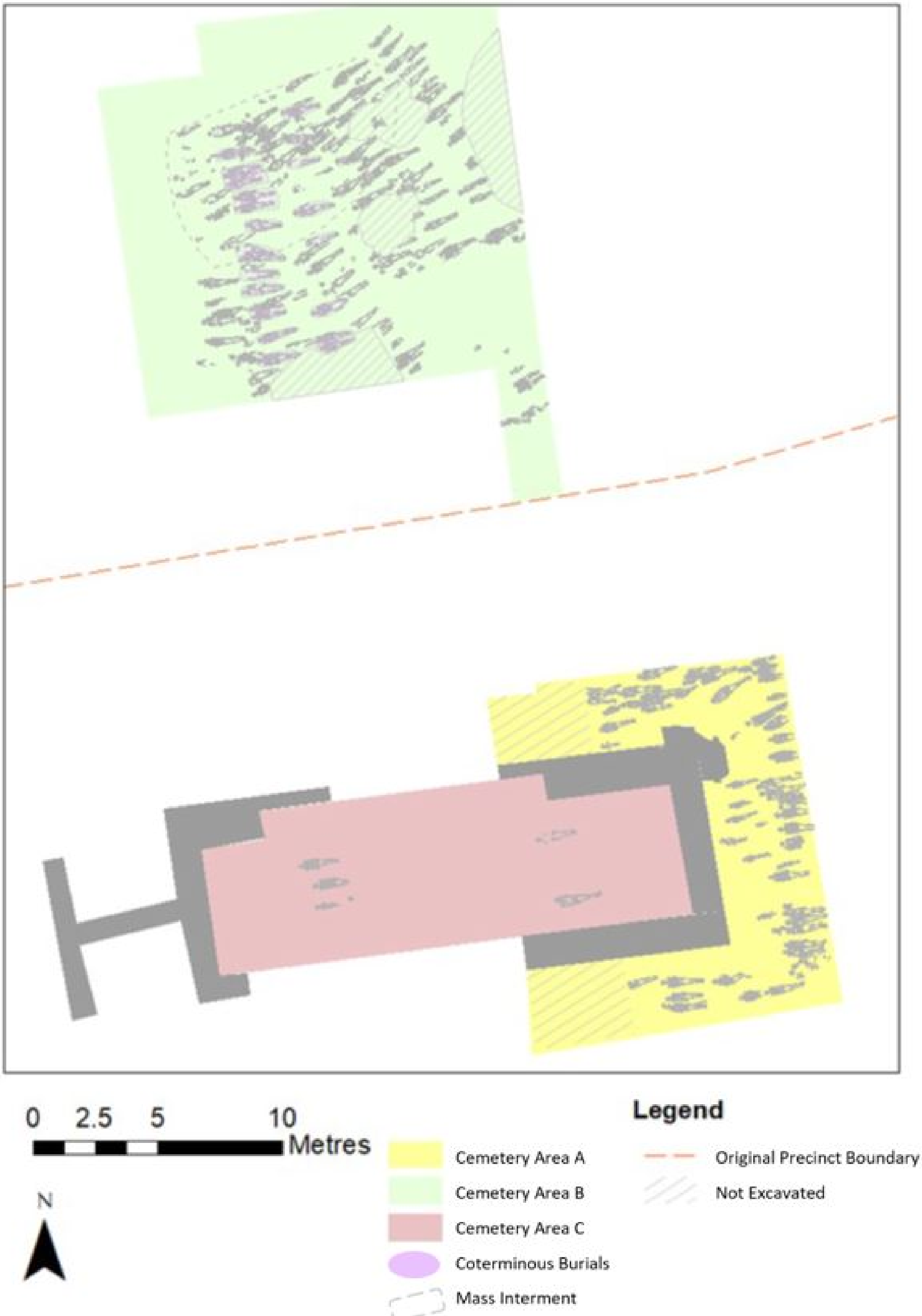

Figure 1.3.5: A schematic plan of the cemetery areas identified and excavated at the Hospital of St James, Thornton Abbey.

1.4 Thesis structure

The remainder of this thesis comprises seven further chapters. Chapter 2 presents a comprehensive overview of hospitals in later medieval England. It discusses the different categories of hospital, management of hospitals as individual institutions, conditions of admittance, location of hospital sites and the ultimate decline of the medieval hospital. An understanding of the principles of these institutions is established before greater discussion of hospital form and function later in the thesis. Chapter 3 provides an exploration of the burial practices taking place at the Hospital of St James. This allows for an exploration of the hospital's role in burying the dead and forms a picture of the hospital upon which the following chapters on demographic profile and paleopathologies can build. Chapter 4 sets out the osteological methods employed in this thesis to examine the skeletal assemblage. Chapter 5 establishes the demographic profile of the cemetery population and compares this profile with contemporary hospital assemblages as well as assemblages of lay and monastic populations. This is followed by Chapter 6, examining the paleopathologies present and investigating the ailments for which the hospital provided care. Chapter 7 focuses on the large non-adult population of the hospital (as discovered in Chapter 4). This chapter explores themes of childcare in later medieval society and leads into a discussion on the role of religious communities in taking care of children. This chapter draws to a close in a discussion of how the hospital's location may have affected its use and influenced its housing of a large non-adult community. Drawing on these earlier themes, Chapter 8 provides a summary characterisation of the Hospital of St James established through the multidisciplinary analysis carried out throughout the thesis. Finally, suggestions for future research are presented regarding both the future potential for the study of late medieval hospital demographic profiles and the skeletal assemblage from the Hospital of St James.

1.5 Summary

This chapter has introduced the thesis, which will analyse the Hospital of St James based on osteological analysis and archaeological investigation, contextualising this evidence with a wider body of archaeological and historical data. The research techniques employed in this investigation include new primary data collection undertaken using osteological analysis, integrated with previous osteological and archaeological research, and documentary sources. This combination of sources enables a truly interdisciplinary investigation of the hospital's population, while also providing context to the institution.

2

The medieval hospital in England

The medieval hospitals of England were founded on the religious and pious ideals of the Seven Merciful Acts of Christ (Courtenay 2007, 104). These acts were to feed and clothe the poor, to bring drink, to house the wayfarer, to visit prisoners, to nurse the sick, and to bury the dead (Gilchrist 1995, 9). The manifestation of these acts is reflected in the term ‘hospital’ derived from the Latin *hospitalis* - the provision of hospitality to visitors (Carlin 1989, 21; Gilchrist 1995, 8; Godfrey 1955, 15). These provisions were administered through a liturgical regime maintained by a regular group of secular clergy and lay folk. The provisions made to those in need varied throughout the later Middle Ages.

This chapter begins by addressing the foundation of hospitals in England along the lines of religious ideals and their association with the regular monastic houses. Following this, the four main categories of hospital characterised in modern scholarship are discussed. The function of the hospital is explored through their type, their inmates and the conditions surrounding admittance into a hospital. Following this, the management structure of the hospital is outlined and its relationship with the monastic world is explored, leading to discussions of a hospital’s provision of burial and finally their location in the medieval landscape.

2.1 Religious foundations of medieval hospitals in England

Christianity was a major influence on the development of medieval healthcare, due to the belief that suffering through ill health was a result of original sin (Bottomly

2002, 9). Original sin was the belief that everyone is born with the sin of disobedience, the term 'original sin' was developed by St Augustine to articulate the biblical doctrine of Adam and Eve's rebellion in Eden (Stemp and Kretzmann 2001, 6; Vorster 2013, 45). It was from such beliefs that the medieval hospitals of England were founded on the eleemosynary ideals of Christianity (Knowles 1963, 485; Kealey 1981, 83). The affiliation of hospitals with religious foundations meant that the care they provided was grounded in the provision of spiritual wellbeing and administered via religious teachings, prayer and forgiveness of sin (Buklijus 2008, 152). The entrenchment of religious doctrine within medieval hospitals remained throughout the medieval period, as it was not until the late fourteenth to the early fifteenth century that trained medical practitioners began to operate within hospitals, and the hospital's role transitioned from primarily palliative care to one focused on medical intervention (Lawrence 2001, 165). Thus, care was provided to the physically impaired, the old, the sick and the otherwise needy primarily through a regime of religious teachings and prayer (Lawless 2001, 195-7; Buklijus 2008, 152). It is important to define the difference between impairment and disability when investigating disability and/or impairment in any society. As defined by Irina Metzler (2011), impairment is an anatomical, biological or physical condition that affects a person. Disability is a social construct that is laid on top of this somatic. For example, a broken leg which never heals is an impairment, whereas the lack of mobility which results from the broken leg and the resulting socio-economic impact are what may or may not result in the individual being defined as disabled (Metzler 2011, 45). To summarise, it is society's perception of an impairment which results in disability.

As already stated, the care provided in the medieval hospital was broadly defined by the Seven Corporal Works of Mercy; of which six acts, providing food and drink to the hungry, shelter to the homeless, alms to the poor, visiting the sick and burying the dead, were specified repeatedly in the surviving statutes of hospitals (Prescott 1992, 2; Swanson 1995, 114). The average member of the lay community in later medieval England lived in various levels of poverty; experiencing poor sanitation, undernourishment and over work (Roberts 2015, S119). Populations in urban environments, more so than rural, would also have experienced poor air quality, dense housing and more crowded spaces. This is evidenced in the bioarchaeological analysis carried out by Redfern *et al.* (2015), Betsingera and DeWitte (2017), Walter and DeWitte (2017), and Roberts (2018), to name just a few. Should a hospital fulfil the Corporal Works of Mercy, it is likely that the majority of minor physical ailments could be overcome and the inmates would experience some relief. Even temporary removal from deleterious environments by admission to a hospital where the stresses of everyday life were alleviated and adequate food and hygiene was available, would have greatly improved general health and reduced the risk of disease progression (Müller and Krawinkel 2005, 279-284; World Health Organization 2001, 55-92, 132-5; Orme and Webster 1995, 62).

The most prevalent orders running hospitals for the lay community were the Benedictines and Augustinians. The Rule of St Benedict is a set of precepts, written by Benedict of Nursia (c.480-545), who founded a dozen small houses in Italy, each housing 12 monks, over which he presided (Logan 2012, 19; Lynch and Adamo 2014, 45). In about 529, he founded a new monastery at Monte Cassino, Southern Italy where he lived out the remainder of his life. Benedict described this monastery as 'a school for beginners in the service of the Lord', he did not intend his monks to engage in external or socially useful tasks such as manuscript copying, teaching outsiders or completing missionary work (Lynch and Adamo 2014, 46). He did, however, encourage monks to provide food and lodging to travellers. The guidelines documented in the Rule of St Benedict consist of 73 short chapters, which drew upon earlier monastic writers including Basil of Caesarea (c.330-79) and John Cassian of Marseilles (360-435). The rule gave directions for the organisation of and living of a monastic life, but was only originally intended to govern life in the monastery at Monte Cassino (Logan 2012, 20; Lynch and Adamo 2014, 45-46). Within Benedict's monastery adults wishing to become monks were not to be admitted too easily and they were to ponder carefully the lifelong commitment that they would be making.

Upon acceptance into the monastery they would make a solemn promise to remain in the monastery for life and to adapt to the life of the monastic community (Lynch and Adamo 2014, 46-7). Benedict also allowed for the reception of children who were offered by their parents and they were carefully supervised until the age of 15 when they became adult members of the community (Lynch and Adamo 2014, 47).

Throughout the eighth and ninth centuries, the Rule of St Benedict became the foundation of most monastic rule in the western church, having gained early support from the Carolingian kings (Logan 2012, 20; Lynch and Adamo 2014, 45-46). Western monasticism drew upon Benedict's encouragement of communal life with adequate diet, sleep and a daily pattern of work and prayer. This proved popular in the later Middle Ages, where a self-sufficient community, living in a flexible institution was capable of recovering from the famines and plagues of the time (Logan 2012, 19; Lynch and Adamo 2014¸47). Monks at these institutions were living in a time Benedict himself could not have imagined, yet the foundation of their success can be attributed to teachings from the *Rule* (Lynch and Adamo 2014, 47).

St Augustine was another significant influence upon the development of western monasticism, perhaps only second only to Benedict. (Bonner 2004, 23). The Augustinian order followed of St Augustine, who was Bishop of Hippo in North Africa (c. 354-430). Augustine spent much of his life a monk, writing and preaching on the practice of monastic life within a community setting (Bonner 2004, 23). Augustine's conception of the ideal monastic life incorporated the ideals of contemplation and prayer with the characteristics of hard work and an openness to the outside world (Greene 2005, 1; Johnston 2013, 107). This conception was amalgamated into the Rule of St Augustine, a revision of the Rule of St Benedict which it still closely resembled (Johnston 2013 107).

The Augustinian Rule is a synthesis of several documents, comprising of two main elements, the *ordo monasterii*, regulations for the monastery, and the *pra-*

ceptum, which outlines the more general purposes and observances of monasticism and the nature of the Augustinian monastery (Johnston 2013, 106). The distinctive character of the Rule of St Augustine lies in the ties to community life and fraternal charities based on the notion of the 'apostolic life'. This character was widely adopted in the medieval period by canons and canonesses (Greene 2005, 1). The adaptation of St Augustine's rule saw an emphasis on the choice between a life of contemplation (*vita contemplative*) and a life of active engagement in life outside the monastery through a provision of charity to lay communities (*vita active*) (Lawless 2001, 77; Lawrence 2001, 162; Smith 2011, 8; Zumkeller 1986, 41).

Both the Benedictine and Augustinian Rules stated that care of the sick was to be considered the most important of sacred duties, while a series of papal pronouncements in the twelfth and thirteenth centuries, suggested that every large monastery had a member trained in the rudiments of medicine (Gottfried 1984, 176). However, the monastic infirmary was not widely accessible to the general lay community, and thus hospitals were established as an offshoot of the monastic house to facilitate care of lay communities (Walsh 1920, 24).

St Benedict's concern for the care of the sick and the means by which care should be provided were clearly stated in his Rule:

> *"The care of the sick is to be given priority over everything else so that they are indeed served as Christ would be served since he said of himself, 'I was sick and you visited me' and 'What you did to one of these least, you did to me. [...] For the sick brethren a separate room must be provided, and to serve them a brother who is God-fearing, diligent and zealous. The use of baths should be allowed to the sick as often as is desirable, but to the healthy and the young this should not be granted very often. Moreover, the eating of meat should be allowed to the sick who are in a weak condition, but when they are restored to health again,*

> *all should abstain from meat as usual. The Abbot must take the greatest care that the sick are not neglected by the cellarer or those who serve them, for whatever is done wrong by his disciples concerns him"*
>
> *(Parry 1984, 62)*

It is evident from the Rule that Benedictine houses were to take on the responsibility of caring for sick, however, providing the specified facilities and treatment of the ill could prove problematic within the monastery. The daily tasks associated with care of the ill and the constant movement of people into and out of monastic houses could cause great disturbance to the austere regime and seclusion of monastic communities and the sanctity of the monastic environment. Therefore, it is likely that the establishment of hospitals for the general lay community was necessary to provide the care set out by the Benedictine's *Rule* which would have required the staff of the hospital to deviate significantly from the regime of life within the monastery. While this forced monks to deviate from Benedict's proposals on ideal monastic living, they could still fulfil his idea of community living while also addressing their responsibility of caring for the sick.

The Augustinian Rule took a similar approach to the care of the laity and actively promoted the order to provide charity to those in need. This is particularly pertinent in the study of St James' hospital, which was located within an Augustinian precinct. Within the Rule, the concept of engaging with the secular world was embodied by the concept of *vita apostolica*, or apostolic life. The apostolic principle is established in the opening of *Augustine Praeceptum*, believed to be written in the late 4th century by Augustine himself, where it is stated that (Vessey 2015, 462):

> *"Firstly, because you are gathered as one and live together in the house, may there be one spirit and one heart in God. And do not call anything your own but hold everything in common [...] Such may be read in the*

> *Acts of the Apostles, that everything was in common and distributed to each according to need"*
>
> *(Lawless 1987, 80-1)*

The apostolic influence led to the Augustinian community embracing three basic principles by which their monastic life would be directed. First, members were to imitate the primitive Church with interests and activities restricted to the spiritual domain. Second, members were to hold a passionate love for the soul at home and far afield. This principle called for members of the Augustinian house to preach to, and directly communicate with, communities outside of their monastic realm and therefore contrasts with the traditional concepts of a secluded monastic community. Finally, all members of the Augustinian community were to share in evangelical poverty, whether predicated on mendicancy or mitigated by the work of one's own hands (McDonnell 1955, 15).

The Augustinian-run hospitals, established throughout the medieval period, are rooted in the growth of the *vita active*, the following contextualises the religious framework on which these hospitals were established. St. Augustine's Rule originally stated that excursions outside of the monastery should be limited to necessity as not to disturb the order's life of contemplation (Lawless 2001, 77). The second principle states that Augustinian communities were to fulfil Jesus' command to preach on his behalf as the Apostles did, however, in order to do so excursions outside of the monastery were necessary and therefore a life of contemplation was not possible. St Augustine's second religious foundation at Hippo (c.385) was a community of clerics that assumed the duty of preaching (Zumkeller 1986, 41; Lawrence 2001, 162). Given these inherent conflicts of interest, members of the Augustinian community could relinquish the *vita contemplative* for the *vita active* (Smith 2011, 8). The *vita contemplative* did not view the provision of aid to the lay community as the imperative of the apostolic. Instead, the renunciation of personal property and community living was regarded as the authentic hallmarks of apostolicity. Therefore, it was possible to refuse direct involvement in the cure of souls and opt for a life of seclusion from worldly involvements (Lawrence 2001, 163-4). The *vita active* increased the practice of preaching in the late eleventh and twelfth centuries through canonical reforms. They preached on the importance of faith and religion to one's wellbeing for which a hospital provided the ideal platform in which to do so (Smith 2011, 9).

While the *vita active* promoted the engagement of monastic communities with caregiving, there remained a tension with medieval religious ideals of seclusion and austerity, especially where the former might result in financial benefit. The system of care provided by the monasteries to society was revised in rulings of the First (1123) and Second (1139) Lateran Councils, which sought to direct the religious community back to their prime vocation, which would include their retreating from society (Newman 1998, 128). Authorities were attempting to prevent the monastic administration of care to the lay population where financial gain may occur, thus monks and canons were prohibited from studying medicine for economic gain (Schroeder 1937, 193). The Third Lateran Council (1179) was introduced to sustain the prohibition of payment for monastic medical services and to reaffirm the belief that healing was a charitable duty. This Canon Law directly addressed the overall aim of the reforms to reinforce the importance of spiritual healing over physical treatment which had been installed by the translation of the works of classical physicians, such as Hippocrates and Galen, and to ensure that care was not being provided for the monasteries' financial gain (Jonsen 2000, 796). The fourth Lateran Council (1215), further emphasised the importance of care of the soul over that of care for the physical body. *"Since bodily infirmity is sometimes caused by sin … we declare in the present decree and strictly command that when physicians of the body are called to the bedside of the sick. Before all else, they admonish them to call for the physician of souls, so that after the spiritual health has been restored to them, the application of bodily medicine may be of greater benefit, for the cause being removed the effect will pass away"* (Halsall 2019, canon 22).

In summary, medieval hospitals in England were established and shaped by the influence of religious ideals and the system of relief provided by religious communities. The influence of faith transcended every aspect of the hospital from its daily function to the care provided as prescribed in the Seven Corporal Works of Mercy. Although each hospital institution was established as a single unit, it is clear from the rules of different religious houses that these institutions were founded on the same ideals and motivations to provide care to the needy. Furthermore, the overarching function of the medieval hospital was governed by the Lateran Councils, giving an impression of the restrictions under which these establishments were run.

2.2 Categories of medieval hospitals in England

The four key categories of hospital, defined by modern-day scholarship, are those for sufferers of leprosy, alms-houses, hospices for poor wayfarers and pilgrims, and institutions that cared for the sick poor. However, the names given to hospitals in historic scholarship are broad and interchangeable. For example, previous studies have referred to medieval hospitals by a variety of names, such as Spital Houses, Maisons-Dieu (God's houses), Bedehouses, alms-houses and infirmaries (Clay 1909; Orme 1988; Gilchrist and Sloane 2005; Nicolson 2012; Roffey 2012). The following will discuss the various categories of the medieval hospital through a brief review of the classification system and a detailed overview of each hospital type.

The first comprehensive hospital classification was undertaken by Knowles and Hadcock (1971), which documented a total of 1,103 institutions, based on hospital foundation charters, statutes and other historical references. They identify four categories: hospitals for sufferers of leprosy, institutions that cared for the sick poor, alms-houses, and hospices for poor wayfarers and pilgrims. This gazetteer has informed and influenced many subsequent works, including Carlin's (1989) 'Medieval English Hospitals', which calculated the proportion of hospitals in the gazetteer belonging to the four classifications. The four categories of hospital employed by

Knowles and Hadcock (1971) and Carlin (1989) have been widely employed in both historical and archaeological studies (Barber and Sibun 1994; Farley and Manchester 1989; Lee and Magilton 1989; Roffey and Tucker 2012). However, key studies of the medieval hospitals diverge from the four-group classification system. Gilchrist and Sloane (2005, 205) only consider three hospital classifications – infirmary hospitals, leper hospitals and alms-houses – in their extensive examination of the medieval monastic cemeteries of Britain. They argued that these three classifications were distinguishable via their demographic profile (Gilchrist and Sloane 2005, 205). Moreover, Rawcliffe (2013), categorised hospitals into those for the leprous, for long-term care for the elderly and disabled, and for short-term care of inmates suffering an acute illness, inmates close to death or travellers requiring accommodation. While authors have chosen to use various categorisations of hospitals, many use the same categories but under different titles. For example, Rawcliffe's (2013) hospitals for long-term care for the elderly and disabled are comparable with Knowles and Hadcock's (1971), Carlin's (1989) and Gilchrist and Sloane (2005) alms-house categories.

This thesis employs the scheme of classification established by Knowles and Hadcock (1971). Having reviewed academic literature referring to the use and establishment of hospitals this classification system does provide the best overall fit to hospitals of later medieval England, as it accounts for the most commonly occurring hospitals yet leaves room for those which do not fit the classification to be defined separately (Clay 1909; Carlin 1989; Gilchrist 1995; Godfrey 1955; Orme and Webster 1995; Prescott 1992; Rawcliffe 2006; Rubin 1989; Gilchrist and Sloane 2005; Watson 2006; Huggon 2012; Nicolson 2012). Furthermore, utilisation of the four categories facilitates a cohesive and comparative analysis of the Hospital of St James with contemporary published literature, although it is important to note that this thesis recognises that not all medieval hospitals can be easily defined by one of these four categories, especially from the archaeological evidence alone.

2.2.1 Hospitals for the leprous

Approximately 345 of the 1103 (31%) hospitals listed by Knowles and Hadcock (1971) were dedicated to the care of leprous individuals, some of which doubled as later almshouses (Roffey and Tucker 2012, 170). At their peak in the early fourteenth-century, hospitals for the leprous sick in England and Wales totalled approximately 350 active institutions at any one time (Huggon 2018, 18). In the historic and archaeological record, hospitals for the leprous are identified via hospital statutes, confirmed by analysis of the skeletal material. For example, the Hospital of St Mary Magdalen, Winchester was identified via documentary resources and was then subject to osteological and aDNA analysis which identified the strain of leprosy present (Roffey and Tucker 2012, 171; Roffey *et al.* 2017, 1-27).

Leprosy is a chronic bacterial infection caused by *Mycobacterium leprae,* spread via droplet infection and prolonged skin-to-skin contact with the infected (World Health Organisation 2018, 1; Manchester and Roberts 1989, 268; Taylor *et al.* 2006, 1569). The disease has a prolonged incubation period from three years to several decades, followed by a drawn-out period of chronic symptoms with devastating effects on the infected (Pinheiro *et al.*, 2011, 28; Bhat and Prakash 2012, 2). Leprosy is primarily a skin disease which manifests in blotchy, lumpy and inflamed dermis. As the disease progresses, inflammation of the tissue surrounding the eyes can result in blindness and rhino-maxillary collapse occurs due to the destruction of cartilage, giving the nose a sunken appearance (Pinheiro *et al.*, 2011, 218; Bhat and Prakash 2012, 3). The progressive disease results in the destruction and reabsorption of bone throughout the skeleton with resulting secondary infections such as gangrene (Magilton 2008, 10; Roberts and Cox 2003, 267-8).

During the Middle Ages, the causes of leprosy were believed to be wide and varied. These included the consumption of rancid food, unpleasant smells in the atmosphere or the consequences of certain celestial alignments (Rawcliffe 2006, 44-103). Furthermore, it was widely thought that the disease could be contracted as a result of sin, often sexual in nature, committed by the infected themselves or their parents (Roffey 2012, 20; 204). Therefore, it is consistent with medieval beliefs about leprosy that the religious nature of the medieval hospital should have offered solace and a place for the infected to be treated through piety, devotion, prayer, absolution and diet.

Due to the debilitating and disfiguring symptoms of leprosy, the leper hospital is thought to have had the most strictly defined function and ruling of all medieval hospital types (Roffey 2012, 21; Roffey and Tucker 2012, 170-1.) Provisions made for the leprous sick were significant. Once admitted, inmates were segregated from the general population for life, they were to refrain from casual or long-term contact with the healthy and had to wear distinctive and enveloping clothing (Carlin 1989, 22). The primary means by which seclusion was enforced was via the location of hospitals on the outskirts of towns. Magilton (2008, 17) suggests such locations were chosen to seclude the leprous from general society via forbiddance of entry through the town gates. However, it is also suggested that the location provided visibility, and through this, an opportunity to procure donations and prayers for the leprous from travellers to the town who passed through the gates (Orme and Webster 1995, 45).

Inmates of leper hospitals could be from both religious and lay backgrounds, and unlike many other institutions in the medieval period, they would house both male and female inmates (Carlin 1989, 23). It is thought that the average leper hospital usually had a maximum capacity of only 12 inmates, as did the majority of hospitals in medieval England (Gilchrist 1995, 14; Brodman 2007, 124). This is primarily due to the small size of hospital buildings; in the leprosaria of St James, Colchester and the Lazar House in Norwich the chapels themselves doubled as infirmaries (Roffery 2012, 224). However, much larger establishments also existed, including the leprosy hospital at Sherburn in North Yorkshire, which was founded in 1181 with the capacity to house 65 patients, a master, and three priests (Clay 1909, 243).

The Hospital of St Giles in London was founded in 1101 for 40 leprosy patients (Carlin 1989, 22-3). The establishment of such large leper hospitals is a reflection of the diseases' powerful transmission and its widespread impact upon medieval society.

By the early fifteenth century hospitals for the leprous were in decline, as was the disease (Mendum *et al.* 2014, 2). Many of the earliest established hospitals for the leprous remained institutions for the care of the sick and needy but were converted to more general use. For example, the hospitals of St Margaret, Huntingdon, Cambridgeshire (Nenk *et al.* 1994, 195) St Nicholas, York (Evans 2004) and the leper hospital at Southampton, Hampshire (Rawcliffe 2006, 350) became alms-houses and hospitals for the poor and infirm (Roffey 2012, 215; Magilton 2008, 11). A decline in hospitals solely providing for the leprous sick coincides with the decline of the disease from its height in the eleventh century to the fifteenth century (Mendum *et al.* 2014, 2). The reasons for the decline of the disease remains uncertain yet potential explanations have been attributed to a cross-immunity between leprosy and tuberculosis (Manchester 1984, 172; Manchester and Roberts 1989, 269; Stone *et al.* 2009, 73), growth of natural immunization (Boldsen and Mollerup 2006, 350), and that those with leprosy had compromised immunological systems and were therefore susceptible to epidemics including the Black Death (1348-9) and later outbreaks of plague (Antoine 2008, 101; Catling 2009, 27).

2.2.2 Alms-houses

The alms-house originated in close association with the Church and monastic establishments as a charitable mechanism to distribute alms and care to society. Alms-houses formed the most numerous of the four categories of the hospital, accounting for 742 of the 1103 (67%) listed by Knowles and Hadcock (1971). The houses fell into two categories: those intended for the poor in general, and those that restricted admission by distinction, meaning only certain sectors of the population were permitted entry (Carlin 1989, 23). Many of those with restricted admission were established by local guilds to care for members of their respective communities.

For example, alms-houses would house those in need who had fallen into poverty through no fault of their own, such as orphans too young to work, single parents and those kept from work by illness, injury, or a physical impairment, as well as the elderly who had fallen into ill-health or poverty on account of their age or infirmity (Goose 2010, 37; McIntosh 1988, 210).

Care of the elderly and infirm in alms-houses extended to members of the clerical community who had retired from the strict monastic setting due to ill-health or long-term impairment. The alms-houses of Basingstoke (1230-40), Norwich (1246) and Beverley (1279) catered for a mixed community of clerical and secular inmates, often funded by the payment of an initial entry fee and an annual payment from the inmates which supported their care, but also guaranteed them both the prayers of the full company after death and a fitting funeral (McIntosh 1988, 214; Orme 1988, 3). The Church's concern for the clergy also resulted in the establishment of alms-houses specifically for priests. Examples include the alms-houses at Canterbury (founded before 1224), Bishop's Clyst, Exeter (1311), Wyndham, Chichester (1253) and St David's, Pembrokeshire (1280-93) (Orme 1988, 3).

2.2.3 Hospitals for pilgrims and poor wayfarers

The hospital for pilgrims and poor wayfarers is a unique category of the institution which acted more like a modern-day hostel than a hospital, in that they provided board and lodging to those traveling, rather than care for the ill and infirm. Establishments providing for the poor wayfarer and pilgrim were estimated by Knowles and Hadcock (1971) to account for 12 percent (136 of 1103) of all hospitals, a similar proportion to the number of hospitals providing for the sick poor (Carlin 1989, 24). Despite many hospitals for the sick poor and alms-houses already offering to house the common traveller, the need for more establishments rose in the twelfth and thirteenth centuries due to the increasing popularity of pilgrimage (Theilmann 1987, 94). The spread of pilgrim routes throughout the country resulted in the need for more accommodation, in particular locations along major thoroughfares and well-trodden routes. Furthermore, under the Rule of St Benedict, monasteries were obliged to provide free board and lodging to pilgrims and other wayfarers for up to three nights (Harpur 2016, 82). This is reflected in the statutes of the Hospital of St Mary, Chichester, which stated that the hospital should wash the feet and tend to the needs of those that seek accommodation for just one night (Page 1973, 100-2).

Many hospitals established for travellers also gained a reputation for caring for the sick, as pilgrims could also be unwell themselves, illness often being their initial motivation for their pilgrimage (Magilton 2008, 18). The statutes associated with the 1233 re-foundation of the Hospital of St John the Baptist, an institution providing for pilgrims and wayfarers in Oxford, stated "that therein infirm people and strangers might receive the remedy of their health and necessity" (Nichols 1968, 329). Moreover, financial accounts of the Hospital of St John the Baptist, Winchester, recorded that in 1352/53 six pilgrims stayed for thirty days (Keene 1985, 815-16). The Archbishop of Stratford had previously directed in 1342 "that poor pilgrims in good health shall be entered only for one night... the greater regard shall be had for the sick" (Clay 1909, 8), thus it seems like the long-term guests were more likely admitted for the sake of their health than simply as wayfarers.

The extent of provisions made for the poor wayfarer and pilgrims is likely the most under-estimated form of care provided to the medieval populace. This is because, in addition to hospitals, the majority of monasteries also maintained a guest house for those who could pay. Examples include the *hospitum* within the abbey gates at St Mary's, York, and the Strangers' Hall at Winchester (Clay 1909, 3; Kerr 2007, 17). However, the hospital dedicated to the traveller enabled the separation of the poor traveller from visiting monks and high officials (Harpur 2016, 82-3). Hospitals for the sick poor could also cater to pilgrims (see below), such as the Hospital of St Bartholomew, Smithfield, which housed a great number of pilgrims seeking care in 1148, including victims of the falling sickness (generally interpreted as epilepsy), paralysis, dropsy, fevers, insanity as well as other conditions (Clay 1966, 3-5). The reasonably wealthy traveller, meanwhile, could take accommodation in inns and taverns rather than entering the hospital establishment.

2.2.4 The sick poor

The final category of hospital to be discussed are those dedicated to the sick poor, but excluding those suffering from leprosy (Carlin 1989, 24), and accounting for 112 of the 1103 (10%) hospitals listed by Knowles and Hadcock (1971). The sick poor were thought to embody the living representation of Christ and their suffering in life would reduce their time in Purgatory (Courtenay 2007, 87; Bonfield 2006, 18). The premise of Purgatory was well established by the time of the medieval period; however, it was not until the twelfth century that Purgatory was conceived as a distinct physical space (Brandt *et al.* 2014, 381). The concept of Purgatory was that upon death, virtuous souls would go to Heaven and await the Last Judgement or Second Coming, whereas wicked souls would be dammed to Hell for all eternity. However, the vast majority of souls, who fell between the virtuous and wicked would be sent to Purgatory, where they were cleansed and made pure before joining the virtuous in Heaven (Tugwell 1990, 110–55). The time one's soul spent in Purgatory could be influenced by their living actions and the actions of others. Once in Purgatory a person could do nothing to further shorten their time there, however, any charitable actions they made while living could. For example, donations and benefactions made to religious institutes which encouraged prayer and worship would continue to help one's soul in Purgatory (Craig-Atkins *et al.* 2019, 159). The ostensible influence that the sick poor had over entry into Heaven, via decreased time in Purgatory, became a key motivation behind the establishment of hospitals as a charitable donation to the sick poor (Bonfield 2006, 187). Private benefactors and patrons to hospitals sought spiritual prayer from the sick and poor as a return on their monetary investment (Sweetinburgh 2004, 26-7; Ashby 2005, xv).

Investment in hospitals for the sick poor, and ultimately those living in poverty, resulted in the widespread establishment of hospitals throughout the thirteenth century (Courtenay 2007, 87–8). During this rise in hospital foundations, and following it into the fourteenth and fifteenth centuries, hospitals did not provide charity without discrimination. For example, hospitals could tightly define the types of illnesses they were willing to care for, the age and sex of their inmates, and as discussed in section 2.3, on many occasions refused entry to those they deemed unworthy of their charity (Sweetinburgh 2002, 240-1; Ashby 2005, xv).

Hospitals for the sick poor account for the largest hospitals, including St Leonard's in York, whose infirmary held over 200 sick, and was the wealthiest in England with an annual income of £1,369 11s 2¼d in the year 1369 (Seymour 1946, 73). Similarly, the Hospital of St Mary without Bishopgate in London held a total of 180 beds for the sick poor, and St Bartholomew's at Gloucester, which in 1333 housed 90 sick poor (Knowles and Hadcock 1971, 360-73). Those of a more medium size included St Thomas' at Southwark, St Mary's at Newark, and St Giles at Beverly housing 40, 30 and 21 inmates respectively in the years 1295, 1331 and 1279 (Knowles and Hadcock 1971, 342-93; Carlin 1989, 25; Giles 1999, 82-95). In contrast, the smaller hospitals such as Corpus Christi, York and St John the Baptist, Winchester cared for only seven and six persons respectively in the fifteenth century (Knowles and Hadcock 1971, 407; Keene 1985, 815). The sheer size of the larger hospitals draws attention to both the needs of the sick poor but also medieval English society's regard for the impoverished and the strength of their belief in the spiritual benefit that acts of charity could produce (Sweetinburgh 2002, 240). The importance of these establishments is further evidenced in the fact that, like alms-houses and hospitals for the pilgrim and poor wayfarer, the establishment of hospitals for the sick poor continued throughout the fourteenth century, with the exception of a fall in establishments in the immediate aftermath of the Black Death between 1348-50 (Knowles and Hadcock 1971). This decline in the establishment was only temporary; in the decades following the Black Death over 100 further hospitals were established in the second half of the fourteenth century (Roberts 2007, 35).

In return the sick poor were obliged under the rules of their admittance to pray for the salvation of the founders and benefactors of their hospital, led by a member of the religious community (Ashby 2005, xv). Only those deemed too ill to take part in this act were excused from this element of the hospital's daily routine, despite the belief that this was a key part of spiritual cleansing and ultimately restoration to full health (Courtenay 2007, 104–5; Sweetinburgh 2004).

2.3 Inmates and the conditions of their admittance into the medieval hospitals of England

As previously observed, hospitals in medieval England could further reflect the apostolic values of their founders through the number of inmates they cared for, as the average hospital housed approximately 12 inmates (Brodman 2007, 124; Gilchrist 1995, 14). Examples include the Hospital of St Nicholas, Lewes, East Sussex (Page 1973, 104); St Bartholomew's, Bristol (Price and Pondsford 1998, 176); and St Mary Magdalene, Norfolk (Orme and Webster 1995, 29). Despite this ideal, hospitals with more than 12 inmates ultimately emphasised late medieval society's need for care provided outside of the home. Although exact figures as to the number of inmates all hospitals housed are not available due to a lack of surviving documentation, it is estimated that the number of inmates in a single alms-house could vary from two to upwards of 30. Further evidence, in the form of cemetery populations and hospital architecture, suggests the average number of people housed in any one setting was 12, yielding a very approximate national average of 4,700 people under hospital care at any one time in the fourteenth and fifteenth centuries (McIntosh 1988, 216).

In addition to the efforts of the hospital staff, the inmates were also expected to work to facilitate their own recovery. While those admitted to the hospital would be cared for to the best of the hospital's ability, in return an inmate would be expected to attend confession and receive communion. Throughout their stay, they would adhere to the rules of the master and follow a quasi-monastic lifestyle as governed by the hospital (Rubin 1989, 50). Inmates would typically live and sleep in common halls, attend daily mass and offer daily prayers.

While later medieval England saw the establishment of a large number of hospitals, these institutions did not remain static in their function. The period from the late twelfth to the early-sixteenth century saw the evolution of the form and function of hospitals alongside a general decline in use from the early fourteenth century. As already stated above, one of the largest reforms of hospital function was due to the decline of leprosy in the mid-thirteenth century (Magilton *et al.* 2008, 20-1). The high degree of functional specialisation of the leper hospital, in addition to their geographically-isolated nature, left them under-occupied, under-staffed and under-funded as cases of the disease fell. As a result, many were reallocated to more prevalent needs, for example, the Hospital of St Mary Magdalen in Newcastle-upon-Tyne was dedicated to victims of pestilence, and the leper hospital at Stourbridge, Cambridge became a free chapel (Carlin 1989, 25; Horden 1988, 362). The hospital at St Giles, Holborn housed just nine leprosy sufferers in 1402 and as a result came to admit of 14 paupers (Carlin 1989, 23). Similarly, in 1434 the hospital at Sherburn was reconstituted for a master, four chaplains, four clerks, two boy choristers, 13 poor brothers and a woman servant to look after them, but was also required to provide for two leprosy sufferers (Knowles and Hadcock 1971, 319). An unnamed Hospital of Cambridge remained as a leper hospital from its establishment in c.1361 into the fifteenth century and thus is one of the latest surviving medieval hospitals for people with the condition. This continued function was partially maintained by having diversified the hospital's function to also admit the mentally ill among its inmates (Horden 1988, 361).

While the decline of diseases such as leprosy and tuberculosis could undermine the economic security of hospitals by reducing their pool of potential inmates, the impact of epidemics which created greater demand for their services could also be problematic. The Great Famine of 1315-1317 and the outbreak of the Black Death in

1348-1349 inevitably affected the function of hospitals (Bonfield 2006, 189). These events would have placed tremendous strain on hospital resources, including the availability of food and the number of healthy staff available to run the hospitals, as well as the ability to provide burial for those who did not survive (Barnhouse 2013, 222). One way in which a hospital could respond to change was to alter its function. This could be a minor change, for example, accepting the sick poor in addition to the infirm. A further development within the alms-houses saw elderly lay people know as corrodians purchase accommodation and board, occupying places previously dedicated to the care of the sick poor, and living out thier lives in a cared for retirement (Rubin 1989, 53; Bond 2001, 69; Sweetinburgh 2004, 27). The Hospital of St John, Cambridge progressed from the admission of paupers to the admittance of poor scholars and corrodians (Horden 1988, 368). The hospitals of St Bartholomew's, Oxford supplanted inmates with healthy, fee-paying individuals as early as 1316 (Carlin 1989, 25) and the Hospital of St Nicholas, Salisbury transitioned from a hospital for the poor sick and wayfarers to an alms-house by 1479 (Seymour 1946, 60). On the other hand, the Hospital of St Bartholomew's in Gloucester survived by charging admittance fees to all inmates by the late fourteenth century (Knowles and Hadcock 1971, 360).

2.3.1 Conditions of admission

Hospitals had the right to deny entry to those they deemed unsuitable, including those affected by particular afflictions. An understanding of the admittance protocols used by hospitals helps to illuminate their social structure and daily activities conducted within their community.

Although the various categories of hospital cared for the needy, the sick and the poor in their own way, hospitals regularly refused entry to particular divisions of society (Carlin 1989, 25; Rubin 1989, 49). The reasons behind these clauses on admission may have lain in the desire to evaluate the moral standing of the individuals, or to ensure the hospital only accepted those for whom it had the resources to care for (Carlin 1989, 25; Rubin 1989, 49). When investigating the 'worthiness' of those admitted medieval attitudes seem to have distinguished between the 'deserving' and 'undeserving' (Cavallo 1989, 98). People considered worthy of care included those unable to support themselves due to a physical or mental ailment and those who were also victims of poverty (Rawcliffe 1984, 3; Orme and Webster 1995, 58). Most evident were the elderly, but also widowed mothers and fathers of small children unable to provide for their family, orphans too young to work, as well as sufferers of illness and injury (Cavallo 1989, 101). In contrast, the undeserving were defined as those who were able but unwilling to work to support themselves (Langland 1992, 169-90).

The Hospital of St John in Cambridge has one of the best-surviving documented rules of admittance, which stated that the chronically ill and permanently maimed were to be admitted, while admittance of the "wounded, cripples, lepers, the insane and pregnant women was strictly forbidden" (Rubin 1989, 300-1). Similarly, the hospital statutes of St John, Bridgewater, drawn up in 1219 by Joselin Bishop of Bath and Wells, stated that "no lepers, lunatics, persons having the falling sickness or other contagious diseases, no pregnant women or suckling infants and no intolerable person" were to be admitted (Orme and Webster 1995, 58). Even though they may be poor or infirm, if anyone was admitted with the above condition they were to be expelled (Maxwell-Lyte 1934, 289). To ensure such mistakes were limited, the warden of hospitals such as St Mary's, Newark (Carlin 1989, 26) and the Savoy Hospital, London (Salter 1917, 21; Somerville 1960, 30), screened potential inmates at the gate to assess the seriousness of their complaint before admitting them. The rationale behind such exclusions was that the wounded may have been injured through violence and therefore were dangerous cripples and the mentally ill could not care for themselves and would, therefore, take up much of the hospital's resources; leprosy sufferers were catered for elsewhere and pregnant women seeking a hospital bed were likely to have conceived out of wedlock, and in any case, could not with modesty be accommodated in a male community (Rubin 1989, 49, 157-9). Furthermore, Carlin (1989, 25) argued that caring for the sick became an 'unwelcome or impossible burden' upon the hospital institution and thus restrictions regarding admission were implemented to protect the resources of the hospital by circumventing those deemed to be a too great a strain on the hospital.

Those individuals excluded from the specific hospitals discussed above were not prevented from entering all institutions. Indeed, a number of hospitals made special provision for groups otherwise excluded from most institutions, most notably for pregnant women. Maternity patients were specially admitted to St John's Hospital, Sandwich, which had a 'chamber for strange women' where women who were not native to Sandwich and in labour could seek help (Clay 1909, 12). Likewise, the leper Hospital of St John the Evangelist at Blyth in Nottinghamshire was refounded as a hospital for poor strangers and pregnant women in 1446 (Knowles and Hadcock 1971, 34). The three London hospitals of St Thomas, Southwark, St Bartholomew's, Smithfield and St Mary without Bishopgate all accommodated pregnant women (Carlin 1989, 32). The Hospital of St Thomas cared for pregnant women as early as 1295, when Richard Whittington, mercer and mayor of London, is recorded to have bestowed an eight-bed chamber for unwed mothers which was to be run with the strictest discretion so as not to hinder the women's later chances of marriage (Rawcliffe 1984, 12). The only evidence of maternity practices contained in the papal indulgences of the Hospital of St Mary without Bishopgate dating to 1445 described the continued care for the women's infants until weaned (Carlin 1989, 32).

Provision for those with mental illnesses was central in social concepts of the medieval period which considered 'insanity' to be the manifestation of sin. It is recognised that a hospital's founder could lay down principles of admission of the mentally ill from the outset, as seen at the Hospital of St John the Baptist, Chester which was founded in 1232 'for the sustentation of poor and silly persons' (Carlin 1989, 33). Similarly, a nameless hospital at the Stone House, Charing Cross, London was founded for the 'distraught and lunatic', who were later transferred to the Hospital of St Mary Bethlehem, London in the 1370s (Knowles and Hadcock 1971, 402;

Carlin 1989, 33; Historic England 2017). A further London hospital was granted a royal licence in July 1370 to house priests and those who had fallen into mental turmoil and lost their memories, however, its proprietor, chaplain Robert de Denton, changed the licence in 1378 to establish a perpetual chantry in St Katherine's Hospital instead (Carlin 1989, 34).

The Hospital of St Mary Bethlehem, London, which later became Bedlam hospital (c.1329), is the best-documented hospital dedicated to serving those with mental conditions and has been named England's first hospital for the mentally ill (Rawcliffe 1984, 4). Its origins lay in the 1247 foundation of the Priory of St Mary of Bethlehem to heal the sick paupers of London, though when exactly the hospital made a transition from caring for those with physical ailments or disease to those with symptoms of mental illness is unclear. By 1403, however, patients were termed 'lunatic', including patients with learning difficulties, falling sickness/epilepsy and dementia (Rawcliffe 1984, 4).

In summary, admittance to the medieval hospitals of England was a right reserved to those truly in need of the care and provisions they offered. Those deemed worthy of care, as outlined in the statutes discussed, follow the categories of hospital outlined at the beginning of this chapter. Exclusion of persons with specific afflictions such as falling sickness and contagious disease, or pregnant women, can be interpreted as a way by which hospitals managed their populations and resources to provide care within the means of their establishment.

2.4 Management of medieval hospitals in England

Management of the hospitals, including the conditions of admittance, was overseen by a member of the religious communities, appointed as master of the hospital (Seymour 1946, 41; Carlin 1989, 24). Being established by religious communities the hospital staff broadly matched the profile of a religious house, for example a highly regarded priest, canon or chaplain was appointed as hospital master (McIntosh

2012, 89; Bottomly 2002, 29). Following the master was a community of monastic or quasi-monastic brothers and servitors who maintained the hospital's religious function, tended to the spiritual needs of the inmates and its daily running (Rubin 1989, 46). Should the hospital be established by a religious community of females then the same structure was followed but with a master prioress and community of nuns.

The religious staff of hospitals were supplemented by members of the lay community, consisting of one or both sexes, who took control of daily activities vital to the hospital's survival (Horden 1988, 360). This included running the kitchen and the brewhouse, tending to the kitchen garden, collecting supplies, and attending to inmates (Seymour 1946, 41; Carlin 1989, 24). The health of women was considered the responsibility of women and therefore female lay sisters were employed as nurses and midwives in hospitals (Wigelsworth 2006, 101). Much of our understanding of the hospital's staff, such as the distinction in roles of the religious and lay members of the hospital staff, comes from the episcopal injunctions of the hospitals of St Thomas the Martyr, Southwark dating to 1387 (Carlin 1989, 32). These injunctions reveal that, while canons carried out regular religious observance, the lay-brethren ensured the hospital's general maintenance and daily function; in addition to which, it states that when sisters and lay-sisters were present in a hospital they oversaw the inmate's care and domestic responsibilities which otherwise were seen to by male staff (Gilchrist 1995, 16; Carlin 1989, 32; Rawcliffe 1984, 5).

The broad role of the religious in the hospital called for a more lenient and flexible lifestyle than that typical of a monastic community. For example, although they were to conform to the monastic rule, study scripture and observe the canonical hours, the hospital-based brothers interacted with the secular population on a daily basis and supervised the sick (Rawcliffe 1984,5). Therefore, it is arguable that the idiosyncrasies of monastic rule enabled the provision of care in hospital environments to take place. A prime example of this is the aforementioned Augustinian *vita active* canon, and this order of canons were able to fulfil a number of roles in medieval society as they were permitted to live outside the cloister as a community of integrated brothers and thus could integrate into the quasi-monastic mixed community of a hospital (Lawrence 2001, 165-7). This order of canons grew to become the largest religious order in England with 274 Augustinian foundations compared to the next largest of 219 Benedictine foundations (Lawrence 2001, 164).

While hospitals were based on the Christian ideals of charity it was not uncommon for them to be affected by corruption and poor administration. In some cases, the extent of maladministration was great enough to cause economic failure, resulting in the closure or reestablishment of hospitals for the sick poor (which did not take money directly) as almshouses and pilgrim hostels charging fees for their service or their conversion to secular colleges (Carlin 1989, 34). In 1403 the Royal Commission ordered an investigation of abuse and malpractice by Peter Taverner, the acting deputy warden at St Mary Bethlehem, London. It was found that Taverner and his wife had exploited his position, stolen the hospital's entire revenue over four years, and a portion of the revenue for a further fourteen years (Carlin 1989, 34). In addition to this, they stole money from the alms boxes and food given by charity to the patients, as well as everything from bedding to cooking utensils, gardening tools, two keys to the garden gate, a bier, a complement of four pairs of iron manacles, five other chains of iron and six iron chains with locks (Seymour 1946, 139-40). It is evident that each hospital was subject to the influence of its administrators, as is evidenced further below.

The Hospital of St Leonard's, York also fell victim to its masters, who rejected the poor in favour of those who could pay large sums for admission, which they then appropriated (Seymour 1946, 86-7). The Hospital of St John's, Sandwich charged 6*s.* 8*d.* and St Bartholomew charged up to £19 to ensure the inmates were housed for the remainder of their life; considering the inmate could potentially live in the hospital for decades the difference in fees is reasonable (Seymour 1946, 87). In 1303 at St Mary's without Bishopgate, it was discovered that legacies intended for the sick poor were not paid, the poor were denied their full dietary allowances, and that the lamps hung among the infirm 'for their solace' had been removed (Carlin 1989, 35). By order of the Bishop, the hospital was to restore the legacies, allowances and lamps at the hospital's cost and not by means of selling the clothing of inmates, which was common practice to raise funds for hospitals (Carlin 1989, 35). This apparent lack of due diligence in financial management was undoubtedly a contribution to the decline in active hospitals for the sick poor in later medieval society; of the 112 sick poor hospitals listed by Knowles and Hadcock (1971), by 1535, 24 had disappeared, 49 changed the type of care they provided and just 39 continued to care for the sick poor (Carlin 1989, 35).

Due to donations made towards the establishment and maintenance of English hospitals, they continued to largely be run under religious management from the late eleventh century. These generous donations are thought to have been made in support of the charitable concepts of Christianity and in the development of care for the poor from the twelfth to fifteenth centuries (Metzler 2011, 50–1; Rubin 1989, 46; Watson 2006, 87). Such donations were made via endowments by private benefactors to the welfare system and the investment of noblemen and merchants in their respective communities (Rubin 1989, 43-6). As a result of economic growth during the late-twelfth and early-thirteenth centuries, the number of donations to the establishment of hospitals increased (Bottomly 2002, 59; Thomas *et al.* 1997, 88). The founder or benefactor made a donation in return for the privilege of elevated social status, influence and intercessory prayer (Cavallo 1989, 108; Rubin 1989, 44). Their influence could extend to, in corroboration with the Church, appointing a master, setting fees, stating admittance regulations and deciding the age, sex and overall demographic structure of the hospital's inmates. There is no evidence of restriction regarding who could found a hospital, only that their establishment was to be based on concern for the soul's journey through purgatory (Magilton 2008, 20). The Hospital of St John, Cambridge was established by the local lay community to address growing concerns surrounding the provision of care (Rubin 1989, 52). The town was overrun run by the sick, destitute and unemployed who required care of the physical body and soul. Although initially founded by the townspeople in c.1195, the hospital became a place of religion, run under ecclesiastical supervision of the Augustinians in c.1250 (if not earlier), and remained as such until its decline in the fifteenth century (Cessford 2015, 57; Rubin 1989, 157).

In summary, the emphasis of spiritual concepts of care and well-being manifest in the relief system of late medieval England. The foundation and oversight of hospitals by monastic organisations was made possible via the divergence of orders from the ideals of a secluded existence towards practices that promoted engagement with the spiritual needs of the lay community. The influence of apostolic teachings saw the monastic orders embrace caregiving in a hospital setting aided by the donations made by founding partners and benefactors.

2.5 Provision of burial in the medieval hospitals of England

While spiritual wellbeing was the emphasis of the hospital, the Seventh Act of Mercy was the interment of the dead, and as a consequence, hospitals were also obliged to bury those who died in their care. In many instances, this was explicitly stated in the terms of their foundation or was a caveat in the granting of their own cemeteries (Gilchrist and Sloane 2005, 63).

Not all hospitals had their own cemetery and therefore in order to provide burial to their inmates they were reliant upon other hospitals and local parish cemeteries to do so (Gilchrist 1992, 103-4). For example, the Hospital of St John, Exeter buried their dead in Exeter Cathedral's cemetery before being granted their own cemetery in 1351 (Lepine and Orme 2003, 9). Within the hospitals that did have cemeteries, burial was not limited to the hospital's residents and some cemeteries were also open to those who chose to be buried there (Gilchrist 1992, 104). This must be kept in mind when assessing the population of a hospital's cemetery, however these individuals will only account for a small percentage of a hospital cemetery's population as parish cemeteries remained the principal focus for burial throughout medieval England (Barrow 1992). As with any paleodemographic investigation, populations were not stationary and the presence of migrants, in the widest use of the term, in the local community being studied will always be an immovable element affecting the analysis.

A number of archaeological studies focusing upon hospital cemetery data have been able to identify the burials belonging to hospital inmates and have used the subsequent data to aid the exploration of the hospitals use. In the case of burials at the Hospital of St Mary Magdalene, Partney, distinctions in the cemetery's population were made via sex distribution, grave form and burial location within the cemetery. The cemetery was split by a path; to the north of the path, the community consisted of men, women and children, to the south of the path all burials were male (Atkins and Popescu 2010, 218). Within these southern burials, a number of stone-cut anthropomorphic graves were uncovered which have been interpreted to be the burials of religious staff from the hospital or members of the religious community at Bardney Abbey, under whose jurisdiction the Partney hospital operated. A similar distinction in grave form existed at the Hospital of St Nicholas, Lewes where 82 percent of burials were shallow ill-defined graves dug into quarry fills and the remainder in chalk-cut graves, which were all located to the south of the cemetery (Barber and Sibun 2010, 93). It has been suggested that these chalk-cut graves were of higher status individuals such as brethren (Barber and Sibun 2010, 93). Hospitals for the leprous sick offer an opportunity to apply a more thorough division of the population. The majority of skeletons from these hospitals will have physical markers of leprosy and the minority aDNA evidence of the disease, dependent on preservation and testing, which can be employed as a method of population identification. Analysis at the Hospital of St James and St Mary Magdalene, Chichester did not require the expensive application of aDNA analysis. Instead from just the ostological analysis of the remains it was possible to calculate the presence of leprosy for each cemetery area (Lee and Magilton 1989; Magilton *et al.* 2008). Of those buried in Area A1 over 61 percent showed physical evidence of leprosy, in Area A2 43 percent, and in Areas B1 and B2 just 15 percent. The presence of leprosy provides a direct link of affected skeletons to the hospital, while the decreased presence of leprosy in Areas B1 and B2 may reflect the time when the focus of the hospital's use changed to that of local sick poor.

2.6 Location and situation of medieval hospitals

Hospitals were undeniably an element of wider monasticism influenced and run, in part, by religious communities. Nonetheless, they were a distinct division and thus a unique entity in later medieval society. They held a somewhat liminal position in the physical landscape and acted as a physical marker for the divided zone between religious and lay environments (Gilchrist 1995, 40; Roffey 2012, 220; Geremek 1987, 105). As such, hospitals were most commonly located at the gates of towns, on bridges or on the edges of monastic precincts.

This discussion of hospital location begins with an examination of leprosy hospitals due to the ideas of segregation surrounding the sick (Knowles 1963, 483; Rowell 2000, 73; Mahood 2014, 50). Thirteenth-century understanding of the spread of disease stems from the idea that it was accompanied by foul odours and that distancing oneself from the sick decreased the chance of infection (Rawcliffe 2013, 123-4). Thus, the leprous were marginalised in society and often forbidden to pass through a town or stay there (Carlin 1989, 22–3; Manchester and Roberts 1989, 268). Exclusion of the leprous sick from urban centres resulted in them being located outside the gates as a way to keep the sick at 'arm's length' (Knowles 1963, 483; Rowell 2000, 73; Mahood 2014, 50). In Norwich there were a total of five hospitals for the leprous sick, and each was located outside a city gate (Orme and Webster 1995, 45). This positioning made the hospital the first establishment visible to visitors to the urban centres, so consequently hospitals on the periphery of urban centres often provided service to poor wayfarers and pilgrims.

Being situated outside the walls of a town meant that visitors could arrive at any time and not be governed by the opening and closing of the town gates (Orme and Webster 1995, 45). This location also allowed the hospital's greater interaction with the public, due to the high traffic passing on its way to the urban centre (Rawcliffe 2013, 327). This aided the hospital's collection of both donations and prayers for their inmates and benefactors (Rawcliffe 2006, 307-13; Roffey 2012, 221-2). At Bury St Edmunds, all four town gates had a hospital situated outside, which, to different degrees, were dependent on the income from donations (Rowe 1958, 257). Similarly, the entrance to the major port towns of Bristol, Dover, Hull and Southampton were all accompanied by a hospital (Godfrey 1955, 15). Hospitals located at road junctions and bridges are also thought to have been positioned for the passing of travellers; St Thomas Hospital at Southwark and the hospitals of St Giles at Brompton Bridge are such hospitals which were located on major thoroughfares.

The idea that hospital location was largely a means of segregation has continued in the discussion of their situation on the periphery of monastic houses. As previously discussed, hospitals were separate from the care provided with in monastic houses and therefore differ from the monastic infirmary and the monastic guest house which served the unwell religious and wealthier guests respectively. In contrast, the hospital housed the sick poor and poorer visitors to the monastery, such as pilgrims. Their location on the boundary of the monastic precinct provided a physical division between the religious and the lay communities. Yet they enabled the monastery to demonstrate their 'participation' in carrying out pious acts of charity without having to physically interact with the hospital's community, and therefore without compromising the sanctity of the inner precinct (Knowles 1951, 89; 1963, 483; Rowell 2000, 73). The location of Augustinian almonries before the gates of monastic houses has been used by Rowell (2000, 73), to demonstrate the importance of protecting the sanctity of the inner precinct by keeping hospitals at an ‘arms length’.

Further motivations for such locations are that the hospital acted as a reminder of the charitable acts being carried out by its affiliated monastic house. The backdrop of the monastic communities provided a reminder to visitors that they were on the bounds of a sacred space (Helms 2002, 436). The dogmatic overtones of the religious setting also focused the minds of the hospital’s inmates and visitors to the importance of faith and forgiveness of sins to one’s general wellbeing (O’Boyle 1992, 197; Nutton 2000, 68-72). The reverse was also true, and the presence of the hospital and its inmates, whether they be sick, poor, destitute or leprous, in the vicinity of the monastic community would have reminded them of the plight of the lay people and the importance of their role in providing spiritual relief through prayer and through facilitating hospital accommodations.

The positioning of hospitals in the medieval landscape was arguably chosen to control the seclusion of the sick and maintain the sanctity of the religious while ensuring the visibility of the hospital. It has become apparent that the protection of the healthy from the diseased was at the forefront of positioning in the case of leprosy hospitals (Roffey 2012, 220). However, also of equal importance seems to be the visibility and publicity of the monastic community’s involvement in the giving of alms and acts of piety.

2.7 The comparative medieval hospitals and their osteological studies

The following provides introductory descriptions of the nine hospital cemeteries and their osteological studies which are utilised for comparison in this thesis. These sites represent a range of hospitals contemporary to the Hospital of St James at Thornton Abbey. The topographic and temporal bounds of these sites are broad in order to make the most of the archaeological record available in England. These nine hospitals have all been categorised by their respective researchers/authors into one of the four hospital types as defined by Knowles and Hadcock (1971) and Carlin (1989). However, the aim of their comparison in this thesis is not to categorise the Hospital of St James in to one of these hospital types, but to characterise it by drawing upon demographic data available from these hospitals. Nonetheless, it will become clear whether there is any particular similarity between St James and one hospital or type of hospital.

Comparative analysis has been employed throughout this thesis as the skeletal remains of hospital populations add to our interpretation of what demographics the hospitals housed and the ailments they cared for. As discussed in Chapter 2, it is known from written records that hospitals would outline a strict set of rules on who they would allow access to the hospitals and the care resources which they provided. For example, the Hospital of St John, Cambridge had it written in their regulations that the admittance of pregnant women, lepers, the wounded, cripples and the insane were strictly prohibited (Rubin 1989, 157). It is possible to identify the enforcement of such rules in the skeletal remains of a hospital's population. If a hospital made a specific rule against the admittance of females then the population would have a strong male bias with the exception of female's who may have worked in the hospitals or who were afforded burial but were from an external community. While it is still possible for females to be in the cemetery population the bias towards males would still be clear in a male dominated community. While some hospitals forbade the admittance of people with leprosy, others were set up for the sole care of those with the disease. In the skeletal remains of these institutes there will be a high presence of leprosy related pathologies and of course aDNA evidence of the disease which confirms the hospitals cared and housing of individuals with leprosy. If a hospital cares for the general sick poor there will be a range of pathologies present throughout the skeletal assemblage, but unlike the specialised hospitals for leprosy these will be an array of different pathologies ranging from markers of biological stress, disease, trauma and lifestyle. If very little evidence of pathology or disease is located among the population this could contribute to an understanding that the hospital housed the poor or travellers/pilgrims. Therefore, from observing the demographic and pathological profiles of the hospital populations insight can be gained into who was admitted into a hospital and the types of care they may have been afforded, as is explored further through the application of Tilley's bioarcheology of care in Chapter 6. As a result of this the nine comparative hospitals utilised in this thesis were chosen as they provide examples of both rural and urban hospitals which acted as hospitals for those with leprosy and the sick poor, as well as almshouses and hospitals for wayfarers and pilgrims. Therefore these provide an overview of different hospital types located in different settings with populations that have been subject to osteological analysis and publication which can be utilised to compare and contrast the Hospital of St James.

St Mary Magdalene, Partney, Lincolnshire

The Hospital of St Mary Magdalen, Partney was a rural hospital existing by c.1115 until the year 1318 (Atkins and Popescu 2010, 204). Excavation of the site carried out between 2003-4 uncovered the hospital chapel as well its associated cemetery. The excavations identified 43 graves and further disarticulated material. Due to issues of preservation a total of 33 skeletons were subject to analysis by Sue Anderson (in Atkins and Popescu, 2010). Of these 33 skeletons, 28 were adults. The adult population consisted of 17 males, one female and 10 individuals for whom biological sex could not be attained. The remaining five individuals were non-adults, aged 7-16 years of age at death, no attempt to determine biological sex of the non-adult population was made. Atkins and Popescu (2010, 218), suggest the possible occurrence of cemetery zoning between lay and religious burials based on the location of grave type and grave goods within the cemetery. As noted above, it was suggested that in this instance, the 14 shallow graves laying north of the cemetery pathway represent the lay population, while the 26 deep and often anthropomorphic graves located south of the pathway signify the burial of priests/monks (Atkins and Popescu 2010, 218). All non-adults were north of the pathway. A single burial was uncovered from within the hospital chapel itself and is therefore suggestive of a patron or benefactor. This shallow burial containing a male (25-30 years at death) lay to the western end of the chapel, and radiocarbon dating indicated that this look place between 1150-1280. Little discussion of this burial was made but the skeleton was categorised as belonging to a lay individual due to a lack of any material culture (Atkins and Popescu 2010, 222).

In addition to the apparent spatial zoning that took place the presence of grave goods were also suggestive of social division. For example, the presence of nails, presumably from coffin fittings, were all identified to the south of the pathway suggesting coffined burial was resigned for the religious community. Furthermore, remains of pewter chalices were recovered from four graves (Burials 32, 35, 38 and 41). The presence of such goods is indicative of priestly burials according to the custom of burying pewter replicas of silver communion vessels following the instruction in 1229 by William of Blois, Bishop of Worcester (Oman 1990, 790). The evaluation of the hospital at Partney not only considered the spatial division of the hospital and its cemetery but also the use of chest/coffin burial outside of the known geographical range and date, as well as the use of socketed and ledged graves (Atkins and Popescu 2003, 263). These strains of evidence have been compiled to reveal a greater understanding of the use and the potential to recognise social division among the cemetery population at the Hospital of St Mary Magdalene, Partney.

St Nicholas, Lewes, East Sussex

The medieval Hospital of St Nicholas lay outside the town wall of Lewes, East Sussex, in the parish of St Peter and St Mary Westour. The exact year of foundation is unknown, although documentary evidence records the hospital was established by the de Warenne family as an infirmary for the poor under control of the priory of Lewes (Page 1973, 104; Barber and Sibun 2010, 81). The first reference to the hospital is from an account of the Battle of Lewes (c.1264) in which the hospital is described as a leper house, later sources refer to it as an institution for the poor and after 1547 as an almshouse (Barber and Sibun 2010, 81). At the time of Dissolution, the hospital housed 13 inmates, for which they received a support payment totalling £5 10*s*. (Page 1973, 104).

Excavations carried out in 1994 uncovered the remains of 102 burials dating from the late-twelfth to the early-sixteenth-century (Barber and Sibun 2010, 93). Excavations revealed 82 percent of burials were located in quarry fills and the remainder in chalk cut graves in the southern area of the cemetery. The degree of intercutting is varied across the site, and therefore the excavators suggested that it was impossible to establish either phasing patterns or dates for the individual graves (Barber and Sibun 2010, 83). Of both the chalk-cut and quarry-fill graves, just 19 burials were interred in coffins, the greater proportion of which were in chalk-cut graves, suggesting that these graves were afforded greater investment of both cost and physical labour. It is likely that the majority of remaining burials were shrouded. No spatial patterning was evident in regard to age or sex. However, the 14 non-adults were all in the quarry cut graves with the exception of one. There were 88 adults and 14 non-adults, 65 males, 16 females and seven skeletons of undetermined biological sex.

While it is possible that the chalk cut graves were of a higher status than the quarry fill graves, there is little doubt surrounding the non-normative or atypical burials within the cemetery. These burials consist of two individuals buried with their arms and hands behind their backs, one individual buried with an iron manacle around their right ankle, several double burials and a further two individuals interred in a single grave where they appear to have been stood at one end of the grave and allowed to fall in backwards (Barber and Sibun 2010, 97-9). Double interments were present in both chalk and quarry graves, these were thought to represent either familial relations or have resulted from a small scale epidemic where two or more people died at the same.

St John's Hospital, Cambridge

The medieval site of St John's Hospital Cambridge was excavated from 2005-12, during which the remains of 400 complete and partial burials were recovered along with features of the associated cemetery. The hospital was established in 1195 as a foundation by the townspeople which later became a place of religion with an ecclesiastical licence and supervision (Cessford 2015, 57). Documentary evidence indicates the hospital cared for the poor and infirm under Augustinian rule (adopted c.1250), however, strict rules against the admittance of pregnant women, lepers, the wounded, cripples and the insane were specified in the hospital's regulations (Rubin 1989, 157). By the fifteenth century, the hospital housed only a few alms people and instead carried out charitable institutions and chantry services (Cessford 2015, 62).

Excavation revealed five phases of use to the urban cemetery; of the 404 individuals recovered 341 (84.4 percent) were adults and 63 (15.6 percent) were non-adults. Of the adult population, 86 were determined to be male and 74 females, only a small proportion of the adults could have biological sex determined due to issues of truncation, inter-cutting and preservation (Cessford 2015, 84). The cemetery composition revealed the large majority of burials to have been interred in the extended supine position aligned west-east and to be without grave goods. However, social status has been inferred from geographic location within the cemetery, orientation and burial practice (Cessford 2015, 104). For example, several burials did not conform to the norm; these abnormalities presented in those aligned east-west or south-north, a double burial, a prone burial and individuals interred with grave goods and coffin nails (Cessford 2015, 76-82). In addition, the skeletal remains provided some context to the reasons for admission, for example, the palaeopathological evidence revealed individuals at the hospital suffered from Diffuse Idiopathic Skeletal Hyperostosis (DISH), Tuberculosis (TB), scoliosis of the spine as well as cases of trauma.

St Bartholomew's, Bristol

The Hospital of St Bartholomew, Bristol, was founded by Sir John de la Warre around 1232/4 as a hospital for the sick poor later becoming an alms-house before its dissolution in 1532 (Price and Ponsford 1998, 53). Documentary evidence consisting of records presented by the Earl of Ducie to Gloucestershire Records Office, from which Price and Ponsford (1998, 53-6) have noted the administrators and staff of St Bartholomew's Hospital from 1234-1532. This documentation has revealed that the number of brethren within the hospitals steadily decreased and from 1340 the hospital was subsequently run by women under Prioress Eleanor (Price and Ponsford 1998, 87). In 1387 men, women and sisters are recorded at the site and after 1445 the hospital was used to house 12 poor mariners and their priests (Price and Ponsford 1998, 87, 176). Cemetery excavations uncovered the remains of 45 burials; of these seven were non-adults, 26 were adults and 12 could not have age identified due to extensively poor preservation. Of the 26 adults 12 were male, 11 female and three of indeterminate sex (Price and Ponsford 1998, 176). Further examination of the cemetery population suggests the hospital was serving an elderly infirm population with no evidence of serious trauma or unusual pathology (Price and Ponsford 1998, 214). From the cemetery excavation and analysis of burial it was estimated that the hospital housed approximately 30 people at any one time, which would be in-line with the aforementioned record of 12 poor mariners with the addition of the religious and hospital population (Price and Ponsford 1998, 87).

St Mary Magdalene, Winchester

The Hospital of St Mary Magdalene, Winchester was excavated from 2008-2012 as a research-led investigation aimed at studying the history and development of a well-documented medieval leper hospital. The site of the hospital was located on the outskirts of the medieval town suburbs. Although first documented in the mid-twelfth century as an institution to house those suffering from leprosy, archaeological evidence suggests the hospital's foundation took place in the late eleventh century (Roffey and Marta 2010, 405). By the fourteenth century the hospital underwent a phase of rebuilding and reorganisation into an institution that likely no longer ran exclusively as a *leprosarium*. In the late sixteenth century further building works took place and the hospital was re-established as an alms-house (Roffey and Marta 2010, 405).

A total of 54 skeletons were recovered, of which ten were male, three were female, 31 were of undetermined sex, and just ten were non-adults (Roffey and Tucker 2012, 172). 38 burials were recovered from the early northern cemetery, interred in anthropomorphic graves with head niches to the west. 33 of these burials presented with indications of leprosy, and also included an amputee of the lower left leg and a pilgrim (identified as such though the inclusion of a scallop shell) (Roffey and Marta 2010, 406; Roffey and Tucker 2012, 174). The second phase of burial, estimated to have commenced in the mid-late twelfth century, took place to the south of the new hospital chapel. Two of the five burials excavated from this phase also presented with evidence of leprosy (Roffey and Tucker 2012, 172). The final burials date to the fourteenth to the sixteenth-century phases of burial in which 11 individuals were interred in nine graves inside the south aisle of the chapel, in which there is no confirmation of leprosy (Roffey and Tucker 2012, 172).

Roffey and Tucker (2012) concluded that the Hospital of St Mary Magdalene brings to question the belief that *leprosaria* were isolated hospitals and that their inmates were segregated. This is a result of the evidence they saw for palliative and remedial care, suggestive there were attempts to alleviate the suffering of this community. It is suggested that the level of care challenges the traditional thought surrounding leper hospitals and this is seen here on the same level as that of minor monastic houses (Roffey and Tucker 2012, 178)

St Margaret, High Wycombe, Buckinghamshire

The Hospital of St Margaret, High Wycombe, Buckinghamshire, was investigated as a rescue excavation in 1986, when the incomplete remains of 12 skeletons were recovered (Farley and Manchester 1989, 84). Discrete graves were excavated where possible, however, the majority of graves were fragmentary due to machine disturbance and poor preservation (Farley and Manchester 1989, 84). Nonetheless, it was apparent that all burials had been interred west-east and one was laid on the left side, flexed at the knees. From a count of anatomically different recognizable elements it is estimated that a minimum number of ten individuals were represented in the cemetery, but a count of incomplete mandibles suggests twelve (Farley and Manchester 1989, 86). Although the estimation of sex resulted in the identification of just four males and two females it is possible to identify that sex segregation did not occur in this area of the hospital's cemetery. Although no definite diagnosis of leprosy could be made, several elements of the skeletal material did present with pathological changes indicative of the disease (Farley and Manchester 1989, 86-7).

St Leonard Hospital, Newark, Nottinghamshire

According to its foundation charter, the Hospital of St Leonard outside the walls of Newark in Nottinghamshire was established in 1133/4 by Alexander Bishop of Lincoln (Page 1910, 167). It functioned up until 1642, during which time complaints of financial abuse by the master were recorded claiming inadequate care was provided to inmates, and poor men were refused entry into the hospital (Page 1910, 167). The hospital's use changed from a *leprosarium* to that of an alms-house and reduced in size to house a master, a chaplain and two poor men, as confirmed in the 1417 decree by Philip Repingdon, Bishop of Lincoln. Excavations uncovered a total of 87 burials as well as disarticulated material. The burials consisted entirely of adult individuals, 66 of which were male, 11 were female and 10 were not assigned a category of biological sex (Bishop 1983, 24). Among the burials was a priestly burial containing a pewter chalice and patent.

St Mary Spital, London

The medieval priory and Hospital of St Mary Spital were originally founded in approximately 1197 by a group of wealthy London merchants. The foundation arose as a result of an expanding population and an increased need to provide care for the elderly, sick and infirm (Thomas *et al.* 1997, 104). St Mary Spital was the largest infirmary in medieval London, with a total of 180 beds. It was run by twelve lay brothers and sisters under the supervision of a prior. The hospital was responsible for tending to pilgrims, the sick, pregnant women, and orphans (most often children whose mothers had died during childbirth) until they reached the age of seven (Thomas *et al.* 1997, 104). The two subsets (OA5 and OA11) of the wider cemetery have been singled out and utilized in this thesis as they are distinct phases of burial, contemporary in time to the Hospital of St James, and come from arguably the most extensively studied hospitals of later medieval England.

The original infirmary cemetery, classified as OA5 by Thomas *et al.* (1997), was in use for 45 years from 1235-1280 and excavations uncovered 101 skeletons (Thomas *et al.* 1997, 39). The burials comprised 9 rows of 25 graves aligned west-east (Thomas *et al.* 1997, 117). The distribution of biological sex occurred at a ratio of 2.4 males: 1 female; 54.5 percent of the burials were less than 25 years at death and for every increase in age category the number of deaths lowered. Thomas *et al.* (1997, 39), suggest that this age distribution is representative of a population of pilgrims or migrants passing through on their route into London. The presence of infants and stillbirths within the cemetery was interpreted to represent the hospital's continued care for women in childbirth and their children (Thomas *et al.* 1997, 39).

Cemetery Area OA11 was in use throughout the thirteenth century as a cemetery for the canons and sisters of the hospital and later included the burials of hospital inmates. The population was comprised of 1.15 males for every 1 female, just 10.68 percent of the population were non-adults and the remaining were adults (Thomas *et al.* 1997, 63). In addition to single burials expected of a typical hospital cemetery, two types of multiple burials were represented. One was inhumations of two to seven bodies lain horizontally and the other was two to eleven bodies stacked on top of each other. The occurrence of multiple burials has been attributed to the infirmary experiencing multiple deaths in short succession. Also uncovered were mass pit burials containing approximately 4,000 bodies. These burials contain between eight and forty-five bodies interred in multiple layers, they are similar to the Black Death burials uncovered at East Smithfield (Thomas *et al.* 1997, 122). These burial pits date somewhere between the early- to mid-thirteenth century, which makes it likely that these mass burials were a result of the famines of 1252 and 1257-58 (Thomas *et al.* 1997, 122).

2.8 Summary

This chapter has established that the role of the medieval hospital was one of great complexity and variation. An explanation of how care was provided in the medieval hospital was provided, with an emphasis on the importance of Christian ideals. The hospital's role within society has also been explored through an evaluation of the various categories of the hospital, their conditions of admittance and the changes that could be made to a hospital's function and management over its lifetime. The provision of burial and the location of the hospital has been discussed and finally a comparative overview of hospital's contemporary to the Hospital of St James has been provided. An appreciation and understanding of these aspects of hospitals in medieval England are of great importance in the present study when establishing the social function of the Hospital of St James.

3

Burial customs and cemetery use at the Hospital of St James

This chapter explores the burial customs employed at the Hospital of St James. The structure of the following discussion outlines the broad layout of the cemetery, followed by more detailed analysis of specific grave characteristics and burial practices. This includes grave alignment, skeletal positioning, grave location within the cemetery, intra-mural burials, and the grouping of non-adults and multiple burials. The chapter goes on to explore the changing alignment of the burials as the hospital's burial practice developed over the cemetery's use. This chapter will help to form a picture of how the hospital carried out the seventh Corporal Works of Mercy of burying the dead (as discussed in section 2.1). Any distinct patterning within the cemetery is used to further interpret distinction in the population, such as between the laity and the religious members and their treatment of the inmates upon death.

3.1 The setting of the cemetery at the Hospital of St James

The cemetery of the Hospital of St James was established to the east and north of the hospital building (figure 1.3.5). No network of pathways through the cemetery could be identified during excavation. This is in contrast to the findings of the hospitals of St John's Cambridge (Cessford 2012), St Mary Magdalen, Partney (Atkins and Popescu 2003), and St Mary Spital, London (Connell *et al.* 2012), in which excavations revealed a series of paths throughout the cemetery used to analyse cemetery zoning and burial patterning (Cessford 2012, 63; Atkins and Popescu

2003, 217-8).

The border of the abbey's inner and outer precincts was defined by a stone-built wall running east to west. The original medieval boundary was discovered upon excavation, and located 10 meters north of the hospital building. At some point during the cemetery's use the precinct boundary was moved approximately 50 metres further north, into the inner precinct to extend the size of area available for burials (Figures 1.3.2 and 3.1.1). As a result of this relocation, the hospital gained land (Area B) into which later burials, including the mass interment of plague victims (c.1348-9) and the final phase of burials were located (this area is indicated in green in figure 1.3.5).

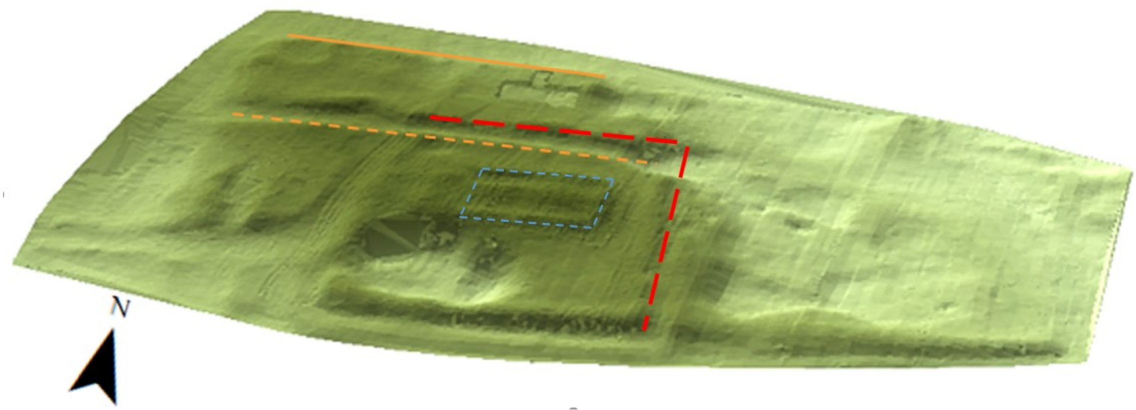

Figure 3.1.1: The topographic survey of the outer precinct shows the probable northern and eastern extent of the cemetery (indicated in red), surrounding the outline of the hospital building (blue) and in relation to the original (orange dash) and extended (solid orange) precinct boundaries.

3.2 The burials

The following discussion examines the social and spatial hierarchies that structured burial in later medieval England, revealing patterns of the interment of different social and religious groups within a cemetery. Preferences regarding the location of burials are discussed and evidenced by the zoning of burials by age and grave formation, such as earth-cut graves, stone-lined graves and coffined burials. In addition, the form and location of burials which took place in response to a sudden death and epidemics are also discussed.

3.2.1 Grave Location

The development of spatial hierarchies within the cemetery is a result of the medieval practice of burying individuals according to their status. Within the chapel of the Hospital of St James, two individuals were afforded burial in the most prestigious location, in front of the high altar in Area C. These were skeletons SKN053 (5343), a male aged 36-45 years at death and SKN054 (5238), also a male for whom assessment of age could only be determined as greater than 18 years at time of death. SKN053 is known to have been a priest as he was named on an elaborate stone grave marker (see section 3.4.4) and interred with a pewter chalice, but both probably held positions of importance within the hospital such as hospital master or chaplain. Four further individuals were buried within the nave of the hospital chapel; SKP004 (5514), SKP005 (5612), SKP006 (5616) and SKP007 (5616), all adult males. No grave goods were associated with these burials; however, they were dug to a depth of approximately 1.2 metres which reflects a greater investment of labour than in the extramural burials which were dug to an average depth of 0.6 metres. The individuals interred in these graves were all adult males, one skeleton had lesions associated with ankylosing spondylitis and two had arthritic lesions in the upper and lower limbs. The demographic profile of these individuals, being adult males, is compatible with that of burials deemed to be members of the religious community at the hospital sites of St Mary Magdalene, Partney (Atkins and Popescu 2010, 218); St John, Cambridge (Cessford 2015, 101) and the Hospital of St Leonard, Newark (Bishop 1983, 24). At these sites, demographic data, location of graves and/or grave form have been employed to discuss the status of the individual's interred, concluding that burials in the 'holiest' of positions were members of the religious community.

In both life and death an individual's status could be defined by their holding a religious role, ancestry, earthly wealth, age, sex and even health (Gilchrist and

Sloane 2005, 56; Bynum 1995, 215). In addition to the classification of an individual's status, burial location was also determined by the concept of 'holy' positions within the cemetery (Daniel 2005, 101). Status has always been closely associated with specific topographies within religious buildings or monuments. Since the thirteenth century the 'holiest' burial position within any religious establishment was at the high altar of the church (Cassidy-Welch 2001, 218; Daniel 2005, 86; Finucane 1981, 43-4; Harding 1992, 131; Crabtree 2013, 48). These partitions of holiness continued into the cemetery where locations closer to the chapel were in greater demand than those further removed (Daniel 2005, 86). The concept that a burial position was a reflection of 'holiness' is evidenced in the requests for burial made in medieval wills and in the resulting charges that developed in some parish churches (Gilchrist and Sloane 2005, 56). Tanner's (1984) study over 1500 wills from Norwich, which date from 1370-1532, records numerous requests of specific burial locations within the Cathedral church and its cemetery. More specific examples from Somerset are the requests of one Thomas Browne of Yatton to be buried on the north side of the parish church in 1491 and a John Bedill of Portbury to be buried in the north part of the church in 1457 (Weaver 1901, 173 and 291).

Even cemeteries which specialised in the burial of certain social groups, such as the medieval hospitals, presented their social hierarchies through burial location. Within the Augustinian order, the strict regulation of burial had somewhat lessened by the thirteenth century, allowing the inclusion of a broader cemetery population, including laity, to be buried within the monastic cemetery (Lepine and Orne 2003, 8-9). Senior monastic members favoured burial in the chapter house and prominent locations within churches but are also found buried in the general cemetery of their institutions (Butler 1993, 79). For example, in 1222 at the Premonstratensian Abbey of St Mary, Titchfield, Hampshire, nine abbots were buried in the western cloister walk (Dounleday and Page 1903, 181). Canons, monks and nuns are traditionally found to have separate cemetery areas from the laity. Burial of the religious community has been located to the east and south of the churches in published plans of Christchurch, Canterbury and Bury St Edmunds Abbey respectively (Wills 1868, pls 3 and 4; Whittingham 1951). However, in more diverse religious establishments, such as hospitals, the standard division of burial location is less definite (Gilchrist and Sloane 2005, 61). For example, at the Hospital of St Bartholomew, London, the canons' burial ground was situated to the south-east of the church, but also permitted burial of the hospital's lay sisters (Moor 1918, 159-60). Similarly, the Hospital of St John, Ely was open to the burial of religious and laypeople alike (Daniell 1997, 91). Gilchrist and Sloane (2005, 61), concluded that the majority of institutions did inter members of the monastic community, lay brothers and sisters together, and any division could be lost. However, they added that if a monk or canon were interred extramurally then it is highly unlikely that any lay brother would have been afforded intramural burial.

At the Hospital of St James, status can and has been discussed concerning the situation of burials within the hospital chapel. However, it is not possible to discern status among the extramural burials from burial practices alone due to the simplicity of grave structure and an absence of grave goods throughout all extramural burials. However, the extramural burials do present an extent of spatial patterning, and thus suggest a deliberate allocation of space within the cemetery. Of the non-adults interred in Area A, 57.7 percent (n=15/26) were interred around the eastern third of the hospital chapel. Of these 15 burials, 12 were interred within immediate proximity of the hospital (figure 3.2.1, 3.2.2 and 3.2.3).

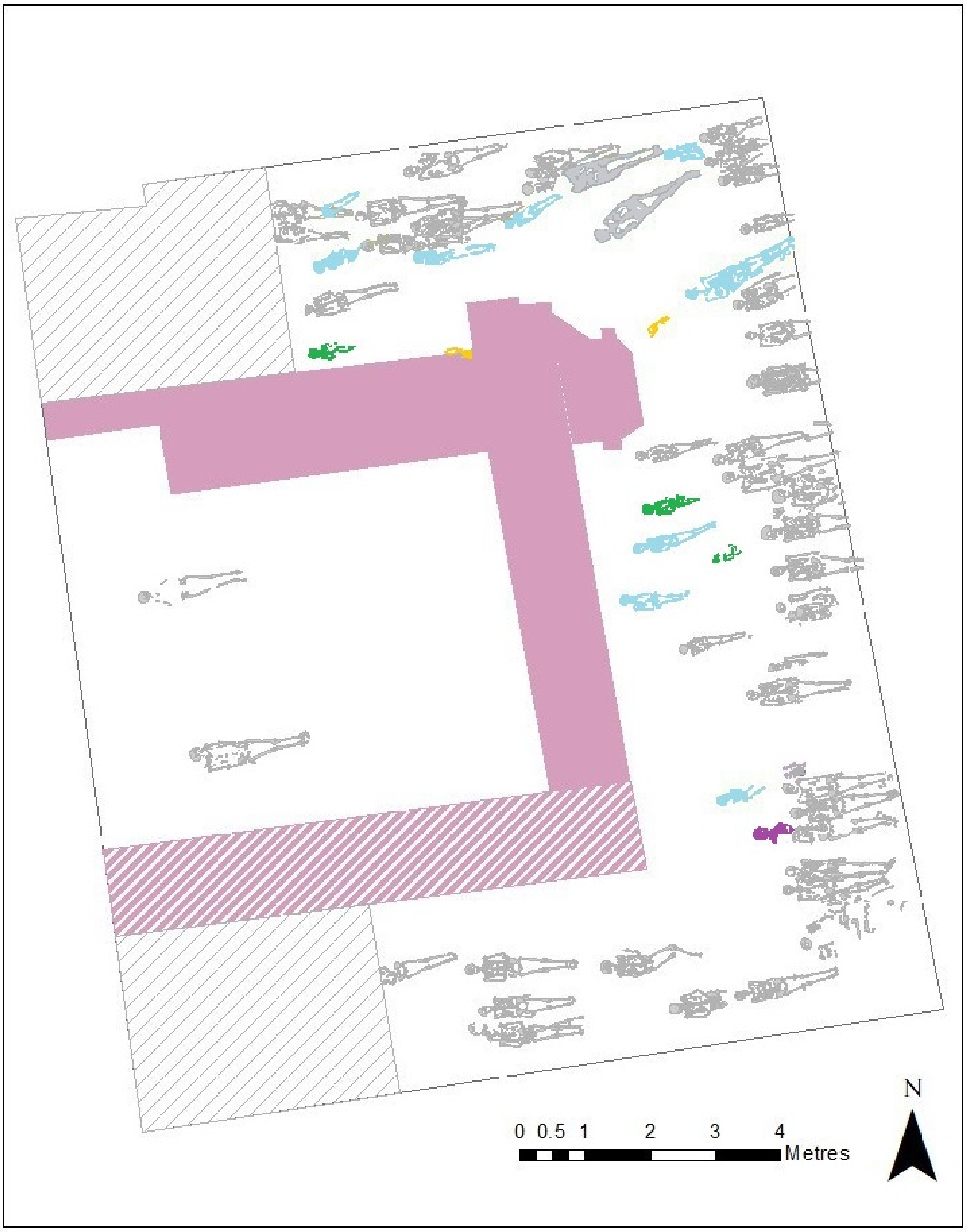

Figure 3.2.1: Non-adult individuals are highlighted in colour, showing their interment around the eastern third of the hospital chapel. This demonstrates the practice of purposely burying the young in close proximity to the chapel. The different age categories are represented as follows: orange aged 1-11 months, green 1-5 years, blue 6-11 years and purple <18 years.

Figure 3.2.2: SKN003, aged 1 – 11 months, interred alongside the northern wall of the hospital chapel, with a later buttress cut through the lower part of the skeleton.

Figure 3.2.3: SKN005, aged approximately 4-5 years at death, interred along the northern edge of the hospital chapel's buttress.

The burial practice of placing non-adults in close proximity to religious buildings, has received attention in archaeological literature as it presents an opportunity to explore attitudes toward non-adult death within medieval society (Hausmair 2017, 211). Archaeological investigations of medieval Christian cemeteries across Europe have encountered the zoning of non-adult burials within burial grounds. The studies generally deal with the very young and assume these individuals were not baptised before death (Ulrich-Bochsler 1997; Crawford 2013; Gardeła and Duma 2013; Hausmair 2013; Craig-Atkins 2014). Many consider the infant burials to be situated next to a holy building where water falls from the building acting as a form of posthumous baptism, sanctifying the zone of infant burial (Craig-Atkins 2014, 1; Hadley 2010, 109; Crawford 1999, 85-9; Boddington 1996, 55). In the twelfth and thirteenth centuries, scholars such as Thomas Aquinas argued that unbaptized infants would be eternally confined to *limbus puerorum*, an isolated place at the margins of hell (Le Goff, 1990: 220– 221). To prevent such a fate, from the thirteenth century onwards, the use of emergency baptism was permitted by the Church. This enabled a layperson to administer baptism when a child's life was at risk as a result of complications of childbirth (Signori 2013; 236, 243; Shahaer 1990, 49; Orme 2001, 25).

A total of 13.3 percent of the non-adult remains recovered in proximity to the chapel were aged below eleven months at time of death. The absence of foetuses and perinates at the Hospital of St James greatly reduces the possibility that the burials around the hospital's church were situated as a result of baptismal qualities. Furthermore, the cemetery was in use when emergency baptism was introduced in the thirteenth century and therefore could have provided such to the non-adults buried at the Hospital of St James.

Zoned' Non-adults	<11 mnths	1-5 yrs	6-11 yrs	12-17 yrs	Total
Count	2	7	5	1	15
Percentage	13.3	46.7	33.3	6.7	100

Table 3.2.1: Age at death distribution of the non-adults thought to be 'zoned' burials in relation to the building of the Hospital of St James.

As shown in table 3.2.1, the non-adult burials clustered around the hospital's chapel are primarily aged between one and eleven years at death. Therefore, there is no reason as to why these individuals would not have been baptized at their time of death. Nor were these individuals suffering from one particular, skeletally identifiable, illness. However, one of the non-adult burials situated around the hospital suffered from the debilitating congenital disorder synostotic scaphocephaly, (discussed in greater detail in Chapter 6). Anderson (2007) suggests the positioning of non-adult burials in particular locations within a cemetery is the result of practicalities. Such arguments suggest that non-adult burials presented the opportunity to utilise areas of the cemetery which were not suitable for adult burial. For instance, non-adults could fit in small spaces and did not require the same depth of grave as adults, thus they could be placed close to buildings and wall structures without disturbing their foundations (Stoodley 2000, 458; Crawford 1993, 85).

3.2.2 Grave Alignment

Burials at the Hospital of St James are predominantly aligned with the head to the west and feet to the east. While many are positioned due west-east, some appear to have been orientated towards the claustral complex which is located just north of true east, and thus these burials were actually on a west-south-west – east-south-east orientation. The orientation of graves west to east is consistent with the medieval Christian practice, which has been associated with the belief that on the day of Judgement, Christ will appear from the east and the congregation will rise to face him upon resurrection (Daniell 2005, 148).

Both variations in orientation are seen throughout Areas A and B of the cemetery, however in Area C all of the burials are aligned true west-east, as is the chapel itself. The majority of burials in Area A were orientated west-east with the exception of nine burials (87.8 percent, n=65/74) which were orientated west-south-west – east-north-east (figure 3.2.4). The burials located in Area B demonstrate the opposite patterning; the majority were orientated west-south-west – east-north-east in line with the cloistral complex (64.4 percent, n=65/101). However, two groups of burial north of the boundary wall were interred on a true west-east orientation. These consist of 17 burials to the southwest and a distinct phase of 25 burials (discussed in section 3.3.1), identified as the final phase of burial within the cemetery (figure 3.2.5).

Given that the majority of the earlier burials in Area A are west-east aligned, and more of the later burials in the Area B are west-south-west – east-north-east aligned, it is suggested that the orientation of burials changed over the duration of cemetery use. The extension of the cemetery into the abbey grounds (Area B) may represent a turning point in practice at which point a shift in attention was made towards the abbey church. Furthermore, orientation towards the claustral complex may also reflect the holy status of the abbey and the high regard in which the hospital population held it.

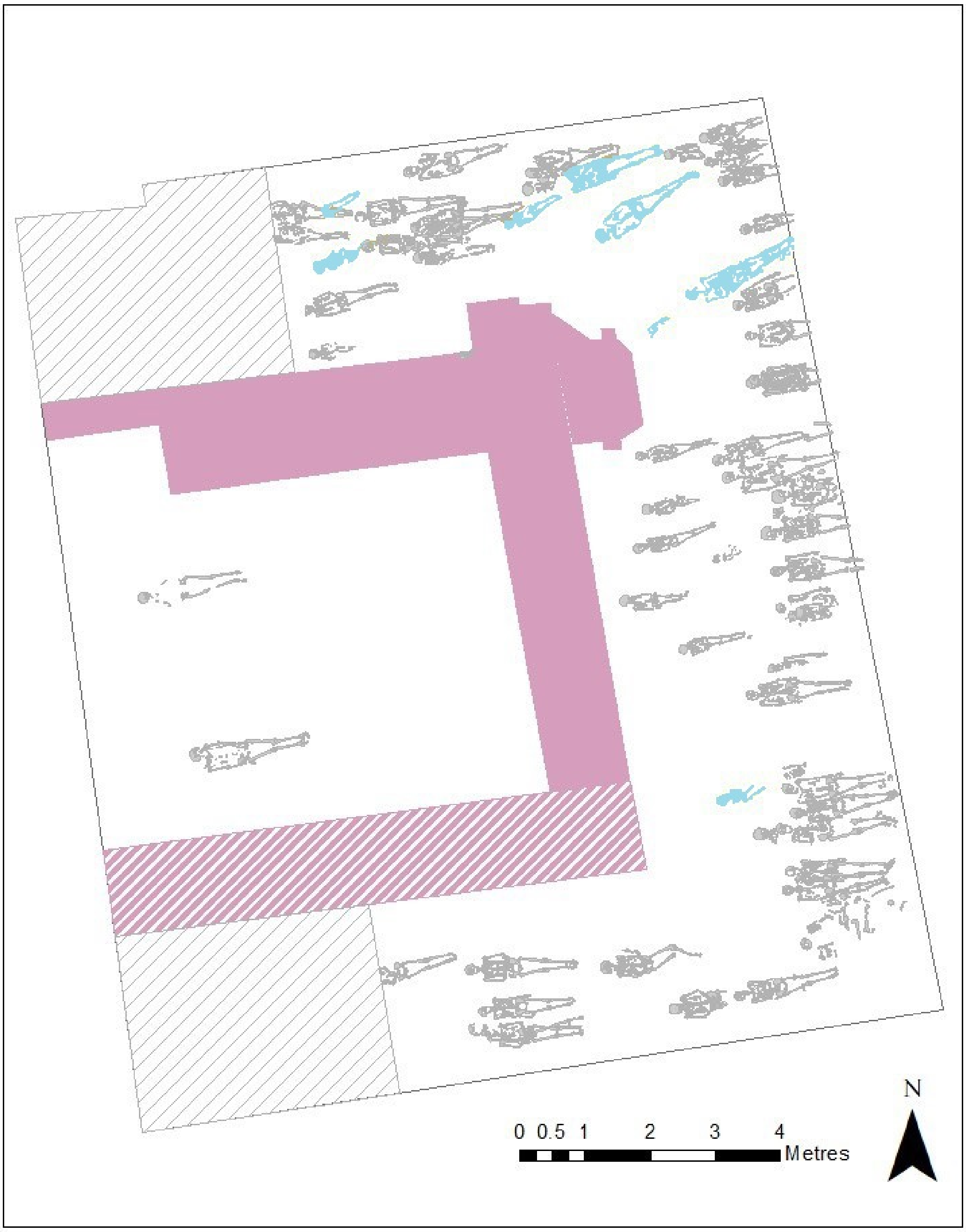

Figure 3.2.4: All burials within the hospital's immediate cemetery were orientated west-east with the exception of those highlighted in blue, which were orientated west-south-west – east-north-east in line with the Abbey complex which is located to the north-east of this plan.

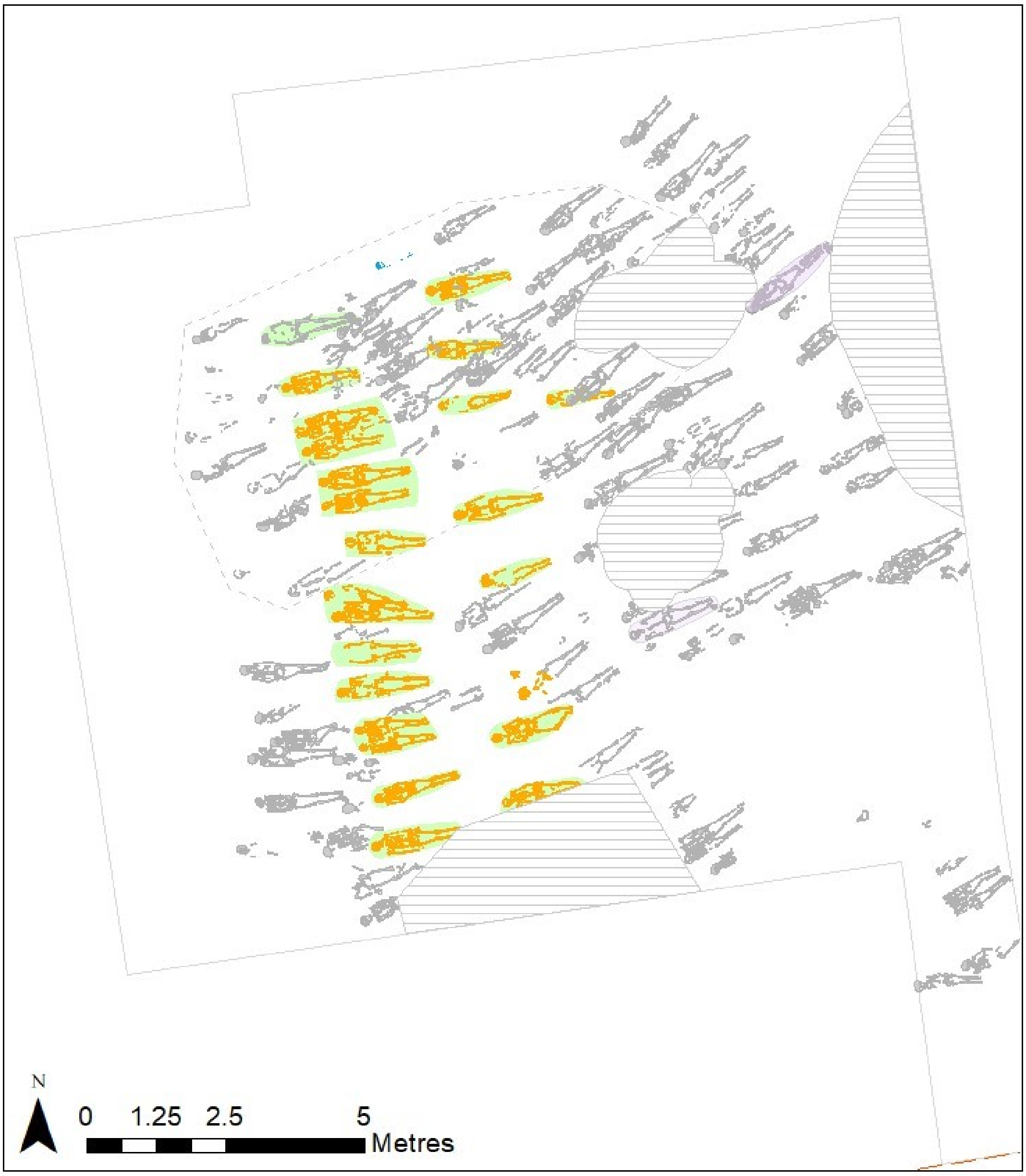

Figure 3.2.5: The majority of burials located beyond the original boundary wall were orientated west-south-west – east-north-east in line with the claustral complex, with the exception of those highlighted in orange (and their grave cuts in green).

Cemetery planning is often assumed to be based on logic and pragmatism, as evidenced by medieval burials being typically organised side by side in straight rows. Deviation from this layout and orientation are often ascribed to practical considerations such as lack of space (Daniell 2005, 146; Roberts and Cox 2003, 222). A burial ground was often restricted due to fixed cemetery boundaries and the availability of consecrated ground. As a result, cemetery space was often subject to reuse where the cutting of new graves encountered earlier burials which may have stimulated alteration to the positions of later burials. At the Hospital of St James, the orientation of graves appears to be the result of a deliberate and systematic planning, as orientation is clearly applied to an entire area of graves and not the selective few. There is no discernible pattern suggestive of previous burials determining the orientation of those which follow, and the large amounts of disarticulated bone redeposited in backfill imply little concern of disturbance.

3.2.3 Body Position

The majority of bodies were interred in the supine position, with their hands and forearms placed crossed across the chest or crossed at the pelvis. However, SKN059 (5207), a non-adult aged 6-11 years at death, was interred with their chin resting on their left shoulder, their hands together above the left hip and their pelvis twisted to the left. The individual's upper legs are crossed, with slight flexion at the knees (figure 3.2.6). This positioning is indicative of when an individual is lying on their side.

When interpreting the positioning of a burial it is important to remember that it is the living's actions that form the burials recovered in the archaeological record and therefore, they provide insight into the treatment of and relationships with the dead (Murphy 2017, 227-8). One proposal for the semi-flexion of the hips and knees in full term/neonates and infants is that this position is related to the natural configuration of the limbs (Murphy 2017, 234-5; Dawson 2014, 83-4). However, for older non-adults such as SKN059 (5207), this explanation is not applicable. Instead it is plausible to suggest this individual had been placed on their side with flexed lower limbs to imitate the sleeping position. It is suggested that the purposeful positioning of non-adults in such positions reflect a sleeping position and therefore a more restful burial then the extended supine position (Gilchrist and Sloane 2005, 155-6; Murphey 2017,243). Murphy (2017, 245) discusses the occurrence of such burials suggesting that they may reflect a family's involvement in the burial of their dead children, especially considering the sleeping positions connection to themes of care and tenderness.

Figure 3.2.6: SKN059, aged 6-11 years at death, it is possible that the body turned as it was being lowered into the grave, note the pelvis is faced down, the lower limbs are awkwardly crossed to the side and the upper torso is twisted.

Located to the north of the hospital chapel was a prone burial, in this case, SKN011 (5063) a male adult aged 36-45 years. The skeleton was placed on their front, with the upper body rotated to their right, so the head faced slightly north, but was not twisted with respect to the superior vertebrae (figure 3.2.7). This individual laid partially on top of the burial of a 16-25-year-old male, interred in the supine position. There is no evidence of the prone burial intercutting or disturbing in any way the supine burial beneath and therefore it can be inferred that the burials of these individuals took place at once.

When interpreting the placement of the body it is important to consider the wider context of the burial to determine whether unusual body placement is the result of deliberate action or an accidental consequence of the burial process, or other taphonomic factors. For example, Gilchrist and Sloane (2005, 154) state that at least three of the prone burials in their survey were the result of casual or hurried burial practice among mass interments. Their examples include prone burials from the northern cemetery at London Blackfriars and the Black Death Cemetery at East Smithfield. The interment of two of these 'prone' burials in mass graves draws attention to the possibility that an association of prone positioning with rushed burial did occur, and that this is possible across all burial contexts and not just those of mass interment. In the case of SKN011, there is little to suggest that prone internment was the result of a hurried burial.

Figure 3.2.7: SKN011, a male adult aged 36-45 years, the skeleton was placed on their front with the head facing north, it partially overlays the burial of a 16-25-year-old male, interred in the supine position.

The ubiquity of prone burial during the medieval period suggests a shared trans-community idea concerning its use (Gardeła 2015, 109-123; Barber 2010, 44–50; Reynolds 2009, 89–91, 160–1). These ideas may be based on the cause of death, the actions of the dead during life or superstitions of the living about the deceased (Reynolds 2009; Faull 1976; Matheson 1951). The practice of prone burial has been a topic of great interest in archaeological literature, particularly within Christian cemeteries. Traditionally, the practice has been recorded as a disrespectful treatment reserved for the 'deviant' (Kroll Bachrach, 1986; Gilchrist Sloane, 2005; Tsaliki 2008, 2–3; Weiss-Krejci, 2008; Reynolds, 2009). Such interpretations consider prone burial, variously, as a response to murderers, decapitations, mutilations, superstition and victims of communicable disease (Kroll Bachrach 1986; Gilchrist and Sloane 2005; Weiss-Krejci 2008; Reynolds 2009). Alternatively, Philpott (1991) suggests the practice could have been applied under less apprehensive conditions, for example, when prone burials are found in association with another interment the practice may reflect the burial of family members such as married couples.

In the context of Christian burial grounds, one must consider why prone burials have been deemed a suitable practice (Murphy 2017, 235). One suggestion is that the prone position may be used for individuals who have suffered during life; for example, the burial of a teenage male with lesions characteristic of Scheuermann's disease, a chronic and debilitating condition, has been recorded at the later medieval Gaelic burial ground of Ballyhanna, Co. Donegal. (Murphey 2017, 235). At the Roman Poundbury camp, Dorchester, a 5-year-old who is believed to have been deaf and mute was also buried in the prone position, in a tile lined grave (Farwell and Molleson 1993). However, the prone position is unlikely related to the individual's disabilities, instead, within this context prone burial was interpreted as a high-status rite due to the tile lined grave forms. Five additional individuals, with no sign of physical disability, were also buried in the prone position (Lewis 2018, 475).

The association of prone burials with high profile individuals is present throughout the archaeological record. Gilchrist and Sloane (2005, 154) record the request of prone burial by devout individuals as a reflection of kneeling or genuflecting, which were to show humility in death. Furthermore, Hadley (2010, 107-8) lists six prone burials in a cemetery thought to have served a monastic community in Beckery chapel near Glastonbury, as well as instances in the cemeteries associated with religious communities at Wearmoth and Jarrow, Northumbria. Given the presence of prone burials at these religious sites, it is likely that the burial practice was also employed as a symbol of status. Considering the context of the prone burial at the Hospital of St James being both within the hospital's Christian burial ground and within the abbeys precinct, it is plausible that the burial practice here was also of good intentions and not as a disrespectful action.

3.3 Grave variation in the cemetery of the Hospital of St James

3.3.1 The final phase of burial at the Hospital of St James

The final phase of burial within the hospital cemetery refers to 15 single graves, four double graves and one triple grave interred in one distinct phase (figure 3.3.1). These burials consist of two rows of side-by-side, that clearly cut through the earlier areas of interments and thus represent the final phase of burial. Significantly, this is the only phase of burial at the Hospital of St James which included double or triple burials, although the site did contain a single mass burial, discussed in Chapter 1, sections 1.3.

The burial of several individuals within a single grave during the medieval period is not an uncommon practice and is seen throughout the archaeological record (see Gilchrist and Sloane, 2005; Cessford, 2015). What makes the burials of multiple occupancy at the Hospital of St James particularly interesting is their frequency, both compared to other phases of burial at St James and to other medieval cemeteries, and the demographic profile of the individuals interred. Within this final phase, burials of multiple occupancies occur at a rate of 0.73:1, or 42.3 percent (n=11/15). This frequency of multiple occupancy burial is rare in the archaeological record of later medieval hospital cemeteries in England. For example, at St Mary Merton, Surrey the only multiple burial consisted of two mature adult males and a child (Miller Saxby, 2007), at St Nicholas, Lewes two mature adults were buried together (Barber Sibun, 1998) and at St John's Hospital, Cambridge, two mature adults and two children were interred in a single grave (Cessford, 2015). The absence of other cemeteries with similarly high rates of multiple occupancy burial to the Hospital of St James, further emphasises the special nature of the burial practice taking place in the cemetery at this point.

The final phase of burial includes individuals aged from 4 years at death to over 45 years at death. As seen in table 3.3.1, the representation of each age group does not follow a typical attritional mortality profile where the very young and the elderly represent the largest proportion of the population. The biological sex profile of the adult population in this phase of burial consists of 15 males, one female and two individuals of indeterminate sex (figure 3.3.2).

Age at Death	The final phase of burial	
	Count	Percent
0-5	1	3.85
6-15	7	26.92
16-25	5	19.23
26-35	3	11.54
36-45	8	30.77
≥45	2	7.69
Total	26	100.00

Table 3.3.1: Age at death distribution of the final phase of burial.

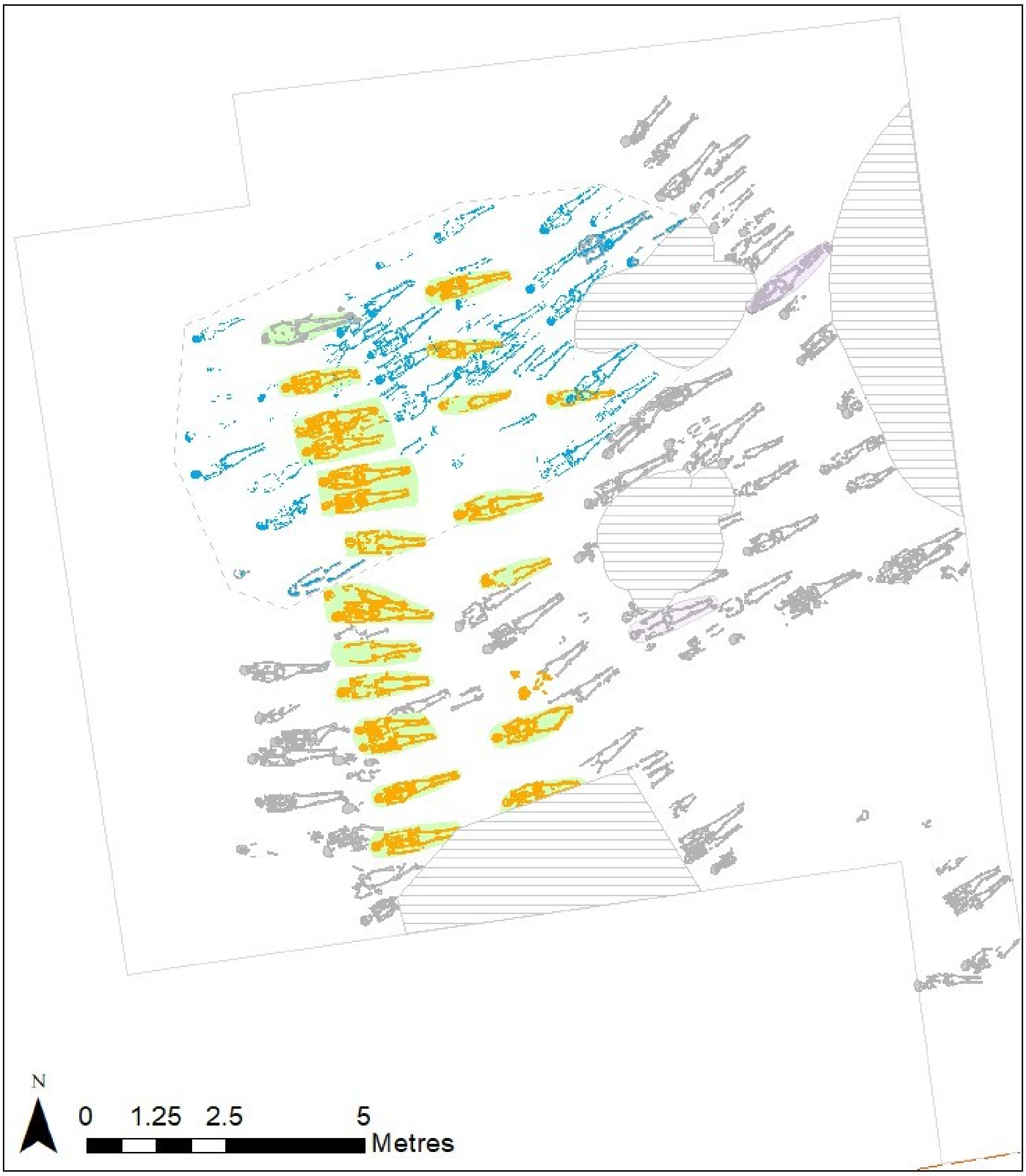

Figure 3.3.1: The final phase of burial in the cemetery comprised of 26 individuals (orange, with their grave cuts in green). It is evident here that this phase of burial overlies all other burials, including the mass burial (highlighted in blue).

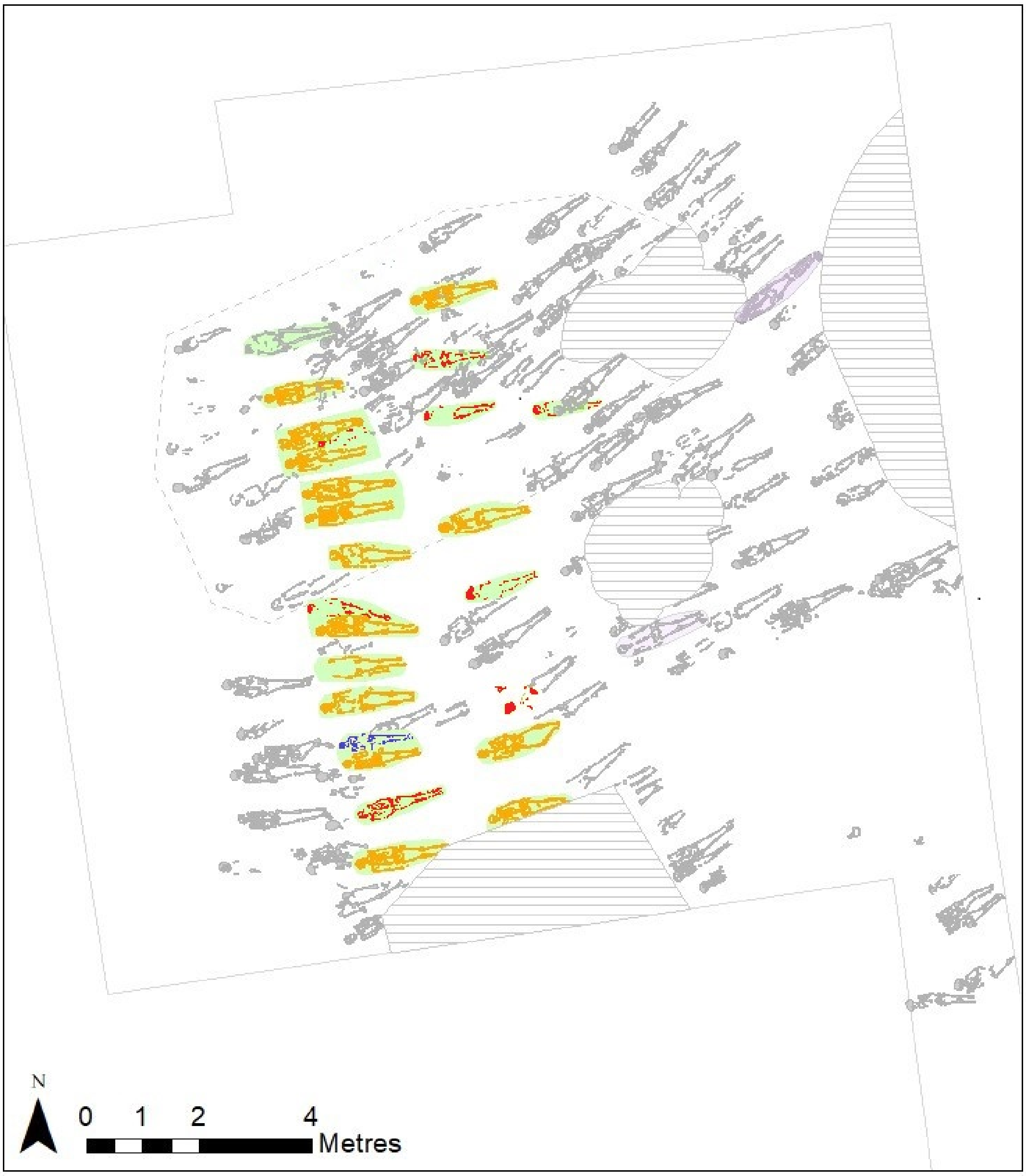

Figure 3.3.2: The final phase of burial categorised into males (orange), females (blue) and non-adults (red).

This profile of biological sex is in accordance with the male bias evident throughout the cemetery population at the Hospital of St James and therefore the atypical profile of this burial phase may be a reflection of the hospital's quasi-monastic status. However, the age at death profile does not fluctuate in the youngest and eldest categories as expected of a normal attritional profile. Therefore, from the mortality profile, it is suggestive that these deaths may have been the result of a catastrophic event, such as an outbreak of disease within the hospital community. Epidemics can occur due to the introduction of a new infectious pathogen into a population with no prior immunity to them, or, because of an existing pathogen's mutation into a more virulent form (Gowland and Chamberlain 2005, 147). The suggestion that the final phase of burial consists of a catastrophic burial profile is further supported by the physical characteristics of the burials (Crawford 2007, 84-5). As has been discussed within this phase there were several burials including more than one body, the application of this burial practices can be inferred as a reflection of several deaths taking place in quick succession. Throughout thirteenth and fourteenth centuries England experienced numerous famines and plagues, most significantly the Black Death of 1348-9, the Great Famine of 1315-1317 and the famines experienced in the years up to 1322 (Schofield 2013, 71- 86). Therefore, we must consider the possibility that the quick succession of death could be a result of famine. However, famine is hard to identify in the archaeological record as it cannot be determined through the skeletal remains nor is there an identifiable pathogen (Antoine 2008, 101-44). Additionally, the uniform layout of the graves in two very distinct rows suggests the burials took place within a short time of each other, enabling the gravediggers to know precisely where the graves were positioned in relation to one another.

In order to further explore the relationship of the individuals interred in the double and triple burials, future research would benefit from the application of hierarchical aDNA with the primary aim of assessing paternal lineage (Brück 2021; Vai *et al.* 2020; Mulligan 2006). Such techniques would be beneficial to the burial at the Hospital of St James as well as St Mary Merton, Surrey; St Nicholas, Lewes and St John's hospital, Cambridge to establish any familial relations. Similarly, the application of genome sequencing could be applied in an attempt to identify whether such burials take place as a result of shared illness.

3.4 Grave forms in the cemetery of the Hospital of St James

The most commonly occurring grave form seen at the Hospital of St James were earth cut graves (accounting for 96.6 percent) in which the body was interred in a cloth shroud. Second to this were coffined graves (accounting for 2.8 percent). There was only one instance in which a stone grave marker remained in place (accounting for 0.6 percent). The following investigates the grave forms identified within the hospital and its cemetery placing these into the wider context of later medieval burial practice.

3.4.1 Earth-cut graves in the cemetery of the Hospital of St James

All identifiable grave cuts were rectangular or sub-rectangular in form, and as previously discussed, all were orientated west-east or west-south-west – east-north-east. The graves cut for a single interment measured between 0.24-2.44 metres long by 0.16-0.99 metres wide. It appears that the graves were dug with some foreknowledge of the individual buried in them as all graves were an appropriate length and width for the skeleton entered. SKM129 (4001), a male aged 26-35 years, was an exception to this as they were placed into a grave that appears too small for the individual. The feet were pushed against the end of the grave and the skull was propped up against the western section of the grave cut (figure 3.4.1). Disparities observed between grave size and the individuals interred has been interpreted as evidence of graves being dug prior to their being needed, and therefore without foreknowledge of the dimensions of the corpse. For example, graves may have been dug in advance of the winter months when ground conditions make the task more arduous (Cessford *et al.* 2012, 76). It is also possible that mismatched grave formation is the result of human error or hurried grave digging. As discussed in Chapter 2, hospitals received burials from outside of their community and thus the body may have been transported from elsewhere and therefore the gravedigger did not have the required dimensions. Finally, it is, of course, possible that the grave was smaller than it ideally would have been as a result of a lack of space, as seen in figure 3.4.2.

Figure 3.4.1: The head, shoulders and feet of SKM129 are pressed against the edges of the graves, indicating the grave was too short and narrow for the individual interred.

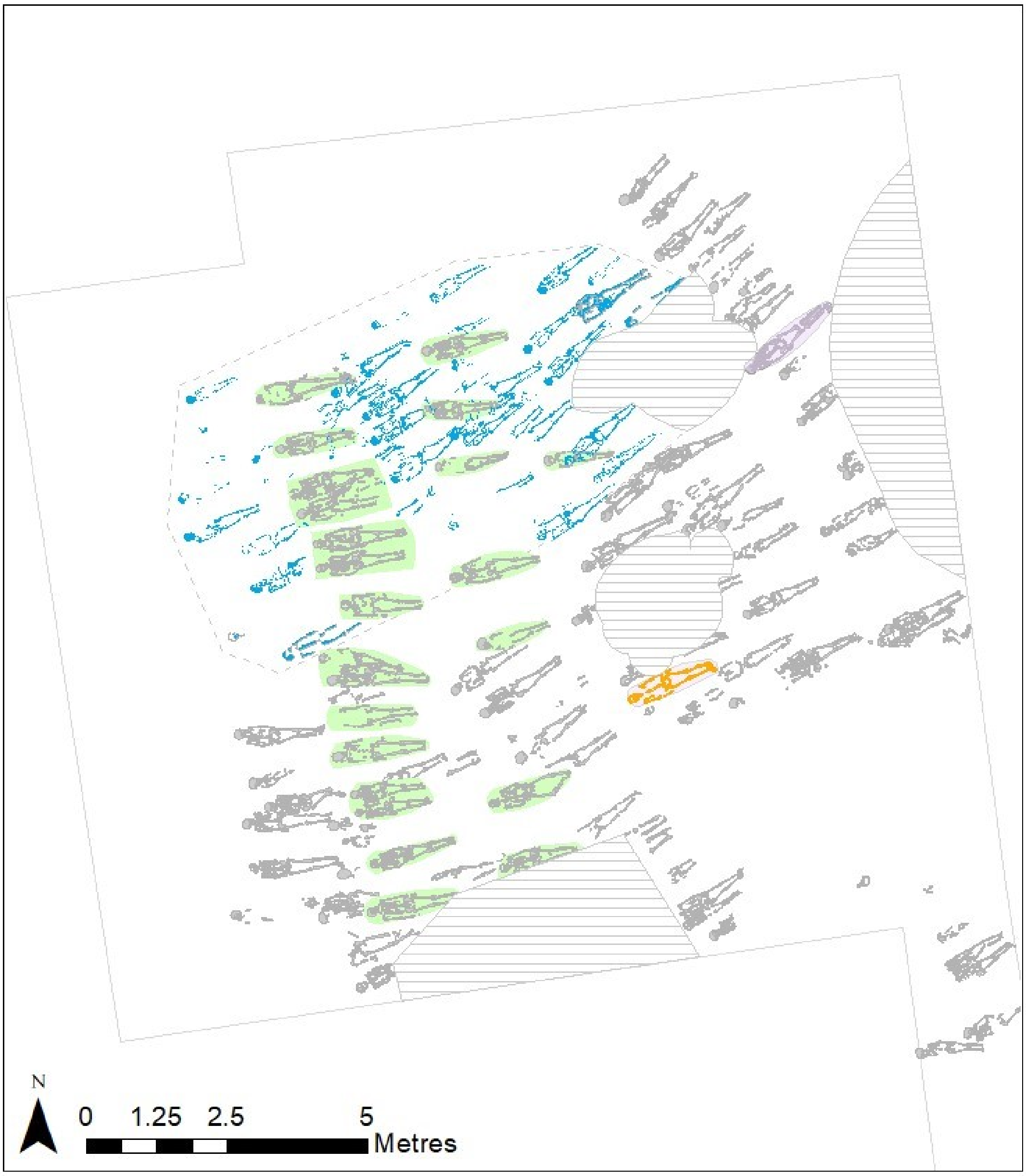

Figure 3.4.2: Location of SKM129 (orange) within cemetery Area B. Note the proximity of the burial to adjacent burials and the restriction this place on the size of the grave.

3.4.2 Shrouded burials in the cemetery of the Hospital of St James

There is no direct evidence of shrouded burials via the presence of surviving cloth fragments, shroud pins, or staining of the bone from shroud pins. However, it is known that the use of cloth ties and sewing thread to secure the shroud instead of pins was common practice in later medieval burial treatment (Dawson 2011, 77), and therefore an absence of archaeological evidence of shrouding is not compelling evidence for the absence of the practice itself. Instead, it is possible to infer the use of shrouds at St James' from the compact position of skeletal remains within the grave through archaeothanatology. Archaeothanatology is a method for analysing the post-decomposition spatial arrangement of skeletal remains to evaluate the original position of the corpse in the grave and infer details of the funerary rites performed (Duday 2009, 6; Knüsel 2014, 27). However, in current practice there is no standardised methodology by which excavators should record the body position or by which it should be interpreted, thus compromising the effectiveness of archaeothanatology in current research (Green 2018, 2). While this study has not applied a full suite of archaeothanatological methods to the burials at St James', some conclusions can be inferred on the basis of its general concepts.

It has been postulated that burials found with their hands over the pelvic region, elevated clavicles and bodies in a narrow position are suggestive of shrouded burial (Roksandic 2002, 109; Thomas *et al.* 1997, 121). Recording of the burials from the Hospital of St James looked to document whether the arms were held with the humeri rotated inwards and arms placed across the body or remained close to the sides of the body, and if the knees and/or feet appeared to have been bound (as demonstrated in figures 3.4.3, 3.4.4 and 3.4.5). The result of this assessment showed that of the 170 extramural burials 77.6 percent (n=132) did display one or more of the aforementioned limb positions and thus could be documented as displaying traits of shrouded burials.

Figure 3.4.3: SKN026 demonstrates the tight positioning of the arms, knees and feet which are indicative of binding in shrouded burials.

Figure 3.4.4: SKN066 demonstrated the positioning of the hands across the pelvis which is a key characteristic of burial practice at the Hospital of St James.

Figure 3.4.5: SKM069 demonstrates the combination of bound limbs evident in shrouding, combined with a tight anthropomorphic grave cut.

3.4.3 Coffined burial

A total of five burials displayed evidence for the use of wooden coffins, which were identified through either degraded wooden fragments in the base of the grave or the presence of iron coffin fittings. All were located within the confines of the hospital chapel. The first two, SKN052 (5341) and SKN053 (5343), were located at the eastern end of the hospital chapel just before the altar steps and are discussed further in the section 3.6.6. The remaining three burials (SKP005 (5612), P006 (5616) and P007 (5616)) were interred in the chapel's nave to the west of the altar (figure 3.4.6-3.4.10). These were all males aged over 45 years at death, and the apparent reservation of coffin burials for those in prestigious burial locations suggests an association between the burial right and status (see section 3.2.1), and that there was a division between grave form and burial practice between intra- and extramural burials.

Figure 3.4.6: The grave cuts of the three individuals interred within the nave of the chapel are evident. Photo taken looking west.

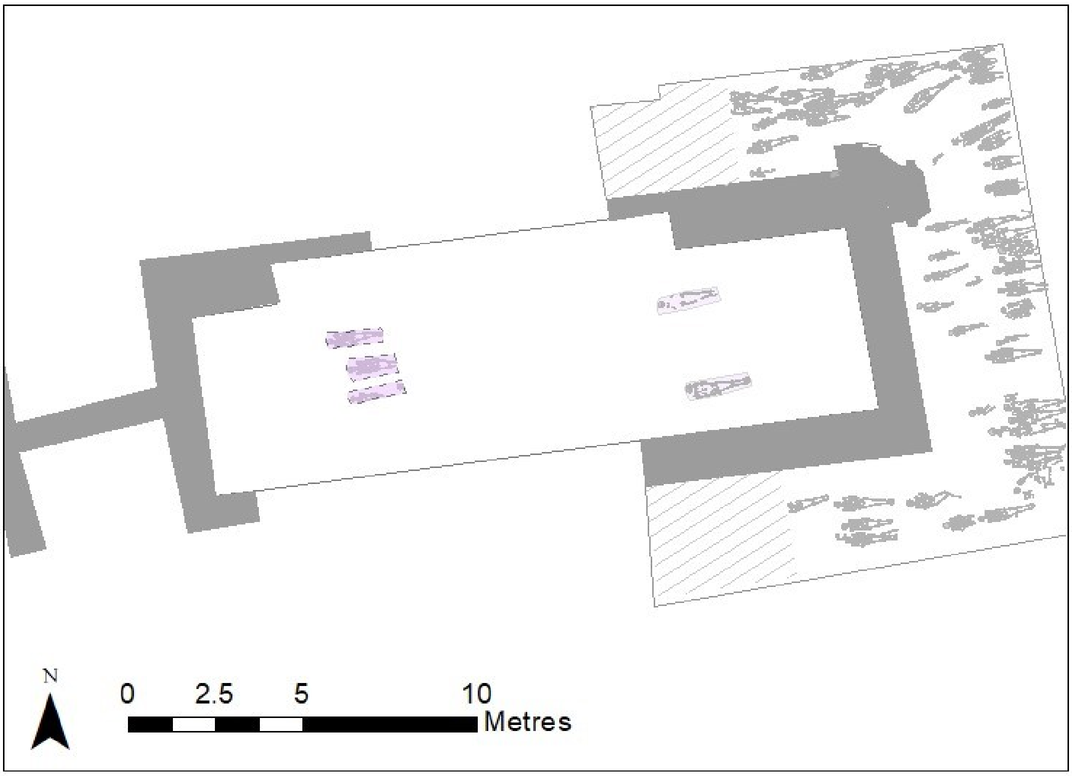

Figure 3.4.7: The location of the three individuals interred within the nave of the chapel are evident as the western most graves within the hospital building.

Figure 3.4.8: Intramural burial of SKP007, located against the southern wall of the hospital chapel.

Figure 3.4.9: Intramural burial of SKP005, located north of SKP005 by approximately 45-50cm.

Figure 3.4.10: Intramural burial of SKP006, located north of SKP005, completing the row of three burials.

3.4.4 Stone grave marker dedicated to Richard de W'perton

The only burial to have a surviving stone grave marker was SKN053. The grave was one of two burials interred in the easternmost end of the hospital, just before the altar step (figure 3.4.11 and figure 3.4.12). To the south of SKN053 lay SKN054 (an adult of indeterminate age and sex). Due to their close proximity to SKN053 and positioning at the eastern end of the chapel, it is also thought that this individual would have held a high position in the hospital. It is also highly likely that this grave was also adorned with a stone grave marker, but this had been robbed leaving a blank space in the tiled floor over the location of the body.

Figure 3.4.11: The two excavated graves of the burials interred in the easternmost end of the hospitals chapel. Photo taken looking west.

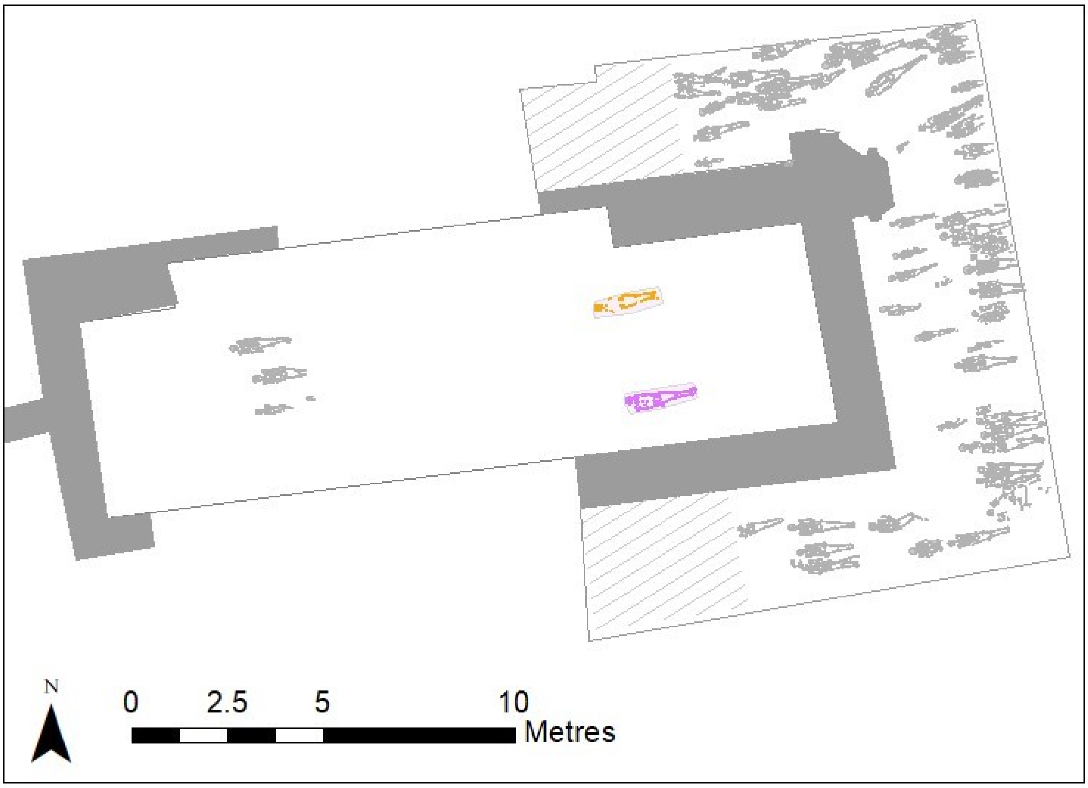

Figure 3.4.12: The location of the two individuals interred in the eastern-most end of the hospital, just before the altar step. SKN053 (Richard de W'perton) is highlighted in orange and SKN054 is highlighted in pink.

The stone grave marker was made of limestone and had a carved depiction of its occupant (SKN053), their name 'Richard de W'perton' and the date of his death April 13th, 1317. The main portion of the grave marker depicts a man in clerical robes, with tonsured hair, blessing a chalice, which is all indicative of the commemoration given to priests or canons of the time and demonstrating that Richard was a churchman. In addition, a reference to Philippians 2:10 was inscribed on the stone: 'that at the name of Jesus every knee should bow, of those in heaven and of those on earth, and of those under the earth' (figure 3.4.13).

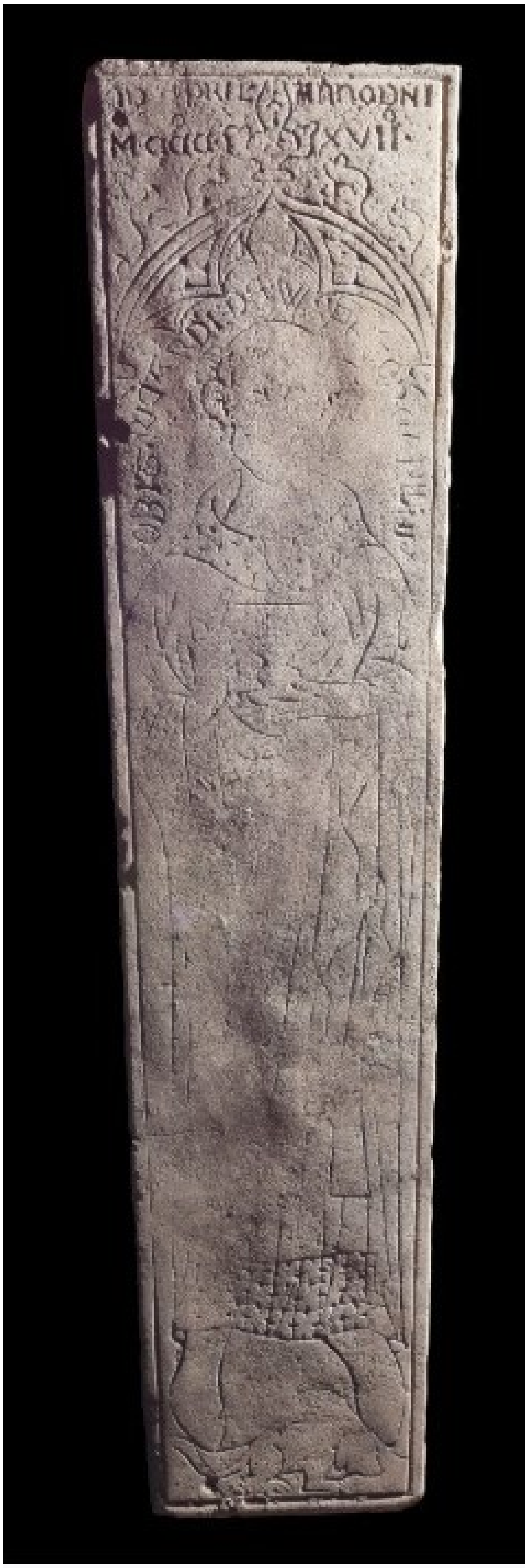

Figure 3.4.13: The stone grave marker of Richard de W'perton, dating his death to April 13th, 1317.

The grave marker had been disturbed (figure 3.4.14 and 3.4.15), presumably after the Abbey's dissolution in 1539. Upon excavation, it was found to be upturned, lying on its side, as the result of an attempted robbing of the grave, which had also disturbed the grave fill. This disturbance and the resulting instability of the burial environment caused a great degree of damage to the skeleton, resulting in the effacing of the thorax, specifically the vertebrae and ribs. Nonetheless, the skeletal remains confirmed the burial to be of a male aged 35-45 years at death with a stature of 1.63 ($\pm$3.66cm) metres tall.

Figure 3.4.14: In-situ profile view of the up-turned grave marker of Richard de W'perton.

Figure 3.4.15: In-situ front-on view of the up-turned grave marker of Richard de W'perton.

In addition to the stone grave marker, there was also evidence for a wooden coffin signified by decayed wooden fragments and iron nails. Moreover, this was also the only burial from the Hospital of St James to include any grave goods. The burial included a pewter chalice, similar to the one depicted on the grave marker, which confirms the individual's status in life as a priest (figure 3.4.16; 3.4.17). The chalice was most likely placed on the abdomen of the deceased but over time slipped towards the right hip and was in a highly fragmented state due to grave disturbance. Comparable chalices have been uncovered from hospital burials at St Mary Magdalene, Partney, Lincolnshire, St Leonard's Newark, Nottinghamshire as well as a major ecclesiastical centres such as Cirencester Abbey, Gloucestershire, Beverley Minster, East Yorkshire and the largest known English collection consisting of 25 chalices recovered from York Minster (Atkins and Popescu 2010, 220; Rogers *et al.* 2015, 193-8).

Figure 3.4.16: In-situ picture of the pewter chalice that had laminated and fragmented.

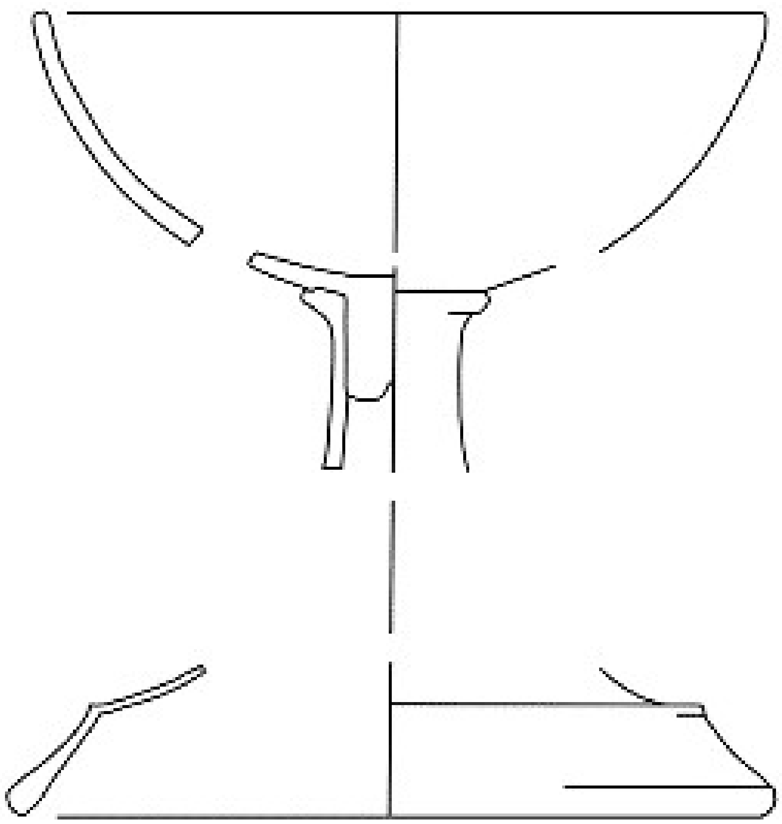

Figure 3.4.17: Scaled (1:1) drawing of the pewter chalice interred with SKN053.

3.5 Intercutting and the interment of charnel

The reuse of the cemetery throughout its life resulted in large deposits of co-mingled disarticulated skeletal remains as a result of the continued intercutting of burials upon the digging of new graves. It is evident that the location of earlier burials from previous phases of use was not well understood, or of great concern, when later graves were dug. The lack of any evidence for wooden or stone grave markers in the cemetery suggests that the grave locations were probably determined from the mound of earth that forms after backfilling the grave. These would have remained visible for several years, if not decades after burial, but not the full life of the cemetery's use (Thomas *et al.* 1997, 117).

Disturbance to, and intercutting of, earlier graves by later ones occurred across the cemetery in both Areas A and B. The extent to which intercutting took place, and the treatment of the disturbed material, varied from grave to grave. For example, the grave of SKM135 (4071) was dug through several earlier burials and the skeletal remains of the earlier burials were then redeposited in the grave alongside SKM135. figure 3.5.1 shows the array of material being placed at the foot of the burial and included in the backfill, which included fragments of two skulls, two femurs, a right os coxae, sacrum, humerus and ulna. Within this deposit it is also possible to identify the deliberate placement of disarticulated bones alongside their counterpart in the new burial, for example, a femur has been placed along the leg and an os coxa has been placed in the pelvic region of the articulated burial (figure 3.5.2). A similar practice was seen in the excavated grave of SKN026, as shown in figure 3.5.3.

A more drastic example of the heavy disturbance is evidenced in figure 3.5.4. It is evident that an earlier burial of an adult male (SKN015(5080)) had been cut through with disregard for disturbance of the burial. The non-adult individual inserted later is presumably the cause of the SKN015's disturbance and demonstrates the inclusion of disarticulated material in the new grave. The disarticulated material consisted of fragments of several long bones which coincided with the elements missing from SKN015. Furthermore, when measured these bones were approximately the same size and robusticity as SKN015 and presumably originated from this skeleton.

Figure 3.5.1: SKN135. Demonstration of the array of material being placed at the foot of the burial.

Figure 3.5.2: SKN160. Note the deliberate placement of disarticulated bones alongside their counterpart at the lower stratigraphic layers of the burials backfill.

Figure 3.5.3: SKN026 with redeposited skeletal remains.

Figure 3.5.4: Considerable disturbance of two adult burials with the addition of a later non-adult burial. From left to right SKN013, 014 and 015.

In addition to these examples, cemetery reuse was obvious by the occurrence of mass charnel deposits which did not intercut other graves. Figure 3.5.5 demonstrates the extent of disarticulated material present on the site, and the treatment of this material as it was 'dumped' into large disorganised deposits. Such evidence of the disturbance of burials suggests that respectful treatment of the remains of the long-dead was less stringent than the treatment of the newly deceased (Geake 2002, 153; Gilchrist Sloane 2005, 194-9). A similar occurrence of intercutting and charnel deposits is evident at the sites of St Nicholas, Lewes (2010, 94); St John's Hospital Cambridge (Cessford 2015, 112); and Norton Priory, Cheshire (Brown and Howard-Davis 2008, 122). At each of these sites, there are examples of burials which have been cut through, and large deposits of disturbed material throughout the cemeteries as is seen at the Hospital of St James.

Figure 3.5.5: Demonstration of the extent of disarticulated material present with in the cemetery.

3.6 Summary

Exploration of the burial customs employed at the Hospital of St James have proved to be consistent with the key characteristics of hospital cemeteries across medieval England: simple shrouded burials, anthropomorphic graves, and broadly interred on a west-east alignment (Gilchrist and Slone 2005, 131-2). For example, the sites of St Mary Spital, London; St Mary Magdalene, Winchester; St Nicholas, Lewes; St John's Hospital, Cambridge and St Mary Magdalen, Partney, all follow the same trend with the majority of their burials being interred in the supine position on a west-east alignment. The cemetery also displays a concentration of non-adult individuals around the hospital's church as is characteristic of cemetery organisation observable in Christian cemeteries across medieval Europe. The coterminous burials form a distinctive phase within the cemetery, it is possible that these burials resulted from several fatalities in quick succession within the hospital, potentially as a result of the widespread famine's or diseases experienced in later medieval England.

Despite this analysis of the cemetery's layout and burial practice, it has not been possible to distinguish between the religious and the lay members of the population, as has been possible at the sites of the Hospital of St Bartholomew, London (Moor 1918, 159-60), the Hospital of St John, Ely (Daniell 1997, 91), the Hospital of St Mary Magdalen, Partney (Atkins and Popescu 2010) and the Hospital of St Nicholas, Lewes (Barber and Sibun 1998). The majority of the individuals buried at the hospital were provided with shrouded burials in anthropomorphic graves, with no discernible distinction in the general cemetery; suggesting all individuals, regardless of status, were afforded equal burial rights upon death. The only distinctive burials within the cemetery were those interred in the arguably higher status burial location within the hospital's chapel. Such burial practice was present throughout medieval England in both hospital and non-hospital related churches. The status of these burials is further confirmed by the presence of the stone grave marker and pewter chalice interred with SKN053, Richard de W'perton. This individual emphasises the hospital's relationship with the religious community with the engraved figure being indicative of the commemoration given to canons and priest in medieval society.

4

Materials and methods

The following chapter outlines the materials and methods employed in this investigation. The skeletal assemblage from the Hospital of St James comprised 175 individuals: 99 adults and 76 non-adults (skeletally immature individuals considered to be under c. 18 years of age at death). 26 of these individuals have been subject to demographic, but not palaeopathological, analysis as part of a preliminary research project on the skeletal material from the site by the author (Hook, 2016). Disarticulated material was present among the burials, but due to the large quantities and complex disturbance patterns of this material, the disarticulated bone is not subject to investigation here. The decision not to study the disarticulated material was made to ensure the large sample of articulated skeletons were prioritised due to the quantity and quality of data which could be obtained from them. This decision was made in keeping with the advice given by Historic England (2018, 17), which states disarticulated material is a lesser priority than the study of the articulated skeletons and is not usually considered worthy of study at the analysis phase. Further burials remain unexcavated and therefore neither the individuals excavated, nor the sample studied here represent the complete buried population. At the time of writing it is not possible to postulate what percentage of burials have been excavated as the size of the cemetery is unknown.

This chapter will present the methods utilised in analysis of the St James skeletal material in the order in which these data will be interpreted. The chapter first addresses the recording methods employed including how the skeletal data was stored, and the issue of intra- and inter-observer variations was addressed. Having established the recording system, the first method of examination to be approached is the establishment of preservation and completeness among the population. This is necessary to establish the level of skeletal analysis which can take place and identify any bias in the data set. Such bias may include the underrepresentation of non-adults due to the reduced survival of poorly mineralised immature bone, absence of skeletal elements essential to the determination of the age at death, biological sex and identification of paleopathologies in a skeletal assemblage (Gordon and Buikstra, 1981). Results of the preservation and completeness are presented at the beginning of Chapter 5 before the discussion of paleodemography takes place. Next, methods for assessing the demographic composition of the cemetery population are laid out. These data are a primary focus of this investigation, as they are vital in establishing the age and sex of the population the hospital served, this data will be used in Chapter 5 to discuss who the hospital cared for and any reflections this may have on the quasi-monastic environment that hospitals are thought to have followed, as discussed in sections 2.3 and 2.4. The statistical analysis used for comparing the data from the Hospital of St James to contemporary archaeological assemblage is introduced.

Following from this, the methods applied to assess paleopathological markers in the skeletal assemblage are addressed. The paleopathological methodology has been presented in the following themes; markers of biological stress, joint disease, non-specific infection, specific infection and trauma. It is beyond the scope of this thesis to consider all skeletal changes that could be included here and attention will be given to those that can be sufficiently examined at a macroscopic level considering the large sample of skeletal material from the Hospital of St James. While dental conditions are acknowledged to be valuable indicators of nutrition, health and status their inclusion was beyond the scope of this thesis (Hillson 1986; Roberts and Manchester, 1995; Larsen 2018). Recording the dental conditions in the detail necessary for a specialist report and proper analysis was impractical in the completion of this research and therefore the decision was made not to include dental conditions here at a level unworthy of the material. Enamel hypoplasia is the exception to the dental analysis because of the contribution this makes to the markers of biological stress which are used in this thesis to establish the overall health of the skeletal population at the Hospital of St James. Following an outline of the paleodemographic methods used to analyse the primary data, this section of the chapter goes on to discuss the application of Tilley's (2012) 'bioarchaeology of Care' methodology and the way in which this is to be applied to specific case studies from the Hospital of St James assemblage.

4.1 Methods of recording and comparative analysis

A database was designed to enable direct entry of the osteological data, utilising Microsoft Access and Microsoft Excel. The employment of a digital database enables the standardisation of both morphological and metric data collection, and thus enables systematic cataloguing of all skeletal remains. The physical examination of each skeleton saw the remains laid out in anatomical position, following which the methods outlined below were applied.

Any osteological analyses are subject to the effects of both intra- and inter-observer error. Kimmerle *et al.* (2008), investigated how different observers compare in assigning phases or collecting metric data from skeletal material. They conclude that both the inter-observer variations and broad categorisations in methodologies contribute to increased error margins. The following methodology was devised to result in the least possible observer error. All primary data collection was undertaken by a single observer, the author, following detailed published guidelines to reduce the effects of the inter-observer error. Nevertheless, the input of experienced fellow osteologists was obtained to discuss some of the observations made by the author where pathological lesions required differential diagnosis.

All of the methods employed have been selected with consideration of past comments and criticisms of their accuracy and precision. Where methods have been adapted, the rationale will be explained clearly throughout. In order to ensure the repeatability of the methods applied and maximise the consistency of the data collected, the following provides a detailed description of all the methods applied. This will enable future osteologists wishing to assess and/or replicate the methods used here to do so with a high degree of precision.

The method of comparative analysis adopted throughout the thesis is statistical comparison. This compares the assemblage to nine contemporary hospital sites (introduced in section 2.7 and summarised in table 5.5.1), as well as additional populations where necessary. For example, in Chapter 6 the health markers at the Hospital of St James are compared to the local and contemporary populations buried at St Peter's Church, Barton-upon-Humber. St Peter's church served as the sole parish church for Barton since the early medieval period. A total of 2,750 skeletons were excavated from the church site along with disarticulated material, the largest proportion of burials date from 1300-1700AD (Waldron 2007, 10, 33-4). Similarly, specific pathologies have been compared to examples from the archaeological record, especially where examples were not present in the nine comparative hospitals, for example, DISH and the amputation discussed in chapter 6 draw on wider comparisons.

Before moving on to the specific methods employed in this thesis, a discussion on the osteological paradox and how this impact the study of paleodemogrpahy and paleopathology will be addressed. The fundamental paradox in bioarchaeology is the attempt to reconstruct the lives and health conditions of past populations by using data from inherently biased samples of deceased individuals (DeWitte and Stojanowski 2015, 406). The osteological paradox was written to challenge bioarchaeologists to consider the effects of heterogeneous frailty and selective mortality in health inferences in past populations, as if these are not controlled for or considered then they will negatively impact any interpretation of health from past populations (Wood *et al.* 1992, 344). The three fundamental issues of hidden heterogeneity in frailty, selective mortality and demographic nonstationarity as identified by Wood *et al.* (1992) complicate the study of disease and demographic patterns in past populations, particularly in that they prevent the ability to make direct inferences about health from frequencies of skeletal lesion and disease patterns (DeWitte and Stojanowski 2015, 400). Furthermore, the challenge of studying past populations through archaeological remains include small sample sizes, poor preservation and selection bias (Jackes 2011; Ortner 2002, 2009; Pinhasi and Bourbou 2008; Waldron 1994, 2007). In addition, only a subset of diseases that affect humans are reflected in the skeleton and therefore the understanding we can gain about health and lifestyle in past populations is limited (Appleby *et al.* 2015; Brickley and Buckberry 2015).

In regard to the analysis of demography the osteological paradox questions the ability to establish a population's true demographic profile due to the challenges of demographic stationarity, selective mortality and heterogenous frailty (Wood *et al.* 1992, 350-1). A population that is not stationary is one that experiences populations growth or decline due to changes owing to fertility, mortality and migration. When one assumes that a population is stationary then the construction of life tables based on the observed distribution of ages at death in a population sample then life expectancies can be estimated (DeWitte and Stojanowski 2015, 405). However, if a population is not stationary, as most are not, then the demographic estimations based on rigid age at death distributions do not account for the natural changes of a population. For this reason, the application of life tables has not been employed in this thesis, as discussed in section 5.6. The osteological paradox further suggests that biologically stressed individuals may be represented by skeletons displaying no pathology and younger ages at death as they did not survive until such a point where the stress manifests in the skeleton (Wood *et al.* 1992, 353). Therefore, populations which report very low occurrences of pathology and stress markers could indicate a community for which living conditions and health were generally worse. In reverse this would mean that the skeletons which display the greatest level of stressors are arguably those who survive to an older age are those who have been strong enough to withstand and survive events that lead to a skeletal response long enough for the bony lesions to manifest. Whether an individual expresses stress marker's is partially subject to their susceptibility as determined by their genetics and immune system, a paradox referred to as hidden heterogeneity of risks (Wood *et al.* 1992, 344-5; Palubeckaite *et al.* 2002, 190). This paradox can be somewhat controlled for, if all samples being observed originate from the same population it can be assumed that to a degree the population has a standard level of underlying susceptibility to the stressors, however it is hidden heterogeneity that cannot be controlled for (Wood *et al.* 1992, 345). The paleopathological analyses carried out in this study have been done so with this in mind. Additionally, the analyses are considered alongside comparisons to contemporary populations and remaining mindful of the contact of this populations as one of a hospital community. By doing so this approach aims to alleviate some of the limitations imposed by the skeletal data such as limited knowledge of the social situation of the individuals which may have an impact on their physical health. While this lack of knowledge cannot be resolved, it is possible to reduce this, and the concerns raised by Wood *et al.* (1992) in the osteological paradox can be reduced by applying this bio-cultural approach to interpretation.

4.2 Skeletal assemblage preservation

The condition of bone is influenced by taphonomic factors such as the pH composition of the soil, soil type, micro-organisms within the soil, exposure to water, exposure to extreme weather and the effects of animal-related activity (Mays 2010 23-7; Historic England 2018, 16-23; Wescott 2018, 328-41). Furthermore, anthropogenic interference such as choices of funerary rite, intercutting of archaeological sites in antiquity and damage during excavation may also affect the assemblage (Bell, Skinner and Jones 1996; Baxter 2004; White and Folkens 2005, 52-7).

The condition of the skeletal material from St James has been determined by quantifying the *completeness* and *surface preservation* of the surviving skeletal material. *Completeness* refers to the proportion of the skeleton that survives; this is recorded as a percentage during the inventory of each skeleton and then subdivided into four categories commonly used in the field of osteoarchaeology (<25%, 25-49%, 50-74%, >75%) (McKinley 2004, 6). *Surface preservation* refers to the extent of erosion, abrasion and post-mortem damage the skeletal material has undergone. To quantify this the standards produced by the Chartered Institute for Archaeologists and British Association for Biological Anthropology and Osteoarchaeology were utilised (McKinley 2004, 16). Definitions and illustrations of the seven criteria for bone surface condition are given in figure 4.2.1. This quantitative method of recording makes ambiguous qualitative statements such as 'the bone was poorly preserved' redundant and ensures continuity when making comparisons within or between cemetery populations.

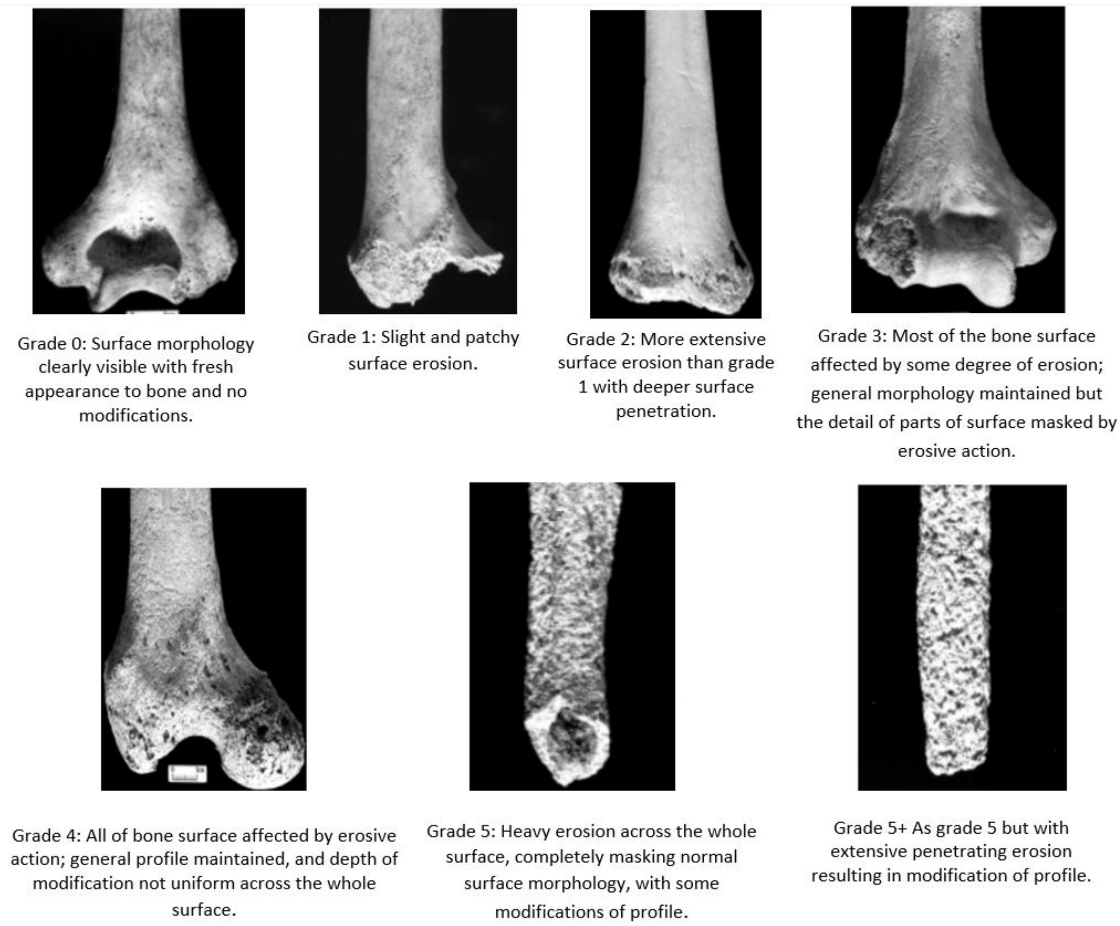

Figure 4.2.1: Description and diagrammatic representation of the variation in severity of cortical erosion (adapted from McKinley 2004, 17).

Assessments of completeness and surface preservation for each skeleton enable assessment of the extent to which further osteological analysis is possible. Furthermore, by establishing the state of preservation of the skeletal remains it is possible to identify any potential for bias in the data. Skeletal elements vital in the establishment of age at death or biological sex may be absent in incomplete skeletal remains and result in missing data (Katzenberg and Saunders 2008, 78). Similarly, poor surface preservation may result in the loss of indicators of skeletal pathology and therefore a true representation of the demographic profile and health status of a population is jeopardised (Katzenberg and Saunders 2008, 80; Waldron, 1987, 1994). The scale of impact taphonomic and anthropogenic factors have on the representativeness of skeletal data has been demonstrated in many ways. For example, the increased rate of degradation of poorly mineralised non-adult bone has been implicated in the under-representation of infants in some burial contexts (Buckberry

2000). On the other hand, Manifold (2010) suggests that non-adult remains should not be underrepresented as the bones of the skull and long bones can be accounted for and do survive in the archaeological record due to greater bone mineral density and burial position. The susceptibility of non-adult remains is supported by Gordon and Buikstra's (1981) assessment of soil pH, bone preservation and sampling bias. Having analysed skeletons from several burial mounds in Illinois, USA they concluded that at marginal pH ranges all or most of the non-adults may be systematically eliminated from the mortuary sample and therefore palaeodemographers face the problem of potential age bias (Gordon and Buikstra 1981, 569).

At the Hospital of St James, the soil comprised of silty sand. Sandy soil has been ascribed as the reason for poor preservation as the sand enables water to permeate burials and then evaporate. This periodic soaking and drying caused the disintegration of fragile skeletal elements such as vertebrae and ribs, which are all but absent from the assemblage (Walker and Johnson 1988, 184). Arguably the most obvious example of anthropomorphic interference is the intercutting of remains both in antiquity and as a result of modern activity. This process severely disturbs and can result in the removal of skeletal elements as well as disrupting the equilibrium of the burial environment. As discussed in Chapter 3 (section 3.5) instances of intercutting are common in the medieval period as a result of later graves being cut and a change in attitude towards disturbing burials. Evidence of intercutting was also widespread at the Hospital of St James as well as at the comparative site of St Mary Spital, London (Connell *et al.* 2012), St Mary Magdalene, Partney (Atkins and Popescu 2010) and St John's Hospital, Cambridge (Cessford 2015).

4.3 Paleodemographic methodology

The first step in paleodemographic analysis is establishing the age at death and biological sex of the individuals in the population. The following presents the methods employed to assess age at death followed by biological sex. The section then goes on to discuss the statistical methods that will be applied in Chapter 5 where the paleodemographic analysis of the population interred at the Hospital of St James takes place.

4.3.1 Age at death assessment

During life, the human body progresses sequentially through a series of developmental and degenerative stages (Latham and Finnegan 2010, 263). Observation of a range of skeletal makers of development or degeneration enables the assignment of an individual to a particular age category at their time of death (Buckberry and Chamberlain 2002; Brooks and Suchey 1990; Lovejoy *et al.* 1985). The age categories utilised in this study, displayed in table 4.3.1, were also used in the bioarchaeological study of the medieval burials at the site of St Mary Spital, London (Connell *et al.* 2012); the Hospital of St John's, Cambridge (Cessford 2015); Merton Priory, London (Mikulski 2007); St Grace's, London (Bekvalac 2007); and Guildhall Yard, London (Cowal, 2007). Employing these standard age categories enables the data collected in this research to be compared more generally to existing skeletal reports.

In some cases, the absence of the required skeletal age indicators or ambiguity of the age at death provided by two or more indicators meant that an individual could not be assigned to one age category. In this case, broader terminology is necessary: individuals who were skeletally mature (18 years and over) at death were referred to as *adults*, while skeletally immature individuals (under 18 years) were referred to as *non-adults*.

Description	**Age Range**
Perinate	37 weeks gestation up to 4 postnatal weeks
Infant	1-11 months
Early childhood	1-5 years
Late childhood	6-11 years
Adolescent	12-17 years
Non-adult	$<$18 years
Young adult	18-25 years
Early middle adult	26-35 years
Later middle adult	36-45 years
Mature adult	$\geq$ 45 years
Adult	$\geq$ 18 years

Table 4.3.1: Age categories utilised in this thesis (following Connell *et al.* 2012).

It should be noted that the age categories used throughout this thesis (table 4.3.1) are biological categorisations based on skeletal development; they do not reflect socio-cultural age categories in use at the time these individuals were living. This distinction is important to make, as the formation of age identity is entangled in biological, cultural and chronological concepts of development (Gowland 2006). Therefore, as individuals mature within a social context which may relate age identity to the fulfilment of social roles such as marriage and parenthood rather than biological changes such as puberty it is necessary for researchers to state their chosen approach to construction of age (Schildkrout, 1978). As a result, several authors have employed the terms physiological/biological age (the physical ageing of the body), chronological age (corresponding to the amount of time that has passed since birth) and social age (reflecting socially constructed norms concerning appropriate behaviours and attitudes for an age group) (Gowland 2006; Crawford 2008; Halcrow and Tayles 2008; Buckberry and Brickley 2017). Throughout this thesis the demographic profile of the population of St James refers to the biological age of the skeletal assemblage. To avoid any confusion this terminology is applied throughout and when discussions of an individual's age occur within the social context of medieval England it is clearly stated.

Age at death estimates for adults were ascertained via degenerative changes to the teeth and bones. Degenerative changes to the morphology of the following skeletal elements were assessed: the auricular surface of the ilium (Lovejoy, *et al.*, 1985; Buckberry and Chamberlain, 2002), the pubic symphysis (Todd, 1921; Suchey and Brooks, 1990), wear of the occlusal surfaces of the teeth (Miles 1963; 2001). The decision was made not to use the method of cranial suture closure, this method is considered to be inaccurate and is being employed less and less in osteoarchaeological analysis (Cox 2000, 68). It has been reported that observations of the ectocranial surface offer a more accurate reflection of age then the endocranial surface (Meindl and Lovejoy 1985), however this is still subject to greater levels of inaccuracy especially in archaeological samples where the skull is often damaged or incomplete and therefore not all of the cranial sutures can be observed. Likewise, the decision was made not to include the analysis of sternal rib ends as a method of age estimation. This decision was made as the method relies heavily on good preservation of the ribs, similarly to the cranial suture closures, this is not ideally applicable to archaeological samples where the remains are subject to fragmentation and poor preservation (Cox 2000, 69). In the assemblage from the Hospital of St James the ribs were subject to poor levels of preservation where the periodic soaking and drying of the sandy soil led to disintegration of fragile skeletal elements including the ribs. No additional distinctions in age were made for those over 45 years, as idiosyncratic differences in the rate of degeneration of the skeleton accumulate with age, and thus severely undermine the accurate estimation of age in more mature individuals (Mays 1998, 76).

Non-adult remains were assigned an age at death by observation of ontogenetic and developmental changes to their bones and dentition. The assessments of skeletal development utilised were epiphyseal formation and fusion (Krogman and İşcan 1986; Schwartz 1995), and dental development and eruption (Anderson *et al.* 1976; Moorrees *et al.* 1963; Smith 1991; AlQahtani, Hector and Liversidge 2010). Dental development is far less susceptible to the influence of external environmental stressors and therefore is considered to provide superior accuracy and precision when assessing the age of immature individuals (Hillson 2000). Thus, where possible, age assessment based on stages of tooth eruption, dental calcification, root extension, and apical closure of roots following Ubelaker (1978) was given priority over developmental stages of epiphyseal fusion following Krogman and İşcan (1986) and Schwartz (1995). Epiphyseal fusion was utilised to supplement the results of dental analysis and also where dental analysis was not possible due to an absence or poor preservation of the dentition. The estimation of age from non-adult long bone lengths is a method applied widely throughout osteological analysis, the intention was to employ such an approach to the assemblage of the Hospital of St James. This method would follow Gunnell *et al.* (2001), who analysed the assemblage from St Peter's Church, Barton-on-Humber, and found that humeral length showed the highest correlation with age at death. However, upon examination of the skeletal assemblage it was apparent that this would not be possible as the highly fragmented nature of non-adult long bones meant only a very small sample would be subject to this analysis. This also affected the exploration of non-adult skeletal growth in association to health, as discussed in section 6.1.5.

4.3.2 Biological sex assessment

Biological sex of the adult skeletal population was determined through the analysis of sexually dimorphic characteristics of the skull and pelvis. A total of 25 sexually-diagnostic morphological features from both the skull and pelvis, available in table 4.3.2, were assessed where possible (Phenice 1969; Ferembach *et al.* 1980; Krogman and İşcan 1986; Schwartz 1995; Loth and Hennenberg 1996). The metric assessment of the vertical diameter of the femoral and humeral heads was undertaken following Stewart (1979, 100), however, the requirement for the skeletal elements to be complete meant that this was not possible for all individuals in the assemblage.

Morphological analysis of biological sex has been subject to numerous evaluations concerning its accuracy and the effects of intra- and inter-observer error. When intra- and inter-observer errors are not taken into account, methods such as Phenice (1969) which employed the os pubis, and Loth and Hennenberg (1996) which investigated mandibular ramus flexure, report accuracy levels in excess of 95 percent. This level of accuracy was further proven in Bruzek's (2002) analysis of the os coxae of 402 adults of known sex. This found accurate sex assessment in 95 percent of the sample, with an error of 2 percent and an inability to determine sex in just 3 percent of the sample. Similarly, Inskip *et al.* (2018, 344) evaluation of macroscopic sex estimation methods carried out on 66 individuals from the hospital of St John the Evangelist, Cambridge, concluded macroscopic evaluation to have an accuracy rate of 97.7 percent. However, when the inter-observer error is taken into consideration the accuracy statistics of visual analysis declines. Walker (2005) demonstrated this utilising an ordinal method of scoring greater sciatic notch morphology. A total of 22 volunteers of varying experience scored the same ten specimens; the results show that, while inter-observer error was insignificant when assessing specimens of extreme morphology (i.e. definably female or male), those with intermediate morphologies (i.e. probable female or probable male) resulted in increased inter-observer error (Walker 2005). Nonetheless, Walrath *et al.* (2004) state that both intra- and inter-observer errors related to visual inspection are largely the result of unclear definitions and a lack of illustrated reference material. In their investigation of cranial traits for sex determination, Walrath *et al.* (2004) found that when adequate reference material is available, inter-observer statistical gamma scores of up to 0.92 were attained. Gamma scores vary between 1 and -1; a value of 1 indicates perfect concordance, and -1 where one scale is the reverse of the other, while a value of 0 indicates a total lack of concordance (Svensson 2000).

	Traits of the Skull
1	Overall shape of the cranium
2	Glabellar profile
3	Frontal Slope
4	Frontal and parietal tuberosities
5	Zyomatic process of frontal
6	Supraorbital ridges
7	Orbital outline
8	Nasal bones
9	Zygomatic bones
10	Temporal ridges
11	Suprameatal crests
12	Mastoid process
13	Nuchal area
14	External occipital protuberance
15	Occipital and mandibular condyles
16	Pterygoid plates
17	Canine eminence
18	Palate
19	Mandibular ramus(ant-post)
20	Mandibular ramus
21	Depth from incisors to mentum
22	Mental protuberance
23	Lower margin of mandibular corpus
24	Angle of mandible
25	Lower first molar

	Traits of the Pelvis
1	Overall structure
2	Overall shape
3	Pelvic inlet
4	Iliac crest
5	Iliac blade
6	Iliac tuberosity
7	Greater Sciatic Notch
8	Auricular surface
9	Preauricular sulcus
10	Postauricular space
11	Acetabulum
12	Pubic symphysis height
13	Pubic rami
14	Sub-pubic angle
15	Pubic tubercle
16	Inferior pubic ramus
17	Ventral arc
18	Sub-pubic concavity
19	Medial ischio-pubic ridge
20	Obturator foramen
21	Ischial tuberosity
22	Ischial spine
23	Width of sacral ala
24	Anterior sacral curvature
25	Sacral auricular surface

Table 4.3.2: Non-metric sexually diagnostic morphological features of the skull and pelvis (Phenice 1969; Ferembach *et al.* 1980; Krogman and İşcan 1986; Schwartz 1995; Loth and Hennenberg 1996).

Morphometric assessment methods offer an alternative to morphological methods for sex assessment. Gómez-Valdés *et al.* (2012) investigated the accuracy of the three methods for biological sex assessment from the greater sciatic notch. Their dataset consisted of 130 pelvic bones of known sex from a contemporary population from the National Autonomous University of Mexico Skeletal Collection. The results found geometric morphometrics to achieve a 96.2 percent accuracy rate (Gómez-Valdés *et al.* 2012), compared to previously noted accuracy rates of 75-87.1 percent among linear metric analysis (Sing and Potturi 1978). However, analysis of the os coxae produced an accuracy rate of just 68.5 percent (Gómez-Valdés *et al.* 2012, 156.e3). This and similar methods of metric analysis such as İşcan *et al.* (1998), İşcan and Steyn (2008) and Dabbs and Moore-Jansen (2010) do not account for the preservational problems associated with archaeological assemblages. They call for material with 'excellent preservation' and often require exclusion of skeletons that are incomplete to ensure the multiple measurements that their methods call for are complete. Therefore, their reported rates of accuracy can only be met in exceptional circumstances. In reality, it is highly unlikely that archaeological remains are entirely intact, and this situation is accommodated for by morphological methods which enable the osteologists to use their best judgement as to whether a feature can be subject to analysis or not. In the present study, the state of preservation of the material led to an emphasis on morphological methods, with which a greater proportion of the sample could be included in analysis.

Where possible, each mature individual was assigned a biological sex category of male (M), probable male (M?), female (F) or probable female (F?), in line with standard guidance for osteological assessment (Buikstra and Ubelaker's 1994; Brickley 2004). For those who presented an equal mixture of male and female characteristics, the category indeterminate (I) was applied. Where the sexually dimorphic traits were missing due to poor preservation, biological sex was recorded as unknown (U) (Brickley and McKinley 2004). The M? and F? categories reflect the continuous nature of the presentation of male and female traits and not meaningful categories of biological sex, therefore while combining them with the male and female categories may introduce some error it is preferable for the division of sex data to be in realistic and meaningful categories. Thus, for the sake of analysis data for males and probable males and for females and probable females were pooled to enable overall statistical analysis of males and females to take place. This practice is common in osteological assessment and has been carried out by Gilchrist and Sloane (2005) in their investigation of population demographics in the medieval monastic cemeteries of Britain.

Numerous morphological and metric assessment methods for determining the biological sex of non-adults have been developed, however, as the immature skeleton does not present the same type and extent of sexual dimorphism as the mature skeleton, the validity and accuracy of such methods have been called into question (Black and Ferguson 2011; Black and Scheuer 2004). Their performance in inter-observer error testing has proven particularly poor. For example, Loth and Henneberg (2001) concluded that sex assignment was accurate to 81 percent when morphological differences between male and female mandibles in early childhood were observed, however a blind test of the same method by Scheuer (2002) reported a much lower accuracy of 64 percent. Therefore, current methods of determining the biological sex of non-adults do not show consistent levels of success (Mays and Cox 2000; Scheuer and Black 2000, 15; Vlack *et al.* 2008). It is unreliable to assess biological sex until sexual maturation has completed. Consequently, this study will not attempt to determine the biological sex of the non-adult population.

4.3.3 Demographic analysis

To achieve meaningful reconstructions of the populations demographic profile and understanding of population structures these should be compared to contemporary assemblages of skeletons (Chamberlain 2006, 177-80). Chapter 4 completes this thorough an analysis of the hospital's population and then comparisons of the population demographic with attritional and catastrophic profiles. Following this the demographic profile is compared to the nine contemporary hospital populations outlined in Chapter 2, these comparisons were made through statistical analysis. Chi-squared test of independence has been employed here and throughout to identify and test the correlations between categorical groups of data such as biological sex, age, pathology and hospital. In each instance of the test being applied, the null hypothesis was that there is no significant difference between the age and sex of the hospital populations, the pathologies present in the populations and the different hospital types. Rejection of the null hypothesis was set to the threshold of 0.05.

The decision was made not to produce life tables; this is because life tables produce a discrete time survival analysis of a population's mortality, meaning it is assumed that mortality rates do not fluctuate between age categories and therefore the impact of infant mortality or other age-related ailments are not considered (Chamberlain 2006, 27). Furthermore, the application of life tables would produce ineffectual results, as the hospital cemetery does not contain a normative demographic structure where all individuals have immigrated into the community from external populations. With the site of St James being a hospital, the population was not static and the inmates would be admitted from their original communities. As life tables do not take into account for a population comprised entirely of external migrants the results would hold little resemblance to how the population actually developed.

4.4 Paleopathology methodology

The paleopathological analysis was undertaken following the methodologies outlined below and considering the limitations of this thesis as discussed in the opening to this chapter. All data were recorded by the author and methodologies were selected based on numerous factors including the preservation of the Hospital of St James material and the compatibility of results with that of comparative skeletal assemblages. Prevalence rates have been displayed as true prevalence rates calculated using the number of individuals with observable elements present) and crude prevalence rates (calculated using the total number of individuals present).

4.4.1 Markers of biological stress

Osteological stress markers are the manifestation of episodes of biological stress resulting from a range of factors, including malnutrition, disease and poor hygiene (Marklein *et al.* 2016; Meyer 2016; Weston 2008; Klaus 2014). In modern populations, it has been evidenced that socioeconomically deprived populations have inferior health status, smaller adult stature and shorter lifespans than 'well-off' populations. This is a result of differential exposure to stressors such as polluted living sites and water sources, poor or no medical care, and long working hours and years of physically demanding or risky jobs (Robb *et al.* 2001, 213). Therefore, it is highly possible that the distinction between groups of different social and economic status is evidenced in the prevalence of osteological stress markers (Zhang *et al.* 2016; Redfern *et al.* 2015; Slaus 2008; Roberts and Manchester 1995, 60; Goodman and Capasso 1992). The following pathologies are evidence of an individual's response to nutritional deficiency and immunological stress; their characteristics and process of identification are outlined below.

4.4.1.1 Porotic hyperostosis and cribra orbitalia

Porotic hyperostosis and cribra orbitalia are both skeletal manifestations of chronic health problems resulting in porous lesions in the orbital and parietal cranial vault bones respectively (Stuart-Macadam 1985; 1987; 1989; Ortner 2003, 55-6; Wapler *et al.* 2004). Both variations of the lesion result from impaired meiosis of marrow cells that would normally divide into red blood cells ; this causes an inefficient erythropoiesis producing abnormally large erythroblasts called megaloblasts which in turn cause the visible widening of the diploic space and increased vertical trabeculation (Stuart-Macadam 1985, 394; 1989, 215-7; Grauer 1993, 203; Brickley 2018, 889-901).

Porotic hyperostosis and cribra orbitalia were identified on the basis of a porotic, pitting or sieve-like appearance of bone (Welcker 1888 cited in Wapler *et al.* 2004; Steckel *et al.* 2006). Usually, only surface morphological methods are used for lesion classification, to distinguish between healed and active cases, for instance. The importance of differential diagnosis was discussed by Stuart-Macadam (1985) and demonstrated by Schultz (1988; 2001) through histological analysis. The orbital lesions are generally considered to be a part of the initial stage of chronic health issues which then lead onto changes in the skull, mainly porotic hyperostosis.

In this study, porotic hyperostosis and cribra orbitalia were recorded following a modified version of the work's of Steckel *et al.* (2006) and Stuart-Macadam (1991). The recording systems have been made available here in table 4.4.1 and 4.4.2. These methods do not consider whether the lesion is active or healed, which is necessary to determine if lesions seen in adults are representative of childhood or adulthood disease (Stuart-Macadam 1985, 105). A limited understanding of the physiology behind cribra orbitalia and porotic hyperostosis means that interpretation of lesion type, stage of illness and the pathogenesis is unclear and Jacobi and Danforth (2002, 256) have argued that as a result there is great variation between observers when scoring the severity and status of lesions. Therefore, to increase the consistency with which the status of lesions are scored efforts should and have been made to improve scoring through the use of descriptive stages and inter-observer collaboration and training.

Score	Description
0	No parietals present for observation
1	Absent with at least one recordable parietal
2	Presence of slight pitting or parietal porosity
3	Gross parietal lesion with excessive expansion and exposed diploe

Table 4.4.1: Description of the variation in severity of porotic hyperostosis (adapted from Steckel *et al.* 2006, 13-4).

Score	Description
0	Normal
1	Capillary impressions
2	Scattered fine foramina
3	Large and small isolated foramina
4	Foramina have linked into the trabecular structure
5	Outgrowth in trabecular form from the outer table surface <18 years

Table 4.4.2: Description of the variation in the severity of cribra orbitalia (adapted from Stuart-Macxadam, 1991).

In palaeopathological literature, the occurrence of porotic hyperostosis and cribra orbitalia have been most frequently attributed to iron deficiency anaemias (Wapler *et al.* 2004; Walker *et al.* 2009). The occurrence of genetic anaemia in modern-day Northern Europe is extremely rare and therefore applying concepts of genetic mapping, their presence in the archaeological record should also be similarly rare (Mahoney Swales 2012, 120). Thus, where associated with anaemia, cribra orbitalia is arguably more likely an indicator of nutritional deficiency. However, the relationship with nutrition is very complicated, for example a deprived iron status may not be considered detrimental to a person living in a parasite rich environment, here iron deficiency can be a protective quality whereby iron is being withheld from the parasitic organism (Weinberg 1992, 106-12). The association of cribra orbitalia (and to a lesser extent porotic hyperostosis) with iron-deficiency anaemia has been called into question by researchers who argue iron-deficiency anaemia depresses red blood cell production and therefore would not contribute to the stimulation of increased marrow space (Walker *et al.*, 2009). Walker *et al.* (2009) suggest megaloblastic and hemolytic anaemia as potential contenders for causing cribra orbitalia and porotic hyperostosis lesions, while others are connecting the lesions with malarial infection (Rabino Massa *et al.* 2000; Nerlich *et al.* 2008; Gowland and Western 2012; Smith-Guzmán 2015). Remains from ancient Egypt and the Nile Valley have demonstrated that malarial infection has a synergistic effect with other factors to increase overall anaemia levels and thus has the potential to raise the overall frequencies of cribra orbitalia (Nájera and Hempel 1996; Gilles 1997; Lusingu *et al.* 2004; Shanks *et al.* 2008; Smith-Guzmán 2015). Furthermore, Schultz (1993a; 1993b; 2001) demonstrated that many cases of cribra orbitalia lacked the histological features of anaemia. Instead the pathology has been related to generalised inflammatory responses to ill-health (Schiltz 1993a; 1993b; Carli-Thiele and Schultz 1997; Fairgrieve 2000; Walker *et al.* 2009; Oxenham and Cavill 2010; Smith-Guzman 2015). Inflammations with orbital involvement include sinusitis, conjunctivitis, trachoma, glaucoma, nasopharyngeal infections, tooth abscesses and suppurating skin inflammations (Wapler *et al.* 2004, 337; Jacobi and Danforth 2002, 256). Realistically, numerous factors have the potential to contribute to the production of cranial lesion. Anthropologists have identified flaws in the attribution of one causative factor and instead suggest a multi-factorial aetiology including diet, parasitic infection, diarrheal disease, environment, climate and social change (Hengen, 1971; Lallo *et al.* 1977; Mensforth *et al.* 1978; Walker 1986; Holland and O'Brien 1997; Wapler *et al.* 2004). Despite the many factors that can cause physiological change, the skeleton can only respond in a limited number of ways which leads to the identification of non-specific responses to biological stress. Therefore, the presence of cribra orbitalia and porotic hyperostosis is a reflection of physiological response to ill-health and not a demonstration of specific causative deficiencies.

4.4.1.2 Linear enamel hypoplasia (LEH)

Hillson (1996, 165) defines enamel defects as deficiencies of enamel thickness initiated during enamel matrix secretion. These defects manifest in localised lines or bands of depressed enamel visible on the buccal, lingual, mesial and distal surfaces of the tooth crown. They represent temporary interruptions in amelogenesis (enamel formation), following a period of physiological stress (Henriquez and Oxenham 2020, 510; Goodman and Rose 1991, 281; Hillson 1996, 177). LEH is a non-specific physiological response to a variety of extrinsic environmental stressors including dietary deficiencies, infection and childhood fevers (Palubeckaitė *et al.* 2002; Primeau *et al.* 2015, 384). The age at which stress occurred can be determined by measuring the distance between the hypoplastic defect and the cemento-enamel junction (Henriquez and Oxenham 2020, 511; Berbesque and Hoover 2018; Reid and Dean 2000).

LEH has been attributed to the transmission of endemic disease by close contact or weakened immunological systems resulting in prolonged periods of childhood illnesses (Berbesque and Hoover 2018, 4371-2). The likelihood of such transmissions taking place is exacerbated by poor hygiene and overcrowded living conditions and therefore LEH can be viewed as a means by which such environmental conditions can be inferred. It must be considered that variation in tooth enamel thickness will result in differences in susceptibility. For example, Dobney and Goodman (1992) prove that genetic differences between populations of different ethnic backgrounds resulted in contrasting defect frequencies. Therefore, when a population records a significant occurrence of enamel hypoplasia, one must consider if this is due to inherited enamel weakness or a reflection of exposure to environmental stressors.

Utilising the quantifiable coding system designed by Steckel *et al.* (2006, 15-6), the occurrence and severity of LEH was assessed. All available incisors and canines were subject to analysis; these were chosen over the molars as linear lines of enamel secretion are more easily seen on the buccal surfaces of the incisors and canines (Roberts and Manchester 1995, 58). LEH on the anterior dentition document disruptions between one and seven years of age, as this is the period over which the teeth form (Goodman and Rose 1991, 281; Mays 1998, 158). Each band of enamel hypoplasia was recorded as visible only when they ran across the majority of the crown width of the labial tooth surface, and only those visible to the naked eye were accounted for (table 4.4.3).

Score	Description
0	Tooth not present or unreportable owing to wear or damage
1	No linear enamel hypoplasia
2	One hypoplastic line present (may not be macroscopically visible, but can be felt)
3	Two or more hypoplastic lines present

Table 4.4.3: Description of variations in the severity of enamel hypoplasia (adapted from Steckel *et al.* 2006, 15-6).

The age at which the non-specific stress took place has been determined here following Reid and Dean (2000), which takes into consideration the developmental stage of the tooth crown at the time of enamel disruption. The methodology outlined by Reid and Dean (2000), measures the distance from the cemento-enamel junction on the buccal surface of the tooth to the occlusal margin of the enamel defect. This distance is then plotted on the diagram in figure 4.4.1, where each tooth crown was divided into ten equally spaced quantiles. Each of these quantiles correlates with an age range at which the hypoplastic defect would have developed. This non-metric visual method of examination is not the most precise method of identifying enamel hypoplasia, however it is the most widely employed method in archaeological material as it meets the restraints of excavated material, such as damaged and obscured views of the dentition (Primeau *et al.* 2015, 387).

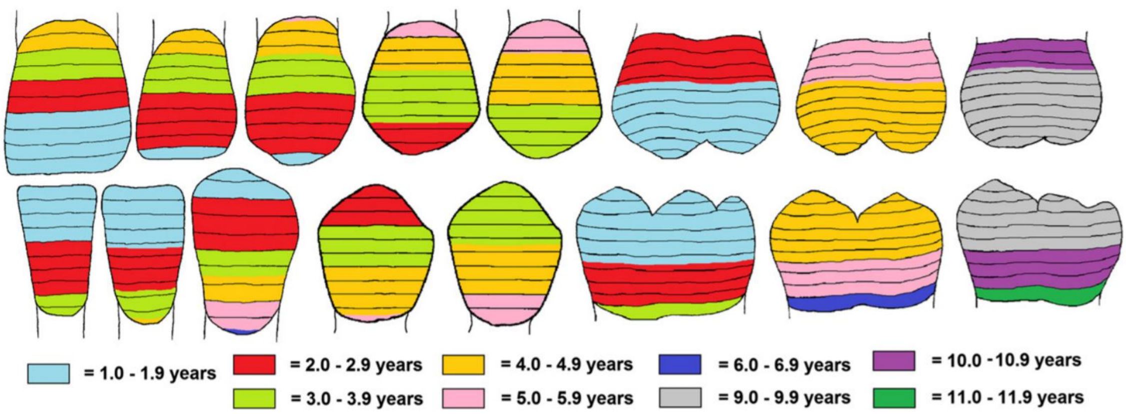

Figure 4.4.1: The formation of enamel, denoted by horizontal black lines and colours representing annual formation. This figure was created by Primeau *et al.* (2015) based on the work of Reid and Dean (2006) and Holt *et al.* (2012).

4.4.1.3 Adult stature

Body size during ontogeny and adult stature are highly dependent on a combination of postnatal health, nutrition and genetic inheritance, the latter of which determines maximum potential height (Buckberry 2004, 246). However, growth is only achievable when a surplus of resources is available for the body to surpass a state of internal equilibrium, while the body's potential to provide resources to skeletal development is dependent on its ability to absorb nutrients and combat infection (Hillson 1991, 53). Thus, rates of skeletal growth can reflect a plethora of factors ranging from a population's socioeconomic status to susceptibility to disease (Lunn 2000, 152-3; Scheuer and Black 2000, 5; Giannecchini and Moggi-Cecchi 2008, 284).

Estimates of adult stature were calculated from long bone length measurements following the formula devised by Trotter and Gleser (1952) for white males and females. This method was evaluated by Mays (2016) using anatomically reconstructed stature estimates of adult skeletons from Wharram Percy, England, concluding that the Trotter and Gleser (1952) estimation of stature from long bones is satisfactorily accurate when applied to a medieval cemetery population contemporary with that subject to investigation in this research.

All measurements were taken to the maximum length of the skeletal element in millimetres using an osteometric board, with the exception of the tibia. Trotter (1952) instructs users to omit the cruciate eminences but include the medial malleolus when measuring the tibia. However, Jantz *et al.* (1994) found the definition provided by Trotter (1952) to measure the maximum length of the tibia was misleading, resulting in erroneous stature estimates. Jantz *et al.* (1994, 528) found this could be overcome by measuring the 'maximum' tibial length from the most proximal part of the lateral half of the condyle to the most distal projection of the bone, not including the malleolus. Trotter and Gleser's (1952) regression equations and error margins are available in table 4.4.4; the error margins reveal the femur to produce the most accurate stature estimates (Krogman and İşcan 1986, 348). Statistically significant differences are detectable if different bones are used to establish stature, for example Molleson and Cox (1993, 24) found stature estimates from the upper limb were up to 8-10 cm lower than estimates form the lower limb having applied Trotter and Gleser's (1952) equations to material from Christ Church, Spitalfields. Therefore, only the lower limb was utilised in determining adult stature in the present study to maintain accuracy and inter-compatibility. Taking into account the recommendations of measurement definitions made by Jantz *et al.* (1994), and in this thesis the femur, tibia and fibula were utilised.

To further maintain consistency , and in line with recommended good practice, the left limb was utilised unless it was not present or was incomplete, in which case the right was substituted. Only complete long bones were used, as required by Trotter and Gleser's (1952) methodology. Stature was only calculated for adult individuals for whom the proximal and distal epiphyses of the femur, tibia and fibula had fully fused.

Male Std error	Equation	Female Std error	Equation
3.08 Humerus +70.45	±4.05	3.36 Humerus +57.95	±4.45
3.78 Radius +79.01	±4.32	4.74 Radius +54.93	±4.24
3.70 Ulna +74.05	±4.32	4.27 Ulna +57.76	±4.30
2.38 Femur + 61.41	±3.27	2.47 Femur +54.10	±3.72
2.52 Tibia +78.62	±3.37	2.90 Tibia +61.53	±3.66
2.68 Fibula + 71.78	±3.29	2.93 Fibula +59.61	±3.57
1.30 (Fem+Tib) +63.29	±2.29	1.39 (Fem+Tib) +53.20	±3.55

Table 4.4.4: Regression equations of Trotter and Gleser (1952, 495 table 13) with standard errors. Measurements and resulting statures are in centimetres.

The assessment of immature growth rates were originally planned as a measure of any skeletal growth deficit among the non-adult population. This was to be assessed by comparing estimates of age from diaphyseal long bone length with an estimate of age from dental development. This would enabled the skeletal growth of non-adults, which is highly sensitive to external environmental stress, to be measured against dental development which is far less sensitive to external pressures (Hoppa 1992, 276; Saunders *et al.* 1993, 266; Cardoso and Garcia 2009, 137). However, upon examination of the skeletal assemblage this was deemed impossible to carry out due to the poor preservation of non-adult long bones which would have made any measurements difficult and any overall comparative data would be questionable at best due to the small sample which would have been achievable.

4.4.2 Joint disease

The degradation of joints is an inevitable consequence of ageing and, while the aetiology of joint disease can be attributed variously to neuromechanical, inflammatory, immune and metabolic conditions, the extent of degradation is also influenced by numerous additional factors including biological sex, occupation, trauma, body weight, genetic dispositions, physical activity and congenital malformations (Jurmain and Kilgore 1995; Rogers and Waldron 2001; Ortner 2003; Weiss and Jurmain 2007; Rojas-Sepulveda *et al.* 2008). Joint degradation is evidenced through porosity, osteophytosis, malformation of the normal joint contours, eburnation and, in the spine, new bone growth on symphyseal articulations between vertebral bodies (Buikstra and Ubelaker 1994, 122-3; Waldron 2009, 25-7).

Archaeological examination needs to consider the multi-factorial nature of skeletal markers which include activity and age as well as differentiation in bone biometrics. Clinical and sports medicine is contributing to an expansion of our knowledge in bone response by providing comparative data from living subjects. Many standards for recording changes have lacked consistency and are often poorly controlled. Therefore, in this study arthropathies will be identified throughout the skeleton on a case by case basis, differentially diagnosed based on the set of criteria outlined in Rogers and Waldron's (1995) 'A field guide to joint disease'. The arthropathies being looked for through this method of differential diagnosis include osteoarthritis, rheumatoid arthritis, gout, psoriatic arthritis and reactive arthritis. More specifically spondylolosis, diffuse idiopathic skeletal hyperostosis (DISH) and ankylosing spondylitis (AS) will be identified and diagnosed following the methods outlined below. Through applying the set of criteria outlined by Rogers and Waldron (1995) and not combining a number of methodologies the aim is to maintain consistency and avoid any issues in controlling for observer interpretation of methodological approaches.

Arthropathy

Arthropathy is a disease of the articular cartilage of the synovial joints, characterised by the progressive degeneration of cartilage with secondary bone changes, such as marginal osteophytes and subchondral bone sclerosis (Marinovic *et al.* 2011, 19; Waldron 2012, 514). It occurs as a result of ageing, genetics, obesity, labour intensive physical stress and/or injury (Felson, 1988). Skeletal pathology resulting from arthropathy is categorised into three components: first, the breakdown of articular cartilage resulting in bone on bone contact and eburnation of the subchondral bone; second, sclerosis occurring in the subchondral compact bone and in the underlying trabecular layers; and thirdly, the formation of new cartilage and bone growth known as osteophytes which occur at synovial joint margins (Ortner 2003, 546; Rogers and Waldron 1995, 13).

Differential diagnosis was determined by location and severity according to the criteria laid out in Rogers *et al.* (1987) which can be applied to any joint, both spinal and extra-spinal, throughout the skeleton. The criteria call for (1) the formation of true, marginal osteophytes; (2) subchondral bone reaction (eburnation, sclerosis and cysts); (3) pitting of joint surfaces; and in severe cases (4) alterations in the joint contours (Rogers *et al.* 1987, 185). Variations of these criteria are depicted in figure 4.4.2. Osteoarthritis can be classified only if (1) and (2) are present. The presence of (1) alone can only be ascribed to general age-related degeneration. If there was evidence that the osteoarthritic changes occurred as a secondary reaction to any other pathology such as trauma this was noted and, where possible, the primary cause was identified and recorded.

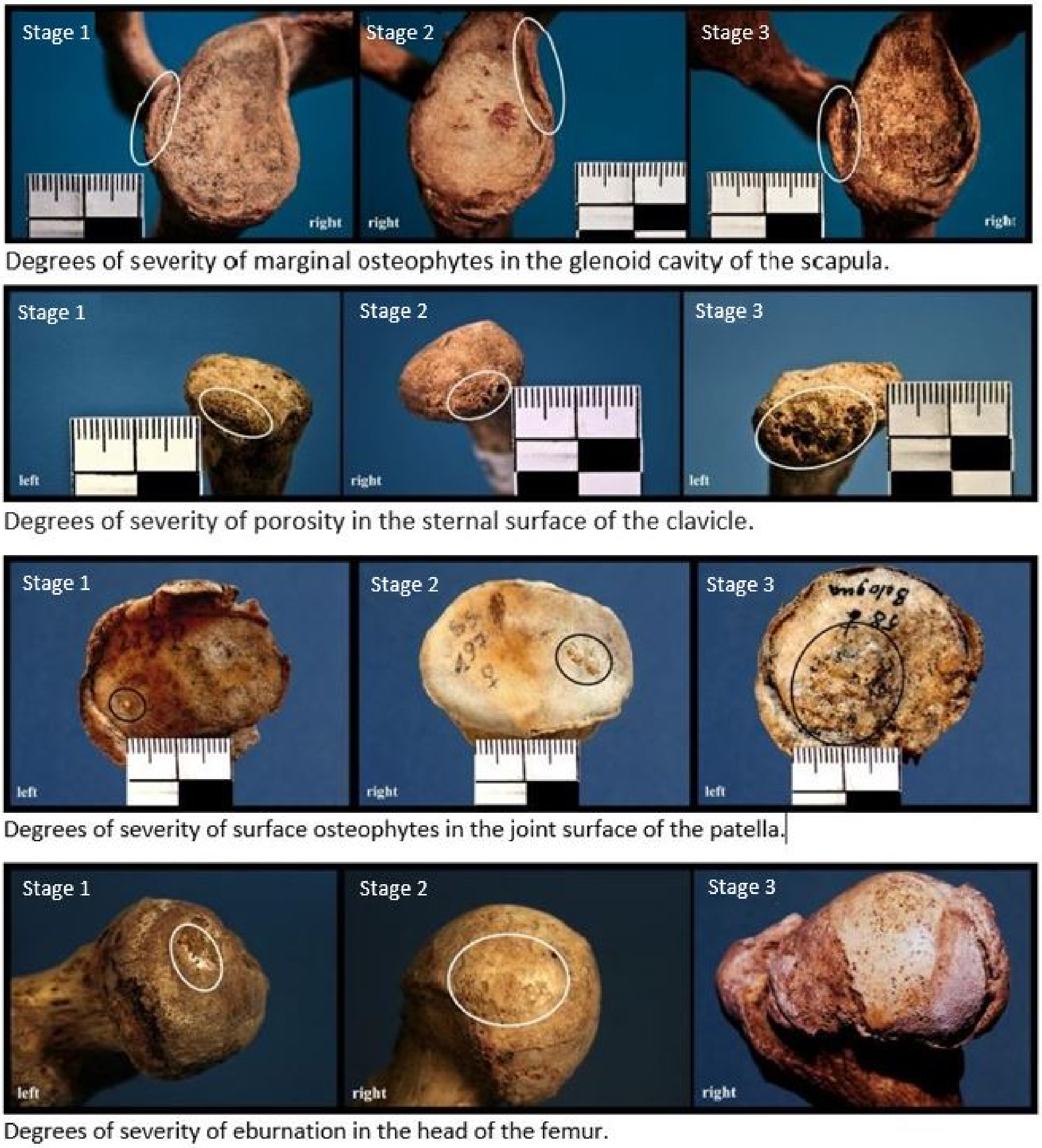

Figure 4.4.2: Stages of joint degradation and degrees of severity (Zampetti *et al.* 2016, figure 4, following Rogers and Waldron 1998).

Osteophyte Formation

Osteophytes in the vertebral column occur as the body loses its ability to maintain joint cartilage. In an attempt to strengthen the vertebral bodies against the physical pressures imposed on them, vertebral body osteophytes form to re-stabilise the structure of the vertebral column. Compressional forces cause horizontal expansion of the cartilage projecting beyond the joint margins and subsequently, the synovial lining ossifies, and osteophytes form at the margins of vertebral bodies (Mann and Hunt 2005, 18-9; van der Merwe *et al.* 2006, 462). Osteophytes represent areas of new cartilage and bone formation; they have been identified in this study by the bony outgrowth or spurs occurring at joint margins (Weiss and Jurmain 2007, 445).

Schmorl's Nodes

Schmorl's nodes are the result of herniation of the *nucleus pulposus* of the intervertebral disk superiorly or inferiorly through the cartilaginous endplate and into the cancellous bone of the vertebral centrum, leaving an excavated lesion in the vertebrae which is seen in archaeological specimens (Burke 2012, 571).

Osteoarthritis

In order to identify an arthropathy as an arthritis the methodology outlined by Rogers *et al.* (1987) was employed. This method continues to be supported in slightly augmented methods proposed by Crubézy *et al.* (2002, 581); Debono*et al.* (2004, 397-8) and Waldron (2009, 34) which state the presence of either one or two of the following pathologies are required to deduce a diagnosis of arthritis: marginal osteophyte formation, new bone formation on the joint surface, pitting on the joint surface, alteration in contour. These pathologies are analogous to those outlined by Rogers *et al.* (1987).

Rheumatoid arthritis

Rheumatoid arthritis is a chronic inflammatory disease of synovial joints and connective tissue which results in osteolytic erosions. Rheumatoid arthritis is the most common erosive arthropathy, which affects between 0.5 and 1 percent of the population, with regional variation (Firestein 2001, 921; Ortner 2003, 561; Guo *et al.* 2018, 1). The disease becomes more frequent with age and arises more frequently in females than males, with published ratios ranging from 4:1 (Firestein 2001, 924) to 3:1 (Vollenhoven 2009; 12). It primarily affects the lining of the synovial joints and can cause progressive disability; the clinical manifestations include arthralgia, swelling, redness and limited range of motion (Guo *et al.* 2018, 1). Rheumatoid arthritis occurs as inflammatory infiltration of the synovium, the interface tissue becomes highly vascularised, proliferates and the pannus tissue extends into the joint gradually destroying the cartilage (Hale and Hayes 2001, 1107). The destruction of tissue, especially cartilage, is a slow and progressive process which takes place over years and in advanced cases can ultimately destroy the joint cartilage and the underlying subchondral bone. Individuals usually experience the involvement of multiple joints; joints of the hands are most frequently affected, and the metacarpal-phalangeal and interphalangeal joints are characteristically the first elements to be involved (Ortner 2003, 562). Other commonly affected joints are the knee, carpal joints, the shoulder and the elbow (Ortner 2003, 562). All obervations were made in line with examples and guidance layed out in Rogers *et al.* (1987).

Spondylosis

Acute overloading of the vertebral column causes initial microfractures in the vertebrae which worsen with repeated stress (Waldron 2009, 151). Activity related spondylosis is most prevalent in the lumbar vertebrae (Syrmou 2010, 18). Spondylosis is the result of sudden hyperextension of the spine, this increases lumbar lordosis and compressive force on the *pars interarticularis* which is the cause of bone fractures (Syrmou 2010, 18; Green *et al.* 1994, 2687-9). McTimoney and Mitchell (2003, 42) found five percent of individuals in any given population have some form of spondylosis, and that the condition is more common in males than females. Spondylosis has been identified by a cleft in the neural arch of a vertebra at the *pars interarticularis*, as has been applied by D'angelo Del Campo (2016), Weiss (2009) and Mays (2006).

Diffuse idiopathic skeletal hyperostosis (DISH)

Diffuse idiopathic skeletal hyperostosis (DISH) is a complex disorder distinct from degenerative joint disease manifesting in hyperostosis and ankyloses of the spinal column, and calcification or ossification of supra-spinal entheses and ligaments (Forestier and Rotes-Querol 1950; Rogers and Waldron 2001; Bombak 2012). The skeletal condition has a greater occurrence in males than females and becomes more prevalent with age, being found primarily in individuals over 40 years of age (Kim *et al.* 2004; Weinfeld *et al.* 1997).

The true aetiology of DISH remains unknown despite countless medical investigations having been carried out. Such investigations have considered the association of DISH with obesity and diabetes (Sarzi-Puttini and Atzeni 2004; Kiss *et al.* 2002), lipid metabolism and hyperuricemia (Vezyroglou *et al.* 1996), unbalanced growth hormone levels (Altomonte *et al.* 1992; Denko *et al.* 1994; Denko and Malemud 2006), vascular disorders (elMiedany *et al.* 2000), repeated microtrauma (Pappone *et al.* 1996), and idiopathic hypoparathyroidism (Lambert and Becker 1989; Fornasier *et al.* 1983). Although the exact aetiology remains unknown it is widely accepted that DISH is a multisystemic condition related to abnormal bone activity influenced by various metabolic, environmental and genetic factors (Sarzi-Puttini and Atzeni 2004, 291). Regardless of its aetiology DISH has been found to occur in association with several other conditions, including acromegaly (Littlejohn *et al.*, 1986), Paget's disease (Morales *et al.*, 1993; Marcelli *et al.*, 1995), multiple myeloma (Scutellari *et al.* 1995), and gout (Littlejohn Hall, 1982).

Individuals diagnosed with DISH are known to be bone formers, meaning they are more susceptible to experience ossification of cartilage, ligaments and tendons throughout the body (Roberts and Manchester 1995, 121). The term 'bone formers' has been given to individuals who are predisposed to high rates of new bone formation, a notion which has been supported in clinical studies where genetic factors have proven to play a crucial role in the development of primary osteoarthritis (bone formation) and osteoporosis (bone loss) (Schmitt *et al.* 2007, 55). Clinical studies have also revealed that DISH can be asymptomatic, but can also manifest as generalised stiffness and swelling, dysphagia and spinal cord immobilisation (Westerveld *et al.* 2009, 145).

Several methodologies have been developed to identify DISH and while these vary in detail, each require specific changes in the spine to be present for confirmed diagnosis (Resnick and Niwayama 1976; Utsinger 1985; Crubezy 1990; Rogers and Waldron 2001). Therefore, the methodology applied focused on the spine. DISH was recorded on the basis of the fusion of at least four adjacent vertebrae along the right side of the bodies with the appearance of ‘candle wax’ and retention of the spaces between vertebral body surfaces and apophyseal joints (Kagotani *et al.* 2015, 225). The fusion in DISH occurs due to ossification of the anterior longitudinal ligament. In addition to changes in the vertebral column, ossification occurs throughout the skeleton including the os coxa, patella and calcaneus (figure 4.4.3).

DISH represents the extreme end of bone forming skeletal changes and as discussed here, is characterised by the extensive production of new bone with calcification or ossification of extra-spinal entheses and ligaments and other soft tissues. However, the diagnosis of DISH can be misinterpreted for osteophytosis that occurs in disc disease or seronegative arthritides. Distinction between the disease profiles is especially difficult in osteoarchaeology where incomplete skeletons make it difficult to identify the extra-spinal manifestations which can distinguish DISH from other spinal arthritides. One way in which this can be overcome is by stating the diagnosis of DISH on finding fusion in four contiguous vertebrae.

Figure 4.4.3: Bone growths characteristic of DISH; (1) fusion of five thoracic vertebra (2) bony growths on the iliac crest of the right os coxa (3) bone growths on the right patella (4) bone growth on the right calcaneus (Ventades *et al.* 2018).

Ankylosing spondylitis

Ankylosing spondylitis is a progressive inflammatory disease of the connective tissue resulting in its calcification (Slaus*et al.* 2012). The joints most commonly affected are the sacroiliac joints, the joints of the spine and the costovertebral joints (Roberts and Manchester 1995 119; Aufderheide and Rodriguez-Martin 1998; Ortner 2003, 571-7). In the appendicular skeleton, the most commonly affected joints are the hips and shoulders (Van der Linden and Van der Heijde 2001). The condition results in reduced quality of life, causing lower back pain, weight loss, fever, limited chest expansion and, in the final stages, immobility can occur (Slaus *et al.* 2012).

The methodology applied here recorded presence/absence of ankylosing spondylitis based on the following characteristics outlined by Waldron (2009) and Slaus *et al.* (2012). The diseases often starts with sacroiliitis, followed by spinal fusion with ossifications in the annulus fibrosus of the intervertebral discs. Where these ossifications are extensive the spine takes on an undulating contour described as a ‘bamboo spine'. Spinal fusion extends up the spine with advanced cases reaching the cervical vertebrae, the vertebra present with smooth anterior surfaces as osteophytosis is not a prominent feature of ankylosing spondylitis. As the diseases progresses up the spine, ribs become fused to the vertebrae and calcification of the interspinous and supraspinous ligaments occur. Extra-spinal enthesophytes are not common, but when they do occur are most usually found on the calcaneum at either the insertion of the Achilles tendon or the plantar fascia. Advanced cases of ankylosing spondylitis are easily identifiable in the skeletal material as the pelvis and spine will be fused into one unit and an undefined number of ribs will be fused to the vertebrae (Waldron 2009, 59).

4.4.3 Non-specific infection

4.4.3.1 Periosteal bone formation

Periosteal reaction is the skeletal response to extrinsic or intrinsic pathological stimulation of the periosteum (Roberts and Manchester 1995, 127-9; Weston 2008; Waldron 2009, 115). Regardless of aetiology, the prevalence of periosteal bone formation can be used as an indicator of a population's ability to respond to immunological stress (Lee 1995, 563-4; Powell 1996; Loe and Robson-Brown 2005, 51). The aetiologies of periosteal bone formation include: primary infection, haemorrhage resulting in the spread of bacteria or a secondary response to trauma, as well as specific infections, including leprosy and syphilis (Ortner and Putschar 1981, 129-38; Roberts and Manchester 1995, 127-9; Steckel *et al.* 2002). In many situations precise diagnosis of the aetiology of periosteal bone formation is not possible, and the lesions are therefore reported as non-specific.

Normal healthy bone is deposited in long, regular, bodies called lamellar bone, however, if the metabolism of bone formation increases it results in the irregular layering of lamellar bone or the formation of woven bone identifiable by the irregular bone matrix of porous and disorganised structures (Roberts and Manchester

1995, 3-7; De Boer and Van Der Merwe 2016). Therefore, periosteal reaction was only classified when areas of woven bone or irregular layering of lamellar bone were observable.

When assessing immature skeletal remains for reactions manifesting in new bone formation, the occurrence of physiological or reactive periostitis must be considered. Immature individuals often display the deposition of immature disorganised bone upon the cortical surface of long bones as a result of normal appositional growth processes. This deposition of bone appears morphologically identical to periosteal bone formation (De Silva *et al.* 2003, 1124; Scheuer and Black 2004, 36). The deposition of disorganised bone is most commonly found in those aged two to six months and disappears thereafter (Scheuer and Black 2004, 36). Thus, in order to avoid the misidentification of normal developmental bone physiology as disease process, individuals aged three years at death and under were excluded from this analysis, allowing for 28 months of bone 'recovery' from any deposits of potential confusion (Scheuer and Black 2000, 24; de Silva et al. 2003, 1124). On examination of the skeletal remains this decision was concluded due to poor preservation of periosteal bone, in particular the flaking and fracturing of periosteal bone in the fragile bones of the youngest individuals, as aforementioned. When assessing the non-adult population the periosteal bone formation must be at least one centimetre from the epiphyseal growth plates of the diaphysis in order to avoid any confusion with normal porosity associated with growth (Ortner *et al.* 2001).

The occurrence of periosteal bone formation was recorded by the extent of manifestation in the tibia of both the non-adult and adult populations. The tibia was chosen for analysis as it has been utilised in modern scholarship due to the anterior tibia having little soft tissue between it and the external environment, making it susceptible to repeated injury and bacterial infection (Yuassy and DeWitte 2018). In addition, the tibia's slow immune response and elevated osteogenic potential make it likely to develop periosteal new bone in response to acute insult or chronic infection

(Gallay *et al.*, 1994; Roberts and Manchester, 2007; Klaus, 2014). This makes the bone a reliable measure by which to interpret an individual's immune response and on a greater scale the overall immune competencies of a skeletal population (DeWitte 2014, 41). The decision to focus periosteal new bone formation prevalence on the tibia was also based on the fact that the comparative hospital populations of St John, Cambridge (Cessford 2015, 94), St Mary Magdalene Partney (Atkins and Popescu 2010, 248), St Nicholas, Lewes (Barber and Sibun 2010, 104) and St Margaret, High Wycombe (Farley and Manchester 1989, 86) all recorded the highest presence upon the tibia. Furthermore, the comparative population of St Peter's Church, Barton-upon-Humber reports that virtually all periosteal new bone formation was confined to the lower limb and in particular the tibia (Waldron 2007, 80).

This may cause concern that other pathologies indicated by periosteal new bone formation may be missed such as tuberculosis and scurvy or rickets in the very young. However, if periosteal new bone formation patterns were present throughout the skeleton this would be recorded and reported upon for the identification of further disease processes. Furthermore, none of the aforementioned diseases can be diagnosed with certainty solely from periosteal new bone formation and must also consider porosity, lytic lesions, bone destruction, sequestra, ankylosis and bowing of the leg bones in rickets (Nikita 2016, 312-5). Furthermore, this was not a concern, for upon examination throughout the assemblage periosteal bone was poorly preserved due to sandy ground conditions and continuous water drainage through this ground type. This meant that the bones were in no state from which any potential and grounded identification of pathologies such as scurvy, rickets or tuberculosis from periosteal new bone formation alone could take place. Similarly, analysis of the ribs from skeletons throughout the cemetery displayed poor preservation of the periosteum, this preservation left the periosteal bone flaking and peeling away from the main structure of the bone. The flaking nature of the bone condition made the identification of any periosteal new bone formation or lytic lesions extremely tentative and have very little in the way of substantial grounding. As a result of this further diseases such as tuberculosis and leprosy were to be identified on a number of diagnostic skeletal changes widely associated with the relevant disease as outlined in section 4.4.4 and table 4.4.6.

Figure 4.4.4: Spiculated and reticulated bone formations and vascular tracks on the lateral and posterior portions of a tibial shaft (image courtesy of Assis *et al.* 2018, 30 figure 3).

Periosteal new bone formation was identified following the criteria set out by DeWitte (2014), which takes into account whether lesions were active or healed at the time of death. The tibia was selected for analysis as it typically shows good rates of survival and preservation in the archaeological record due to its robust nature and the relatively high frequency with which it is affected by periosteal bone formation (Eisenberg 1991; Galloway *et al.* 1997; Willey *et al.* 1997). Periosteal lesions were scored on the anterior tibial diaphysis; the posterior surface was excluded to avoid accidental scoring of minor muscle attachments (DeWitte, 2014). Similarly, articular surfaces were excluded from examination to prevent the confusion of bone formation from degenerative joint diseases such as osteoarthritis, which can result in new bone formation similar in characteristics to that of periosteal bone formation (figure 4.4.4) (Roberts and Manchester 1995, 5-6; 102-4). Lesions were identified macroscopically and scored as present if at least one distinct patch of woven or lamellar bone (irregularly thick layered bone) of any size could be identified. Extent of healing was scored as either woven (active) or sclerotic (healed) in line with the criteria outlined in table 4.4.5 by Weston (2008).

Weston (2012) states that in order to reduce the chance of identifying the unilateral manifestation of periosteal lesions as a result of traumatic injury, only individuals with both left and right tibia should be considered in the identification of periosteal new bone formation. This should facilitate observation of bilateral lesions that are most confidently associated with infection and underlying immune incompetence. However, due to the low occurrence of periosteal bone formation in the assemblage and poor preservation preventing observation in bilateral pairs, this method of observation was not applied.

Score	Description of Periosteal bone formation
Woven	Active bone formation. Porous bone with sharp, unmodeled edges.
Sclerotic	Healed bone formation. Lesions of new bone with rounded, remodelled edges.
Lacking	Tibia free of periosteal lesions and post-mortem damage.
Unobservable	Lesions cannot be observed due to absence of damage to the tibia.

Table 4.4.5: Scoring and description of periosteal bone formation (adapted from Weston, 2008).

4.4.3.2 Maxillary Sinusitis

The most common cause of sinusitis is either an upper respiratory tract infection or invasive dental infection (Simuntis *et al.* 2017, 3651; Slavin *et al.* 2005, s16). Today the condition has a prevalence of 10.9 percent in Europe and 14 percent in the USA (Fokkens *et al.* 2012, 2-9), thus demonstrating geographical variation in the condition's occurrence. Paleopathology can only observe the presence of chronic sinusitis and not acute infection, as acute sinusitis is unlikely to manifest skeletally, yet both are caused by bacterial infection of Streptococcus pneumoniae, Haemophilus influenzae, Staphylococcus aureus and Moraxella catarrhalis (Brook 2011, 90; Hanson and Lepule 2017, 46).

Observable sinusitis was recorded with present or absent sinusitis, according to the criteria described in Boocock *et al.* (1995). In addition, pitting and/or new bone formation in the sinuses was recorded. The method presented by Boocock *et al.* (1995) has been utilised in recent studies including; Roberts (2007), DiGangi and Sirianni (2017) and Purchase *et al.* (2019). The decision to not carry out x-ray or endoscopic examination was concluded by an assessment of the methods used on the skeletal populations which will be used for prevalence comparisons in Chapter 6. For example, the closest geographical lay population to the Hospital of St James was St Peter's Church, Barton-upon-Humber, in which ancillary investigations were noted only when the facial bones were broken (Waldron 2007, 78). Similarly, the comparative hospital sites of St Mary Magdalene, Partney, St John's, Cambridge and St Bartholomew, Bristol also employ a more traditional stance with no record of using X-rays and endoscopic examination. Therefore, the choice to exclude such examination here also maintains that the data recorded is comparable to that in the published literature. That being said, the observation of maxillary sinisitus is one area for development that could be explored further on the skeletal assemblage.

4.4.3.3 Osteomyelitis

Osteomyelitis is a non-specific infection of the bone and bone marrow caused by infectious agents of fungi, viruses and parasites, which result in the inflammation and necrosis of bone (Mast and Horwurs 2002, 234; Ortner 2003, 105-6; Lewis 2006, 141; Labbé *et al.* 2010, 274).

Pathogens gain access to the skeleton via haematogenous and non-haematogenous avenues. Haematogenous osteomyelitis facilitates movement of pathogens into the inner structures of the bone, thus can result in infection of the medullary cavity. It is the most common aetiology of osteomyelitis in non-adults, who are the group most commonly affected by this form of the infection, especially between 3-15 years of age (Capitanio and Kirkpatrick 1970, 488; Dahl *et al.* 1998, 573). When bacteria gain entry to the medullary cavity, they can multiply rapidly and create an immunological response. The response causes a production of pus resulting in increased intra-medullary pressure and, gradually, increased bone size. The presence of bacteria under the periosteum stimulates the formation of new bone as the body's response mechanism; the thick deposit of new bone that forms around the shaft of the infected area known as an involucrum (Kavanagh *et al.* 2018, 4). Pus is expelled from the body through draining sub-periosteal abscesses, or cloacae, in the bone and then through either an open wound or sinus in the overlying soft tissue (Ortner 2003, 112; Waldron 2009, 85-6; Lewis 2006, 140; Labbé *et al.* 2010, 270). The bony responses to infection can cause an interruption of blood supply to the cortex. If this happens, areas of necrotising bone occur and the dying bone forms into sequestra, which are seen macroscopically as large cloaca. In a study carried out by Trueta (1959) it was established that out of 200 cases of haematogenous osteomyelitis, seven percent of the affected were infants, 80 percent were children and 13 percent were adults. Among the 160 children affected, males and females were affected at a ratio of 3:1. Osteomyelitis is most frequently found in the long bones of immatures and is limited to just one bone in 80 percent of cases (Ortner 2003, 110). The majority of infections take route in the metaphysis near active growth plates and thus the localisation of infection correlates with growth rates and skeletal development. Non-haematogenous routes include infection from traumatic or surgical wounds or via direct contact from adjacent infected soft tissue. The occurrence of osteomyelitis resulting from wounds and surgery can occur in any part of the skeleton. Osteomyelitis secondary to adjacent soft tissue infection is often more localised; the infection is also often limited to the periosteum and cortex and does not spread to the medullary cavity. This results in focal periosteal bone deposition around a defect in the cortical bone, with sclerotic response and either with or without a sequestrum.

Dependent on the duration of infection, osteomyelitis can be classified as either acute or chronic. Chronic osteomyelitis persists for years and the skeletal manifestations include minor inflammation, the presence of sequestra and a fistilous tract (Lew and Wadvogel 2004, 369). Acute osteomyelitis is particularly prevalent in non-adults because haematogenous acute osteomyelitis causes life-threatening septicaemia, before the condition can develop into a chronic state (Lewis 2006, 140). Acute hematogenous osteomyelitis manifests from one or several localised discharges of pus from the bone metaphysis and lytic destruction of cancellous bone. The infection spreads through the marrow cavity via blood vessels, increasing pressure in the diaphysis and resulting in extensive necrosis of the cortex via vascular compression. In an immature individual's active growth plates and thin cortical bone this enables the expansion of the infection under the periosteum leading to the formation of subperiosteal abscesses and a blood-deprived diaphyseal cortex. The resulting necrosis of bone enables the formation of a sequestrum, which in cases of large areas of necrosed bone, enables the infection to maintain its presence if surgical intervention is not under taken.

Osteomyelitis was identified through a scheme of differential diagnosis based on the characteristics of osteomyelitis outlined by Ortner and Putscha (1981, 105-121). They reported that localised osteomyelitis manifests in focal periosteal bone deposition around a partial cortical defect, with or without a small sequestrum, and with some sclerotic response in the vicinity. The infection may heal with sclerotic scarring around a depression, in which case the scars may subsequently be greatly effaced by remodelling. While differential diagnoses are largely based on the work of Ortner, it is further supported by reference to reports of osteomyeltits in medical literature (Jain *et al.* 2018; Keerthana *et al.* 2017; Chiappini *et al.* 2016; D'souza *et al.* 2016). Radiographic confirmation of osteomyelitis was not carried out on this skeletal assemblage. From the outset this skeletal material was to be considered on macroscopic analysis, it is scientifically valid to identify osteomyelitis through the macroscopic bone changes including sequestra and/or cloaca which can be further confirmed through radiology which is an option for further investigation of pathologies (Ortner and Putscha 1981, 105-129; Nikitia 2016, 311-2).

4.4.4 Specific infection and disease

The most commonly reported specific infections and diseases are skeletal tuberculosis, leprosy, syphilis, rickets and scurvy. The main diagnostic skeletal changes associated with these are summarised in table 4.4.6, and described in greater detail by Ortner and Putschar (1985), Rogers and Waldron (1989), Roberts and Manchester (1995), Resnick and Niwayama (1995), Manchester (2002), Waldron (2009) and Nikita (2016). These sources emphasise that a disease should not be diagnosed based on isolated lesions, particularly those that are less characteristic. In the Hospital of St James assemblage, no such pathology was identified, despite each skeleton in the assemblage being systematically studied so any occurrence of the listed pathologies would be recognised by a combination of the associated skeletal changes.

Infection or disease	Lesion type	Lesion distribution	Skull lesions	Axial lesions	Long bone lesions	Hand and foot lesions
Tuberculosis	Destructive. Proliferative.	Predominantly axial, hip and knee joints	Lytic	Destruction of cancellous bone leading to scalloping in the anterior vertebral bodies. Commonly involving the lower thoracic and upper limbal vertebrae. Proliferative changes on the visceral surface of the ribs.	Fusiform swelling.	
Leprosy	Destructive. Proliferative in secondary infections.	Left and right sides of the body but can be asymmetrical.	Atrophy of the nasal and maxillary regions. Maxillary sinusitis Cribra orbitalia. Resorption of the alveolar bone, loss of anterior teeth. Tooth malformation.		Periostitis in the tibia and fibulae.	Atrophy and shortening. Tarsal exostoses.Grooving of the volar surface of the proximal phalanx.

Infection or disease	Lesion type	Lesion distribution	Skull lesions	Axial lesions	Long bone lesions	Hand and foot lesions
Syphilis	Destructive. Proliferative. Osteomyelitis. Gummatous.	Venereal syphilis involves the entire skeleton.	Perforation of the nasal area and palate. Hutchinson's teeth and Mulberry molars.	Collapsed vertebrae	Sabre shin and charcot joints.	
Rickets	Proliferative.	Skull, dentition, axial and long bones	Craniotabes in the parietals and occipitals, delayed frontal closure, subperiosteal deposition. Disordered tooth eruption and defects.	Decreased vertebral height, scalloping and kyphoscoliosis. Ribs – flattened, enlarged and periosteal bone deposition. Pigeon breast deformity of the thorax.	Porous and rough bone surfaces with a thinned cortex. Flared metaphyses, bending deformities and stress fractures. Reduced angle of the femoral neck.	
Scurvy	Proliferative.	Skull, dentition axial, os coxae, long bones.	Porosity of the sphenoid, mandible, maxilla and alveolar. Non-adult –NBF: endocranial. Adult – Periodontal disease.	Non-adult –NBF: scapulae and os coxae	Non-adult –NBF: upper and lower limbs. Adult – NBF: humeri, femora. Bilateral ossified hematomas in the lower limbs	

Table 4.4.6: Summary of the main diagnostic skeletal changes associated with tuberculosis, leprosy and syphilis, rickets and scurvy.

4.4.5 Trauma

Throughout this thesis the term trauma is used to describe all injury to the bone, whether deliberate or accidental. Trauma can manifest on the skeleton by partial or complete breakage of a bone (fracture), displacement or dislocation of a bone, abnormalities in bone shape or contour and disruption to the skeletal blood supply (Roberts 2000, 338). This list is not exhaustive of all the bone changes which can occur from trauma but does cover the most commonly occurring changes. Within the Hospital of St James assemblage all peri-mortem fractures were recorded including those healed at the time of death. These observations were carried out in order to identify any pattern in breakage patterns which may be indicative of occupation or prevalent activity pattern.

4.4.5.1 Analysis of Fractures

Due to the fragmentary nature of the assemblage any skeletal element which was at least two thirds complete was examined for a fracture. The inclusion of incomplete elements has not been favoured in the past as it can result in a reporting and sample bias (Lovejoy and Heiple, 1981). However, Judd (2002, 1264) reported that if only complete bones are observed for fracture analysis then approximately 21 percent of the true fracture prevalences would be missed.

Macroscopic identification of fractures was observed through discontinuity in bone alignment. When a fracture was identified the skeleton was examined to determine which bones were involved, if multiple bones were involved then what patterns of involvement could be seen, what type of fracture occurred, did the fracture take place ante-mortem or peri-mortem and is there evidence of fracture healing. Fracture types were determined as compound (open) or simple (closed), they were then analysed on the shape and pattern they took within the bone, the most common of which are transverse, oblique, spiral and crush fractures, as illustrated by Crawford Adams, 1983; McRae, 1981 and Rogers, 1992). Peri-mortem fractures refers to those that occur around the time of death and usually show no sign of healing.

The peri-mortem period is defined by the maximum time period in which bones do not start to heal following a break, which is two to three weeks (Kemp 2016, 36). Therefore, peri-mortem fractures are defined as those which take place up to three weeks prior to death and immediately following death until the organic matrix of the bone is no longer retained (Kemp 2016, 43).

Fracture healing was initially assessed on whether the bone was fully healed or in the process of healing at the time of death. This was determined through macroscopic examination of the bone type. Lamellar bone indicated the healing process was complete while woven bone indicates the process of healing was ongoing and therefore the fracture would be defined as unhealed (Buikstra and Ubelaker 1994, 35). From here bone displacement, rotation, angulation and overlap were all analysed following Grauer and Roberts' (1996) methodology. Bone displacement was determined if the ends of the bones were misaligned relative to each other and their known anatomical position (McRae, 1981). The direction of the displacement was described as anterior, posterior, lateral, medial, or a combination of these directions. Rotation and angulation of the bone was recorded by comparing the fractured element with its contralateral element or with a normal reference bone where this was not possible. Bone shortening was used to indicate an overlap of the fracture fragments and in instances accompanied by a thickening at the point of overlap. Measurements of the maximum length in millimeters of complete fractured bones were taken and compared with the maximum length of the contralateral bone. Grauer and Roberts (1996, 533) attribute this to suggest that reduction of the fracture had been unsuccessful or was not attempted. Following fracture is it not uncommon for secondary bone changes to occur as a result of stress on adjacent joints, therefore the skeleton was assessed for any possible resulting complications. The presence of degenerative joint disease was recorded as per the criteria outlined in section 4.7. This was done whilst keeping in mind that any joint disease could have occurred prior to the fracture. While secondary infections such as periostitis or osteomyelitis were observed following the criteria in section 4.6.

4.4.5.2 Analysis of cranial trauma

In the occurrence of any cranial trauma, the following recordings were taken; which bone was affected, the side involved as well as measurements of the height, breadth and depth of the lesions. Classification of the injury was separated into blunt force trauma and sharp force trauma following Cohen *et al.'s* (2014) method of identification and analysis. Blunt force trauma refers to any injury caused by force. The injury is defined by a wide area of impact and determined by a lesion with a clear external border (rounded or polygonal in shape), with radiating and concentric reticulations and the affected area being depressed (Cohen *et al.* 2014, 725). Here sharp force trauma refers to all lesions produced by sharp instruments. Sharp force trauma manifests in a smaller lesion than blunt force trauma and will present in a linear, v-shaped groove up to 5 mm in depth and 60-70 mm in depth. The cut mark is determined by the direction of the blow, however, it is important to consider that a single linear fracture can be the result of blunt force trauma (Cohen *et al.* 2014, 725)

4.4.6 The bioarchaeology of care methodology

Integrated with the analysis of paleopathologies in Chapter 6 is the application of the 'bioarchaeology of care' methodology set out by Lorna Tilley (2010). The term 'bioarchaeology of care' was developed by Tilley (2012) as an umbrella term to encompass any bioarchaeological research into the provision of healthcare. Application of the methodology identifies health care practices through the archaeological record to reveal insights into the lives of those who were afforded care and those who provided it (Tilley 2012, 3-4). Following Tilley's intentions, the methodology has been applied at case-study level employing the skeletal remains from the Hospital of St James as an article of evidence. The four stages of analysis within the model are as follows:

(1) Record all evidence of disease within a set of skeletal remains, describing all pathology and attempting a diagnosis. At the Hospital of St James the recovery

context is defined as areas A, B or C within the hospital's cemetery (as described in Chapter 3).

(2) Consider the functional and clinical impacts of the pathology, employing modern clinical data to infer impacts in past populations as the disease symptoms and complications have remained the same over millennia (Tilley 2012, 3). Explore the impacts disease has on the individual to establish the individual's experience of disability and whether they would have required direct support or accommodation. Direct support refers to provisioning, nursing, physical therapy and accommodation strategies that enable a level of participation in social and/or economic activity (Tilley 2012, 3).

(3) Identify what the care provided likely consisted of, within the parameters of 'the probable' and 'the possible' given the contemporary context. In regards to the cases explored in this thesis, it is known that the care provided was done so by a hospital institution and that within later medieval hospital medical intervention was limited to somewhat basic provisions such as the application of herbal remedies and limb resetting, but greater care was provided in the form of food and lodging, daily assistance and above all, care and prayer for the soul (Riddle 1974, 178).

(4) Interpret the findings of stages 1-3 and discuss what the application of the 'bioarchaeology of care' model suggests about the contemporary social practice and about group and individual identity (Tilley 2012, 4).

Within this thesis the model is employed to gain insight into the condition of inmates at the hospital and about the type of care the Hospital of St James could have been providing. The types of care will be described in line with the example provided by Tiley (2012, 5). Such examples include if the care was long or short term, skilled or unskilled, for inmates with deteriorating or potentially improving conditions and if the patient was able to adapt to their new position with the help of hospital staff. Limitations of this application must be noted; not all disabilities and care needs manifest in the skeleton and therefore the full extent of disabilities present within any archaeological assemblage cannot be assessed though a bioarchaeological approach.

4.5 Summary

This chapter has outlined the methods utilised throughout this thesis, the methods have been chosen to explore the skeletal assemblage and apply statistical means of comparison. The osteological methods employed were examined at a macroscopic level, the decision to complete this form of analysis was justified in the size of the skeletal sample that was to be examined over the course of this research project, as well as taking into account the poor preservation status of the skeletal material and the methods applied in the published analysis of the comparative skeletal populations utilised in this thesis.

In the following chapter the paleodemographic methods discussed above are applied to the skeletal assemblage to reconstruct the Hospital of St James' demographic profile. This chapter uses a multi-disciplinary approach applying both morphological skeletal analyses to assess preservation levels, age at death and biological sex followed by statistical analysis which utilises chi-squared calculations to test the degrees of significance between the Hospital of St James and comparative archaeological populations.

The thesis goes on to apply the paleopathology methodology outlined above in Chapter 6. This chapter includes a synthesis of the types of pathologies covered in the skeletal analysis, via three research themes of 'health and stress markers', 'markers of activity and lifestyle' and 'medical intervention and potential for long term/palliative and skilled care'. Within this chapter analysis of the pathologies are further explored through the application of Tilley's (2012) 'bioarchaeology of care' methodology.

5

Paleodemography of the population of the Hospital of St James

Through analysing the osteological remains of a past population, it is possible to reconstruct that population's demographic profile. To achieve meaningful reconstructions and understanding of population structures these should be compared to contemporary assemblages of skeletons (Chamberlain 2006, 177-80). The following provides an analysis of the Hospital of St James' population, alongside a comparative contextualisation of this data with demographic profiles from medieval populations. Before the discussion of paleodemography can take place, the completeness and preservation of the skeletal assemblage is presented to provide context to the physical condition of the skeletal material analysed.

5.1 Completeness and preservation

Completeness and preservation of the assemblage was documented in two ways: quantification of the percentage of the skeleton recovered, and assessment of the quality of surface preservation. While preservation is informative in research seeking to explain taphonomic processes of different burial environments (Pokines and Symes 2013, 3-4), here it has been applied to quantify surface preservation in order to assess the quantity and quality of the pathological data obtained from the skeletal assemblage. If the surface morphology of bones is obscured by erosion, it will impact on the extent to which pathological conditions can be identified and investigated on the skeleton. A prime example of this is the susceptibility of new bone formation to erosive activities.

Percentage recovered	Area A	Area B	Area C	Total
<25	5	20	0	25
26-50	3	27	1	31
51-75	17	26	0	43
>75	44	27	5	76
Total	69	100	6	175

Table 5.1.1: Skeletal completeness, represented here with the number of individuals in each cemetery area.

The highest rate of completeness was seen within the chapel (Area C), where 83.3 percent (n=5/6) of the burials comprised more than 75 percent of the skeleton (table 5.1.1). Completeness within Area A was slightly lower, at 63.8 percent (n=44/69), but in Area B only 27 percent (n=27/100) of the burials contained more than 75 percent of the skeleton (table 5.1.1). The seven grades of surface preservation (following the Chartered Institute for Archaeologists and BABAO guidelines (McKinley 2004, 16) reflect variation between slight erosion which has limited impact on the recording of skeletal variation and pathological conditions (grades 0-2), moderate erosion, which has the potential to affect the accuracy of skeletal assessment (grades 3-4), and severe erosion which may significantly obscure important skeletal features (grades 5-5+) (McKinley 2004, 16). The quality of surface preservation proved to be superior in Area A; 79.7 percent of the skeletons were categorised in the first three grades where, at most, slight surface erosion has taken place; 18.8 percent fell in the mid-range preservation categories and just one individual was categorised as grade 5, where severe erosion had deteriorated the surface preservation of bone. Despite higher proportions of completeness, the intramural burials were more heavily affected by poor surface preservation than the hospital cemetery, with 33.3 percent heavily eroded. However, Area B presents as the area of burial most severely affected by taphonomic factors. Although just six percent of these burials were considered to be heavily affected, 46 percent sat in the mid-range of 25-74 percent complete.

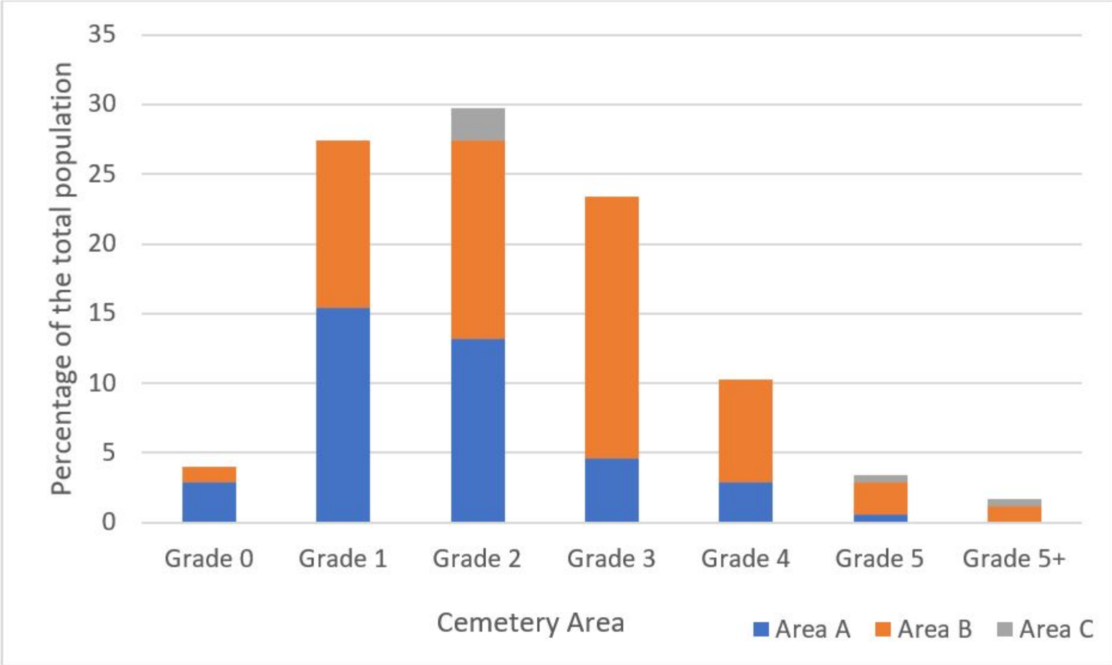

Figure 5.1.1: Skeletal preservation across the three areas of burial.

It is evident that levels of skeletal preservation varied throughout the site. This is likely a result of compounding taphonomic factors related to variations in soil composition, water drainage, disturbance of primary burials during cemetery reuse and excavation-related damage. It is evident that burials within the hospital cemetery (Area A), in general, survived in far better condition than those buried in the cemetery extension (Area B) and the chapel (Area C) (figure 5.1.1). This results in a potential bias in the extent to which detailed palaeopathological analysis can be undertaken on different parts of the assemblage. Indeed, the cemetery extension contained the greatest number of individuals for whom a specific category of biological sex or age at death could not be determined, as will be discussed below. While the differential effects of taphonomy on the assemblage cannot be ameliorated, their impact on the results obtained in the forthcoming analysis will be examined to account for any resulting bias.

5.2 Biological sex profile

Of the 175 individuals studied, 99 (56.6 percent) were adults, aged 18 years and above at death. Of these adults, biological sex could be determined for 75 individuals (75.8 percent). As discussed in Chapter 4, the non-adult population (n=76), have not been assigned biological sex due to the current inaccuracy and lack of assurance surrounding methods of biological sex assessment in immature skeletal remains (Cunningham 2016, 17).

Of the total population 34.9 percent (n=61) were male, just 5.1 percent (n=9) were determined to be female, 2.9 percent (n=5) were indeterminate and 43.4 percent (n=76) were non-adults (table 5.2.1). Just 13.7 percent (n=24) could not be assigned biological sex due to issues of recovery and taphonomy. It is unlikely that the dominant representation of males would be altered to any significant extent had these individuals been assigned biological sex; even if they were all female, males would still dominate the sample.

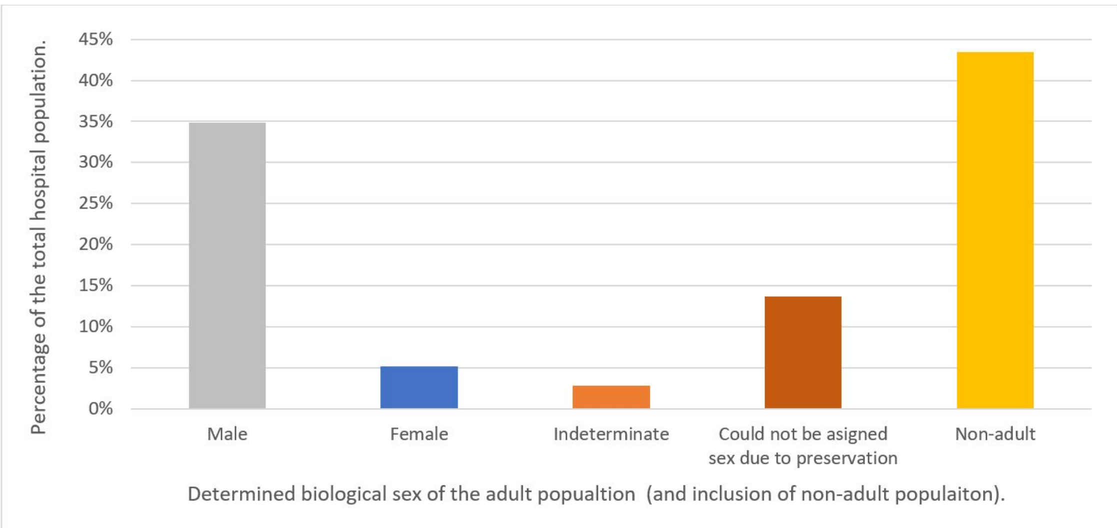

Figure 5.2.1: Distribution of biological sex of the adult population within the total population.

Within cemetery Area A, a ratio of 16 males: 1 female was present, while Area B demonstrates the highest proportion of females at a ratio of 3.4 males: 1 female (refer to figure 1.3.5 to review the cemetery areas). However, females still only accounted for 19 percent of the population in Area B. No female individuals were recovered from Area C (the intramural burials within the hospital chapel), which is suggestive of a strict division of the sexes within the higher echelons of the population (figure 5.2.2). A discussion of the presence and distribution of females within the cemetery at the Hospital of St James is carried out in section 5.4.

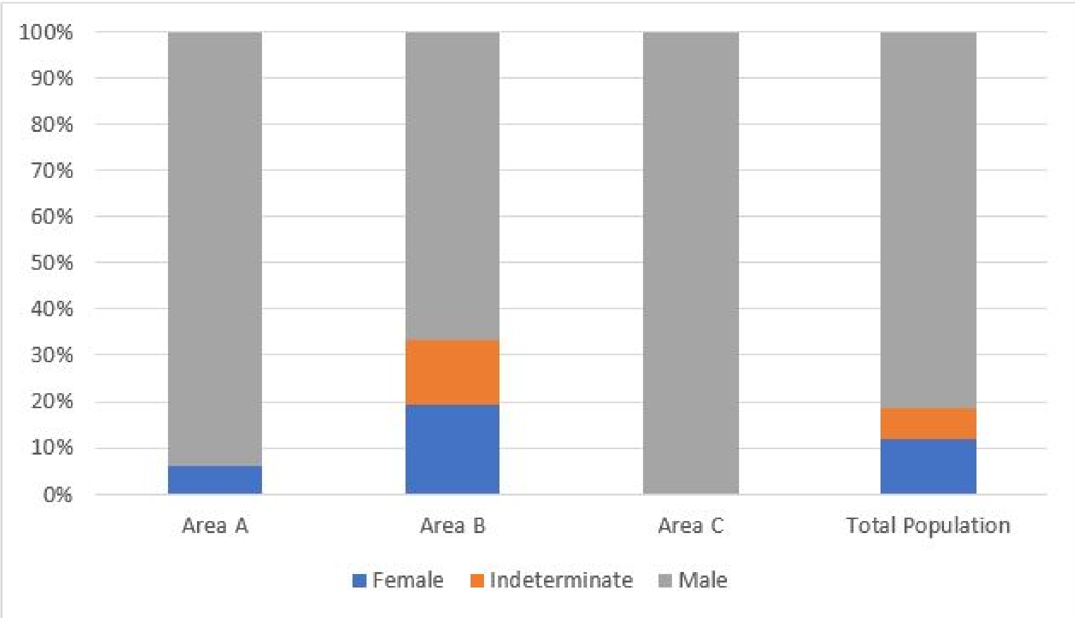

Figure 5.2.2: Distribution of biological sex of the adult population.

5.3 Age at death

Of the hospital population, 138 individuals could be assigned an age at death (table 5.3.1; figure 5.3.1). The 37 for which this could not be achieved could still be assigned to the category of non-adult (under 18 years of age at death), in which there are eight individuals, and the category of adult (over 18 years of age at death), in which there are 29 individuals. When all age categories under the age of 18 years are considered, the non-adult population totals 44.0 percent (n=77) of the population, and likewise when all categories of 18 years and over are considered, the adult population accounts for the remaining 56.0 percent (n=98) of the population.

The age at death profile of the cemetery population demonstrate a high proportion of non-adults (43.4 percent, n=76) at the Hospital of St James. Only three individuals (1.7 percent) were aged less than 12 months at death, 22 individuals (12.6 percent) in the 1-5 year category displays a significant increase in the number of non-adults, the number is even greater in the 6-11 years at death category which is comprised of 36 individuals (20.6 percent), which is the largest age category within the population. The number of non-adults then significantly drops and just 8 individuals (4.6 percent) represent those aged 12-17 years; this distinct drop of individuals around the age of 12 years is discussed in greater detail in Chapter 7 where the presence of children within later medieval religious communities is explored. The adult population demonstrates a steady rise to a peak of individuals in the 36-45 year age category in which there are 30 individuals (17.1 percent) following a decrease to 18 individuals (10.3 percent in the eldest category of greater than or equal to 45 years) .

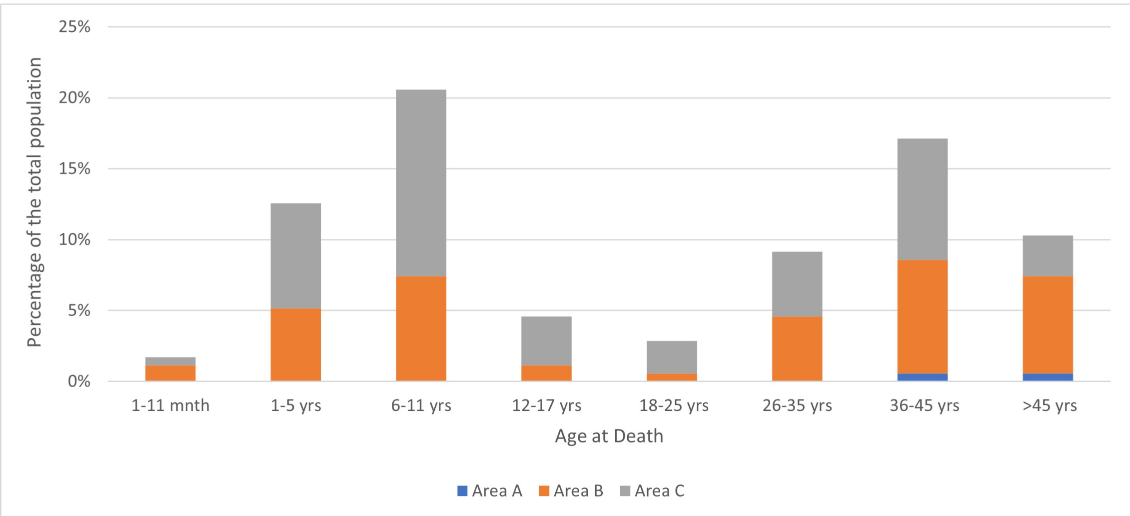

Figure 5.3.1: Mortality profile of the cemetery assemblage, represented by percentage of the total population.

Age at Death	Area A		Area B		Area C		Total	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent
< 4 weeks	0	0.0	0	0.0	0	0.0	0	0.
1-11 mnths	2	2.9	1	1.0	0	0.0	3	1.7
1-5 yrs	9	13.0	13	13.0	0	0.0	22	12.6
6-11 yrs	13	18.8	23	23.0	0	0.0	36	20.6
12-17 yrs	2	2.9	6	6.0	0	0.0	8	4.6
18-25 yrs	1	1.6	4	4.0	0	0.0	5	2.9
26-35 yrs	8	11.6	8	8.0	0	0.0	16	9.1
36-45 yrs	14	20.3	15	15.0	1	16.8	30	17.1
≥45 yrs	12	17.4	5	5.0	1	16.8	18	10.3
<18 yrs	0	0.0	8	8.0	0	0.0	8	4.6
≥18 yrs	8	11.6	17	17.0	4	66.7	29	16.6
Total	69	100.0	100	100.0	6	100.0	175	100.0

Table 5.3.1: Distribution of age at death of the population from all three areas of interment.

To better demonstrate the attritional mortality profile present at the Hospital of St James, the cemetery's profile was compared with two well-known archaeological populations. The aim of comparing the Hospital of St James to typical population profiles is to establish if the hospital cemetery deviates from the norm for the medieval period, if the population appears to exclude any particular demographic groups, and to determine whether the population interred were victims of the numerous epidemics that took place in later medieval England. The cemetery data and demographic analysis utilised for comparative purposes were published by Margerison and Knüsel (2002) and have been used to establish population profiles. The choice of this data was made to enable the easy comparison of the populations of the Hospital of St James with existing population's profiles and to enable easy utilisation of the cemetery data in future paleodemographic studies.

The populations utilised in the publication by Margerison and Knüsel (2002) were; St Helen-on-the-Walls, York, which represents a typically attritional mortality profile and the Royal Mint cemetery, London, which represents a typically catastrophic profile. An attritional demographic profile represents a population experiencing a natural attrition of death, as opposed to a population in which a mass epidemic or catastrophe has affected the mortality of the population (Margerison and Knüsel 2002, 134). It is important to note that the demographic profile of the St Helen's population has an under-enumeration of infants (0-5 years) and an over-enumeration of juveniles (5-15 years), which slightly deviate from the expected attritional cemetery data. Despite these inaccuracies, which will be explicitly accounted for in later analysis, the site has been subject to analysis and chosen for the comparative analysis in numerous studies as it provides an excellent comparative population from an archaeological context (Gowland and Chamberlain 2005; DeWitte and Wood 2008). The church and cemetery at St Helen's were in use from the late twelfth century to 1550, and therefore provides a contemporary population from a preindustrial society for comparison (Margerison and Knüsel 2002, 134). The Royal Mint site was utilised from 1348-50 during the Black Death epidemic and provides a preindustrial society experiencing mass epidemic for comparison (Margerison and Knüsel 2002, 134). As discussed in Chapter 4 section 4.3, life tables have not been employed due to the assumptions they make surrounding population mortality and resulting ineffectual statistics (Chamberlain 2006, 27). Furthermore, life tables are best applied to stable populations and not to the context of a medieval hospital in which the population is comprised entirely of external migrants.

Figure 5.3.2 provides the demographic profile of the Hospital of St James cemetery alongside the attritional profile of the St Helen-on-the-Walls and the catastrophic profile of the Royal Mint cemetery. The following presents the ways in which the hospital's populations meet and deviate from the expected norm before entering a discussion of why such a demographic profile may be present at the hospital site.

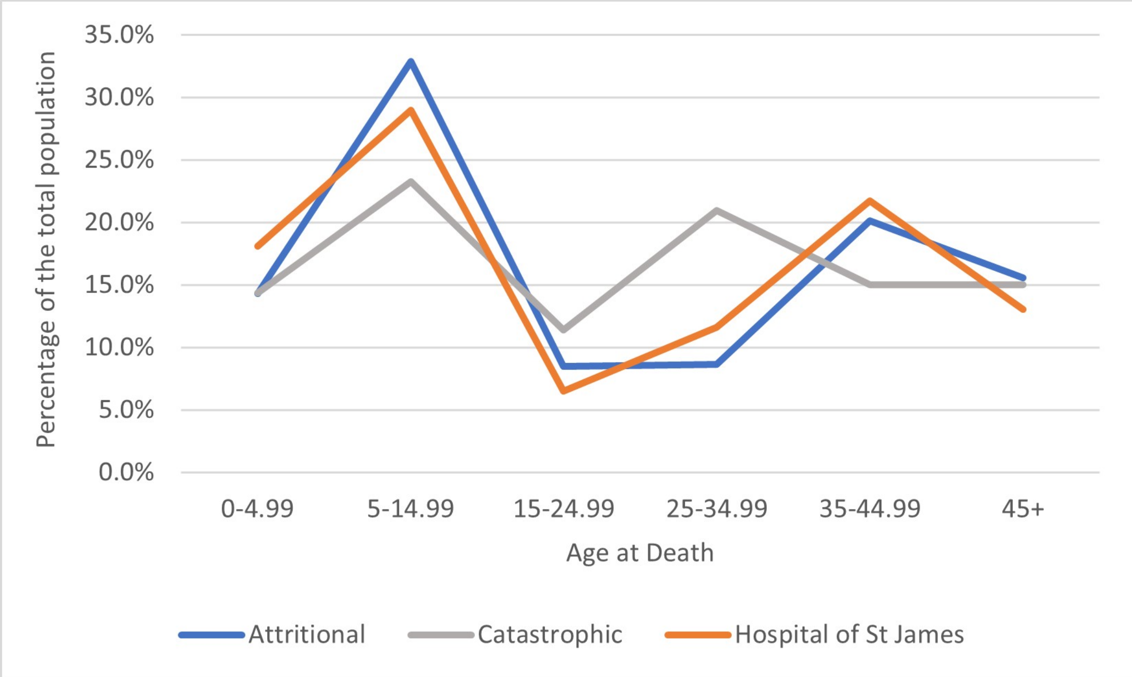

Figure 5.3.2: The mortality profile of the Hospital of St James compared with the attritional profile from St Helen-on-the-Walls and the catastrophic profile from the Royal Mint cemetery population.

As previously stated, an attritional mortality profile is defined by the presence of deaths in all age categories, with elevations in mortality among the youngest and oldest members of the population (Chamberlain 2006: 123, 162). Across the entire hospital population, no individuals were recorded in the perinatal category and just three individuals aged between one and eleven months were recovered. Due to the low number of individuals in these age categories and therefore a lack of data for comparison, all individuals under the age of 5 years were grouped. Individuals aged 5 years and under account for 14.3 percent of the cemetery population at the Hospital of St James. When compared to the data in figure 5.3.2, it appears that this is an over enumeration of individuals for either an attritional or catastrophic mortality profile, however it is here that the St Helen's data under-enumerated the infant population (Margerison and Knüsel 2002, 141). Therefore, the Hospital of St James is consistent with the expected infant mortality of a pre-industrial society, which Chamberlain (2006, 62) suggested shows the highest mortality among the youngest age categories, representing infant mortality at birth and during weaning. The 5-15 year category also follows the attritional trend of mortality; in both attritional and catastrophic profiles a peak in death is recorded in this segment of society. The population of the Hospital of St James experiences a peak in individuals aged 5-15 years above both typical mortality trends. It is possible to explain this peak in representation of young individuals through an analysis of the hospital's use, which will be discussed in Chapter 7. The decrease in the presence of individuals aged 15-24 years at death again follows the expected trend of an attritional mortality profile. This age category is the smallest of all in the Hospital of St James cemetery population accounting for approximately 7 percent of the overall population. This low representation of deaths continues throughout the 25-35 year age category, with a very slight increase in number. The representation of individuals then increases in line with the attritional profile into the 35-45 year age category and tails off in the 45 and up category. Overall, it can be confidently stated that the general trend in mortality within the cemetery of the Hospital of St James is in line with that of an attritional mortality profile.

The demographic configuration of the hospital by cemetery area has been carried out to determine whether any significant zoning of burial based on age took place within the cemetery and to build upon the analysis of burial practice carried out in Chapter 3. The mortality profile of each cemetery area are depicted in figure 5.3.3. Cemetery Areas A and B follow the general attritional trend described above. The first indication of discrepancy between the two cemetery areas occurs in the 5-15 year category where a greater proportion of individuals are present in cemetery Area B. A more significant discrepancy in Areas A and B is represented in the 45 years and above age category with a higher count in cemetery Area A, where they account for 12 percent more then the population in cemetery Area B. A true mortality profile would show a tapering of the final age category to the age of the eldest individual in the population, whereas mortality profiles of skeletal samples show an abrupt end to the population at the point at which accurate age estimation ceases to be deemed accurate. Cemetery Area C cannot be compared to Areas A and B in the same manner. The reason for this is that Area C represents a very distinct area of burial in which only a small subsect of the population is represented. All individuals recovered from cemetery Area C were adults (over the age of 18 years) and of those that could have an accurate age estimation carried out all were aged 36 years or above.

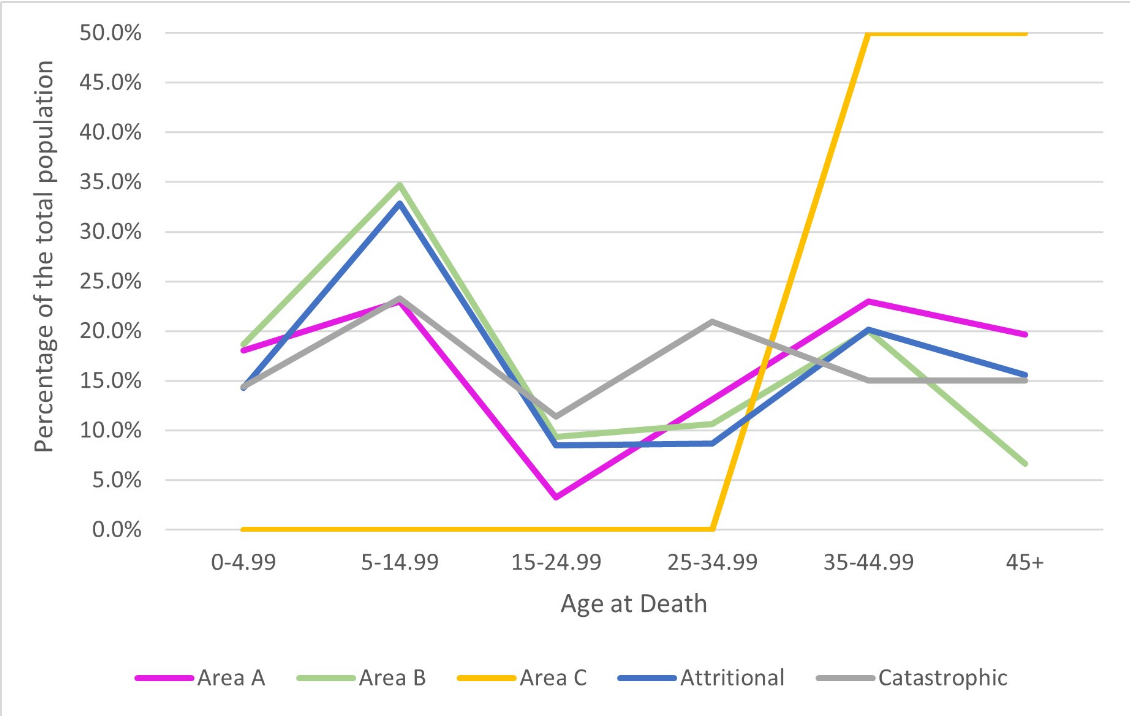

Figure 5.3.3: The mortality profile of all cemetery areas at the Hospital of St James compared with the attritional profile from St Helen-on-the-Walls and the catastrophic profile from the Royal Mint cemetery population.

5.4 Discussion

The analysis of population demography carried out above has revealed that the Hospital of St James does in fact follow the demographic trend of an attritional mortality profile, yet is biased in its paucity of female individuals and the high presence of non-adults aged 6-11 years.

It is apparent that the population as a whole displays an uneven representation of the sexes, at a ratio of 6.7 males: 1 female. The high proportion of male individuals is unexpected of a typical medieval parish cemetery, which would have roughly equal numbers of males and females, reflecting the sex structure of a normal living population. Such normative sex ratios are evident in the parish burial grounds at St Nicholas Shambles, London and at Wharram Percy, Yorkshire, which present with ratios of 1.27 males: 1 female, and, 1.58 males: 1 female respectively (White 1988, 30; Mays 1998, 71-2). Therefore, departure from normative sex ratios expected of medieval cemetery populations must be attributed to socio-cultural factors of the living population, regarding their living community and burial of the deceased. The bias of the cemetery population of the Hospital of St James towards a heavily male dominated population can be attributed to three potential reasons. First, that the cemetery was heavily zoned by biological sex, and, the corresponding female population was not recovered from the site. Second, the cemetery served a monastic or quasi-monastic community that was predominantly male. Third, it is possible that the hospital was heavily restrictive against the female population and had strict admittance rules against the housing of women.

Considering the religious underpinning of the hospital's non-inmate community the lack of female individuals is not to be the result of a division of the sexes within the cemetery, but rather due to the exclusion of females from the hospital community. This is likely the result of the overarching religious foundation of hospitals in medieval society rather than their individual use. The provision of care and management of medieval hospitals was commonly provided by the Augustinian Rule, as has been discussed in Chapter 2. The females present in the cemetery may represent the laywomen active in the hospital community attending to the ill and contributing to the daily running of the hospital. Such an explanation would account for the absence of an equal female population, but the presence of a few distinct females within the cemetery population. A greater discussion of the lack of female burials is carried out in section 5.4, under a monastic comparison of biological sex.

The under-representation of perinates and infants at the Hospital of St James should be considered alongside the general absence of females within the cemetery population, for it might be expected that individuals under a year old would exist in a population where their mothers or female caregivers were also present. In an attritional mortality profile, infant mortality and complications during birth are reflected in the presence of both the child and the mother among the dead (Roberts and Manchester 1995, 25). Neither perinates nor women of childbearing age were present in the cemetery population in proportions that would reflect the dangers of medieval childbearing and infancy. It is possible that this is a direct result of the hospital's function and, more specifically, rules against the admittance of pregnant women. Such rules are evidenced at other, better-documented hospital sites, such as St John's Hospital, Cambridge and St John's Hospital, Bridgewater (Rubin 1987, 300-1). The statutes from St John's, Bridgewater, in particular, specify that no pregnant women or suckling infants were to be admitted even though they may be poor or infirm, and if any such be admitted by mistake, they were to be expelled (Maxwell-Lyte 1934, 289).

Alternatively, preservation issues may be responsible, at least in part, for the underrepresentation of perinates and infants at the Hospital of St James. Buckberry's (2000) publication on the absence of non-adults from Anglo-Saxon burial contexts concluded that children were rarely excluded from normal burial rites and their absence from the archaeological record is the result of taphonomic and mineral related degradation. Buckberry's (2000) publication considers the practicalities of non-adult survival in different burial contexts. The impact of preservation on the absence of non-adult remains is further supported at the site of the Hospital of St James by the fact that there is evidence of differential preservation in the different cemetery areas. For example, skeletons under the age of 5 survived far better in cemetery Area A, where 81.8 percent were more than 50 percent complete compared to Area B where only 21.4 percent were more than 50 percent complete. Thus, preservation is clearly a factor for consideration. Nonetheless, non-adult remains survive well in cemetery Area A, yet the presence of perinates and infants in this area is still far below what would be expected of a normal pre-industrial population. It is reported that the largest proportion of non-adult deaths in pre-industrial communities derive from infant mortality (death of children under one year of age) and children under the age of five years are most susceptible to under-nutrition and increased pathogen load (Chamberlain 2006, 103; Mays 2007, 89). Therefore, in regard to the population of the Hospital of St James it is justifiable to look to social and cultural reasons to explain the small number of females and large number of non-adults.

In contrast to the youngest age categories, those aged 6-11 years account for the largest population of non-adults within the cemetery at 20.6 percent of the total population and 52.2 percent of the non-adult population. This demonstrated a significant proportion of the population being accounted for by just 5 years of age. Chamberlain (2006, 182), White (1988, 30) and Waldron (1994, 23) estimate that in an attritional mortality population non-adults account for between 30-50 percent of the total population. Despite the dearth of perinates and infants and due to the high percent of individuals classed as being in late childhood, 44 percent of the hospital population are non-adults. The high prevalence of older children, which make up the majority of the 44 percent, were recovered from primarily cemetery Area A and also cemetery Area B. The presence of these individuals in late childhood is explored further below in Chapter 5, which feeds into the argument that the hospital may be associated with a monastic or quasi-monastic community.

The possibility that the cemetery of the Hospital of St James was associated with a monastic or quasi-monastic community is further supported by the eldest category aged 45 years and above. As seen in Table 5.2.1, this age category accounted for 10.3 percent of the total population and was present in all three areas of the cemetery. It is possible that the hospital cared for the sick and infirm who retired from the monastic community within the Abbey. If this was the case then like its contemporary Hospital of Gabriel Clyst and St Saviour, Bury St Edmunds the monastic men were those of an age at which they could not continue the religious lifestyle expected of them within the monastic precinct. This theory is further supported by the dearth of individuals in their late teens at which age children can be admitted in to religious houses as adults (explored further in Chapter 7).

5.5 Comparison of the St James' population to other medieval populations

In light of the above demographic analysis it can be concluded that the cemetery population from the Hospital of St James does represent an attritional mortality profile, yet is a population selective of age and biological sex. The most significant discrepancy in the hospital's population is the paucity of female individuals and the high presence of non-adults aged 6-11 years. The lack of females and high presence of non-adults indicated a potential specialised use of the hospital.

The following presents a comparative analysis of the demographic profile of the Hospital of St James as a means to further characterise the Hospital of St James. This approach sets the analysis of the Hospital of St James inline with current archaeolgoical literature on the study of medieval hospitals and follows the approach taken by Gilchrist and Sloane (2005) as outlined in Chapter 2.

As dicussed in Chapter 2, nine medieval hospitals were selected with the aim of establishing similarities and differences with the Hospital of St James. Each comparative hospital was selected on the basis that their function is well established in historical records and via archaeological investigation. The cemeteries subject to analysis represent hospitals dedicated to the sick poor, the leprous, poor wayfarers and pilgrims, run as alms-houses. Background context of each hospital has been outlined in section 2.7 and a summary reminder of each is provided below in table 5.5.1. A breakdown of these cemeteries' demographics is provided in figures 5.5.1 and 5.5.2. The following explored the demographics of the hospital's as categorised by their independent researchers and chi-squared test have been carried out to assess the statistical significance of the difference in male and females and adults and non-adults at the Hospital of St James compared to the populations at each of the nine hospitals; statistical significance was counted at p <0.5.

Hospital site	Foundation	Dissolution	Who they cared for	Non-adults		Adults		Female		Male	
				Count	Percent	Count	Percent	Count	Percent	Count	Percent
St James, Thornton Abbey, Lincolnshire	c.1139	Early 15th c.	?	76	43.4	99	56.57	9	12.9	61	87.1
St Mary Magdalene, Partney, Lincolnshire	1115	1318	Poor wayfarer and pilgrims	5	15.2	28	84.8	1	5.6	17	94.4
St Nicholas, Lewes, East Sussex	Pre 1264	-	Sick poor	14	13.7	88	86.3	16	19.8	65	80.2
St John, Cambridge	1195	-	Poor and infirm	63	15.6	341	84.4	74	46.3	86	53.7
St Bartholomew, Bristol	c.1232/4	1532	Sick poor	7	21.2	26	78.8	11	47.8	12	52.2
St Leonards, Newark, Nottinghamshire	c.1133/4	1642	Sick poor	0	0	87	100	11	14.3	66	85.7
St Margaret, High Wycombe, Buckinghamshire	c.1386	-	Leporous sick	0	0	10	100	2	33.3	4	66.7
St Mary Magdalene, Winchester	Late 11th c.	-	Leporous sick	10	18.5	44	81.5	3	23.1	10	76.9
Infirmary cemetery, St Mary Spital, London	1235	1280	Poor wayfarer and pilgrims	32	31.7	69	68.3	18	29.5	43	70.5
St Mary Spital, London	1197	Late 14th/ early 15th c.	Sick poor	12	11.1	96	88.9	41	45.6	49	54.4

Table 5.5.1: Summary of the nine comparative hospitals cemetery population's to compare and contrast with the Hospital of St James.

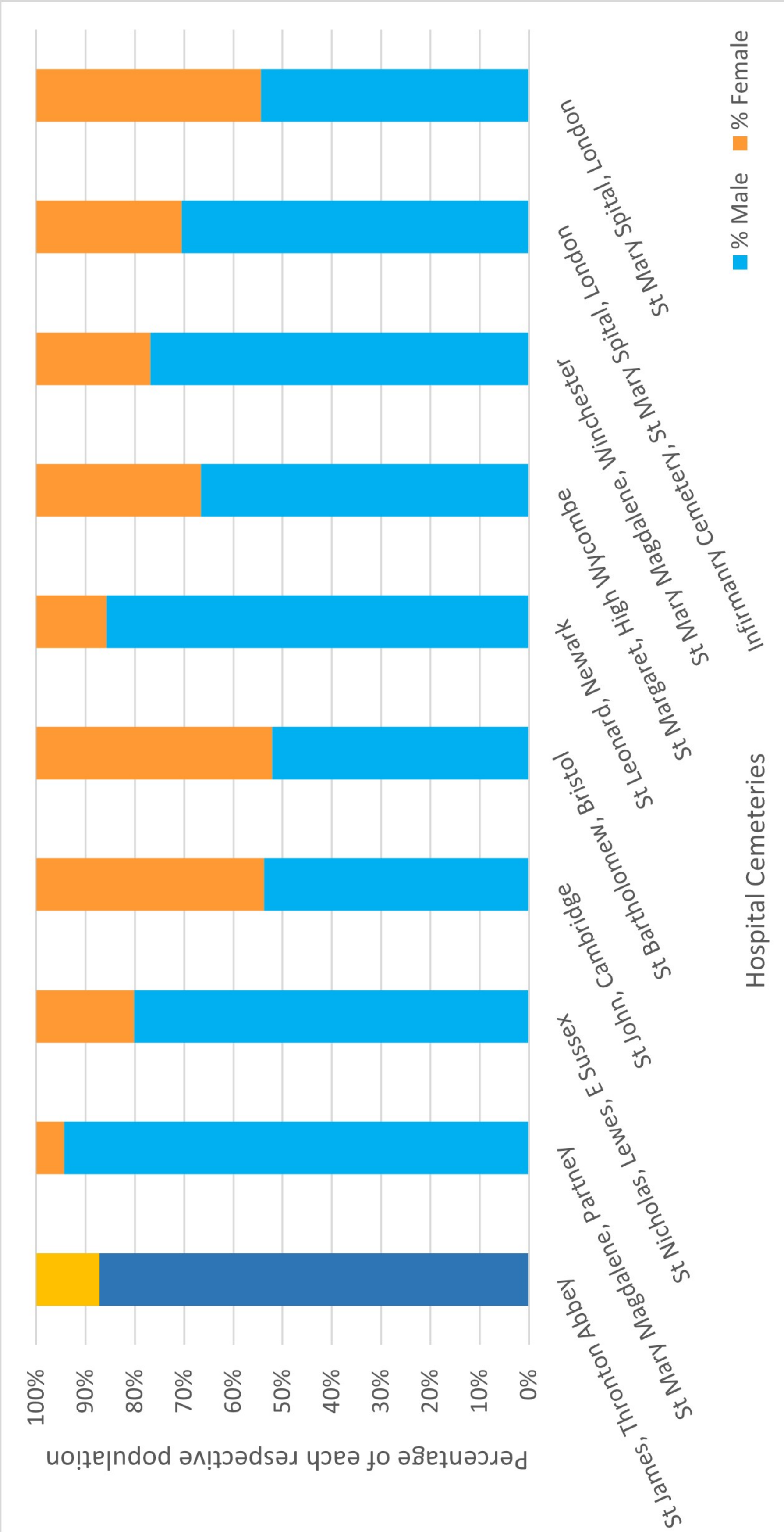

Figure 5.5.1: Division of biological sex within the Hospital of St James compared to the demographic profile of nine contemporary hospital cemetery populations.

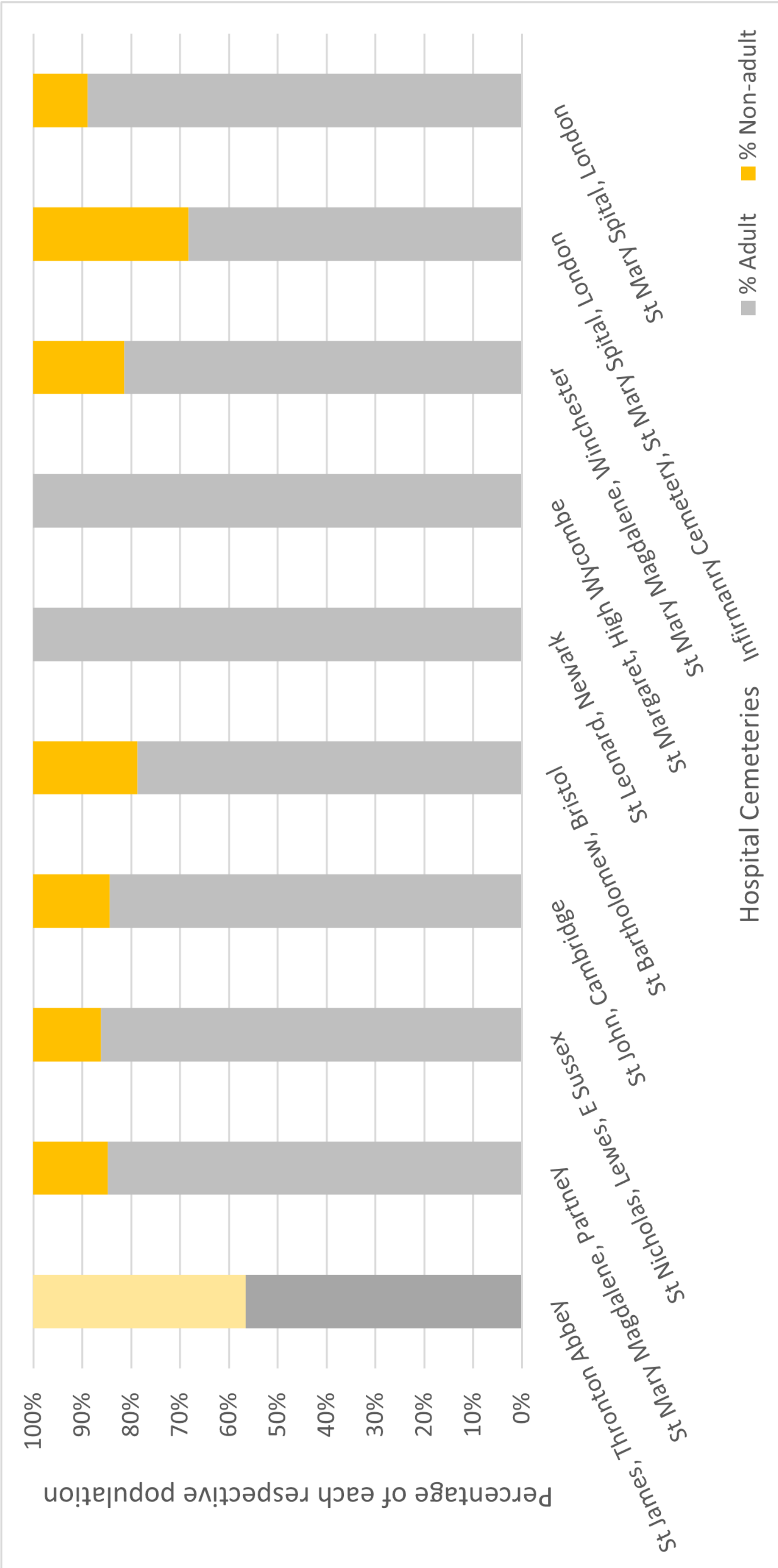

Figure 5.5.2: Representation of adults and non-adults within the Hospital of St James compared to the age and sex profile of nine contemporary hospital cemetery populations.

A comparison of the proportion of males and females (figure 5.5.1) and adults and non-adults (figure 5.5.2) suggests several general observations. The sex ratio of the hospital cemeteries is highly variable and ranges from approximate parity in numbers of males and females to a strong bias towards males. The Hospital of St James fits with examples of the latter, including St Mary Magdalen, Partney and St Leonard Newark. No hospitals from this group had an overrepresentation of females. Children appear to be much more frequent among the Hospital of St James burial (43.4 percent, n=76/175) population than any of the other hospital sites. The demographic at the Hospital of St James is most similar to St Mary Spital and St Bart's, Bristol, both of which have a prevalence of non-adults greater than 20 percent, but nonetheless, St James' are still substantially more numerous. Indeed the majority of the comparative hospitals have less than 20 percent non-adults, and two examples, St Margaret, High Wycombe, and St Leonard, Newark, have no immature individuals in their cemetery populations.

5.5.1 Hospitals for the leprous sick

The hospitals of St Margaret, High Wycombe and St Mary Magdalene, Winchester, are those known to have been founded for the care for the leprous sick. However, there is no historical record indicating that the Hospital of St James housed the leprous, nor is there any skeletal manifestation of the disease among the hospital's cemetery population. Nonetheless, a comparison of the hospitals was made, but was not possible to complete chi-squared analysis on these populations due to the small sample sizes of both the comparative hospitals (n= 6 and n= 13). The ratio of males to females was 2:1 at St Margaret, High Wycombe and 3.3:1 at St Mary Magdalene, Winchester, which show no similarity to the rate of 6.7:1 at the Hospital of St James (as presented as a percentage of the total cemetery populations in figure 5.5.3). However, it should be noted that the skeletal material from St Margaret's was of extremely poor preservation and just 13 individuals could be assigned biological sex (Farley and Manchester 1989, 84). Furthermore, the hospitals do not show any similarities between the comparison of age at death, non-adults account for just 18.5 percent at St Mary Magdalene, Winchester and none were recorded at the Hospital of St Margaret's, High Wycombe (figure 5.5.4). Comparisons were also made with the leper hospitals of St James and Mary Magdalene, Chichester, and St Margaret Huntingdon, Cambridgeshire, as presented by Gilchrist and Sloane (2005, 206 tabs. 20). Again, there was no evidence that the populations shared demographic features, with males accounting for 50.5 percent and 17.0 percent of the respective hospitals adult populations and children accounting for 26 .0 percent and 18.7 percent respectively.

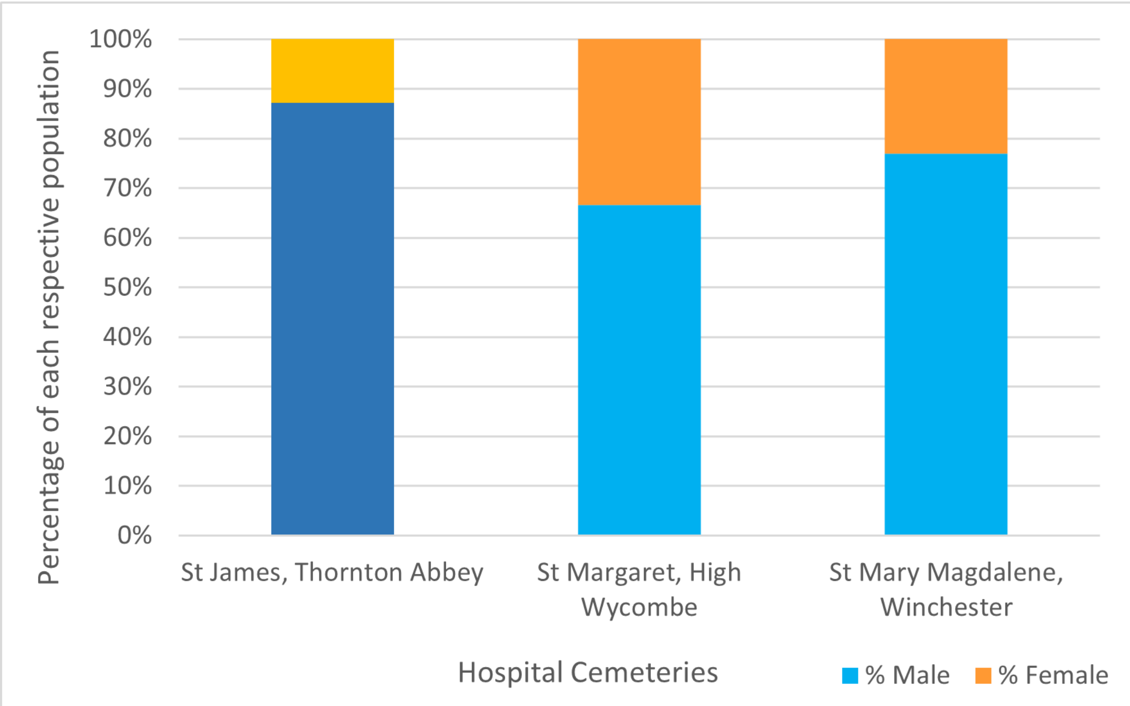

Figure 5.5.3: Representation of male and female adults within the Hospital of St James compared to the demographics of hospitals for the leprous sick.

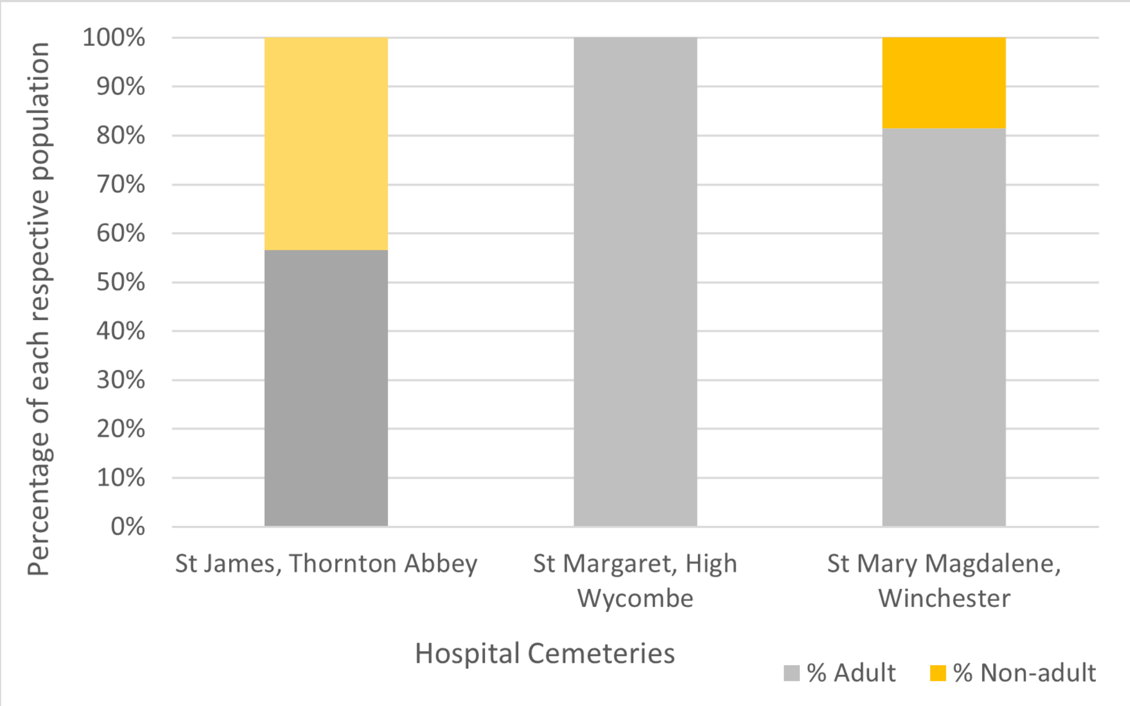

Figure 5.5.4: Representation of adults and non-adults within the Hospital of St James compared to the demographics of hospitals for the leprous sick.

5.5.2 Alms-houses

The assemblage from the Hospital of St James was not compared with those hospitals thought to have been alms-houses. The reason for this is that the vast majority of alms-houses were founded for different purposes, and only became alms-houses when the care the original hospital provided was no longer needed by the local community. For example, many leper houses including St James and St Mary Magdalene, Chichester and St Mary Magdalene, Winchester ceased to be such in the fourteenth century, as the prevalence of the disease declined, when they transitioned into alms-houses (Lee and Magilton 1989, 273; Roffey and Tucker 2012, 178).

As a result of the changing role, the cemetery population would include both the demographics of the hospital's original population, determined by its original function, as well as its later function as an alms-house. If it were possible to identify the year in which the transition had been made and cemetery phase in which this took place, the cemetery population could be segregated into the appropriate demographic. However, this is unrealistic and impossible as for many hospitals it is only possible to identify the century in which transition took place. For instance, the hospitals of St Bartholomew, Bristol; St James and St Mary Magdalene, Chichester; and St Mary Magdalene, Winchester are all known to have changed function from their original foundation into an alms-house at some point between the thirteenth and fourteenth century. Therefore, the dating of the conversion is not recorded well enough to determine a point at which the cemetery population would have changed. In addition to which, the archaeological remains of the hospital cemetery are rarely in such a state that exacting phases can be determined to the level of specificity that would be required. Furthermore, it is likely that the two uses overlapped and therefore each demographic would be infiltrated by members of the other population.

5.5.3 Hospitals for the poor wayfarer and pilgrim

Of the comparative hospitals, St Mary Magdalene, Partney and the infirmary cemetery at St Mary Spital, London represent those whose primary role was care of the poor wayfarer and pilgrim (Thomas *et al.* 1997, 112; Atkins and Popescu 2010, 204). Despite the similarity in function, these two sites have very different sex profiles. The demographics of the Hospital of St James shows a degree of similarity with these hospitals; the male population is dominant in all three. As displayed in figure 5.5.5, males account for 87.0 percent of the Hospital of St James assemblage, 94.0 percent of the Hospital of St Mary Magdalene, Partney and 70.0 percent of the infirmary cemetery at St Mary Spital, London. Both the Hospital of St Mary Magdalene, Partney and St Mary Spital, London demonstrate an under-representation of females in their populations, however, the prevalence of females at the Hospital of St James (13.0 percent) is over double that of St Mary Magdalene (6.0 percent), but less than half of that recorded at St Mary Spital (30.0 percent). The result of the chi-squared tests indicated no significant difference between the Hospital of St James and the Hospital of St Mary Magdalene, Partney (X2=0.7579, p=.383997). At the infirmary cemetery at St Mary Spital, London a significant difference was indicated (X2= 5.5231, p=.018767). Given that the representation of males and females varies so much between hospitals of the same category, biological sex is not a useful characteristic of hospital use, but is still a useful characteristic of the religious association of hospitals.

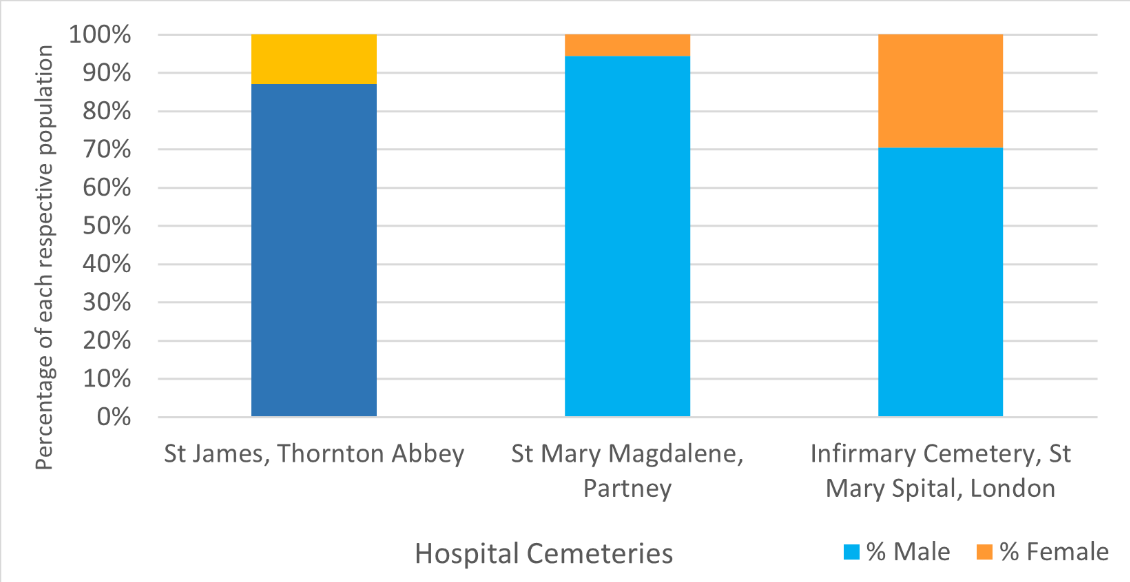

Figure 5.5.5: Representation of male and female adults within the Hospital of St James compared to the demographics of hospitals for the poor wayfarer and pilgrim.

The most significant similarity is the degree to which non-adults are present at the Hospital of St James and St Mary Spital. A substantial 43.4 percent of the Hospital of St James assemblage were under 18 years of age at death, which is inconsistent with the majority of the comparative sites, however, the next largest representation of non-adults was 31.7 percent at St Mary Spital infirmary cemetery (figure 5.5.6). The result of the chi-squared test also indicated no significant difference between the representation of non-adults (X2=3.7091, p=.054116). The representation of non-adults at the Hospital of St Mary Magdalene, Partney did indicate a significant difference (X2=9.3367, p=.002246). While the prevalence of non-adults at the Hospital of St James is more similar to examples of hospitals for the poor wayfarer and pilgrim than other types discussed below, the difference of 11.8 percent between the representation of children at St James and the next largest prevalence of non-adults indicates the former may be a unique hospital population in which the age structure is different from that seen elsewhere.

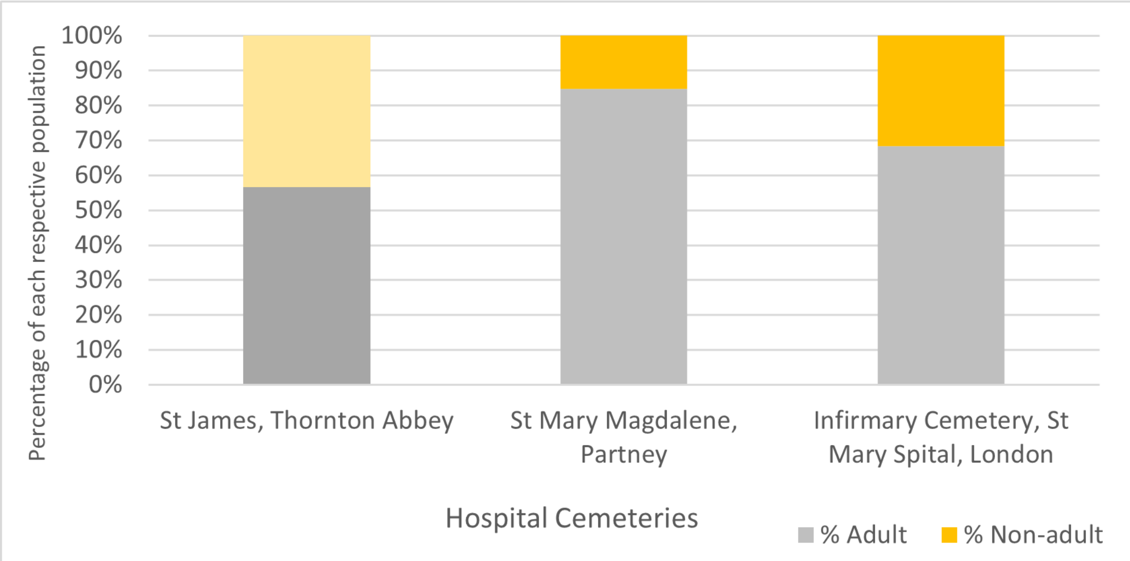

Figure 5.5.6: Representation of adults and non-adults within the Hospital of St James compared to the demographics of hospitals for the poor wayfarer and pilgrim.

There are various types of evidence that enable a hospital to be associated with poor wayfarers and pilgrims, primarily the situation of hospitals on known pilgrim routes and the presence of material culture within the hospital's archaeological assemblage. Pilgrimage played an important role in the religious life of medieval England and was encouraged to generate the memory of the saints. Pilgrim routes could consist of local, nationwide and international travel. Internationally known routes include the road to St James at Santiago de Compostela in Spain or St Thomas Becket at Canterbury (Theilmann 1987, 93; Thomas *et al.* 1997, 89). While pilgrims flocked to the internationally renowned shrines, for many, sites closer to home were more feasible to visit, especially for those embarking on their journey for health-related issues. Irrespective of their destination, pilgrims and general travellers were offered board and lodging in hospitals located along their travel routes. Once they had reached their destinations, hospitals were there to accommodate them during their stay. For example, when visiting the shrine of St Mary Magdalene at Glastonbury Abbey, travellers were housed in the parish church of St John the Baptist functioning as a hospitium for visiting pilgrims, and those visiting Lewes Priory in East Sussex were housed at the Hospital of St James at the town gates (Rowe 1958, 254; Leistikow 1967, 26-30). Likewise, St John the Baptist Hospital, Oxford catered for those travelling the Canterbury road (Durham 1991, 62–3), and the Hospital of St Mary Magdalen, Partney, housed travellers from the east coast (Atkins and Popescu 2010, 251). Hospitals such as St Mary Magdalen, Partney, situated on pilgrim routes and not at the final destinations, were located close to a major travel route so as to receive the business of travellers (Atkins and Popescu 2010, 252).

The closest known shrine to Thornton Abbey is at the Augustinian Markby Priory, approximately 40 miles from the Hospital of St James. The shrine consists of a cross 'made of wood from the Lord's own cross' displayed in the chapel of St Laurence (Webb 2009, 99). Therefore there is no obvious route on which the Hospital of St James would be positioned and there is no reason to believe that Thornton Abbey is a destination for pilgrims as, although the Abbey is a substantial house, it is not known to have held any notable relics.

Archaeological evidence of pilgrims within the cemeteries of medieval hospitals have manifested in the interment of paraphernalia related to pilgrimage within the grave context.The most commonly occurring symbol of pilgrimage to be included in graves was scallop and oyster shells. The scallop shell has been associated with pilgrimage to the shrine of St James the Great at the Cathedral of Santiago de Compostela, Galicia, Spain since c.1130 (Cherry 2007, 40; Roffey and Tucker 2010, 176). Pilgrimage to this shrine grew in popularity throughout the eleventh and twelfth centuries becoming one of the three great pilgrimages of the medieval period along with Jerusalem and Rome (Candy 2009, 6). While the shell was originally associated with the shrine of St James the Great, it came to be a sign of pilgrimage in general (Morrison 2002, 85). Burials with scallop shells are documented across Europe. In England specifically, an adult male at St Mary Spital, London was buried with an array of oyster shells across the upper torso, perhaps originally on a band or necklace (Gilchrist and Sloane, 2005, 98). A second example comes from the Hospital of St Giles by Brompton Bridge, Yorkshire, where two lead badges were found upon the breast of an adult male individual. The badges date to the mid to late thirteenth century and represented pilgrimages to Lucca and Rome (Cardwell 1995). The third and final example given here is the interment of a scallop shell with an adult male at the Hospital of St Mary Magdalene, Winchester (Roffey *et al.* 2017). As such the use of a hospital and its cemetery for pilgrims can, potentially, be independently corroborated. At the Hospital of St James, there was no burial found with any artefact that had been intentionally interred, with the exception of a priestly burial inside Area C. Therefore, no conclusion of pilgrim-related activity can be made.

5.5.4 Hospitals for the sick and the poor

The following comparisons have been made with hospitals dedicated to the care of the sick poor. The hospital sites used in this discussion are St Nicholas, Lewes; St John's, Cambridge; St Bartholomew's, Bristol; St Leonard's, Newark and St Mary Spital, London.

The demographic profile of the adult populations from these hospitals do present a clear distinction between those based in urban centres and those in rural locations. This is evident in the proportions of males and females within the cemetery populations (figure 5.5.7). The urban sites of St John's, Cambridge; St Bartholomew's, Bristol; and St Mary Spital, London all present with a relatively equal division of males and females at a ratio of 1.2 males: 1 female, 1.1 males: 1 female and 1.2 males: 1 female, respectively (figure 5.5.7). These sites all presented significant statistical differences from the Hospital of St James (X2=23.5428, p=.00001; X2=12.5407, p=.000398; X2=19.5953, p=0.00001 respectively). The more rural hospitals of St Nicholas, Lewes and St Leonard's, Newark, presented with ratios of 4.1 males: 1 female and 6 males: 1 female, figures much more comparable with the ratio of 6.8 males: 1 female seen within the Hospital of St James assemblage (figure 5.5.7). Neither of these sites showed a statistically significant difference from the Hospital of St James (X2= 1.2925, p=.255584; X2=.0637, p=.8008).

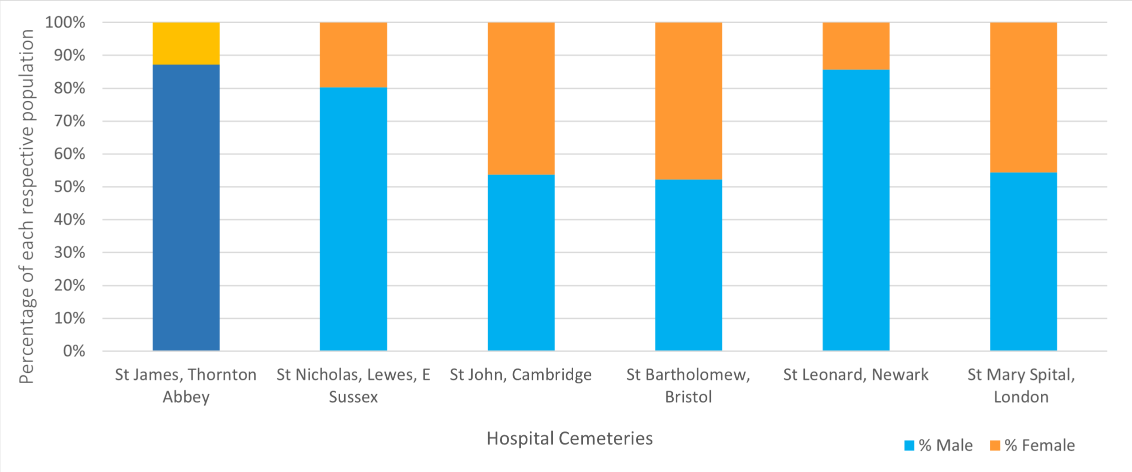

Figure 5.5.7: Representation of male and female adults within the Hospital of St James compared to the demographics of hospitals for the sick poor.

These hospitals do however demonstrate a highly variable age profile; the presence of non-adults ranged from 13.7 percent of the total population at the Hospital of St Nicholas, Lewes to 21.2 percent at the Hospital of St Bartholomew, Bristol, while no non-adult individuals were recorded at the Hospital of St Leonard, Newark. All of these hospitals demonstrated a statistical difference between their proportion of non-adults and that at the Hospital of St James. St Nicholas, Lewes (X2= 25.9201, p= <.00001) St John's, Cambridge (X2= 51.8558, p=<.00001); St Bartholomew's, Bristol (X2= 5.7145, p=.016826); and St Mary Spital, London (X2= 32.5541, p=<.00001). Such proportions are of no comparison to the 43.4 percent of the population accounted for by non-adults at the Hospital of St James (figure 5.5.8), and thus offer no further support for or against the role of St James encompassing the care of the sick poor.

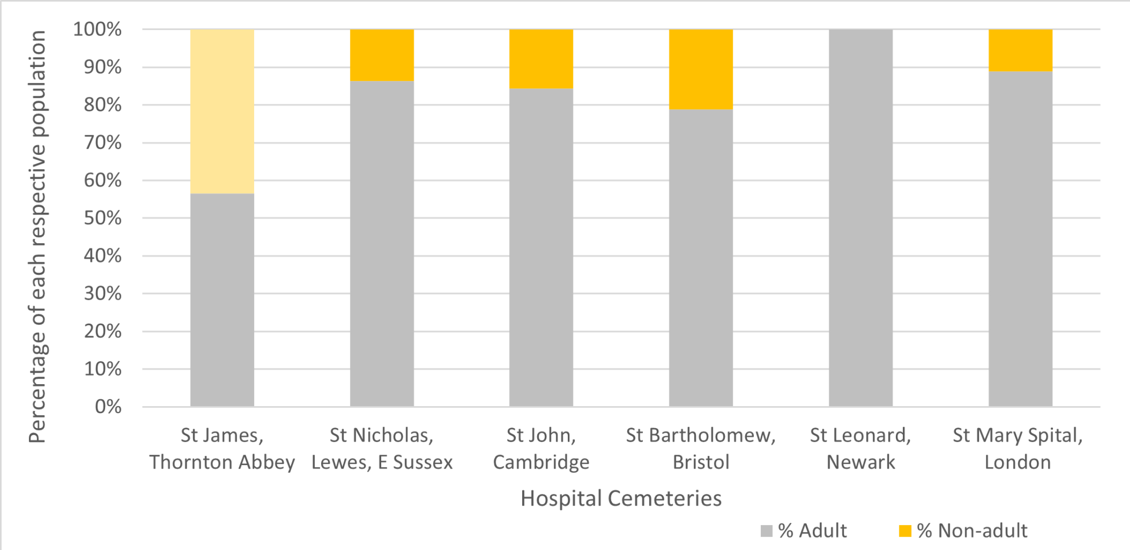

Figure 5.5.8: Representation of adults and non-adults within the the Hospital of St James compared to the demographics of hospitals for the sick poor.

In addition to hospitals for the sick poor, males dominated at the rural Hospital of St Mary Magdalene, Partney and the urban infirmary cemetery at St Mary Spital, London, both of which are believed to have been hospitals for poor wayfarers and pilgrims. The dominant presence of males can be attributed to several factors: first, the hospital is likely to have been staffed by male canons who left the inner precinct and therefore would be buried among the hospital inmates. Second, it is possible that members of the monastic community from within the abbey walls retired to the hospital, when the rigours of monastic life became too hard to bear, as is documented at the hospitals of Gabriel Clyst and St Saviour, Bury St Edmunds (Orme 1988, 3; Rowe 1958, 260). Unfortunately, due to a lack of excavation, there is no comparative demographic data from either Gabriel Clyst and St Saviour, Bury St Edmunds and therefore it was not possible to carry out a comparison of their cemetery profile to the population of the Hospital of St James. Third, Cessford (2015, 101) has argued that the burials in and around the hospital chapel at St John's, Cambridge, are inclusive of wealthy benefactors which added to the male population. However, benefactors are known from numerous statutes to be both male and female and conditions associated with benefactions often include the burial of entire families not just the male members in the hospital cemetery (Price and Ponsford 1998, 79; Huggon 2018, 219).

5.5.5 Non-adults and the medieval hospital

Regardless of the function of the Hospital of St James, it is clear from the comparison of sites that the cemetery demographic contains a large non-adult population, at a ratio of 1.3 adults: 1 non-adult. Non-adults account for 43.4 percent of the total population, of which the majority were aged 6-11 years at death.

The comparative hospital sites displayed a varied presence of children from no presence at the leper Hospital of St Margaret, High Wycombe and the Hospital of St Leonard's, Newark for the sick poor to 31.6 percent at the infirmary Hospital of St Mary Spital, London. Indeed, it is the infirmary hospital at St Mary Spital which holds the closest parallel to the prevalence of non-adults seen at the Hospital of St James, although there is still a difference of 11.8 percent of the population. The uniqueness of the demographic profile at St James is further established by the fact that at six of the nine comparative sites the presence of non-adults range from 11.1 percent to 21.2 per cent, and so it is clear from the demographic profile that the population of the Hospital of St James deviates from the profile of other later medieval hospital populations.

The presence of such a large non-adult population is therefore most likely a result of the hospital's specific function, as was the case with the biased nature of the adult population's sex division, it is possible that the presence of non-adults can be attributed to the hospital's relationship with the monastic community. For example, if the hospital were housing poor wayfarers and pilgrims it is possible that they received ill children among them. As discussed in Chapter 2, for many the motivation for pilgrimage was ill-health (Magilton 2008, 18). Such pilgrims would seek destinations such as the shrine of St Edmund in Bury St Edmund at which it was believed acts of miraculous healing transpired (Rowe 1958, 254). A further possibility is that the hospital housed child novices who were to be educated and raised by the monastic community before entering into life within the monastic precinct. This possibility is discussed in further detail in Chapter 5.

5.5.6 Comparison of the biological sex profile at the Hospital of St James with monastic communities

In addition to the hospital comparisons, the population of the Hospital of St James was also compared to seven contemporary monastic institutions to investigate the extent of sex bias in monastic populations. At the Hospital of St James, there is a ratio of 6.7 males: 1 female and is therefore heavily bias to a male-dominated population. The seven comparative populations all demonstrated a disparity of sex in adult populations regardless of the order or function of the institution (figure 5.5.9). The population with the greatest bias towards a predominantly male population was the Cluniac monks at Bermondsey Abbey, London with a ratio of 22.1 males: 1 female. The smallest bias toward a male population was the Augustinian friars at Hull where the ratio was 2.57 males: 1 female. A disproportion of demographics regarding biological sex is also present in female orders, for example at the Benedictine Priory of St Clement, York females outnumbered males at a ratio of 0.48 males: 1 female and at the Benedictine Abbey of Elstow, Bedfordshire at a ratio of 0.37 males: 1 female. Chi-squared tests were carried out to compare the statistical difference between the Hospitals of St James and each of these seven monastic populations. The result of this analysis showed that there was no statistically significant difference between the sex ratio of the adult population at the Hospital of St James and any of the seven monastic populations (table 5.5.2).

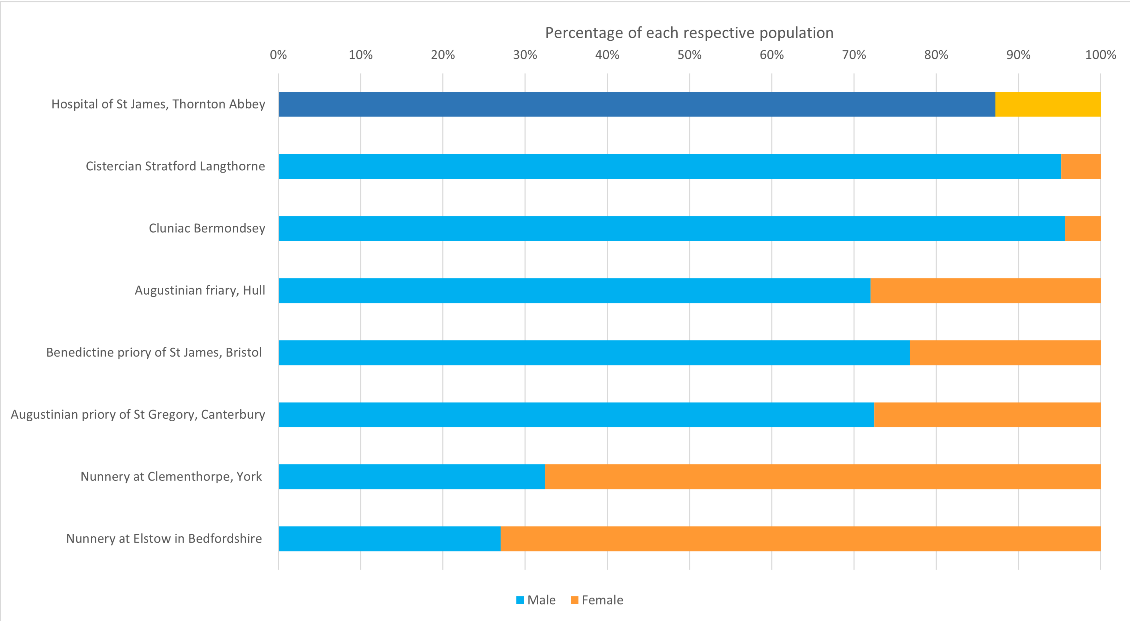

Figure 5.5.9: A comparison of sex ratios at the Hospital of St James with monastic cemeteries across England.

	Cistercian Stratford, Langthorne	Cluniac Bermondsey, London	Augustinian friary, Hull	Benedictine priory of St James, Bristol	Augustinian priory of St Gregory, Canterbury	Nunnery at Clementhorpe, York	Nunnery at Elstow, Bedfordshire
p value	.462336	.418836	.050968	.139108	.050968	.471564	.192105

Table 5.5.2: Chi-squared tests carried out to statistically compare the Hospital of St James with the seven monastic populations revealed there was no significant difference (p <.05) between the hospital's adult population and that of monastic houses from across England.

The disparity in the ratio of males to females at the Hospital of St James is therefore in line with the separation of sexes expected of religious communities in later medieval England. The bias in sex further supports the hypothesis that the adult population of St James is indicative of the monastic populations of later medieval England. Augustinian canons were not privy to the socially restrictive Rules of the Benedictines or Cistercians, and as a result could interact with lay communities. Nonetheless, the Rules of the house still applied and should be considered in the examination of population demographics. The Augustinian establishment at

Thornton Abbey was populated by a male community, a subset of which are thought to have staffed the Hospital of St James, therefore the restriction of females could be due to the inappropriateness of their being housed in a male community.

Rules of hospital admittance provide documentary evidence of hospital foundations that exclude the admission of particular segments of the population such as pregnant women (as discussed in section 2.3.1) and therefore may further account for the absence of women at the Hospital of St James. In the cases of the Hospital of St John, Cambridge and the Hospital of St John, Bridgewater, statutes documenting the rules of admittance clearly state that no pregnant woman was to be admitted to the hospital (Maxwell-Lyte 1934, 289; Rubin 1989, 300-1). To ensure such admittance did not take place, hospitals including St Mary's, Newark and the Savoy Hospital, London, screened potential inmates before entry to assess the seriousness of their complaint (Salter 1917, 21; Somerville 1960, 30; Carlin 1989, 26).

The reasoning behind such exclusion includes the idea that pregnant women could not be accommodated with modesty in a male community (Rubin 1989, 49, 157-9). Such reasoning can be applied to the female demographic more widely and not just to those that were pregnant. Nonetheless provisions for pregnant women were made with specific intention at the Hospital of St John, Sandwich; St John the Evangelist at Blyth in Nottinghamshire as well as the three London hospitals of St Thomas, Southwark, St Bartholomew, Smithfield, and St Mary Spital (Knowles and Hadcock 1971, 34; Rawcliffe 1984, 12; Carlin 1989, 32). Of these five hospitals the demographic profile is only available for St Mary Spital, therefore it is not possible to establish whether or not the inclusion of women was more prevalent in the archaeological evidence of these inclusive hospitals.

The low proportion of females at the Hospital of St James are therefore likely representative of the lay staff who contributed to the daily running of the hospital. As discussed in Chapter 2, it was the lay community who oversaw the daily running of the hospital, tending to the kitchen garden, collecting supplies, running the kitchen and washing hospital linens. In addition, the provision of care fell to female lay staff. They tended to the infirm, cooked their daily meals and maintained a hygienic environment (Carlin 1989 24; Seymour 1946, 41). Nonetheless, without knowing what sectors of society the hospital served and the rules regarding burial in the cemetery, it is not possible to confirm whether these females were hospital inmates, members of the lay public or employees of the hospital.

5.6 Mortality and survivorship of the adult population

Having established that the sex profile at the Hospital of St James is comparative with that of religious communities, further statistical analysis was carried out to test this. The aim of this analysis was to test the statistical similarity of the Hospital of St James with lay and monastic communities. The analysis then looks at the risk of death between the lay and monastic community and to which the Hospital of St James is more similar.

Traditional investigations of paleodemography assess raw frequencies of age at death and therefore do not account for underlying trends in population susceptibility (Cohen 1989; De La Rúa *et al.* 1995; Lewis *et al.* 1995; Storey 1992; Wood *et al.* 1992). However, the reconstruction of any past population is inherently complex and requires factors such as demographic nonstationarity, hidden heterogeneity and selective mortality to be accounted for in analyses (Konigsberg and Frankenberg 2002, 297-309; Wood *et al.* 1992, 344-5). Demographic nonstationarity refers to a population that departs from a stationary state, for example where the population structure varies due to migration, changing fertility rates and fluctuations in mortality. Selective mortality and hidden heterogeneity occur when the population is made up of individuals of varying susceptibility, or frailty, to disease and death due to genetic, socio-economic or micro-environmental factors (Wood *et al.* 1992, 344-5).

Existing paleodemographic investigations of mortality patterns at hospital sites have only ever employed traditional approaches, such as comparisons of mean age-at-death or life tables (Gilchrist and Sloane 2005, 14; Cessford *et al.* 2015, 101-4). Because the population of St James' Hospital presents an unusual demographic, it is problematic to identify the impact of the population's nonstationarity on the overall mortality profile. However, the quantitative models applied here address these shortcomings by accounting for selective mortality and heterogeneity in frailty.

All analyses were performed using SPSS Version 21. Moreover, the statistical approach used in this study, hazards analysis, avoids imposing a particular age pattern on skeletal data, which can occur when using the traditional life table approach (Gage 1988, 429). More accurate age-estimation methods and hazards analyses are increasingly being used in paleodemography (Bullock *et al.* 2013; DeWitte and Wood 2008; Wilson 2014). These approaches, however, have not yet been applied to an investigation of mortality and survival in medieval hospitals. This study uses hazards analysis to assess demographic differences between the rural medieval Hospital of St James, and the contemporaneous non-monastic London sites of St Mary Spital (Connell *et al.* 2012), St Benet Sherehog (Miles *et al.* 2008), Guildhall Yard (WORD database 2012) and St Mary Graces (Grainger and Phillpotts 2011), as well as, the London monastic sites of Merton Priory (Waldron 1985) and Bermondsey Abbey (Malden 1967). These comparative assemblages have been chosen due to their large pooled data set, good levels of preservation and temporal phases comparable to that of the Hospital of St James.

5.6.1 Statistical Analysis

Cox Proportional Hazards Model: The effect of monastic *vs.* lay lifestyles on risk of death for adults was evaluated using the Cox Proportional Hazards Model (Cox 1972) with pooled point estimates of age for adults from all cemeteries and modelling "monastic" or "lay" as a covariate (0 = the Hospital of St James, 1 = monastic or lay). The Cox model is a semi-parametric regression model that estimates the relative risk of death which does not require the specification of the baseline hazard function (Gage, 1988; Wood *et al.* 2002;Gage*et al.* 2012; Moolgavkar *et al.* 2018). The model tests the null hypothesis that the covariate (effects of monastic vs. lay lifestyles) has no effect on the hazard (the risk of death). Significant ratios ($p < 0.05$) that are greater than 1.0 indicate that the covariate is associated with elevated risk of death. Cox Proportional Hazard analyses were performed on SPSS version 21.

Although the risk of mortality can be assessed across all ages using the Cox model, preliminary analyses using this model with the full assemblage of skeletons from the Hospital of St James indicated it would be problematic to include non-adults and distinguish between the sexes in this investigation. The reasons for which are that the St James population comprised a disproportionate number of non-adults compared to the comparative sites and therefore any results would be heavily flawed.

Kaplan-Meier Survival Analysis: The effect of monastic *vs.* non-monastic lifestyle on survival was evaluated. In this test the population of St James was treated as though it was populated by a monastic or quasi-monastic community. Using Kaplan-Meier survival analysis with a log-rank test, point estimates of age were pooled from all cemeteries and 'monastic' was modelled as the covariate (Bewick, Cheek and Ball 2004; DeWitte 2014; Walter and DeWitte 2017).

It is important to note that the results from this analysis should be viewed as informative in so far as they indicate general trends, though the numerical estimates themselves should be viewed with caution (DeWitte *et al.* 2013, 326). This analysis does not account for the errors associated with osteological age-at-death estimation and therefore there is a possibility that the standard deviations of these results are biased, and the corresponding standard errors may be underestimated. However, because this study excluded non-adults from analysis it was not necessary to control for demographic nonstationarity via a fertility proxy. As with any population, it is possible that both the monastic and non-monastic cemeteries contain members of the opposite community alike, and therefore do not reflect exclusive mortality profiles.

5.6.2 Results

The result of the hazards analyses revealed that a significant difference existed between the hospital and the lay communities, while the hospital and the monastic population presented similar survivorship and mortality. The survival functions reveal a significant difference in mean survival time between the lay populations and the Hospital of St James (Mantel-Cox $p = 0.001$), and the corresponding 95 percent confidence intervals do not overlap. The lay populations had lower survivorship compared to the inmates of the Hospital of St James. In contrast, comparison of the survival functions from the London monastic populations and the Hospital of St James did not reveal a significant difference in mean survival time (Mantel-Cox $p = 0.807$) and the corresponding 95 percent confidence intervals did overlap. This suggests that the population from the Hospital of St James had survivorship comparable to that of the monastic communities utilised in this study. Further exploration of survival functions revealed no significant difference in mean survival time between the populations of Bermondsey Abbey and the Hospital of St James (Mantel-Cox $p = 0.175$) or Merton Priory and the Hospital of St James (Mantel-Cox$p = 0.268$). The corresponding 95 percent confidence intervals do not overlap with Bermondsey Abbey but from 40-50 years of age, St James' population raises above that of Merton Priory. This suggests that the population from the Hospital of St James had a survivorship more comparable to Merton Priory then Bermondsey Abbey.

The results of the Cox proportional hazard analyses are shown in figure 5.6.1 and 5.6.2. The estimated odds ratio for the comparison of the lay populations and the Hospital of St James indicates significantly higher odds of dying in the lay populations ($p = 0.385$) (figure 5.6.1) than the monastic ($p = 0.524$) (figure 5.6.2). The corresponding confidence interval for the odds ratio includes only values above 1.0. The estimated odds ratio for the comparison of both monastic populations to the

Hospital of St James does not reveal a significant difference in the odds of dying between the hospital and the monastic populations. However, these results suggest elevated risks of mortality in the Bermondsey Abbey population compared to those in the Merton Priory and hospital populations.

Comparison of the hospital with monastic populations has revealed greater similarity between the Hospital of St James and the Augustinian Merton Priory; both sites display greater survivorship and reduced mortality compared to Bermondsey Abbey, which was a Cluniac institution. The differences in demography between the Cluniac population at Bermondsey Abbey and the Augustine population of Merton Priory can be attributed to the different lifestyles determined by the rules of the house.

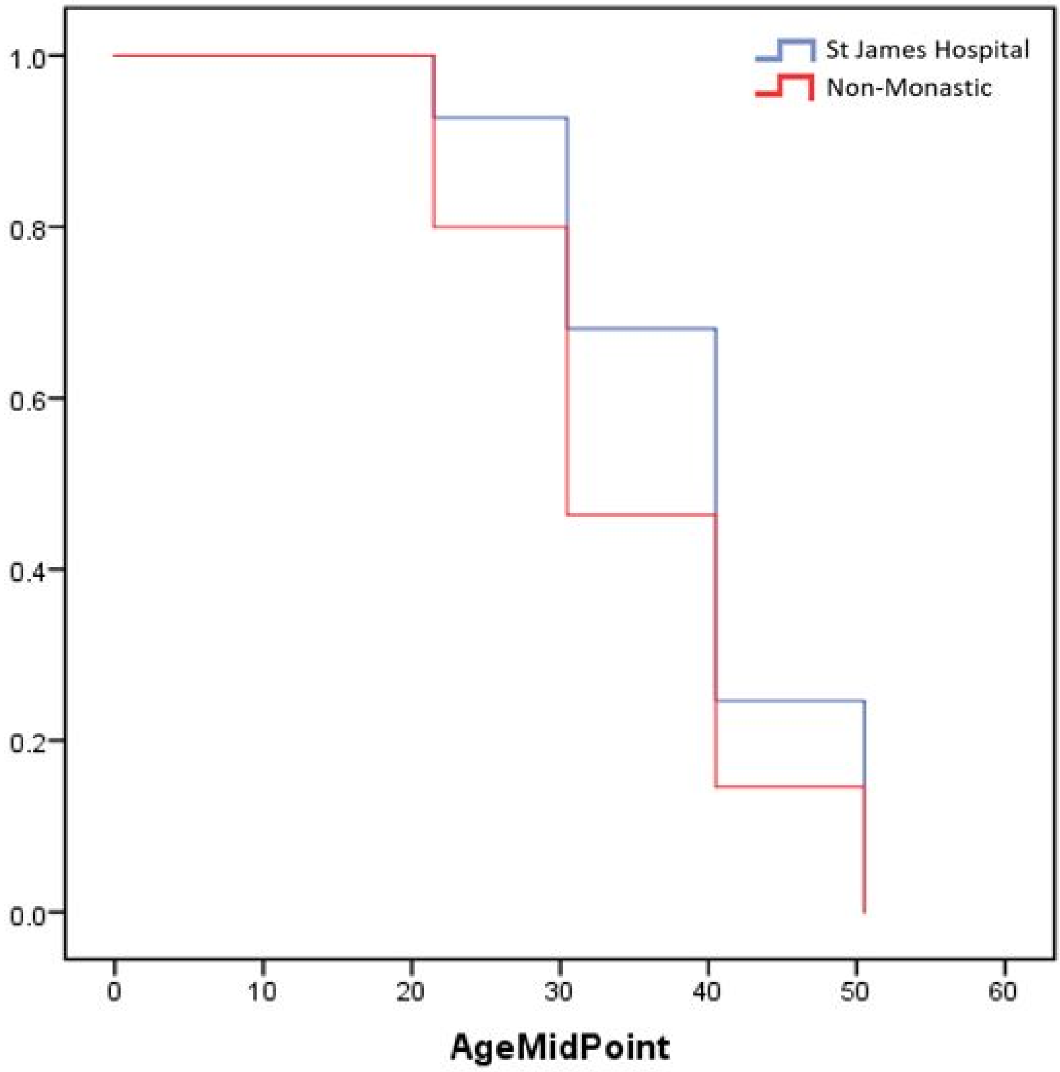

Figure 5.6.1: Cox proportional hazard analysis results show significant differences in the risk of death at each 10 year age interval from 20 years and up between the Hospital of St James and the non-monastic population.

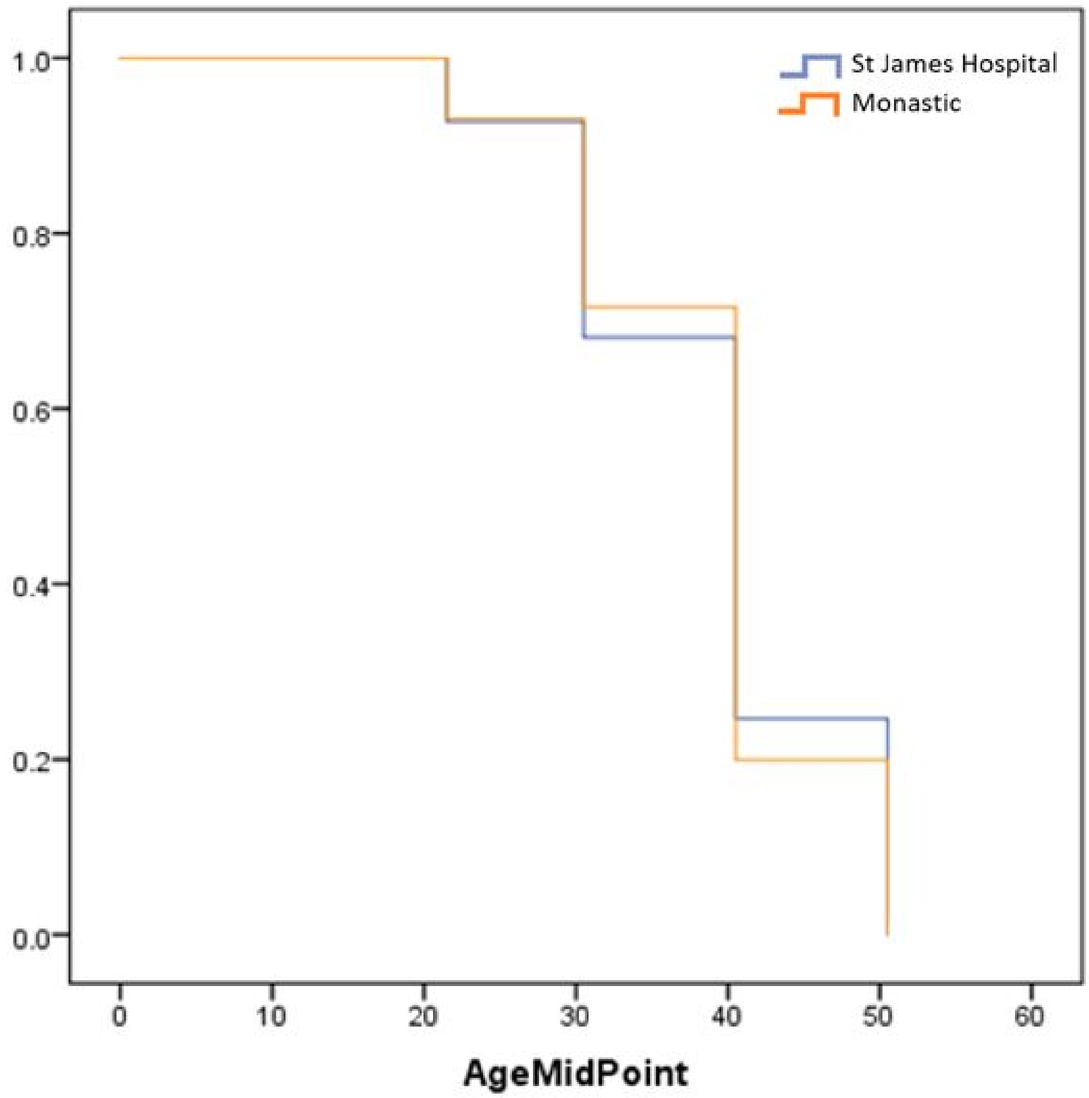

Figure 5.6.2: Cox proportional hazard analysis results show little deviation in the risk of death at each between the Hospital of St James and the monastic population.

The Cluniacs were a reformed Benedictine order who introduced stricter rules in the face of what they thought was a weakening of the original Rule, a result of which was Bermondsey Abbey's renouncement of the outside world. The order sought complete silence and continual prayer, a lifestyle that saw minimal to no interaction with the lay community (Lawrence 1989, 87). The seclusion of Cluniac inhabitants may have reduced mortality risks through social isolation and decreased exposure to disease (Lee and Newberg 2005, 449). However, it is also plausible that the urban location of Bermondsey Abbey inhibited the health of its inhabitants due to the unavoidable exposure to the inherent risks of urban living, including increased population density, sanitation issues, water and air pollution, a high prevalence of infectious disease, and famine (Moore *et al.* 2003).

Merton Priory and the Hospital of St James were both Augustinian houses. Under the Augustinian Rule, members of the house were afforded a less austere lifestyle compared to the Cluniac, Cistercian and Gilbertine orders (Price and Ponsford 1998, 216). Primarily, they were not constrained to the secluded lifestyles or rigorous worship of the other orders, nevertheless, a regular round of worship and self-discipline would have been followed. The Augustinian Rule states that food, shelter and medical care was to be provided to people outside the religious community (Miller and Saxby 2007, 1-2). Not only did this improve the health of the surrounding lay community but exposure to the laity could have improved the immune systems of the canons.

5.7 Summary

The flexible nature of the medieval hospital and its evolving use to fit the charitable needs of the local community makes identifying a hospital's function challenging without the support of documentary evidence. In this chapter, demographic data from St James has been presented and evaluated as an alternative means of assessing hospital function.

The closest comparative hospital to the sex and age structure of the population at the Hospital of St James is the infirmary cemetery at St Mary Spital, London. This cemetery population has been interpreted to consist of young people undertaking rural to urban migration and pilgrims on route to destinations such as the shrine of Thomas Becket at Canterbury in Kent (Thomas *et al.* 1997, 89). The position of the hospital on the northeast outskirts of London, provided a location to rest before entering the city of London, or before commencing pilgrimage out from the city. Although the demographic profiles are the closest match the wider context of the Hospital of St James shows little similarity to the Hospital of St Mary Spital. There is no evidence from St James for use by travellers of migrant or pilgrim status. No material culture suggestive of the presence of pilgrims recovered from excavations of St James' hospital site, as it was from St Mary Spital, London; St Giles by Brompton Bridge; St Mary Magdalene, Winchester, nor is there any suggestion that the Abbey itself was a destination for pilgrims. Furthermore, the rural setting of the hospital on no obvious thoroughfare implies that the hospital would not have been a stopping point for rural migrants to urban centres. Consequently, it has proved impossible to match the population demographic profile of the Hospital of St James to any one of the four hospital types with certainty. Instead, it proved necessary to look for possible explanations for the non-normative cemetery profile and therefore the hospital's use.

Results of the statistical analysis enable a much closer comparison of the adult population. This analysis found that mortality and survivorship at the Hospital of St James followed the pattern of monastic populations as opposed to contemporary lay populations. It is traditionally thought that medieval hospital cemeteries were utilised for the burial of hospital inmates and therefore should reflect the age at death profile of lay populations (Gilchrist and Sloane 2005, 205). However, the Hospital of St James does not conform to this supposition. Rather, it is possible that the hospital community consisted of a mixed lay and monastic community, an idea explored further in Chapters 5 and 6.

This chapter has focused primarily on the adult population of the hospital. Chapter 7 will examine in greater detail the non-adult population; this will include a discussion of the treatment of children in later medieval society, especially those that were infirm and/or orphaned. This discussion goes on to explore the importance that the hospital's physical position had on the high presence of non-adults.

6

Paleopathology at the Hospital of St James

The population recovered from the Hospital of St James presented a complex and varied array of paleopathologies. This chapter presents the results and discussion of the palaeopathological analysis completed on the 175 individuals from the hospital. The paleopathologies are presented under the three research themes of 'health and stress markers', 'markers of activity and lifestyle' and 'medical intervention and potential for long term, palliative and skilled care'. These three research themes have been selected as they provide a framework by which we can assess the health status of the hospital population, aspects of the lifestyles of those interred at the hospital and finally an insight into the medical intervention taking place in order to make inferences about the type of care the Hospital of St James provided though an investigation of the pathologies utilising Tilley's 'bioarchaeology of care' methodology.

The first research theme 'health and stress markers' looks at the overall health of the population. It presents data concerning markers of physiological stress in the skeleton, drawing on comparisons with the health status of other hospital populations and the local lay population from St Peter's Church, Barton-upon-Humber to provide a comparative context. The second theme 'markers of activity and lifestyle', these markers are used to identify patterns associated with a monastic lifestyle, particularly through a focus on diffuse idiopathic skeletal hyperostosis (DISH) and ankylosing spondylosis. The second part of this theme identifies stressors which imply members of the community were engaged in a physical activity. This could indicate lifestyle prior to being housed at the hospital or that they engaged in manual work during their time at the hospital. The third and final theme 'medical intervention and potential for long term, palliative and skilled care' looks at a broader suite of pathologies present within the hospital population to identify examples of medical intervention and assess the potential for provision of long term, palliative or skilled care. This section will cover a broad range of pathologies from trans-tibial amputation to rheumatoid arthritis. The pathologies in this theme have been investigated using Tilley's 'bioarcheology of care' model to help assess their impact on the individual as well as helping to establish the type and potential level of care provided by the hospital. This assessment does not document every pathology that was present in the skeletal assemblage. The reason for this was to focus the investigation on the pathologies which would provide the most enriching interpretations of the population, as discussed in Chapter 4.

The prevalence of the paleopathologies are compared to the nine hospital sites utilised throughout this thesis. To reiterate these are St Mary Magdalene, Partney, Lincolnshire; St Nicholas, Lewes, East Sussex; St John, Cambridge; St Bartholomew, Bristol, St Mary Magdalene, Winchester, St Margaret, High Wycombe, Buckinghamshire, St Leonards, Newark, Nottinghamshire and St Mary Spital, London. Where a specific pathology was present at the Hospital of St James but not present in one of the nine hospital populations, comparisons have been drawn from other archaeological examples. In certain cases (DISH, spondylolysis, synostotic scaphocephally, infected ulceration of the tibia and trans-tibial amputation) additional detailed discussion is provided of the prevalence, manifestation or context of pathologies to explore their particular significance for the present study.

6.1 Research theme 1 - 'health and stress markers'

Health and stress makers were examined to investigate the overall health of the hospital's population. Osteological analysis can reveal markers of non-specific biological stress which are often attributed to stressors experienced during childhood (Steckel 2005, 317-8). The skeletal markers can be a result of nutritional or infection related stressors including but not limited to nutritional deprivation, low body weight, chronic diarrhoea and parasite infection (Steckel 2005; Weston 2008; Klaus 2014; Marklein *et al.* 2016; Meyer 2016). In response to these stressors the body compensates in a number of ways but primarily by slowing down or ceasing of growth, to allow the bodies resources to be allocated to survival (Birx 2010, 52). The markers of health and stress examined in the Hospital of St James populations include cribra orbitalia and porotic hyperostosis which indicate an over-production of red blood cells, created to increase the transportation of oxygen to body tissues (Steckel 2005, 317). Linear enamel hypoplasia was also analysed, hypoplasia of tooth enamel indicates periods of reduced growth via changes in amnioblast production. Similarly, the body's ability and need to form new bone in response to injury or other stimuli was acknowledged via periosteal new bone formation. The final marker recorded is stature, it was not possible to assess skeletal development of non-adults from the Hospital of St James due to poor preservation resulting in incomplete and damaged bones, but adult stature has been recorded and discussed. The data recorded concerning markers of physiological stress in the skeleton, have been compared to the health status of other hospital populations and the local lay population from St Peter's Church, Barton-upon-Humber to provide a comparative context.

6.1.1 Cribra orbitalia and porotic hyperostosis

Cribra orbitalia was observed in a total of 22 individuals, presenting a true prevalence of 16.9 percent (n=22/130) and a crude prevalence of 12.6 percent (n=22/175) (table 6.1.1). Of these, 40.9 percent (n=9/22) were adults and 59.1 percent (n=13/22) were non-adults. There was just one case of the mildest presentation – slight capillary impressions (stage 1 of cribra orbitalia severity as outlined in table 4.5.2). There were eleven cases where scattered fine foramina were observable (stage 2), this accounted for 50 percent of cases and was therefore the most commonly occurring stage of cribra orbitalia in the population. Six individuals were assigned the next stage (3) in which foramina become isolated. Four individuals were assigned to the final stages (4 and 5) in which foramina link into the trabecula structure and outgrowth from the trabecula bone occur respectively. The most severe case was an individual aged 6-11 years at death, from area A.

Cribra Orbitalia Stage	Area A		Area B		Area C		Total	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent
1	1	8.3	0	0.0	0	0.0	1	4.6
2	4	33.4	7	70.0	0	0.0	11	50.0
3	5	41.7	1	10.0	0	0.0	6	27.2
4	1	8.3	2	20.0	0	0.0	13	13.6
5	1	8.3	0	0.0	0	0.0	1	4.6
Total	12	54.54	10	45.45	0	0.0	22	100.0

Table 6.1.1: Prevalence of cribra orbitalia at the Hospital of St James.

The prevalence of cribra orbitalia at the Hospital of St James was statistically comparable to that at the Hospital of St Bartholomew's Bristol where the crude prevalence was 16.6 percent (X2=0.281, p=.596044). The remaining hospitals for which a statistical comparison could be competed were all significantly different from the Hospital of St James with a greater prevalence of cribra orbitalia. These were a crude prevalence of 22.2 percent at the Hospital of St Mary Spital, London (X2= 6.2585, p=.01236), 35.1 percent at the Hospital of St John, Cambridge (X2=10.7699, p=.001032) and 36.9 percent at the Hospital of St Nicholas, Lewes, East Sussex (X2=12.8367, p=.00034). No cases were reported in the cemetery reports of the Hospital of St Mary Magdalene, Partney, the Hospital of St Margaret, High Wycombe or the Hospital of St Mary Magdalene Winchester. This would infer that the population of St James demonstrates a lower rate of biological stressors then the comparable medieval hospitals utilised here.

Only four individuals presented with evidence of porotic hyperostosis, this produces a true prevalence of 2.9 percent (n=4/137) and a crude prevalence of 2.3 percent (n=4/175). Two of the affected individuals were recovered from the hospital cemetery and two from the cemetery extension, suggesting no bias based on the location of burial. Three individuals with porotic hyperostosis were non-adults: SKN046 aged 1-5 years at death and SKM112 (4001) and SKM160 (4106) both aged 6-11 years at death. SKN033, a male individual aged 36-45 years at death, was the only adult with porotic hyperostosis and also presented with stage 4 cribra orbitalia. SKM112 was the only other individual to present with both porotic hyperostosis and cribra orbitalia. All were assigned to grade three porotic hyperostosis, defined by gross parietal lesions with excessive expansion and exposed diploe (refer to table 4.5.1).

Porotic hyperostosis was recorded in the cemetery reports of 4 comparative hospitals. Of these the Hospitals of St Bartholomew Bristol and St Margaret, High Wycombe were statistically similar to the Hospital of St James with crude prevalences of 2 percent (X2=0.014, p=.905823) and 10 percent (X2=1.9012, p=.167941), respectively. At the Hospital of St John, Cambridge the prevalence was 14.86 percent (X2=12.3277, p=.000446) and even higher at 15.95 percent at St Mary Spital, London (X2=19.4118,p=.000011). These were significantly different from the Hospital of St James. As is the case with cribra orbitalia these statistics infer that the population of St James demonstrates a lower rate of biological stressors then all of the comparable hospitals, with the exception of St Bartholomew's, Bristol which demonstrated 0.9 percent lower prevalence.

The effects of nutritional stressors are also observable in the assemblage via the presence of cribra orbitalia and porotic hyperostosis. These conditions have traditionally been associated with iron deficiency anaemia (Aksoy *et al.* 1966; Lanzkowsky 1968; Agarwal *et al.* 1970; Moseley 1974; Oxenham and Cavill 2010), however recent scholarship has disputed this arguing that megoblastic anaemia is the true cause (Walker et al. 2009). These anaemias are acquired through a deficiency of vitamin B12 and via unsanitary living conditions (Walker *et al.* 2009, 119). Furthermore, other potential causes of anaemia include gut parasites and gut disease which prevent adequate vitamin absorption and can result in chronic blood loss (Mays 2010, 212). Therefore, diet has a great influence over the presence and impact of vitamin deficiency anaemia. Within the Hospital of St James population, cribra orbitalia and porotic hyperostosis were of low prevalence, which is suggestive that the long-term population of the hospital benefited from a nutritious diet.

6.1.2 Linear enamel hypoplasia

Linear enamel hypoplasia are lines, or pits, of enamel deficiency in the teeth of people who underwent biological stress in their early childhood. Linear enamel hypoplasia was observed in a total of 15 individuals from the Hospital of St James (table 6.1.2). This reduces to seven adults (six male and one for who sex could not be determined) and eight non-adults. This is a crude prevalence of 7.07 percent in adults (n=7/99) and 10.53 percent in non-adults (n=8/76) (crude prevalence has been used here to enable the comparison to contemporary hospitals as discussed below). Of these individuals 10 were from the hospital cemetery (Area A) and five were from the hospital extension (Area B), therefore no individual with linear enamel hypoplasia was recovered from within the hospital's church (Area C). An analysis of those individuals with enamel hyperplasia defects at the Hospital of St James shows that both the adult and non-adult population demonstrate periods of stress between the first and fifth years of life.

It has been possible to compare the prevalence of linear enamel hypoplasia at the Hospital of St James with five of the comparative hospitals. In order to do so the crude prevalence of at the Hospital of St James was compared with that at the contemporary hospital sites and chi-squared tests were carried out to test the statistical significance. Crude prevalence was used as true prevalence data was not available from the comparative sites (as outlined in Chapter 4). The true prevalence at the Hospital of St James was 8.57 percent (n=15/175); this was proven statically similar to 6.06 percent at the Hospital of St Mary Magdalene, Partney (X2=0.2012, p=.65377), 4.34 percent at St Nicholas, Lewes, East Sussex (X2=1.9418, p=.163471) and 15.95 percent at St Mary Spital, London (X2=1.367, p=.242333). The Hospital of St James was statistically dissimilar to the Hospital of St John, Cambridge where linear enamel hypoplasia was present in 44.6 percent of the population (X2=26.6, p=<.00001) and the Hospital of St Bartholomew, Bristol at 26.6 percent (X2= 6.0445, p= <.013949).

This comparison shows that the occurrence of enamel hypoplasia at the Hospital of St James is in line with that experienced at contemporary medieval hospitals. It is not possible to state the cause of linear enamel hypoplasia as this is a non-specific stress marker (Hillson and Bond 1997, 89-90). However, recent scholarship has explored the association of linear enamel hypoplasia in medieval populations with famine victims (Yaussy *et al.* 2016; Walter 2017). Yaussy *et al.* (2016) proved a significant association between famine victims from medieval London and linear enamel hypoplasia and that those with evidence of early life stressors, as indicated by linear enamel hypoplasia, were on average more frail and more susceptible to death than their peers. Therefore, it is possible that the occurrence of linear enamel hypoplasia at the Hospital of St James signifies the population experience many of the famines and epidemics which took place in later medieval England (as explained in Chapter 1).

Skeleton	Sex/Age (years)	Severity Score	Teeth affected	Age of enamel zone completion (years)
SKM120	Male 36-45	2	Maxillary right canine	2.7-3.1, 3.1-3.6
SKM121	Male 26-35	2	Maxillary right central incisor	1.6-1.8, 2.4-2.9
SKM122	N/A ≥18	2	Maxillary left canine	3-3.4, 3.8-4.3, 4.8-5.3
SKM128	Male 26-35	2	Mandibular right canine	1.7-2.0, 2.3-2.7, 3.6-4.9
SKM154	Male 26-35	1	Maxillary right central incisor	1.8-2.0
SKN022	Male ≥45	1	Mandibular right canine	3.1-3.6
SKN062	Male 36-45	2	Maxillary right central incisor	2.0-2.2, 2.9-3.2, 3.9-4.0
SKM127	N/A	1	Maxillary left central incisor	2.0-2.4, 3.3-3.8
	6-11		Maxillary left canine	3.3- 3.8
SKN004	N/A	2	Maxillary right canine	1.9 -2.2, 3.0-3.4
	1-5		Maxillary right central incisor	1.8- 2.0
SKN006	N/A	1	Maxillary right central incisor	2.9-3.4
	6-11		Maxillary left central incisor	2.9-3.4
SKN008	N/A	2	Maxillary right central incisor	2.4-2.9
	11-17		Maxillary left central incisor	2.4-2.9
			Maxillary right canine	3.0-3.4
SKN018	N/A	2	Maxillary right central incisor	1.8-2.0
	6-11		Maxillary left central incisor	1.8-2.0, 2.9-3.4
SKN027	N/A	2	Mandibular right canine	3.0-3.4, 3.4-3.8
	6-11		Mandibular left canine	2.7-3.1, 3.1-3.6
SKN042	N/A	2	Maxillary right 2nd incisor	2.2-2.4, 2.7-2.9, 2.9-3.0
	1-5		Maxillary right canine	2.2-2.4, 2.7-3.0
			Mandibular right canine	2.0-2.3, 2.7-3.1, 3.1-3.6
SKN047	N/A	1	Maxillary right central incisor	1.8-2.0
	6-11		Maxillary left central incisor	1.8-2.0

Table 6.1.2: Linear enamel hypoplasia at the Hospital of St James.

6.1.3 Periosteal bone formation

Only seven individuals presented periosteal new bone formation in the lower limb; resulting in a true prevalence rate of 6.8 percent (n=7/102) and a crude prevalence rate of 4.0 percent (n=7/175). Of these, 57.1 percent (n=4) were adults and 42.8 percent (n=3) were non-adults, suggesting no notable age bias in presentation of the condition. Burials in Area A account for 85.7 percent of individuals with periosteal new bone formation, Area B accounts for 14.3 percent and no cases were recorded in Area C (table 6.1.3). Due to the low number of cases of periosteal new bone formation, it is not possible to determine if this distribution is a reflection of the status of those interred in Area C (as discussed in section 3.2.1).

Periosteal New Bone Formation	Area A		Area B		Total	
	Count	Percent	Count	Percent	Count	Percent
Woven	4	57.1	1	14.3	5	71.4
Sclerotic	2	28.6	0	0.0	2	28.6
Total	6	85.7	1	14.3	7	100.0

Table 6.1.3: Prevalence of periosteal new bone formation.

Comparison of periosteal new bone formation with the comparative hospitals showed the prevalence of 9.1 percent at St Mary Magdalene, Partney to be statistically similar (X2= 1.3827, p=.239649) to that at the Hospital of St James. The Hospital of St John, Cambridge and St Bartholomew, Bristol were statistically different ((X2= 7.0327, p=.008003; X2= 11.674, p=.000634, respectively). While the prevalence of periosteal new bone formation in the tibia at the Hospital of St James is low, the decision made here to only look at periosteal new bone formation is legitimate. As discussed in section 4.6, the tibia was used in this study because it is more likely than other skeletal elements to present with periosteal lesions in response to both acute insult or chronic infection due to its slow immune response and elevated osteogenic potential (Gallay *et al.* 1994; Roberts and Manchester 2007; Klaus

2014; Yaussy and DeWitte 2018). The high frequency in which the tibia is affected by periosteal new bone formation has been proven in Eisenberg (1991); Galloway *et al.* (1997), Larsen (1997), Willey *et al.* (1997), Stojanowski *et al.* (2002) and Roberts and Manchester (2005). Furthermore, recent osteoarchaeological practices and publications on non-specific infection, frailty and survivorship have applied the same method of looking only at the tibia (DeWitte 2014; Yaussy and DeWitte 2018).

6.1.4 Maxillary Sinusitis

A key skeletal manifestation of non-specific infection in the respiratory system is maxillary sinusitis, porosity of the structures surrounding the nasal aperture and new-bone formation. In the Hospital of St James' population, maxillary sinusitis could only be positively identified in one individual, SKM121 (4001) a male aged 26-35 years at death recovered from Area B (figure 6.1.1). The maxillary sinusitis in this individual was observed to fit category B of Boocock *et al.* (1995) characterisation. Category B is described as "spicule-type bone formation or thin spicules of bone that appear to have been applied to the original bone surface" (Boocock *et al.* 1995, 486). Sinuses could not be systematically examined as there were a large number of intact skulls in which the sinuses are not observable, therefore the crude prevalence rate at the Hospital of St James is 0.6 percent (n= 1/175) or 0.7 percent (n= 1/137) based on the number of examinable crania.

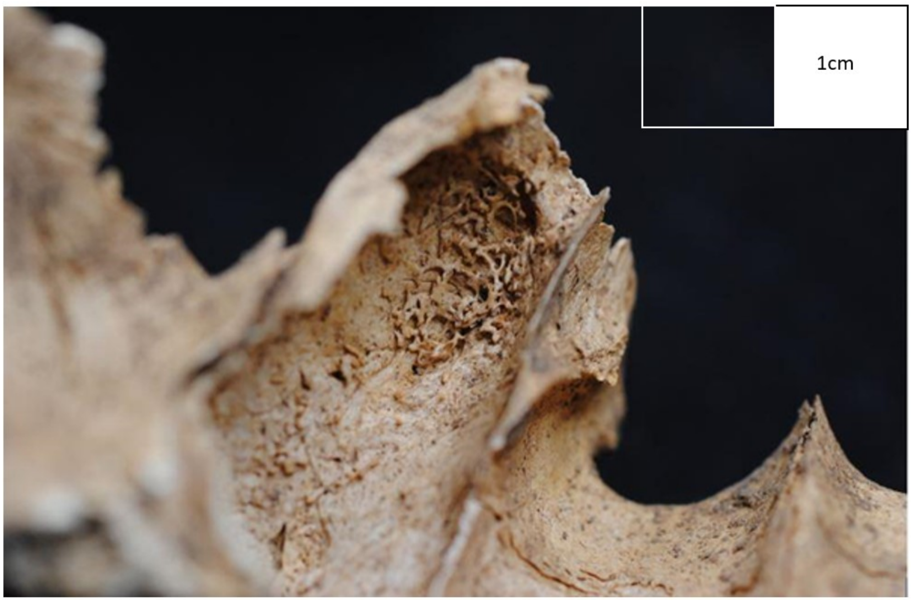

Figure 6.1.1: Maxillary sinusitis observed as spicule-type bone formations in SKM121.

The prevalence of maxillary sinusitis at the Hospital of St James has been compared to the prevalence rates of the comparative hospital populations. When reviewing these comparisons consideration should be given to the lack of observed cases at the Hospital of St James. The only hospital cemetery which was significantly different from the prevalence recorded at the Hospital of St James was the Hospital of St Mary Magdalene, Partney at which a crude prevalence of 21.21 percent was recorded (X2=26.1987, p=.00001). In contrast, the prevalence was statistically comparable at the Hospital of St John, Cambridge 1.1 percent (X2=.2195, p=.639403), the Hospital of St Bartholomew, Bristol 3.3 percent (X=21.9456, p=.163064), and the Hospital of St Mary Spital 1.6 percent (X2=1.071, p=.300713). No cases were reported in the cemetery reports of St Nicholas Lewes, East Sussex, St Margaret, High Wycombe or St Mary Magdalene, Winchester. These findings are in line with recent investigations comparing urban and rural populations from tenth to seventeenth century Poland, which found no significant difference between the urban and rural (Krenz-Niedbała and Łukasik 2016; Betsinger and DeWitte 2017). While the association of urban and rural location was dismissed, the presence of maxillary sinisitus were still attributed to the exposure to environmental pollutants (Krenz-Niedbała and Łukasik 2016, 103; Betsinger and DeWitte 2017, 34).

6.1.5 Stature

Stature estimations from past populations has been assessed through the length of long bones throughout the development of osteological analysis (Brown and Howard-Davis 2008, 153-4). Applying Trotter's (1970) calculations for stature in different ethnic groups, that for white males and white females, were applied to the assemblage from the Hospital of St James. Stature was calculated from femoral lengths, this was possible for a total of 51 of the skeletons (42 male, 4 female and 6 of unknown sex). The mean adult male stature was 168.34 ± 3.27cm, with a range of 159.6-183.38 cm and the mean adult female's stature was 165.07 ±3.72cm, with a range of 156.42-163.64 cm (table 6.1.4).

Sex	Mean (cm)	Range (cm)	No of individuals
Male	168.34 ±3.27	159.6-183.38	42
Female	165.07 ±3.72	156.42-163.64	4

Table 6.1.4: Adult stature at the Hospital of St James.

The mean average stature estimates from the later medieval period have been calculated as 172cm with a range of 170-182cm for males and 161cm average with a range of 152-170cm for females according to Roberts and Cox (2003, 195). The St James stature estimates showed that the males were on average 3 cm shorter than the average for males during the later medieval period while the females were 4cm shorter than the average. Regardless, both were within the ranges and thus the male and female statures can be regarded as fitting the norm. As discussed in section 4.3.1, this thesis originally planned to assess immature growth rates as a measure of any skeletal growth deficit among the non-adult population. This was to be achieved by comparing estimates of age from diaphyseal long bone length with an estimate of age from dental development. By doing so skeletal growth of non-adults, which is highly sensitive to external environmental stress, could be measured against the far less sensitive dental development (Hoppa 1992, 276; Saunders *et al.* 1993, 266; Cardoso and Garcia 2009, 137). However, examination of the skeletal assemblage revealed it to be too poorly preserved to determine age from non-adult long bones and any overall comparative data would be questionable at best due to the small sample which would have been achievable.

6.1.6 Discussion of 'health and stress markers'

In addition to the hospital comparison presented throughout the text above, the health markers have also been compared to the local lay population interred in the cemetery of St Peter's Church, Barton-upon-Humber. This cemetery population represents the closest lay community to the Hospital of St James and has therefore been employed as a comparative resource by which to assess the general health of the hospital's cemetery population. The data employed here has been taken from Tony Waldron's skeletal analysis of the St Peter's assemblage, published in 2007. In this publication Waldron (2007) observes cribra orbitalia, linear enamel hypoplasia, periosteal new bone formation and maxillary sinusitis. Porotic hyperostosis was not recorded by Waldron (2007) and therefore no comparison could be made.

The prevalence of cribra orbitalia, periosteal new bone formation and maxillary sinusitis at St Peter's Church were all statistically similar to the prevalence at the Hospital of St James. Waldron (2007, 81), presents the occurrence of cribra orbitalia in the non-adult population only, a total of 87 cases were recorded at a prevalence of approximately 9.5 percent (n=87/917) compared to 17.1 percent (n=13/76) at the Hospital of St James (X2= 3.4719, p=.062418). Periosteal new bone formation was located as an indicator of stress in 193 individuals (Waldron 2007, 79), which is a crude prevalence of 7 percent (n=193/2750) compared to 4.0 percent (n=7/175) at the Hospital of St James (X2= 2.1041, p=.146905). Waldron (2007, 78) observed only those sinuses which could be viewed from the result of broken facial bones, which is therefore the same as the observation methods emplopyed in this thesis as discussed in Chapter 4. This crude prevalence of 0.25 percent (n=7/2750) is statistically comparable to that of 0.57 percent (n=1/175) at the Hospital of St James (X2=0. 6007, p=.438296). In contrast to these three pathological comparisons the prevalence of linear enamel hypoplasia at St Peter's Church was statistically different to the Hospital of St James. At St Peter's Church a total of sixteen individuals presented with linear enamel hypoplasia, 10 were non-adults (<15 years of age), two aged 15-24 years and four aged 25-34 years (Waldron 2007, 120). This is a true prevalence rate of 0.6 percent (n=16/2750) compared to 8.5 percent (n=15/175) at the Hospital of St James population, demonstrating a significant difference (X2=91.7073, p=<0.00001). This comparison suggests that the population at the Hospital of St James was exposed to a greater level of stressors which resulted in enamel defects. As discussed in section 4.5.1, linear enamel hypoplasia is a non-specific physiological response to environmental stressors including but not limited to dietary deficiencies, infection and childhood fevers (Palubeckaitė *et al.* 2002; Primeau *et al.* 2015, 384). In summary, the overarching comparison of overall health and stress markers of the population recovered from the Hospital of St James has been proved as statistically similar to that of the local lay community with the exception of linear enamel hypoplasia, as ascertained from the community of St Peter's, Barton-upon-Humber.

6.2 Research theme 2 - 'markers of lifestyle'

Markers of lifestyle can be identified as bony changes to the skeleton. These markers can be ossification and calcification of soft tissue structure, damage to the soft tissue which alters the site of muscle attachment on bone most commonly deterioration of the skeleton, which is described here via joint disease. Bony changes related to joint disease include pitting, erosion, eburnation, contour change, osteophyte growth, bone cysts, joint space narrowing and fusion (Walker 2012, 159). In identifying the markers of activity and lifestyle, the types of lesions observed and their distribution across the skeleton are significant factors in interpretation (Rogers and Waldron 1995, 4).The paleopathologies of ankylosing spondylitis and DISH were recorded at the Hospital of St James, these cases are presented below and suggest that some individuals at the hospital led a monastic lifestyle. As will be discussed these conditions have been linked to monastic communities in archaeological literature and are known to correlate to enhanced diet and decreased activity through clinical studies (Rogers and Waldron 1995). Following these, markers of a physical lifestyle are discussed include spondylolysis, soft tissue injuries, osteoarthritis, degenerative changes in the axial skeleton, porosity of the vertebral bodies, formation and Schmorl's nodes. These pathologies are presented to indicate the levels of physical activity displayed through the skeletal material which could be indicative of the inmate's lifestyle before entry into the hospital or their physical engagement during their time at the hospital.

6.2.1 Ankylosing spondylitis

Osteological changes consistent with ankylosing spondylitis were observed in a male and a female adult recovered from Area A of the hospital cemetery. The true prevalence rate of ankylosing spondylitis was 1.7 percent (n=2/119 individuals with observable sacro-iliac joints) and the crude prevalence was 1.1 percent (n=2/175). The two individuals that presented with ankylosing spondylitis were SKN026 (5193) and SKN045 (5224). SKN045, a male aged 36-45 years, presented with developing ankylosing spondylitis, meaning that it was not in its final stage. The skeletal manifestation was the fusion of the lateral aspects along both sides of the thoracic vertebrae the fifth to eighth thoracic vertebrae showed complete fusion of the anterior aspect of the bodies, and sacroiliac fusion on the right hand side (figure 6.2.1). SKN026, a female aged $\geq$45 years, presented with spondylolysis of the vertebral arch of the fifth lumbar vertebrae, ossification of the connective tissue between the third and eleventh thoracic vertebrae, ossification of the right transverse process and body of the fifth lumbar vertebrae to the first sacral vertebrae (figure 6.2.2) and calcifications on the left transverse process, but to a lesser extent of development.

Figure 6.2.1: Fusion of the right sacroiliac joint (SKN045).

Figure 6.2.2: Manifestation of ankylosing spondylitis ossification of the right transverse process and body of the fifth lumbar vertebrae to the first sacral vertebrae (SKN026).

Ankylosing spondylitis is a rare chronic inflammatory autoimmune disease which affects the joints of the spine and causes chronic pain to those who suffer from the condition (Zhu *et al.* 2002, 22). The only comparative hospital with recorded cases of ankylosing spondylolysis was the Hospital of St Mary Spital, London. At the hospital two cases were recorded from the period dating from 1250-1400, the individuals affected were both males aged 36-45 years at death (Connell *et al.* 2012, 75). This is a prevalence rate of 0.2 percent which is statistically comparable (X2= 3.5118, p=.060934) to the prevalence of 1.1 percent at the Hospital of St James. A meta-analysis of 2,236 patients with ankylosing spondylosis revealed that males accounted for 70.4 percent of all patients (Zhu *et al.* 2002, 22). Previous studies support this reporting a ratio of 3:1 male to female and that Caucasian men are most commonly affected (Van der Linden and Van der Heijde 2001; Aufderheide and Rodriguez-Martin 1998). Furthermore, the disease is known to be hereditary with 90 percent of the risk of developing the disease being determined genetically (Brown, 2008). Therefore, as an autoimmune disease, ankylosing spondylosis develops through a combination of genetics, immune reaction, and environmental factors (Zhu *et al.* 2002, 22).

As has been established, the two cases of ankylosing spondylitis were at different stages of development, being more advanced in SKN026 then SKN045. The different manifestations of the disease in each individual are therefore considered in the application Tilley's (2012) 'bioarchaeology of care' methodology. The main clinical manifestations of ankylosing spondylitis are severe chronic pain and progressive spinal rigidity which in more advanced cases can lead to spine fusion. This manifests in functional impacts including lower back pain, arthritis and restricted motion of the lumbar as well as inflammation of the hips, shoulders, wrists, ankles, fingers and toes (Braun and Sieper 2007, 1380). In more advanced cases restriction of chest expansion is experienced as well as extra-articular manifestations, such as blurred vision and inflammatory bowel disease (Zhu *et al.* 2002, 22; Braun and Sieper 2007, 1379). Much like that discussed in relation to the care of those with

DISH (see below), this condition would require long-term care for the remainder of the inmate's life. More similar still, the care provided is likely to have consisted of provision of food, water, shelter, managing hygiene, repositioning and manipulation of the body and where possible pain relief. The care necessary would have therefore been relatively unskilled. It is likely that the individuals with ankylosing spondylitis could not maintain their position in society without assistance, especially sustaining employment, nonetheless, there is little reason to believe that either SKN026's nor SKN045's cognitive ability suffered and therefore they could engage with the hospital's community.

6.2.2 Diffuse idiopathic skeletal hyperostosis (DISH)

The diagnosis of DISH was made on the basis of ossification of the spinal longitudinal ligaments without involvement of disk space and facet joints and/or the presence of multiple peripheral enthesopathies along the bodies of four or more vertebrae (Forestier and Rotes-Querol 1950; Rogers and Waldron 2001; Bombak 2012). DISH was observed in seven individuals from the Hospital of St James, all of which were males aged 36 years and over at death, with the exception of one individual who could only be determined to be skeletally mature. Details of these individuals are outlined in table 6.2.1. The true prevalence rate for DISH was 22.6 percent (n=7/31, when all individuals with four or more thoracic vertebrae are counted) and the crude prevalence was 7.1 percent (n=7/99, when all adults are counted). All individuals were buried within Area A and C. Just two cases of DISH are outlined here in detail, which represent the most advanced cases at the Hospital of St James; SKN020 (5169) (a male aged 36-45 years at death) was recovered from Area A and SKP004 (a male for who age could only be determined as $\geq$ 18 years) was recovered from Area C.

Skeleton	Sex/Age (years)	DISH related pathologies
SKN016	Male 36-45	Ossification of spinal longitudinal ligament along T9-12 without involvement of the vertebral disk space. Peripheral enthesopathies along the bodies of T8-9. Compression of T11, and significant osteophyte formation throughout the vertebral bodies.
SKN020	Male 36-45	Extensive osteophytic growths throughout the throax, ribs and pelvis. Fusion of the fifth and sixth left ribs mid-shaft as the result of a healed break.
SKN041	Male ≥ 45	Peripheral enthesopathies along the bodies of T2-11. Degeneration and splaying of vertebral bodies throughout the spine.
SKN066	Male 36-45	Ossification of spinal longitudinal ligament along T9-10 without involvement of the vertebral disk space. Peripheral enthesopathies along the bodies of T8 and T11-12.
SKN067	Male ≥ 45	Peripheral enthesopathies along the bodies of T8-11 and L3-4 and L3. Calcification of the sacroiliac ligament on the left aspect of the pelvis.
SKP004	Male ≥ 18	Ossification of spinal longitudinal ligament along T5-T9 without involvement of the vertebral disk space. Osteophyte formation and pitting of the thoracic vertebral bodies. Sacroiliac fusion.
SKP005	Male ≥ 18	Ossification of spinal longitudinal ligament along T5-T11 without involvement of the vertebral disk space. Extensive porosity to the left and right femoral head.

Table 6.2.1: Occurrence of DISH at the Hospital of St James

The diagnosis of DISH was made in SKN020 on the basis of candle-wax like osteophyte formation along the right aspect of the bodies of the seventh thoracic vertebra through to the first lumbar vertebrae (figure 6.2.3). In addition to osteophyte formation in the spinal column, osteophytic growth with accompanying porosity of the cortical bone was evident throughout the pelvis. Such pathology was evident on the top border of the superior demiface of the right auricular surface extending posteriorly into the retro-auricular area. This suggests that the insertion of the iliacus muscle or the origin of the *obturator internus* have undergone ossification. Furthermore, within the thorax there were multiple osseous growths signalling the ossification of cartilaginous material. Extensive ankylosis of the manubrium had taken place and the costal cartilage of both first ribs had ossified onto the manubrium (figure 6.2.4). Two left ribs fused close to the distal ends (figure 6.2.5), several costal ends also showed severe malformation with porosity and ossified new bone (figure 6.2.6).

Figure 6.2.3: Osteophyte formation connecting the bodies of five thoracic vertebrae in SKN020.

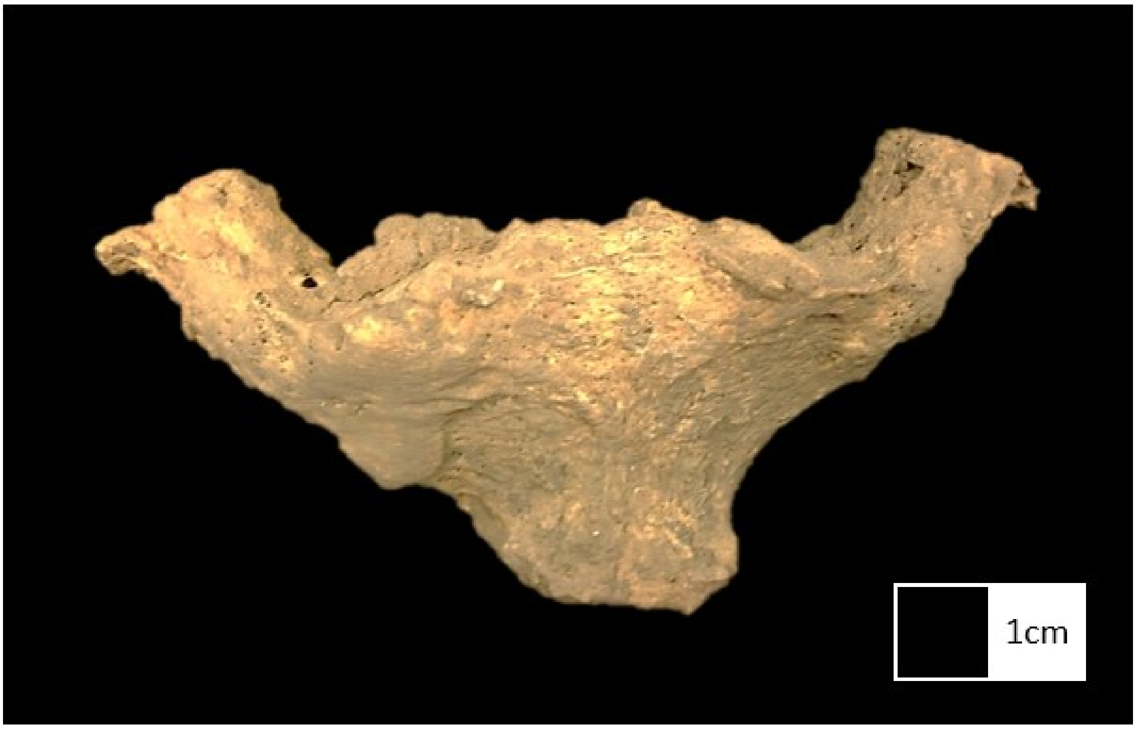

Figure 6.2.4: Ankylosis of the manubrium in SKN020.

Figure 6.2.5: Fusion of two ribs at the distal ends in SKN020.

Figure 6.2.6: Malformation with porosity and ossifying cartilage at the costal ends in SKN020.

SKP004 displayed equally complex skeletal modifications resulting from the primary and secondary effects of DISH. In this individual, skeletal changes included osteophyte formation throughout the spine, fusion of the third and fourth cervical vertebrae (figure 6.2.7) and from the fifth thoracic through to the fourth lumbar vertebrae (figure 6.2.8 and figure 6.2.9). In addition to which, there was fusion between the adjacent spinal processes throughout the thoracic spine. Furthermore, the sacroiliac ligaments on the left and right side of the pelvis had calcified across the joint surfaces (figure 6.2.10 and figure 6.2.11). In addition to these changes which are a direct result of DISH, further calcification of connective tissue across the distal aspect of both acetabula had taken place.

Figure 6.2.7: SKP004, fusion of the third and fourth cervical vertebrae demonstrating osteoarthritic changes in the skeleton (posterior view).

Figure 6.2.8: SKP004, manifestation of DISH via fusion of the fifth to ninth thoracic vertebrae (frontal view).

Figure 6.2.9: SKP004, manifestation of DISH via fusion of the fifth to ninth thoracic vertebrae (lateral view).

Figure 6.2.10: SKP004, manifestation of DISH via sacroiliac fusion (frontal view).

Figure 6.2.11: SKP004, manifestation of DISH via sacroiliac fusion (superior view).

DISH is a complex disorder in which the spinal column undergoes hyperostosis and ankyloses, in addition to associated calcification or ossification of extra-spinal entheses and ligaments can occur (Rogers and Waldron 2001, 357). In the majority of cases individuals with the condition complain of reduced movement and stiffness in the spine (Rogers and Waldron 2001, 359). However, in extreme cases the new bone formations can cause compression of the spinal cord, due to spinal stenosis, which can result in neurological deficits and sudden onset paraplegia (Johnsson *et al.* 1983; Wilson and Jaspan 1990; Goto *et al.* 1995).

The epidemiology of the condition shows considerable bias towards the age and sex of those affected, as well as having a potential genetic association (Rogers and Waldron 2001, 358). The condition has a greater prevalence in men than women and increases in incidence markedly from the age of 45 years and again from the age of 65 years (Rogers and Waldron 2001, 358; Littlejohn and Hall 1982, 84). All individuals affected by DISH at the Hospital of St James were male and over the age of 35 years at death (with the exception of one individual for whom it was only possible to state they were over 18 years with no greater accuracy).

The occurrence of DISH in seven individuals at the Hospital of St James resulted in the 4 percent crude prevalence rate, this is the second highest count of DISH and the second highest prevalence rate of all the comparative hospitals. The highest count was at the Hospital of St Mary Spital, London where a total of nine cases were recorded at a prevalence rate of 0.6 percent, this rate showed a statistically significant difference (X2=16.5242, p=.000048) to the Hospital of St James. The highest crude prevalence was at the Hospital of St Mary Magdalene, Partney where two occurrences equate to a crude prevalence of 6 percent which is statistically similar (X2=0.2577, p=.611707) to the Hospital of St James. One of the cases of DISH at the Hospital of St Mary Magdalene, Partney has been identified as the burial of a monk/priestly figure (Atkins and Popescu 2010, 247). The occurrence of DISH at the Hospitals of St John, Cambridge (n=4) and St Nicholas, Lewes (n=1) were also not statically significant from the Hospital of St James; with prevalence rates of 4.4 percent (X2= 0.0217, p=.882803) and 1.2 percent (X2= 1.4208, p=.233273) respectively.

The association of DISH and religious communities has been supported in archaeological investigation of the Royal Mint Site in London, Merton Priory, and Wells Cathedral (Waldron 1985; Rogers and Waldron 2001; Patrick 2014). At these sites, the prevalence of DISH was measured in the adult male populations as 3.9 percent, 7.3 percent and 9.1 percent respectively (Waldron 1985; Rogers and Waldron 2001). At the Hospital of St James the prevalence of DISH was 11.6 percent (n=7/61, when all individuals with four or more thoracic vertebrae are counted).

Comparisons of the prevalence of DISH in areas of burial reserved for the religious or wealthy with local lay burials in the assemblages from Wells Cathedral and the Royal Mint site both indicated prevalence was highest among the non-lay burials, although not always to a statistically significant degree. At Wells Cathedral, DISH was present in 13.3 percent of burials in the Lady Chapel which was dedicated to the burial of priests and lay benefactors and 23.1 percent in Stillingtons Chapel compared to only 6.5 percent in the lay cemetery (Rogers and Waldron 2001, 360-1). At the Royal Mint site a prevalence of 11.5 percent in the church and chapels compared to no cases in the lay cemetery (Rogers and Waldron 2001, 360-1). The prevalence of DISH in the areas reserved for the religious was compared to the prevalence at the Hospital of St James. The statistical comparison was carried out using chi-squared tests which showed there to be no significant difference between the three religious cemetery areas and the Hospital of St James. The results were as follows; Wells Cathedral Lady chapel (X2=0.0311, p=.86009), Wells Cathedral Stillingtons chapel(X2=0. 8831, p=.347363) and the Royal Mint site (X2=0. 0001, p=.992558). Thus the prevalence of DISH at the Hospital of St James is statistically comparative to the medieval religious populations.

Having established that DISH is a complex disorder in which individuals can be impacted to various degrees, the following applies Tilley's (2012) 'bioarchaeology of care' methodology. The clinical impacts of DISH include degeneration and stiffness of the spinal column, extreme new bone formation, potential paraplegia and neurological defects. In regard to functional impact, in the majority of cases DISH results in reduced movement and stiffness in the spine, making it challenging to maintain employment, and in worsening cases to carry out daily tasks such as hygiene, and obtaining food and water. This implies that care would be required to continue in daily life. The type of care required is likely to have been long-term care, this is due to the disease being progressive, but in the majority of cases not life threatening. Care would most likely have been unskilled and consist of the provision of food, water, shelter, managing hygiene, positioning of the body when stiffness was particularly bad and where possible pain relief. The more extensive cases at the Hospital of St James include SKN067 (5387), SKP004 (5514) with the involvement of the sacroiliac ligament and SKP005 (5612) with extensive porosity to both femoral heads. In extreme cases where paraplegia and neurological defects are present, then the care necessary would increase exponentially, and in some cases may call for constant supervision. The presence of seven cases of DISH at the Hospital of St James would imply that the hospital was comfortable in providing and maintaining the care the disease called for. In the majority of cases neurological health is not impacted, therefore any prior experience in caring for an individual with physical limitations would suffice, the community would need to be willing and able to absorb the cost of care in regard to food and the provision of staff. Furthermore, the care provided is likely to have been long term (for the remainder of the inmate's life) and adaptable to the needs of each individual.

6.2.3 Soft tissue injury

Two occurrences of soft tissue injuries were recorded among the Hospital of St James assemblage. Injuries to muscle, ligament or tendon may result in a bone response, or cause ossification of the damaged soft tissues and therefore be observed in skeletal remains. The first case is that of SKN031 (5189), a 36-45 year old male from Area A, presenting with evidence of new bone formation and a possible enthesopathy at the origin point of the *flexor capri ulnaris* muscle on the medial epicondyle of the humerus. This suggests that a soft tissue injury, either the result of continued strenuous use or an injury causing acute trauma. The second case was SKN062 (5360), also a 36-45 year old male from Area A. A large enthesophyte of mature bone with an inferior-pointing spur was located on the lateral shaft of the left humerus, in the area of the deltoid muscle insertion (figure 6.2.12). Trauma to this muscle, which abducts and extends the shoulder joint, may have caused the myositis ossificans present in the deltoid muscle. The care required for such injury would be minimal, the patient would require minimal intervention and would be able to carry out daily tasks of their own accord, though they may have required short-term housing which could facilitate the care and immobility of the limb which resulted in the complete recovery observed in both individuals.

The presence of soft tissue injury in two humeri of two individuals could be suggestive of strenuous activity being undertaken. The association between entheseal changes and activity is a topic under continued discussion in anthropological literature (Jumain 1999; Alves Caesoso and Henderson 2010; Villotte *et al.* 2010; Molnar *et al.* 2011; Niinimäki 2011; Jurmain *et al.* 2012; Ibáñez-Gimeno 2013). The idea is that mechanical loading resulting from activity is the main cause of entheseal change including both trauma and new development (Ibáñez-Gimeno 2013, 216). This idea has been applied to bioarchaeological research to link musculoskeletal markers with specific activity related stress and to reconstruct behaviours of past populations (Foster, Buckley and Tayles 20124). Therefore it is possible to infer that the soft tissue injuries to the musculoskeletal markers of the two individuals at the Hospital of St James are indicative of strenuous muscle use in active individuals. However, it is not possible to ascertain whether these soft tissue changes are a result of physical activity undertaken at the hospital site such as farming or wool production or whether they were incurred prior to the individual's time at the hospital.

Figure 6.2.12: SKN062, possible enthesopothy located on the lateral shaft of the left humerus, in the area of the deltoid muscle insertion (lateral view).

6.2.4 Spondylolysis

Spondylolysis was observable in 4.6 percent (n=8/175) of the total population of the Hospital of St James cemetery (figure 6.2.13). All cases were observed in adults, thus the crude prevalence among adults was 8.2 percent (n=8/99). Seven examples demonstrated separation of the neural arch from the vertebral body in the fifth lumbar vertebra (6.6 percent, n=7/105 when all fifth lumbar vertebrae are counted), while one individual presented with separation in the second and third thoracic vertebrae (0.8 percent, n=1/120 when all second and third thoracic vertebrae are counted).

Spondylolysis is the separation (complete or incomplete) of the neural arch from the vertebral body. The separation is known to occur as the result of congenital or physically-induced factors. The occurrence of congenital or genetic spondylosis has been investigated by Kaplan *et al.* (2005, 574) and Yamada *et al.* (2013). Congenital spondylolysis occurs when the neural arch fails to unite with the vertebral body causing slippage of the adjacent vertebra. Yamada *et al.* (2013) investigated the occurrence of spondylosis in the lumbar vertebrae of three juvenile siblings. The incidence of the condition among all three siblings led them to conclude the concept of a genetic disposition to separation of the vertebrae supporting the work of

Haukipuro *et al.* (1978) in which the gene responsible for spondylosis had been previously suggested.

Figure 6.2.13: Spondylolysis of the fifth lumbar vertebrae of SKN033 (left) and SKN035 (right).

The most common form is physically-induced spondylolysis, in which vertebral separation occurs as a result of fatigue failure of the neural arch primarily in the mid-cervical and lower-lumbar vertebrae (Thomas 2004, 155; Standaert and Herring 2000, 417). Failure occurs as stress exerted during hyperextension forces the transverse and spinal processes of the vertebra to come into contact with the adjacent vertebra, thus causing increased trauma on the bony structures (Arriazza 1997, 394). Failure of the neural arch is unique to the human skeleton and it thus appears to be associated with the physical stressors of bipedal locomotion, as well as chronic trauma and repeated stress patterns (Merbs 1996; 1989; Ortner and Putschar 1985; Haukipuro *et al.* 1978; Arriaza 1997; Srandaert and Herring 2000).

The impact of spondylolysis varies from person to person, and it can be asymptomatic, meaning individuals live unknowingly with the condition. In individuals where symptoms are present, they most commonly manifest in back pain. The pain results from sharp osteophytes, formed during new bone growth following a fracture, impinging on soft tissue structures and causing attrition between the bony structures (Arriaza 1997, 396). It can also manifest in headaches and, in the most severe cases, result in neural compression and therefore neurological impairment (Thomas 2004, 155). Neurological deficits occur when the body of the vertebra affected by spondylolysis slips forward trapping nerves, or when nerves get trapped in the cleft and new bone forms around them, resulting in increased pressure or damage to the spinal cord and nerve roots (Thomas 2004, 155).

Modern clinical assessments find spondylolysis to be most common among athletes and labourers who endure frequent and large stress reversals between lumbar hyperextension and lumbar flexion (Green *et al.* 1994, 2687-9). Stewart (1956), found age-related associations to the condition which further supports the argument that the condition is induced by ongoing physical-stressors. His conclusions were drawn upon the specific location of spondylolysis in the spine and the impacts of erect posture but recognised the possibility of genetic aetiologies. The association of age with increased frequency of spondylolysis was also supported by the fact that stresses on bone induce an imbalance in the formation of osteoblasts, as does age, and therefore new bone formation is not able to keep up with continued bone damage (Ortner and Putschar 1985, 358). The occurrence of spondylolysis occurring only in adults at the Hospital of St James, falls in line with the positive correlation between spondylolysis and age.

Spondylolysis has been identified throughout the archaeological record. Arriaza's (1997) study of the Hyatt site in Tumon Bay, Guam circa 1200–1521 AD, analysed the remains of 176 individuals of which 21 percent presented with some form of lumbar spondylolysis. Arriaza (1997, 396) concluded that the high prevalence of lumbar spondylolysis among this population, which was known to have participated in labour intensive activity as a result of their building programme, must be the result of environmental and cultural conditions inducing biomechanical stress (Arriaza 1997, 394-6).

The prevalence of spondylolysis at the Hospital of St James has been compared to that at the comparative hospitals used throughout this thesis. Spondylolysis was present in three of the hospital populations. The true prevalence rates at the Hospital of St Nicholas, Lewes (10.9 percent) and at the Hospital of St Mary Spital, London (4.8 percent) were not statistically significant from the prevalence at the Hospital of St James (X2= 0. 2477, p=.61867 and X2= 1. 7676, p=.183684, respectively). Only a crude prevalence rate could be ascertained from the Hospital of St John, Cambridge at a rate of 2.2 percent, when statistically compared to the true prevalence rate of the Hospital of St James this also proves to be an insignificant difference (X2= 0. 8711, p=.350646).

6.2.5 Osteoarthritis

The most commonly-occurring form of degenerative joint disease is osteoarthritis. Numerous factors can influence the likelihood of an individual developing osteoarthritis, including age, sex, activity, diet, environment, hereditary predispositions and metabolic status (Resnick 2001, 1273-6). Table 6.2.2 reports the characteristics of each case of osteoarthritis observed in the Hospital of St James assemblage, detailing the skeletal lesions used for diagnosis, which skeletal elements were affected and any potentially associated pathologies.

Skeleton	Age at Death	Biological Sex	Osteophyte formation	Erosion of the joint surface	Ebernation on the articular facet	Skeletal element effected	Associated pathologies
N001	36-45	M	X	X		Humeral head (R)	Robust muscle attachments throughout the right arm.
N002	≥18	M	X	X		Humeral Capitulum (R)	Possible compensatory morphology in the interosseous membrane attachments of the left arm. Spinal degenerative joint disease.
N026	≥45	Fe	X	X		Humeral head (R, L)	
N034	≥45	M	X	X		Humeral head (R)	
N035	≥45	M	X	X		Radial head (R), Humeral Capitulum (R), Femoral head (L)	Healed fracture to the distal radius (R), Fracture to the proximal femur (L). Spinal degenerative joint disease.
N037	36-45	M	X	X		Tarsals and metatarsals (R, L)	Spinal degenerative joint disease.
N039	36-45	M	X	X		Tarsals and metatarsals (R, L)	Spinal degenerative joint disease.

Skeleton	Age at Death	Biological Sex	Osteophyte formation	Erosion of the joint surface	Ebernation on the articular facet	Skeletal element effected	Associated pathologies
N054	26-35	M	X	X		Olecranon process of the ulna (R)	Spinal degenerative joint disease.
N056	≥18	n/a	X	X		Humeral head (L)	
N060	≥45	M	X	X	X	Femoral head and acetabulum (L), Distal articular surfaces of the tibia and fibula and the trochlea of the talus (R, L)	Healed fracture of the proximal diaphysis of the left femur. Spinal degenerative joint disease.
N062	36-45	M		X	X	Humeral head (R, L)	Arthritic tendencies in the spine.
N069	36-45	M	X	X	X	Olecranon process of the ulna and humeral capitulum (R), Distal articular surfaces of the tibia and fibula and the trochlea of the talus(L), Femoral head and acetabulum (R)	Ossification of joint cartilage e.g. sterno-clavicular, are indicative of age-related pathology throughout the skeleton. Spinal degenerative joint disease.
P004	≥18	M	X	X		Glenoid fossa of the scapula (L), Humeral head (L), Olecranon fossa (L)	Spondylosis and DISH in the vertebral column.
P005	≥18	M		X		Femoral head (R, L), Scaphoid (L)	Osteoarthritis.

Table 6.2.2: Characteristics of osteoarthritis observed in the Hospital of St James assemblage.

Fourteen individuals displayed signs of appendicular degenerative joint disease; all were male with the exception of one female over the age of 45 years, and two individuals for whom sex could not be determined. The true prevalence of osteoarthritis was 9 percent when considering the total population as the number of adults with one or more synovial joints present across the entire population (n=14/72) and the crude prevalence was 8 percent (n=14/99). No cases of appendicular degenerative joint disease were recorded in the 18-25 age category and therefore it has been excluded from discussion here and from figure 6.2.14. The individuals which accounted for the highest proportion of those affected were aged 36-45 years (35.7 percent, n=5), followed by those over 45 years (28.6 percent, n=4) and those aged 26-35 years were least affected (7.1 percent, n=1) (figure 6.2.14). The remaining 28.6 percent (n=4) of the affected could be identified as adults but no further precision in their age could be determined and are therefore assigned the age of 18 years and above. All were recovered from within the hospital chapel (Area C) or from the hospital cemetery (Area A).

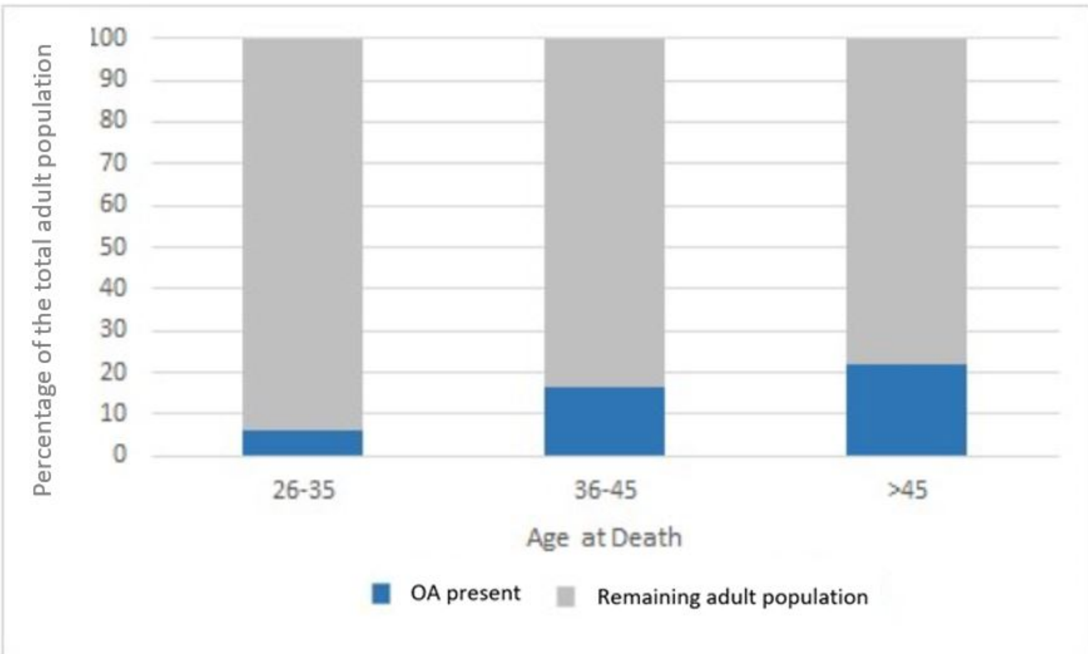

Figure 6.2.14: Age distribution of osteoarthritis in the population of the Hospital of St James.

The onset of osteoarthritis is most frequently the result of age-related degeneration (Anderson and Loeser 2010, 1-2). This association with age is apparent in the population of the Hospital of St James and is displayed in figure 6.2.14. Several individuals also displayed evidence of secondary arthritic changes, most probably associated with traumatic events. For example, the pathologies noted in SKN016 (5081) are associated with compensatory changes from amputation, SKN035 (5199) and SKN060 (5356) can be associated with fracture of the femur, these are discussed in great detail in sections 6.3.1.3 and 6.3.1.4 respectively.

6.2.6 Degenerative changes in the axial skeleton

Several manifestations of degenerative change were observed in the spinal column of skeletons from the Hospital of St James. Porosity, eburnation, and marginal osteophytosis are all associated with degenerative joint disease of the spine. Subchondral bone reaction and marginal osteophyte development are particularly associated with the degeneration of vertebral bodies, while porosity and eburnation occur more sparingly in this location (Ortner 2003, 430). Recording of degenerative changes in the axial skeleton revealed both porosity and marginal osteophytosis, in addition to the presence of Schmorl's nodes. Due to poor survival of vertebrae in the assemblage 68.6 percent of adults (n=68/99, when all adults are counted) could not be assessed for spinal degenerative conditions.

6.2.6.1 Porosity of the vertebral bodies

Erosive lesions and porosity of the vertebrae occur when bone density is affected by degenerative spinal disease, the bone becomes porous, weak and susceptible to fracture (Adams and Dolan 2012, 499; Rodriguez *et al.* 2012, 208-5). The bone surface becomes uneven with numerous perforations of various sizes. Such morphological characteristics were observed in four individuals (a true prevalence of 3.75 percent, n=4/107, when all individuals with assessable vertebrae i.e. those not obscured by surface erosion are counted, and crude prevalence rate of 2.3 percent, n=4/175), all of whom also display signs of osteophyte formation, and in one case Schmorl's nodes.

6.2.6.2 Osteophyte Formation

Degenerative changes to the vertebral column were identified via the presence of osteophyte formation. These formations occur in an attempt to stabilize the vertebral column when the body loses its ability to maintain joint cartilage. This bony response to degeneration of the skeleton was recorded in 17 adults from the Hospital of St James. This results in a true prevalence of 15.8 percent (n=17/107, when all individuals with assessable vertebrae i.e. those not obscured by surface erosion are counted). Of those affected, osteophyte formation occurs most frequently in those aged 36-45 years (accounting for 62.5 percent) and those aged upwards of 45 years (accounting for 25 percent). This data is presented in figure 6.2.15, with the exclusion of SKN002 (5050), for whom accurate age assessment could not be completed (table 6.2.3). Alongside the presence of osteophyte formation, 35.3 percent of these individuals (n=6/17) also presented porosity of the vertebral bodies (figure 6.2.16) and 58.8 percent (n=10/17) also displayed evidence of degenerative joint disease in the appendicular skeleton.

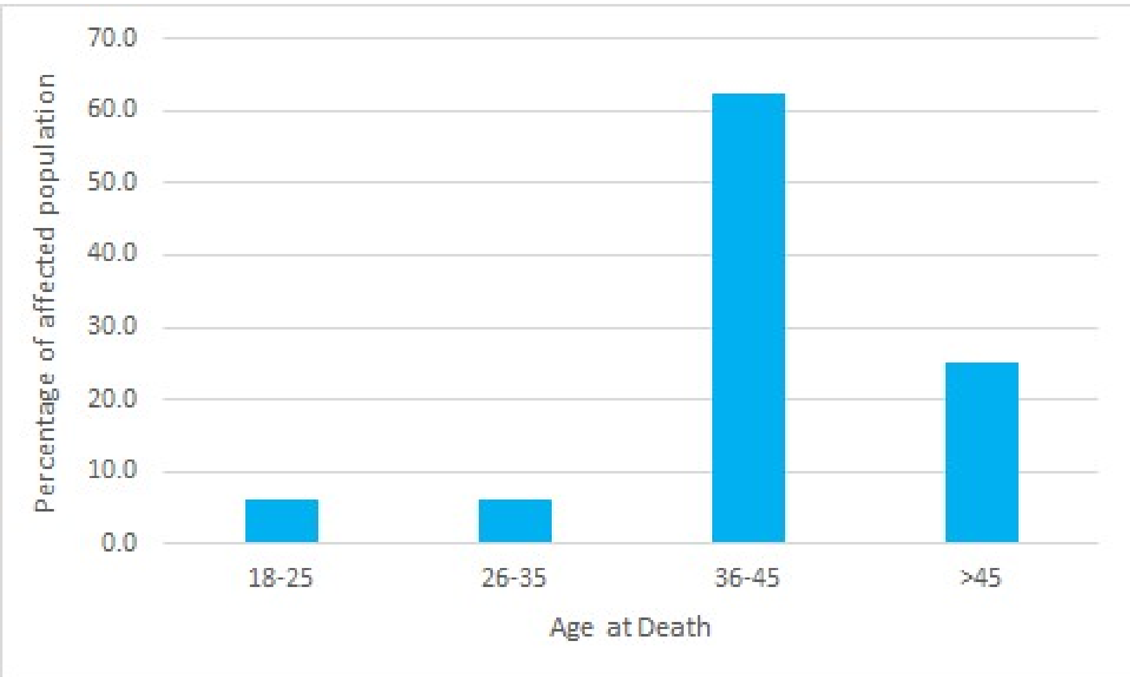

Figure 6.2.15: Age distribution of skeletons displaying osteophyte formation.

Skeleton	Age at Death	Biological Sex	Osteophyte Formation	Porosity
M059	36-45	M	X	
M0128	26-35	M	X	
M0135	18-25	M	X	
M0151	36-45	M	X	
N002	>18	M	X	
N007	36-45	M	X	X
N022	≥45	M	X	X
N033	36-45	M	X	
N035	≥45	M	X	X
N037	36-45	M	X	X
N039	36-45	M	X	X
N040	≥45	M	X	
N045	36-45	M	X	
N060	≥45	M	X	
N062	36-45	M	X	
N069	36-45	M	X	
N072	36-45	M	X	X

Table 6.2.3: Skeletons affected by spinal degenerative joint disease (SDJD) manifesting in osteophyte formation and porosity of the bone. Eburnation was not included in this table as none was observed in the assemblage.

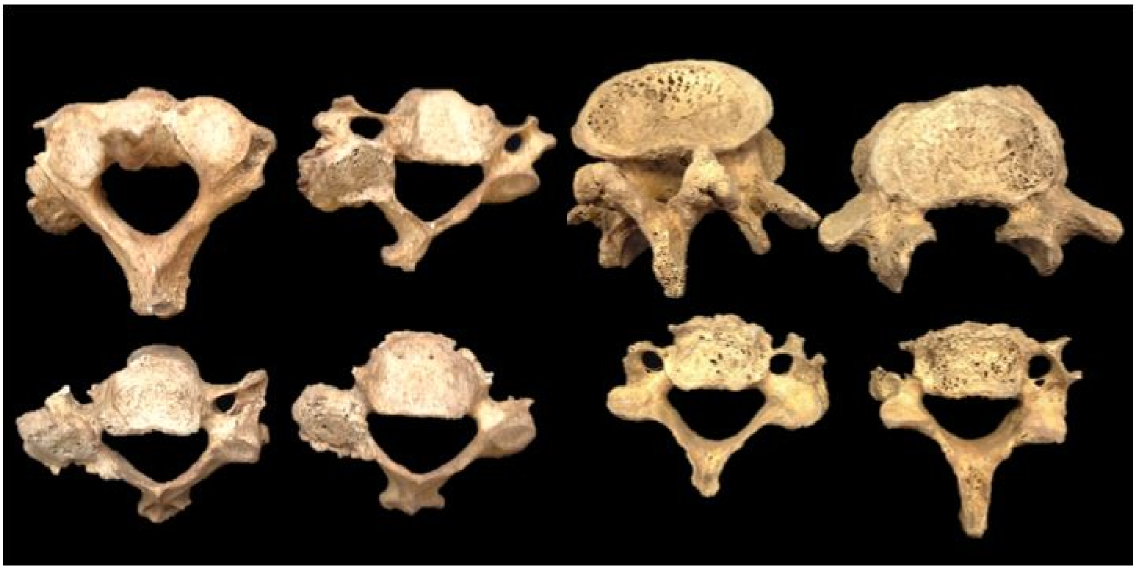

Figure 6.2.16: Vertebral bodies presenting with varying degrees of porosity and osteophyte formation (left- SKN037; right-SKN039).

6.2.6.3 Schmorl's nodes

Schmorl's nodes were observed in nine individuals (a true prevalence rate of 8.41 percent, n=9/107, when all individuals with assessable vertebrae i.e. those not obscured by surface erosion are counted, and a crude prevalence rate of 5.14 percent, n=9/175) from the Hospital of St James assemblage (figure 6.2.17 and table 6.2.4). Any intrinsic abnormality in the structural capabilities of the vertebrae leave it susceptible to Schmorl's node formation as the structure cannot withstand the pressure imposed by the *nucleus pulposus.* The aetiologies of Schmorl's nodes are very varied including, but not limited to, age-related degradation, trauma, joint disease, Paget's disease, osteomalacia, hyperparathyroidism, neoplasm and infection (Resnick 2002, 1430).

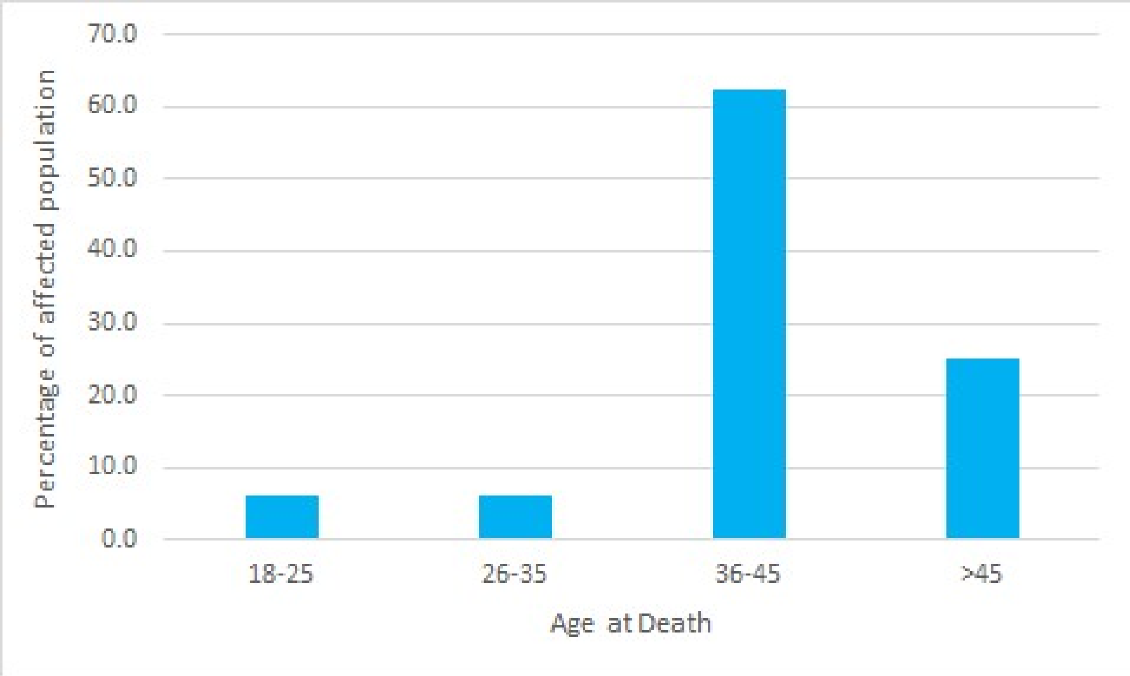

Figure 6.2.17: Age distribution of skeletons displaying osteophyte formation.

Skeleton	Age at Death	Biological Sex
M120	36-45	M
M135	18-25	M
M153	18-25	M
M154	26-35	M
N010	26-35	M
N022	$\geq$45	M
N024	26-35	n/a
N031	36-45	M
N037	36-45	M

Table 6.2.4: Cases of Schmorl's Nodes at the Hospital of St James.

The individuals affected by Schmorl's nodes from the Hospital of St James population range from 18 years to 45 years at death (table 6.2.4), which does not suggest an association with advancing age in this particular population. The correlation between age-related degenerative change and Schmorl's node formation is not conclusively established in current medical practice. Research by Hilton *et al.* (1976, 128-9) found that the occurrence of Schmorl's nodes in individuals under 50 years of age was comparable with that of those over 50 years of age, corroborative results were found by Pfirrmann and Resnick (2001), Hamanishi *et al.* (1994), Saluja *et al.* (1986) and Weiss (2005).

There is a higher prevalence of Schmorl's nodes in the mid and lower thoracic vertebrae (77.8 percent, n=7/9) compared to the lumbar region (22.2 percent, n=2/9) (figure 6.2.18 and figure 6.2.19). This is suggestive that morphology of the spine, movement patterns and the distribution of loading are responsible for the development of Schmorl's nodes. The thoracic vertebrae engage in a greater number of rotational movements compared to lumbar spine (Narimani and Arjmand 2018, 171), the torsional movement of which is a major influence in the manifestation of Schmorl's nodes. Increased stressors in this region of the spine results in a structure more susceptible to stress, the outcome of which is the herniation of the nucleus into the cartilaginous end plate and ultimately the bone structure (Dar 2010, 671). Furthermore, the thoracic vertebrae are less well equipped to tolerate loading of the spine in comparison to the lumbar vertebrae. This is because lumbar vertebrae have a thicker bone cortex, and consequently greater resistance to herniation of the intervertebral disk (Edwards *et al.* 2001, 220).

The occurrence of Schmorl's nodes as the result of repetitive stress to the spine results from the repetitive flexion and extension of the vertebral column (Plomp *et al.* 2015, 532). In modern populations, gymnasts, wrestlers and tennis players present high incidences of Schmorl's nodes but any activity with repetitive movement is a possible cause especially in manual labour where the spine is loaded with additional weight (Baranto *et al.* 2006; Ogon *et al.* 2001). Dar (2010, 673) and Pfirrmann and Resnick (2001, 370) found Schmorl's nodes to most frequently occur in the T7–L1 region than in the higher thoracic vertebrae (T4–T6) or the lower lumbar vertebrae (L2–L5). The prevalence of Schmorl's nodes in the thoracic vertebrae of the Hospital of St James population is therefore consistent with the conclusion that they were caused by stressors on the spine induced by repetitive movements over time.

Figure 6.2.18: Example of Schmorl's nodes from SKM154 (superior view).

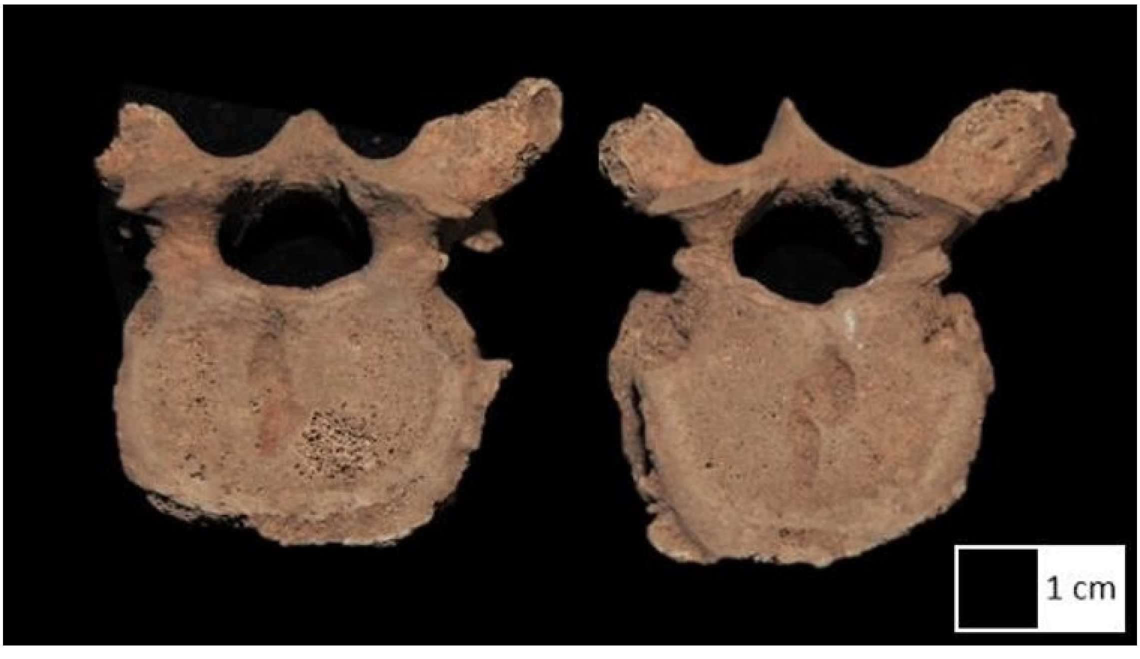

Figure 6.2.19: Example of Schmorl's nodes from SKN022 (superior view).

6.2.7 Discussion of 'markers of lifestyle'

The association of DISH and religious communities is supported in published archaeological literature which demonstrate increased prevalence of the condition in areas of burial reserved for the religious or wealthy (Rogers and Waldron 2001, 360). The care required for those with DISH and ankylosing spondylosis is likely to have been long-term, due to the diseases being progressive, but in most cases not life threatening. The second part has presented several activity markers which show the population to have been involved in repetitive and physical activity. As discussed above within the Hospital of St James population, soft tissue injuries to the musculoskeletal markers indicate strenuous muscle use in active individuals potentially as a result of heavy manual labour such as that which involved farming or wool production. Similarly, physically induced spondylolysis and Schmorl's nodes demonstrate fatigue failure within the vertebral column which occurs as a result of repetitive stress exertion causing increased trauma on the bony structures. Modern day clinical assessments confirm such skeletal changes are common among the physically active who endure frequent and large stress reversals within the spine. Osteoarthritic changes are less definitive in their cause being the result of age-related degeneration, arthritic changes associated with compensatory changes and as a result of a physically active lifestyle. It is not possible to ascertain whether these lifestyle markers are representative of their life before they entered the hospital or once they were there. It is however possible to ascertain that the degenerative impact they show in the skeletal material could have led to diminished capabilities to carry out physical labour on a long-term basis and the potential to cause periods of irritation and pain to the individuals. This may have been cause for their stay as an inmate of the hospital. In such situations it is probable that these were short-term inmates staying for the length of their condition's inflammation. In summary, these pathologies have provided evidence of both monastic and physical lifestyles among the hospital's cemetery population. This combination of lifestyle markers provides further support for the idea that the Hospital of St James housed a quasi-monastic population as discussed in Chapter 4 where the demographic profile of the hospital has significant similarities to contemporary monastic population with the addition of a large non-adult community.

6.3 Research theme 3 - ‘medical intervention and potential for long term, palliative care skilled care’

The third and final research theme addresses a broad suite of pathologies present within the hospital population to identify examples of medical intervention and the potential for provision of long term, palliative or skilled care. The paleopathologies discussed first are those related to trauma, followed by non-specific infection and unique pathologies comprising of rheumatoid arthritis, synostotic scaphocephaly and a case of trans-tibial amputation. All pathologies in this research theme have been investigated using Tilley's 'bioarchaeology of care' methodology to aid in the assessment of their impact on the individual as well as helping to establish the type and potential level of care provided by the hospital.

6.3.1 Trauma

The following describes the specific cases of trauma among the Hospital of St James assemblage. Throughout this thesis the term trauma is used to describe all forms of injury to the bone, whether deliberate or accidental (as stated in section 4.4.5). In the Hospital of St James assemblage, trauma ranged from soft tissue injuries (discussed above under research theme 2) through to bone breakage and blunt force trauma. All traumatic injuries were found to be healed or healing at the time of death and therefore no discussion of these injuries as potential cause of death is provided.

Overall, seven individuals presented with some form of trauma to the skeleton. The cases are outlined in table 6.3.1 and discussed in greater detail on a case-by-case basis below. All instances of trauma at the Hospital of St James were in adult skeletons and therefore the following prevalance rates are calculated using the total number of adults in the skeletal collection of 99. Soft tissue trauma only occurred in the humerus at a prevalence of two percent (n= 2/99), trauma in the form of bone fractures occurred at a prevalence of three percent (n= 3/99) and blunt force trauma to the cranium occurred at a prevalence of two percent (n= 2/99).

Skeleton	**Sex/Age (years)**	**Trauma Type**	**Brief Description**
SKN031	Male 36-45	Soft tissue	New bone formation on the medial epicondyle of the humerus. Suggestive of a soft tissue injury from continued stressors or an injury causing acute trauma.
SKN062	Male 36-45	Soft tissue	A large enthesophyte of mature bone located on the lateral shaft of the left humerus, in the area of the deltoid muscle insertion.
SKN040	Male $\geq$ 45	Cranial trauma	Blunt force trauma to the frontal bone.
SKN065	Male 26-35	Cranial trauma	Blunt force trauma to the frontal bone.
SKN048	Indeterminate 26-35	Vertebral fractures	Fractures to the left transverse processes of the first and second lumbar vertebrae.
SKN060	Male $\geq$ 45	Femoral fracture	Oblique fracture of the left femoral shaft.
SKN035	Male $\geq$ 45	Multiple fractures	A series of fractures throughout the skeleton. Including the right radii and ulna as well as the left femur.

Table 6.3.1: Individuals from the Hospital of St James with instances of skeletal trauma.

The prevalence of trauma to each skeletal element has been compared across the comparative hospital sites in table 6.3.2. The distribution of trauma in the Hospital of St James population is presented followed by the other hospital populations utilised throughout this thesis. The only comparative hospital site which did not report any case of trauma was the Hospital of St Margaret, High Wycombe;

this lack of documentation is likely the result of very poor skeletal preservation and therefore the site has been excluded from the comparative table (Farley and Manchester 1989, 84). The data presented here uses crude prevalence rates of the total adult population at each site, as the large majority of the published literature has recorded trauma data in this form (Price and Ponsford 1998, 178-9; Magilton, Lee and Boylston 2008, 230; Atkins and Popescu 2010, 247; Cessford 2015, 95-8).

As can be seen in table 6.3.2, the prevalence of trauma to each skeletal element varies drastically throughout the different hospital assemblages. Trauma occurred more in the upper limb than the lower limb, this could be a reflection of the lower limbs greater robusticity or that the upper limb was affected more in accidental injury where the arms are used to brace oneself during a fall or to protect the body when a potential hazard is anticipated. Cranial trauma was prevalent across all but one of the hospital sites, suggesting that the occurrence of this at the Hospital of St James is not a specific indication of concern for interpersonal violence. A hospital's size, location or type makes no difference, as all types of hospital cared for individuals who had experiences of trauma. The following discussion of the individual trauma documented at the Hospital of St James offers a greater understanding of the extent of the traumas the hospital cared for, whether this required specialist or basic care and whether the individual would require a long or short term stay at the hospital.

Site	Skeletal Element										
	Cranium	Vertebrae	Ribs	Humerus	Ulna	Radius	Femur	Fibula	Tibia	Hand	Foot
St James, Thornton Abbey	2/99	2/99	1/99	1/99	1/99	1/99	2/99	n/a	n/a	n/a	n/a
	2%	2%	1%	1%	1%	1%	2%	n/a	n/a	n/a	n/a
St Mary Spital, London	110/1392	538/1392	6-8/1392	74/1392	172/1392	119/1392	23/1392	n/a	n/a	n/a	n/a
	7.9%	38.6%	4.9%	5.3%	12.4%	8.5%	1.7%	n/a	n/a	n/a	n/a
St Mary Magdalene, Winchester	n/a	n/a	n/a	2/44	6/44	7/44	1/44	n/a	n/a	n/a	1/44
	n/a	n/a	n/a	4.5%	13.6%	16%	2.3%	n/a	n/a	n/a	2.3%
St Leonard, Newark	8/279	23/279	35/279	3/279	8/279	9/279	3/279	9/279	16/279	12/279	26/279
	2.9%	8.2%	12.6%	1.1%	2.9%	3.2%	1.1%	3.2%	5.7%	4.3%	14.5%
St Mary Magdalene, Partney	1/28	1/28	n/a	n/a	1/28	n/a	1/28	n/a	n/a	n/a	n/a
	3.6%	3.6%	n/a	n/a	3.6%	n/a	3.6%	n/a	n/a	n/a	n/a
St Nicholas, Lewes, E Sussex	9/84	1/84	n/a	1/84	1/84	1/84	n/a	4/84	1/84	5/84	5/84
	10.7%	1.2%	n/a	1.2%	1.2%	1.2%	n/a	4.8%	1.2%	6%	6%
St John, Cambridge	1/339	8/339	1/339	1/339	4/339	1/339	n/a	n/a	n/a	2/339	2/339
	0.3%	2.4%	0.3%	0.3%	1.2%	0.3%	n/a	n/a	n/a	0.6%	0.6%
St Margaret, High Wycombe	2/26	1/26	1/26	n/a	n/a	n/a	n/a	2/26	n/a	1/26	1/26
	7.7%	3.8%	3.8%	n/a	n/a	n/a	n/a	7.2%	n/a	3.8%	3.8%
St Bartholomew's, Bristol	n/a	n/a	n/a	2/44	6/44	7/44	1/44	n/a	n/a	n/a	1/44
	n/a	n/a	n/a	4.5%	13.6%	16%	2.3%	n/a	n/a	n/a	2.3%

Table 6.3.2: Trauma distribution at the Hospital of St James and comparative hospital populations.

6.3.1.1 Depressed fracture to the cranium

Two individuals presented well-healed traumatic injuries to the frontal bone. The first, SKN040 (5209), was a male aged ≥45 years at death from Area A. The skull presented a circular depression measuring 2.24 cm wide, 3.02 cm long and 0.2 cm deep, on the right side of the frontal bone (figure 6.3.1). The second, SKN065 (5383), was a male aged 26-35 years at death also from Area A. This individual's trauma was located slightly left of the centre of the frontal bone and measured 4.25 cm wide, 7.14 cm long and 0.4 cm deep (figure 6.3.2 and figure 6.3.3). Both have been interpreted as healed depressed fractures.

The depression fractures to both SKN040 and SKN065 are typical of a blunt force trauma to the cranium. This case was assessed following the classification of injury outlined by Cohen *et al.* (2014, 725), which states blunt force trauma presents a clear external border (either rounded of polygonal in shape) and the entire affected area is depressed. Blunt force trauma is said to be the hardest type of bone trauma to interpret as it can be the result of violence or accidental injury (Owens 2007; Tung 2007; Dirkmaat *et al.* 2008; Cohen *et al.* 2012). However, attributing an archaeological specimen from a hospital location to either of these categories is problematic and, in these cases, there is no evidence to confidently attribute one over the other. Two individuals with depressed fractures to the cranium were recorded at the Hospital of St Bartholomew, Bristol. Very little comparative data is available in regard to these, however Price and Ponsford (1998, 179) did record that both were small round indentations 10 and 13 mm in dimension. The crude prevalence of 6.6 percent was compared with 1.14 percent at the Hospital of St James when statistical comparisons were applied this provided to be an insignificant difference (X2=3.7845, p=.05173). A comparison to the 1 percent prevalence at the Hospital of St Mary Spital also proved to be statistically similar to the Hospital of St James (X2=0. 0161, p=.89895).

Regardless of cause, trauma related brain injuries typically arise due to blunt trauma to the head which places rapid acceleration–deceleration forces on the brain (De Sousa, McDonald and Rushby 2012, 606). Such forces occur in modern day populations as a result of motor vehicle accidents, falls, and assault (McDonald 2013, 231). Brain damage is most commonly found throughout the ventral surfaces of the frontal and temporal cortices with an array of physical, neuropsychological, and emotional side effects (De Sousa, McDonald and Rushby 2012, 606). Trauma to the brain may cause a brief period of confusion, while those who are impacted by a greater trauma may have prolonged periods of confusion, amnesia and even coma (Nakase-Thompson 2004, 131). Once the initial period of confusion and amnesia have subsided individuals can be left with ongoing cognitive, behavioural and physical impairments (Levin 1992, 359). The impact upon on social cognition affects an individual's ability to recognise, interpret and act upon emotions, empathise and interpersonal cues which help guide us through daily interactions (De Sousa, McDonald and Rushby 2012, 60; McDonald 2013, 231). The deficits which people experience from brain trauma impact their ability to complete daily tasks and to return to their lifestyle prior to the trauma (McDonald 2013, 231).

From the archaeological remains of SKN040 and SKN065 it is not possible to determine with certainty whether the injuries sustained could have resulted in clinical impacts related to brain injury. However, the trauma sustained to the frontal bone of SKN065 was substantial and realistically could have resulted in the side effects of confusion, amnesia and cognitive alterations discussed above. Therefore Tilley's (2012) 'bioarchaeology of care' methodology has been applied to establish that long term care would have likely been required involving a group of carers; the individual could have required food, shelter, a hazard-free environment, assistance carrying out daily tasks and maintaining hygiene as well as help in social interactions and may have had behavioural challenges. There is no reason to suggest this individual would not have reached their life expectancy and therefore the skilled care would be required on a long-term basis for the lifetime of the inmate.

Figure 6.3.1: Healed cranial trauma on the frontal bone of SKN040.

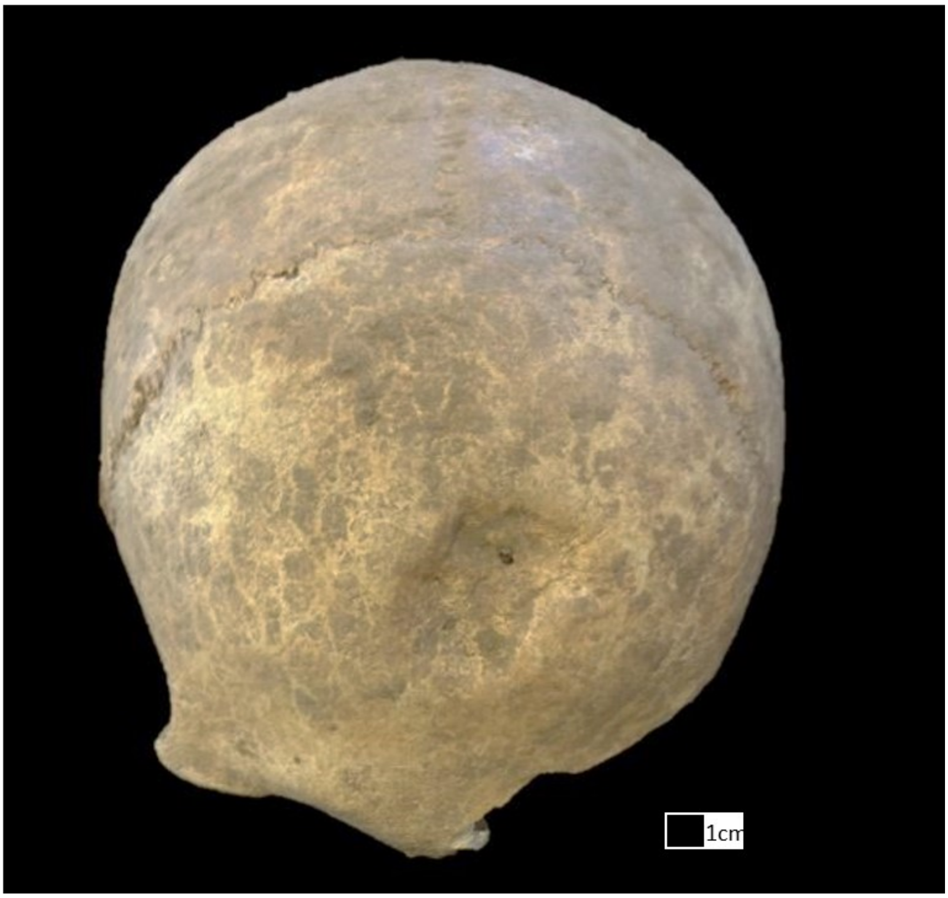

Figure 6.3.2: Cranial trauma on the frontal bone of SKN065.

Figure 6.3.3: Cranial trauma on the frontal bone of SKN065.

6.3.1.2 Vertebral fractures

SKN048 (5230), an adult of indeterminate sex, aged 26-35 years at death presented with trauma to the first and second lumbar vertebrae in the form of a fracture to the left transverse processes. The individual was recovered from the hospital cemetery (Area A). The breaks pictured had healed in life (figure 6.3.4 and figure 6.3.5). Due to the location and successful healing of the fractures, it is highly unlikely that they caused any instability to the spine or damage to the spinal cord. Fractures to the transverse processes most commonly occur as the result of sudden and extreme twisting of the back; they can also occur as a result of direct impact to the process itself, however the transverse process of a spine is well protected by surrounding muscle and soft tissue structures. However, the muscular structures, particularly the Psoas muscle which attaches to the transverse process, can be the cause of fracture when a strong and sudden contraction of the muscle occurs. Clinical studies of comparative fractures revealed that such fractures to the spine result in a decreased range of motion of the lower back and can result in persistent pain (Gültekin *et al.* 2019; Gray and Catterson 2015).

In a study of 306 individuals with isolated transfers process fractures, Boulter *et al.* (2016) found that just 15 percent of patients were recommended the use of a brace or collar, and for over 80 percent of these this was a method of pain release rather than medical intervention. Patient care consists of rest and recovery time which in the modern day can be achieved in hospital or at home (Boulter *et al.* 2016, 287-8). Therefore, the application of Tilley's (2012) 'bioarchaeology of care' identifies a minimal model of care, for SKN048 it may have been necessary to recover within the Hospital of St James owing to home conditions which may not facilitate effective recovery. Therefore, the level of care required by these individuals would be minimal consisting of the provision of a bed and where possible minor pain relief, which could be achieved through correct positioning of the body. The care necessary would be on a short-term basis and require minimal attention from care givers within the hospital, the individual is likely to have returned to normal function although may have experienced some restriction in movement.

Figure 6.3.4: Fracture of the left transverse process in SKN048 (posterior view).

Figure 6.3.5: Fracture to the left transverse processes in SKN048 (right – frontal view, left – posterior-lateral view).

6.3.1.3 Fracture of the femur

SKN060 (5356) was a male adult aged ≥45 years at death recovered from the hospital cemetery (Area A). This individual presented with a very well-healed oblique fracture of the shaft of the left femur. The following outlines the palaeopathological evidence discerned from the skeletal elements with regards to the fracture, its misalignment and secondary joint disease.

The femoral fracture had resulted in displacement of the diaphysis distal to the fracture line and the distal epiphyses were drawn both proximally and medially (figure 6.3.6). As a result, the limb healed with a shortening and rotation. The femur was shortened by 3.8 cm meaning the left femur was 43.3 cm in length whilst the right was 47.1 cm. Angulation of the bone also occurred, in this case the rotational misalignment, of between 45-55 degrees, left the bone distal to the fracture twisted laterally, meaning the knee would have faced outwards. A large callus of bone formed surrounding the point of fracture (figure 6.3.7; 6.3.8), the size of the callus is accentuated by the misalignment of the bone and extensive bone remodelling, all of which is indicative of advanced healing of the trauma. Furthermore, osteoarthritis of the left knee was diagnosed on the basis of osteophyte formation around the joint border and eburnation on the joint surface. Osteoarthritis was noted in both knee joints, plausibly this occurred in the left as a direct result of the break and in the right as a result of compensatory weight bearing.

Figure 6.3.6: Rotational misalignment of SKN060's femur resulted in a lateral twisting of the distal aspect.

Figure 6.3.7: Fracture to the proximal aspect of the left femur of SKN060 (posterio-medial view).

Figure 6.3.8: Fracture to the proximal aspect of the left femur of SKN060 (lateral view).

During the fracture of a long bone, the surrounding muscle structures spasm causing the distal fragments of the bone to be drawn upwards. Such displacement is often countered naturally by adjacent bones acting as a natural split, for example in the forearm or lower leg, as well as the ribs. When such natural countering of bone movement is not possible, displacement is reverted via reduction of the bone, which is to return the bone to its normal anatomical position and immobilising it through the use of a splint or with a cast until healed. Today, reduction of a broken bone is done with the patient anaesthetised meaning the surrounding tissue structures are relaxed and more easily manipulated, and with the assistance of X-ray guidance (Waldron 2009, 142). However, in medieval medical practice it is more likely that brute force was applied while the patient was held down, after which the limb would be immobilised by the application of a splint (Waldron 2009, 142).

In the case of SKN060 rotational misalignment took place. As a general rule a fracture to the femur would necessitate nine to twelve weeks of immobilisation, followed by a period four to six weeks in which the patient could only apply minimal weight to the bone due to atrophy of the muscle during immobilisation which needs to be retrained and strengthened (Waldron 2009, 142). The large callus around the femoral fracture is likely a result of previously failed attempts of immobilisation of the leg. The callus represented the bone recurrently fracturing and re-setting until the bone capsule was strong enough to hold the femur in place.

It should be noted that such injury would also affect the overlying muscle structures, blood supply and nerves which are not visible in the archaeological record. However, due to the misalignment of the fracture, the normal mechanics of the knee joint and its surrounding tissue structures were dramatically altered. It is possible that the limb could function with some difficulty and compensatory movement. The compensatory action of the skeleton is likely the cause of the osteoarthritis observed in the hip and knee joint (Jaarsma and Van Kampen 2004, 1103).

A comparative fracture was identified in a 'middle-aged' female from the Korean Joseon Dynasty skeleton collection (c.1392-1897). An oblique fracture to the shaft of the left femur was recorded, with marked deformity, axial deviation, rotation and shortening of the bone (Kim *et al.* 2013, 204-6). The interpretation of this pathology was that an atypical healing process had taken place in which malalignment of a bony fracture had occurred, and complications from the fracturing of the femur led to osteomyelitis in the bone. The physical description of this femoral break, and it having healed misaligned, offer the closest comparison to the fracture recorded in SKN060 at the Hospital of St James. In the case of SKN060, extensive remodelling indicates that the break took place earlier in the individual's life, further supported by the osteoarthritic changes in the knee joint which indicate that the individual compensated for the injury for some time to enable such degeneration to take place.

Having established the clinical and functional impacts of the femoral fracture as well as degenerative changes to the skeleton in the form of osteoarthritis it is possible to produce a model of care for SKN060 in line with Tilley's (2012) 'bioarchaeology of care' methodology. The individual presented with clinical and functional impacts on mobility, bone strength, limb position and extensive bone remodelling. It is evident from the extensive bone remodelling that the bone fractured on more than one occasion during the healing process, from which it can be inferred that the individual would have required prolonged care, they would have experienced several occasions of severe pain as well the ongoing pain associated with the healing process. During the healing process the individual would need attentive help to carry out daily tasks, to maintain hygiene as well as pain relief, immobility and bed care. Once the fracture finally healed the individual would then require help to learn to walk with the rotational misalignment and to build up strength following a prolonged period of immobility during which muscle atrophy would have taken place. The skeleton displays osteoarthritis in both knee joints which infers the individual did walk after the broken limb had healed and compensatory effects manifested in the right knee. It is possible that the individual aided their locomotion with the use of crutches, however there was no evidence of crutch use in the upper limbs which usually manifests in osseous changes to the upper limb from compensatory load-bearing, as demonstrated in SKN035 (Knüsel, Chundun and Cardwell 1992, 113). Overall, this individual would have required extensive care throughout the several attempts for the bone to heal after the significant fracture had taken place. The care needed would have been more specialised and demanding during the healing process and would have lessened as they regained independence in tasks. However, it is possible that assistance was required for the remainder of the individual's life considering the misalignment of the bone impacting locomotion and the degenerative joint disease evident in the skeleton.

6.3.1.4 A case of multiple fractures

Skeleton SKN035 (5199) presented with multiple pathologies related to traumatic injury to the skeleton. The individual was a mature male adult aged ≥45 years at death, recovered from Area A. They had suffered a series of fractures throughout the skeleton with signs of extensive healing and bone re-modification. Looking further at the overall status of the bone it was determined that this individual presented with lightweight bones, with decreased cortical structure; this reduction in bone mass makes bone more susceptible to fractures as well as degenerative changes (Kanis *et al.* 2008, 468; Harding *et al.* 2020, 1).

The most dramatic skeletal malformation was the inferior and posterior displacement of the femoral head in the left limb, with a reduction of the femoral neck (figure 6.3.9 and figure 6.3.10). The displacement of the femoral head resulted in a 5cm shortening of the femur compared to the right (maximum length: left 36.4 cm, right 41.7 cm). While the femoral head was displaced and there were extensive changes to the femoral neck there was no destruction to the femoral head or the acetabulum. Therefore, there is no evidence to associate the skeletal changes with infection, congenital disposition or septic arthritis which manifest in some destruction of the femoral head and acetabulum with the addition of osteomyelitis and ankylosis of the hip joint (Ortner and Putschar 1981, 250; Berger *et al.* 2017, 29).

The right upper limb presented multiple traumatic lesions. A *Colles'* fracture was present at the distal end in the left radius and torsion was evident in the proximal third of the bone due to soft tissue changes as a result of the *Colles'* fracture (figure 6.3.12). In the right radius two fractures occurred in the distal third of the radial shaft. Both resulted in the posterio-lateral displacement of the distal sections. *Colles'* fractures have been clinically observed to occur approximately two centimetres from the distal articular surface, resulting in the posterior displacement of the distal fragment (Lovell 2008, 363), and therefore those fractures observed in SKN035 are consistent with this diagnosis. In addition, the right proximal humerus presented with the following osteoarthritic characteristics: formation of marginal osteophytes, subchondral bone reaction via eburnation, pitting of joint surfaces, and alterations in the joint contours (figure 6.3.11) (as outlined in section 4.7). It is possible that this osteoarthritis occurred as a result of compensatory movement owing to the fractures in the forearm.

Figure 6.3.9: Inferior displacement of the left femoral head of SKN035 (left= anterior view, right= posterior view).

In addition to the fractures discussed so far, this individual also sustained fractures to two ribs on the right side (figure 6.3.13). The vertebral column presented compression fractures to the third and fourth lumbar vertebrae as well as '*codfish* vertebra' throughout the lumbar vertebrae. The occurrence of '*codfish* vertebra' clearly indicates changes occurring within the skeleton, for the earliest expression of osteoporosis occurring in the vertebral bodies is via a biconcave appearance of the bodies known as *codfish* vertebra (Ortner 2003, 411). This condition is defined by the concavity of the vertebral body which occurs as a result of weakened vertebral bodies which are unable to withstand the mechanical pressure of bearing weight (Francis and Selby, 1997, 148). The bone is compressed by expanding inter-vertebral discs resulting in the concavity of the superior and inferior surfaces of the vertebral bodies (Pitt 1988, 2098; Brickly, Mays and Ives 2005, 394). Further degenerative pathologies were observed in the vertebral column consisting of osteophyte formation throughout the thoracic and lumbar vertebrae, wedging of the tenth thoracic vertebra and spondylolysis of the third lumbar vertebra.

Figure 6.3.10: Inferior displacement of the femoral head took place with no sign of femoral rotation in SKN035 (anterior view).

Figure 6.3.11: The right humerus of SKN035 presents osteoarthritic characteristics including marginal osteophyte formation, eburnation, pitting of joint surfaces and alterations to the joint contours.

Figure 6.3.12: A *Colles'* fracture (left = distal view) and torsion alterations to the bone (right= proximal third of the left radius) present in the radii of SKN035.

Figure 6.3.13: SKN035 sustained fractures to two ribs which were healed at the time of death.

All of the fractures noted in the skeleton were fully healed at the individual's time of death. Therefore, it is not possible to determine whether these injuries occurred as the result of one traumatic incident or as the result of several separate incidents. If the injuries occurred at different times then an event which altered the individual's susceptibility to accidents such as a neurological disorder may have occurred, or they may have been a victim of physical abuse. Although it has been identified that SKN035 has lightweight bones indicative of a reduction in bone mass, which would increase susceptibility to fracturing, the extensive healing of the fractures to the limbs suggests that the injuries occurred earlier in life and would not necessarily be associated with changes in bone density which most commonly occur due to old age (Ortner and Putschar 1981, 289; Ortner 2003, 411; Agarwal 2008, 389; Cosman *et al.* 2014, 2361-3). However, several of the pathologies noted within SKN035 and their being ≥45 years at death are highly suggestive of senile osteoporosis. Namely the degenerative pathologies of the vertebral column, '*codfish* vertebra' and rib fractures. Senile osteoporosis is a condition in which the individual suffers from significantly diminished bone mass making the skeleton more susceptible to malformation and fracturing of bony structures (Ortner and Putschar 1981, 289; Agarwal 2008, 389; Cosman *et al.* 2014, 2361-3). Bone mass diminishes due to a long-standing imbalance in bone resorption and bone formation which increases with age (Ortner 2003, 411). Usually the fall in bone mass to the degree seen in osteoporosis does not manifest before the fifth decade of life, around which time women experience a significant drop in oestrogen at menopause which accounts for some of the disparity in osteoporosis between men and women (Ortner 2003, 411; Agarwal 2008, 391). Due to the decreased bone density, osteopenia puts the biomechanical integrity of the skeleton at risk and fractures are a common complication. However, it does not affect the entire skeleton proportionally. A greater physiological turnover of bone occurs in the cancellous bone and therefore the spine, ribs, sternum, and pelvis are most affected.

Having identified the pathological condition of SKN035 Tilley's (2012) 'bioarchaeology of car' methodology can be applied. The individual would have experienced both clinical and functional impacts from the fractures they sustained. The significant asymmetry of the femora with acute involvement of the femoral neck would have afunctional impact of the hip joint, via alteration to the range of movement. However, in the right femur there is little evidence for secondary complications in the form of unusual biomechanical loading on the bone or increased robusticity. Therefore, while the individual may have experienced instability from the alteration to the hips movement, the femoral changes themselves may not have necessitated professional care. The trauma seen in the right arm is likely a result of a fall on to the hands which resulted in fractures radiating up the arm. Such trauma could result in long term residual disability and likely had a significant impact on the individual's ability to carry out routine tasks due to weakened grip and wrist mobility (Mays 2006, 425). This would have called for a level of care while the limb was healing to ensure the limb was immobilised, and during the time that it was immobile, that the individual received help to carry out daily tasks and access to basic provisions while they were unable to work. The individual did experience instability which resulted in recurring injuries, therefore they are unlikely to have been able to maintain reliable employment and therefore may have sought long-term aid from the Hospital of St James. This level of care the individual required would have increased with age as locomotion became more unstable and as the effects of the potential senile osteoporosis made them more susceptible to injury from basic hazards, from which the hospital could offer the best shield.

6.3.2 Non-specific infection

It is often the case in osteological analysis that there is evidence of infectious processes which cannot be assigned a specific aetiology, and these are termed non-specific infections (Roberts 2000, 146). Differential diagnosis is rarely possible when diagnosing the aetiology of bone reaction in an archaeological sample and this is because the characteristics of the new bone formation of several infectious diseases are indistinguishable (Ortner 2008, 37). The causative organisms responsible for non-specific infection are often bacteria, such as *Staphylococcus aureus*, which enter the bloodstream via localised infection, for example, arising from a penetrating injury to the skin or from instances such as infected tonsils (Brown and Howard-Davis 2008, 167). Once infection occurs it can escalate to life-threatening diseases such as pneumonia, meningitis, osteomyelitis, endocarditis, toxic shock syndrome, bacteraemia, and sepsis (Leekha, Terrell and Edson 2011. 156). Evidence of infection manifests in bone in various ways (Waldron 2009, 116). The following non-specific infections were observed in the St James assemblage: periosteal new bone formation, maxillary sinusitis and osteomyelitis.

6.3.2.1 Osteomyelitis

Osteomyelitis is a non-specific infection of the bone and bone marrow (Ortner 2003, 105-6; Lewis 2006, 141). It is are caused by agents such as bacteria, fungi, parasites and viruses which result in the inflammation and necrosis of bone (Mast and Horwurs 2002, 234; Gutierres 2005; Labbé *et al.* 2010, 274). The most frequently occurring aetiology is infection by *Staphylococcus aureus*, accounting for 90 percent of clinical cases, closely followed by *Streptococcus* species, as well as other strains of cocci and other types of acilli (Ortner 2003, 106). *Staphylococcus aureus* is a pyogenic organism which predominantly causes localised skin infection but can spread throughout soft tissue and the skeleton (Waldron 2009, 85).

One case of osteomyelitis was present among the population of the Hospital of St James, this was an infection of the proximal left ulna of SKN050 (5230). SKN050 was determined to be six years of age at death, as such no attempt to determine biological sex was made. This individual was interred in Area B. The skeleton presented with an extensive infection of the proximal portion of the left ulna. The infection had channelled a fistula, terminating in cloacae, from the posterior aspect of the olecranon and the trochlear notch in a distal direction, which exited on the lateral aspect of the proximal diaphysis of the ulna (figure 6.3.14). The fistula tract had smooth edges suggesting significant remodelling of the bone had occurred, and that the condition was an ongoing and persistent problem. Furthermore, infection had resulted in an inflammation of bone marrow and swelling of the bone. The infection appears to have been restricted to the ulna and showed no changes to the bone's epiphysis. Furthermore, there was no evidence of infection in the adjacent humerus or radius.

Osteomyelitis most commonly occurs as the result of external contamination of an open wound, the wound occurs when a broken bone penetrates the skin and infection can enter the body (Kavanagh *et al.* 2018, 3). Alternatively, osteomyelitis can occur as the result of haematogenous infection in which there is a deprivation of blood to the bone's cortex, necrosis of the bone and damage to the periosteum (Kavanagh *et al.* 2018, 3). In the case of SKN050, it has not been possible to determine the aetiology of the infection as there is no evident break to the ulna or the surrounding bony structures, but likewise it is not possible to infer an haematogenous infection either.

Figure 6.3.14: Osteomyelitis leading to the formation of a fistula cloaca from the posterior aspect of the olecranon and the trochlear notch of SKN050.

Left untreated, osteomyelitis is a persistent condition which can remain active for years. The inflammatory disease can put morphologically-debilitating pressure on the affected bone forcing it to undergo substantial osteolysis which results in pathological fractures due to weakened bone structure. In immature individuals substantial damage can be made to the growth plate which can affect their developmental health and status. Ultimately, if left untreated the infection can spread throughout the body uninterrupted and cause death (Waldron 2009, 87). It has not been possible to infer the progression of infection as it appears to have been isolated to the ulnar bone, therefore if further progression of the disease had taken place it would have been in the soft tissue structures which are not observable from the skeletal remains.

Comparisons of osteomyelitis were made between the Hospital of St James population and the comparative hospital sites. The highest crude prevalence was at the Hospital of St Mary Spital, London where 30 occurrences equate to a crude prevalence of 0.6 percent which is statistically similar (X2=0. 0006, p=.979839) to the Hospital of St James. Similarly the prevalence of 1.1 percent at the Hospital of St John, Cambridge is also statistically similar (X2=0.2195, p=.639403) as is the 2.4 percent prevalence at the Hospital of St Nicholas, Lewes (X2=1.5763, p=.209298) where the two cases of osteomyelitis were recorded in individuals with signs of leprosy.

Having established the case of osteomyelitis in SKN050, Tilley's (2012) 'bioarchaeology of care' methodology is applied to assess the level of care this individual could have required. The clinical impacts of osteomyelitis in the forearm include infection of the periosteum and cortex and on occasion the medullary cavity as well as localised soft tissue infection, leading to curvature and shortening of the limb, instability and dislocation of the proximal and distal joints (Rasool 2011, 21-2). Furthermore, while the infection is active the individual will have experienced fever, pain, swelling and potentially pseudo-paralysis (Rasool 2011, 18). The functional impact of the infection, and once the infection cleared, include reduced or complete loss of the limb's function and deformity. While the infection was active care would have been required as the inmate would have likely been bed ridden by the fever and pain, they would have required constant care, extensive cleaning of the infected tissue and they likely could not eat or drink without assistance. Once the infection had cleared the care required would be dependent on the extent of the deformity and the impact the infection had on the surrounding soft tissue structures. The individual may have regained function of the limb or may not have. In either situation they would require assistance when learning to adapt to the disability and may not have been able to take up a manual career that they otherwise would have. The type of care provided would have been specialised in regards to the cleaning of the infection and management of the fever, the length of care offered would be dependent on the patient's prospects of survival and thereafter would be dependent on how much of the limb's function was retained.

6.3.2.2 Infected ulceration in the tibia

SKM120 (4001) was a male aged 36-45 years at death, recovered from the cemetery extension (Area B). This individual presented with a chronic pathological condition of the left tibia and fibula. Macroscopic examination of the bone surface reveal a well-delineated elevated plaque-like excrescence on the distal-anterior-medial aspect of the left tibial diaphysis (figure 6.3.15). The surface texture of this platform indicates inflammation through the presence of fine pores and vascular impressions (figure 6.3.16). Extensive new bone formation, spiculated thickening of the periosteum and swelling of both the tibia and fibula had occurred (figure 6.3.17). The affected tibia measured 430 mm in length compared to the non-affected tibia which measured 420 mm; the same comparisons could not be made for the fibula as the unaffected right fibula was damaged and therefore accurate measurements were not possible. The femur is entirely unaffected; however, the calcaneus shows a slight enlargement on the most proximal articular surfaces. The skeletal responses to infection in SKM120, include ossifying periostitis, are seen in the swollen state of the tibia and calcaneus and more drastically the fibula's periosteum. Periosteal new bone formation was also evident across the surface of both bones of the lower leg. The individual would have experienced great debilitation as a result of the infection in their lower leg; while the infection was active, they most probably experienced prolonged periods of ill health in which constant care would have been needed (Mohanta *et al.* 2019, 4024). Once the infection had healed the remaining pathology would have made everyday tasks extremely hard and most probably necessitated the use of a crutch (Fife and Horn 2020, 73).

Figure 6.3.15: Infected ulceration of the left tibia and resultant reactive bone formation in the fibula of SKM120 (left – frontal view; right – lateral view).

Figure 6.3.16: Skeletal lesion occurring on the anterior and medial surface of the tibial diaphysis resulting from skin ulceration (medial view).

Figure 6.3.17: Reactive bone formation in the fibula of SKM120 (medial view).

Differential diagnosis of these bone changes suggests the pathologies are the result of a skin ulceration. This conclusion has been drawn from the characteristic features outlined by Boel and Ortner (2013, 304). They describe the 'typical' pathological manifestation of a skin ulcer to consist of: (1) a lesion occurring on the anterior and medial surface of the tibial diaphysis, (2) sharply demarcated margins to the lesion, (3) the formation of an elevated, well-demarcated lesion, although skin ulcers can also stimulate a destructive response in which margins are less distinct, never form or are destroyed, and (4) a porous surface of the lesion, indicative of a chronic condition that was active at the time of death. SKM120 presents all four of these characteristics.

When assessed against Schultz's (2001, 187 table 1) classification of characteristic morphological patterns of proliferative periosteal reactions it is possible that the aetiology of SKM120 ulceration was circulatory periostitis manifesting in hypertrophic osteoarthropathy. This conclusion is justified though a comparison of the appearance of the periosteal new bone that had formed. It is possible to rule out haemorrhagic manifestations as a result of trauma as Schultz (2001, 187) states this does not affect the original bone surface, and manifests in a thin slip-like layer of new bone over the affected area. Similarly, inflammatory and tumorous causes also result in this thin slip-like layer of periosteal new bone which was not present on SKM120. Inflammatory and tumorous causes are also described as affecting only the peripheral region of the affected area. The individual in question presented with extensive new bone formation across the tibia as well as the fibula thus defying the outlined effects of these aetiologies. Confirmation of a circulatory aetiology is made as the bone presented with a thick secondary layer of periosteal new bone at the surface of the original bone, and there is evidence of stratified new bone. The only element in Schultz's (2001) classification that was not possible to observe was the formation of bulky trabecular bone.

The only occurrence of an infected ulceration from the comparative hospitals was from an individual aged 25-35 years at death from the Hospital of St Nicholas, Lewes. The pathology was described by Barber and Sibun (2010) as raised oval patches of pitted bone on the medial surface of the left distal tibia and the lateral surface of the right distal fibula. Pitting striations, shaft expansion and large deposits of reactive bone were also noted. The authors suggest these could be possible obesity ulcers or ulcers formed by irritative chains or restraints, but overall, they are the result of non-specific infection (Barber and Sibun 2010, 104-5). Further comparative analysis was carried out as the skeletal modifications that occurred in SKM120 (figure 6.3.15- 6.3.17) were more akin with that seen in an individual from the Identified Skeletal Collection of the Museu Antropológico at Coimbra University, Portugal. This individual was a male who died in 1929 at the age of 75, from myocarditis. The pathological condition of the lower leg displayed severe localised periosteal reaction with a thick area of reactive new bone formation on the tibia and extensive speculation and thickening of the fibula (Pinheiro *et al.* 2004, 140; figure 2). Furthermore, the skeletal modifications seen in SKM120 are similar to that of a forensic case submitted to the National Institute of Legal Medicine in Portugal (Coimbra delegation) in 2001 (comparative images can be viewed in Pinheiro 2004). The similarities recorded from the forensic case include extensive speculated thickening of the periosteum of both the tibia and fibula, porous bone and plaque-like deposits of periosteal bone on the ulcerated area of the fibula (Pinheiro 2004, 138).

Chronic skin ulcers are defined as a wound lesion which persists for more than four consecutive weeks without sign of healing, or as a frequently recurrent wound (Li *et al.* 2012, 1). Skin ulceration occurs when infectious pathogens enter the body through traumatic breaks in the skin, and in chronic cases where prolonged inflammation persists skeletal lesions form. These lesions are produced by destructive and proliferative bone reactions (Resnik 2002). Their formation may be provoked by bacterial infection (such as cellulitis or ecthyma), specific infectious disease (such as syphilis, tuberculosis and leprosy), venous pathology, or a traumatic injury (traumatic haematoma) causing a wound, which later became infected. The development of ulcers varies depending on the pathogen and cause of the ulcer, as well as an individual's immune response to the infection. The body's response to infection can be impaired by numerous conditions including diabetes, venolymphatic and arterial insufficiency (Boel and Ortner 2013, 303). It is in individuals who cannot respond effectively to infection that pathological changes to the bone occur. Chronic ulcers are estimated to affect just one percent of the general population and have a high rate of recurrence (Bergan *et al.* 2006, 488). Once an ulcer has developed, the likeliness of it healing is dependent upon the individual's health and the conditions in which they live, as poor hygiene and malnutrition hinder recovery (Ngu 1967, 283-5).

Through the application of Tilley's (2012) 'bioarchaeology of care' methodology the following has been established. The clinical and functional implications of the condition include infection of the soft tissue structures which have progressed on to the underlying bone. The infection results in swelling, leakage and chronic pain (Persoon *et al.* 2004, 342). Harrison *et al.* (2001) found that 60 percent of ulcers remain for over 6 months and 33 percent for more than 1 year, in addition to which the rate of recurrence is recorded at 45 percent (Hamer *et al.* 1994; Harrison *et al.* 2001). In terms of functional impact, patients report chronic pain, impaired mobility, sleep disturbance, embarrassment and loss of independence (Persoon *et al.* 2004, 342). Taking the above into consideration SKM120 would have experienced great debilitation as a result of the infection in their lower leg, while the infection was active, and they most probably experienced prolonged periods of ill health in which constant care would have been needed (Mohanta *et al.* 2019, 4024). Once the infection had healed the remaining pathology would have made everyday tasks extremely hard and most probably necessitated the use of a crutch (Fife and Horn 2020, 73). Like SKN050 who presented with osteomyelitits of the left ulna, the type of care provided would have been specialised in regard to the cleaning of the infection and management of the fever. The length of time for which the individual required care could have been anything from 6 months to fight the infection up to a lifetime of recurring care if the infection recurred and depending on the level of mobility the individual was left with.

6.3.3 Unique cases of pathology at the Hospital of St James

One of the aims of this study was to investigate the range and diversity of ailments suffered by the inmates housed within the hospital. Thus, evidence of skeletal changes not conventionally recorded using systematic methods were recorded during osteological analyses in addition to those reported thus far in this chapter. The pathologies presented in the following discussion range in severity and the impact they would have had on the individual's life. The most impactful of these include an occurrence of synostitic scaphocephally, an amputation of the lower limb, and an infected ulceration of the skin infiltrating a tibia.

6.3.3.1 Synostotic Scaphocephaly

SKN059 (5207), aged 6-7 years recovered from Area A, presented with anterior-posterior elongation of the parietal bones leading to a bulging occipital bone (figure 6.3.18 and figure 6.3.19). There is a pronounced forehead (figure 6.3.20) and a considerably narrowed cranium with complete obliteration of the sagittal suture (figure 6.3.21 and figure 6.3.22). In addition to these cranial alterations, stage 3 cribra orbitalia was observed in both orbits.

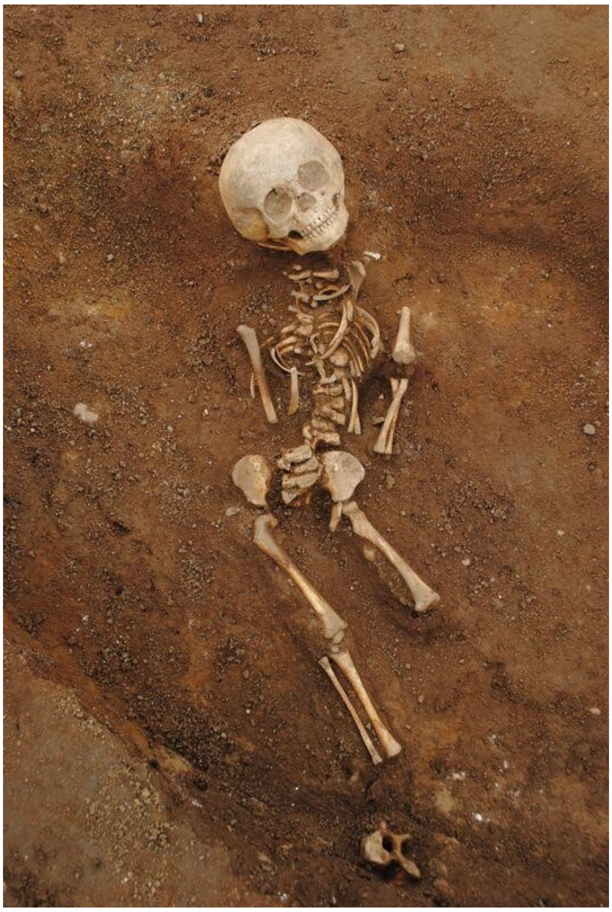

Figure 6.3.18: SKN059, fully exposed with the synostotic skull intact during excavation.

Figure 6.3.19: SKN059, elongation of the parietal bones leading to a bulged occipital bone.

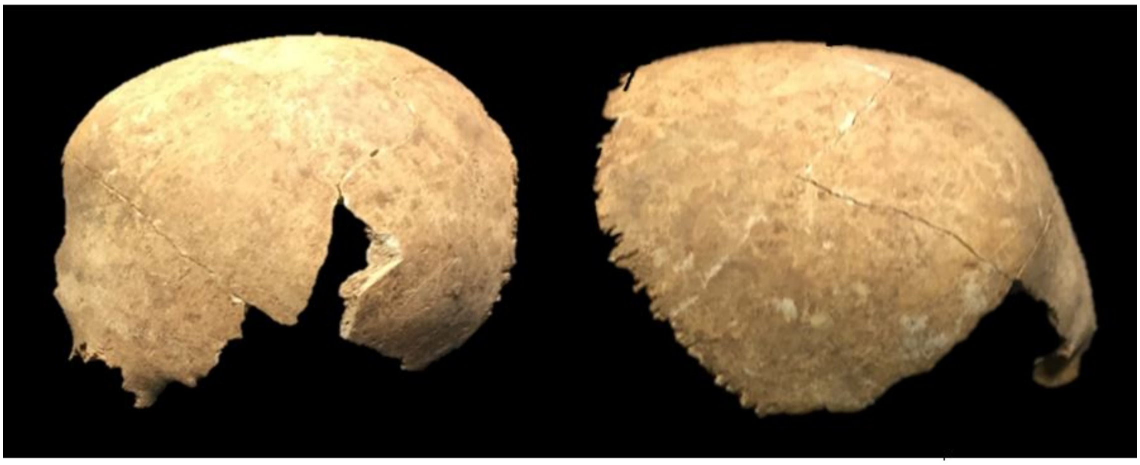

Figure 6.3.20: SKN059, lateral views of the fronto-parietal cranial bones.

Figure 6.3.21: SKN059, lateral view of the parietal and occipital cranium.

Figure 6.3.22: SKN059, obliteration of the sagittal suture and fusion of the parietal bones (left ectocranial; right- endocranial).

These characteristics are all indicative of synostotic scaphocephaly, the premature fusion of the sagittal suture. The cranial sutures separate the bone plates in infancy to allow for the brain's rapid growth in the first two years of life (Mathijssen, 2015, 1736). When these sutures prematurely fuse, normal growth throughout the skull is impeded, resulting in anatomical malformations and inhibited development of the brain. Clinical characterisation of scaphocephaly looks for a disproportionately long and narrow skull, described as a keel- or boat-like appearance (Ocampo and Persing 1994, 563; Posnik *et al.* 1993, 1016), as seen in SKN059 (figure 6.3.21). Such cranial alterations occur as the premature closure of the sagittal suture restricts transverse expansion of the skull and therefore growth can only occur anteroposteriorly, resulting in functional and morphological alterations to craniofacial development and craniocerebral volumetric disproportions (Xiang *et al.* 2017, 324).

Premature fusion of the sagittal suture commonly results in elongation of the brain to both the forebrain and hindbrain structures, resulting in exaggerated prominences of the forehead and occiput (Aldridge *et al.* 2005). Such modification to the brain's structure can impact on the frontal region of the brain which controls working memory while restriction in the posterior of the brain impacts on the visual cortex (Romine and Reynolds 2004; Flores-Sarnat 2002). Further effects of premature fusion include headaches, vomiting, seizures, visual impairment, speech and learning difficulties and irritability (Ciurea *et al.* 2011, 428; Mathijssen 2015, 1783-4; Bristol *et al.* 2004, 306-7; Kapp-Simo *et al.* 2007, 272-6). The neurological and physical effects of scaphocephaly worsen with age as intracranial pressure increases and can ultimately lead to death. In modern medicine infants born with sagittal synostosis are often treated surgically between the fourth and eighth month of life, the surgery consists of opening the prematurely closed suture and reshaping the skull to allow for normal developmental growth (Skrzat *et al.* 2014, 92; Renier *et al.* 2000, 652). From the archaeological remains of the individual it is not possible to determine whether or not the SKN059 would have suffered from the cognitive and developmental delays discussed above. There was one example of scaphocephaly from the comparative hospital sites. The individual was a male aged 16-18 years at death , recovered from the Hospital of St Mary Magdalene, Partney. Atkins and Popescu (2010, 246), describe slight scaphocephaly of the skull along the mid-line affecting the rear three quarters of the sagital sutures and the upper halves of both sides of the lamboid sutures. No further examination of the individual is offered so comparative analysis is limited. It is notable that this individual survived to approximately ten years older then the individual from the Hospital of St James which may indicate longer term care was necessitated from the community at St Mary Magdalene, Partney.

From the archaeological remains of SKN059 is not possible to determine whether or not they would have suffered from the cognitive and developmental delays discussed above. However, by applying Tilley's (2012) 'bioarchaeology of care' it is possible to gain insight into the type of care they would have required and the resources the hospital was willing to afford to one person. As discussed, the clinical manifestations of the condition include abnormal skull growth and consequential irregular brain development, as well as, headaches, vomiting, seizures, visual impairment, speech and learning difficulties and irritability (Ciurea *et al.* 2011, 428; Mathijssen 2015, 1783-4; Bristol *et al.* 2004, 306-7; Kapp-Simo *et al.* 2007, 272-

6). Effects on the individual's function stem from impact to the frontal region of the brain which controls working memory while restriction in the posterior of the brain impacts on the visual cortex (Romine and Reynolds 2004; Flores-Sarnat 2002). Therefore, the individual would have required constant and on-going care in order to carry out the simplest of tasks. They would have required assistance for the most basic tasks including to eat/drink, wash, move and to navigate any environmental hazards. Furthermore, any carer would have to be skilled in dealing with seizures, neurological delays, behavioural challenges and emotional support. The care offered would have been for the lifetime of the inmate and while this individual lived to just 6 or 7 years of age they could have survived for longer and therefore care may have been offered on a long-term basis by the hospital.

6.3.3.2 Rheumatoid arthritis

Rheumatoid arthritis was present in four individuals (2.3 percent, 4/175) from the Hospital of St James assemblage. In all four individuals the pathological alterations to bone presented in either the metatarsals, metacarpals or carpals.

SKN065 (6383), a male aged 26-35 years at death (recovered from Area A), presented with erosive lesions in the right foot on the distal epiphysis of the second metatarsal and the accompanying proximal epiphysis of the proximal phalanx as well as the proximal epiphysis of the first proximal phalanx. In the left foot, erosive lesions were observed on the distal epiphyses of the first and second metatarsal and the proximal epiphysis of the proximal phalanx of the first digit.

Similarly, SKM135 (4071) a male aged 36-45 years at death (recovered from Area B), presented with erosive lesions of the proximal and distal epiphyses of the second metatarsals on the left foot. In addition to swelling, the skeletom presented with extensive new bone formations and a Martel's hook on the distal articulation (figure 6.3.23 and figure 6.3.24). In both cases the lower limb therefore presented with extreme pathology in the metatarso-phalangeal joints, which is reported to be one of the most frequently affected joints in rheumatoid arthritis (Bongartz *et al.* 2014, 1074).

Erosive lesions were present in the right hand of SKN066 (5385). The bones affected are the second through to fifth metacarpals of the right hand and their associated proximal phalanges. The metacarpals display erosion of both the proximal and distal articular surfaces, and the proximal phalanges display eburnation (figure 6.3.25). Furthermore, the lunate shows erosive pathologies and extensive eburnation which matches with corresponding eburnation on the articular facet of the radius. Similar pathologies were present in SKP005, the skeletal elements affected were the left scaphoid as well as the first, second and fifth metatarsals of the right foot (figure 6.3.26, figure 6.3.27 and figure 6.3.28)

Figure 6.3.23: Erosion of the proximal (left) and distal (right) epiphyses of the second metatarsals of SKM135.

Figure 6.3.24: Plantar extension to the distal facet of the second metatarsals of SKM135.

Figure 6.3.25: Erosive pathologies, extensive eburnation and reactive bone growth of the proximal (right) and distal (left) aspects of the metacarpals of SKN066.

Figure 6.3.26: Erosive pathologies and extensive eburnation on the lunate of SKN066.

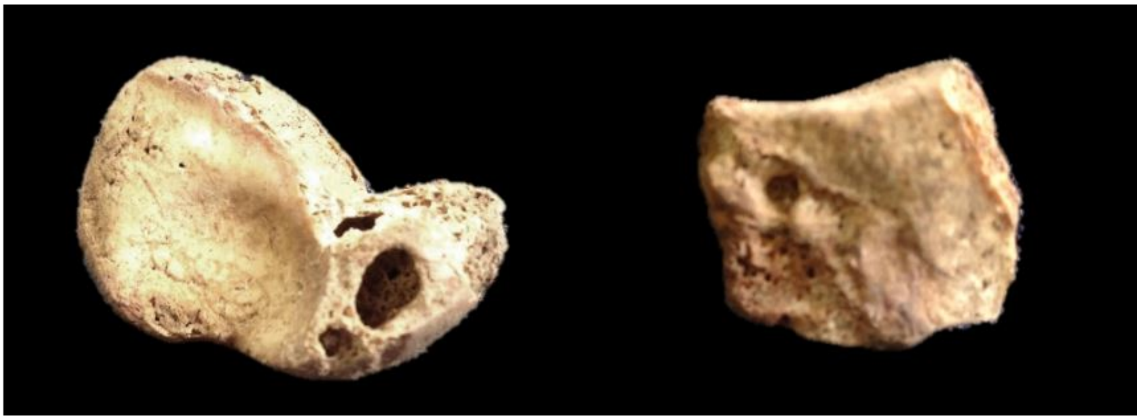

Figure 6.3.27: Erosive pathologies and extensive eburnation on the scaphoid and trapezium of SKP005.

Figure 6.3.28: Erosive pathologies on the first proximal phalanx of SKP005 (right foot).

Before the diagnosis of rheumatoid arthritis was made several other conditions were also considered. First, the erosive lesions presented are largely compatible with several spondyloarthropathies. These include reactive arthritis, psoriatic arthritis and ankylosing spondylosis. Reactive arthritis is characterised by peripheral arthritis, enthesopathy and sacroiliitis; psoriatic arthritis is largely identifiable by the "pencil-in-cup" appearance of the phalanges and ossification ankylosing spondylitis commences in the sacroiliac joint (Ventades 2018, 45-8; Rogers *et al.* 1987, 179-93). Of the four individuals from the Hospital of St James cemetery, none presented with fusion of the sacroiliac joint or a "pencil-in-cup" appearance of the phalanges. Therefore, the conclusion was drawn that they were not affected by the spondyloarthropathies of reactive arthritis, psoriatic arthritis and ankylosing spondylosis.

Second, the possibility of metastatic cancer was withdrawn; metastases are the most common cause of neoplastic lesion in the skeleton, however, these erosions typically affect larger bones of the skeleton such as the femur, skull and axial skeleton (Waldron *et al.* 2009). This is becuse they are richer in hematopoietic marrow which the cancerous cells bed into and destroy though osteolytic activity (Minozzi *et al.* 2013, 2). Thirdly, enchondroma was not considered the aetiology of these pathologies as although osteolytic lesions are most commonly found in the phalanges of the hands, in 86 percent of cases, they also spread through the long bones. Enchondromas are solitary lesions which misshape, distort and expand the small bones of the hand but do not affect the articular surfaces of the bone as was seen in SKM135 (Minozzi *et al.* 2013, 2-3).

Having concluded that SKM135, SKN065, SKN066 and SKP005 were affected by rheumatoid arthritis, Tilley's (2012) 'bioarchaeology of care' methodology was applied. Having considered the clinical and functional impacts of arthralgia, swelling and limited range of motion, gradual destruction of cartilage and increased involvement of joints, the conclusion is drawn that long-term care was likely required, involving a community of carers from continued assistance. The individuals would have called for provision of food, water, shelter, bedding, massage and possibly repositioning of the body. Due to the long term and worsening effects it is probable that the level of care increased over time as the individuals became less mobile and experienced greater levels of stiffness and pain in the affected joints.

6.3.3.3 A case of trans-tibial amputation

SKN016 (5081), a male aged 36-45 year at death, recovered from Area A presented an abrupt end to the diaphysis of both the right tibia and fibula, suggesting a trans-tibial amputation of the right lower limb (figure 6.3.29). The right tibia and fibula had been severed mid-diaphysis, perpendicular to the long axis of the bones (figure 6.3.30). The distal ends of both shafts presented with advanced remodelling and calluses which narrowed to form the residual limb. Irregular new bone formation and macroscopic pitting was present across the periosteum of the diaphysis of both the tibia and fibula. Extensive osteophyte formation was present on the disto-medial aspects of the tibia and the distal ends of both the tibia and fibula. The presence of irregular spicules and porotic lamellar bone suggest bone response to infection, but if infection had occurred it was inactive by the time of this individual's death. Post-mortem damage to the proximal epiphysis of the tibia and irregular bony spicules on both the tibia and the fibula made it impossible to accurately determine the lengths of these bones. However, it is possible to say with certainty that the bones were terminated in the proximal third of the diaphysis.

Figure 6.3.29: SKN016 fully exposed and in-situ. The left foot appeared irregular in the grave, and osteological investigation revealed the direct articulation of the third and fourth metatarsals as depicted in figure 6.6.5.

Figure 6.3.30: The tibia and fibula of SKN016, the distal aspect of both bones shows extensive new bone formation.

The callus shows complete healing of the medullary cavity and osseous tissues. The process of healing and closure of the medullary cavity takes place over a number of weeks, during which time the cavity is capped by new bone which is dense in form (Aufderheide and Rodriguez-Martin 1998, 30). Complete closure will take approximately four to eight weeks in modern cases, where the chance of infection is managed and tightly controlled. In the later medieval period, it is likely that this process was prolonged due to the techniques employed, surgical technology and hygiene practices which would have left the patient susceptible to extensive blood loss, infection and tissue necrosis (Siriaisi 1990, 157). Amputation of any extremity, especially the leg, carries severe risk, and even today the rate of complication following lower limb amputation is approximately 67 percent (Ploeg *et al.* 2005, 635). Such complications include haemorrhage, shock and sepsis. In the case of SKN016, bone remodelling was complete and calluses formed the residual limb which suggests the individual not only survived the initial act of amputation, but that they were able to adapt to the loss of the limb (figure 6.3.31 and figure 6.3.32).

Figure 6.3.31: Posterior and anterior views of the tibia of SKN016.

Figure 6.3.32: Posterior and anterior views of the fibula of SKN016.

The remaining portions of the tibia and fibula were exceptionally light, identified though handling of the bones which were markedly lighter than the corresponding elements. Atrophy, or osteopenia, is a state of low bone mass and has been the subject of investigation in studies of bone morphology of modern-day amputees (Gailey *et al.* 2008, 20). Marcus *et al.* (2013, 1163-5) and Sinaki and Pfeifer (2017, 24-5), state that marked loss of density in the remaining bone is a result of insufficient use of the limb and a reduced weight-bearing on the bone. Notably, loss of bone mass in SKN016 has occurred in the tibia and fibula but not in the femur. This suggests continued use of the femur for weight-bearing, possibly as the result of using a prosthesis. Further pathologies noted across the skeleton can be ascribed to compensatory responses to the amputation and use of a prosthesis. The first of which is increased bone robusticity in certain location. Such increases are considered a result of increased mechanical loading, and therefore reflect the distribution of weight across the skeleton during life (CARTA 2017). In SKN016 the elements affected by increased robusticity were the right clavicle, which had shortened in length by 0.8 cm and increased in thickness by 0.4 cm in comparison to the left. Shortening of the right clavicle can be a compensatory response to mechanical stress placed on the upper limb, such as when a crutch or support is used to walk. Elevated levels of activity in the muscles of the shoulder girdle manifest in increased anterior-posterior curvature in this bone (Knüsel and Göggel, 1993, 161). The left femur shows a marked increase in robusticity as seen in the broadening of the femoral diaphysis.

In addition to evidence of increased bone robusticity, SKN016 also presents evidence of mechanical stress on the joints. Eburnation of the left femoral head and the acetabulum is visible, suggesting degenerative joint disease arising from increased pressure on the left hip joint as a result of altered locomotion and joint use. The right foot also displayed structural alterations, primarily direct articulation of the third and fourth metatarsals had occurred, as well as new bone formation on the anterior distal aspect of the first metatarsal (figure 6.3.33). It is not possible to determine whether such alterations in the unaffected foot are a response to the amputation, however, it can be interpreted as a response to a change in weight-loading. A direct comparison of symmetry in the lower limb was not possible due to post-mortem damage to the proximal end of the right tibia and fibula, however, the muscle attachments on the tibia and fibula did not appear to be enhanced from those seen throughout the rest of the skeleton.

Figure 6.3.33: Direct articulation of the third and fourth metatarsals of SKN016.

The only skeletal modification which are not directly relatable to that of the amputation were those identified in the vertebral column. Partial fusion of the eighth and ninth thoracic and complete fusion of the ninth to twelfth thoracic vertebrae along the right side of the anterior margin of the vertebral body, compression of the eleventh thoracic vertebrae, and significant osteophyte formation throughout the vertebral bodies were observed. Fusion of the thoracic vertebrae (figure 6.3.34), took the form of 'wax-like' bone formation along the right side of the vertebral bodies, while the intervertebral disk space remained unaffected. These changes are consistent with DISH, as discussed in section 6.2.2. In addition, the pathological separation of the pars interarticularis from the vertebral body was observed in the fifth lumbar vertebrae with anterior displacement, a pathology indicative of spondylolysis.

Figure 6.3.34: Fusion of the thoracic vertebrae of SKN016 consistent with DISH.

The skeletal alterations of increased robusticity of the right clavicle and left feumr as well as alterations to the shoulder girdle can be attributed to the use of a prosthesis and crutch over a prolonged period of time. In cases of prosthesis use, the modification to the skeleton are dependent upon a number of factors, including the type of prosthesis, the mobility of the individual and the frequency of use. In amputations resulting in a relatively short residual limb, as seen in SKN016, it is thought that a bent-knee prosthesis (figure 6.3.35) with the aid of a crutch for stability, are most likely employed (Hernigou 2014, 1535-8). Such prostheses comprise of a crutch with a wooden platform on which the knee and lower leg would rest, the crutch extended up the thigh where it was attached with leather or canvas bands which fasten around the thigh. A bent-knee prosthesis would transfer all weight-bearing to the femur at the knee joint rather than the tibia and fibula. This is beneficial to the patient's future mobility, as the tibial tuberosity and patellar tendon provide a proficient weight bearing structure (Webling and Fahrer 1986, 1636). Therefore, in SKN016 it is plausible that a lack of atrophy in the right femur is due to continued use, while the stationary position of the lower leg, which was bypassed in weight-bearing, accounts for atrophy of the remaining tibia and fibula. Any use of lower limb prosthesis results in altered mechanics and therefore degenerative changes to the right hip joint are likely the result of alterations of locomotion, stance and stature (Lazeby and Pfeiffer 1993, 23). Modifications to the transmission forces acting on the hip and knee joints occur, thus resulting in increased pressures of the joints accelerating degenerative processes which result in osteophyte formation and eburnation. Finally, the use of hand-held crutches for stability more than weight-bearing would explain the minimal compensatory changes in the upper limbs.

Having established the clinical and functional impacts of disease, amputation and secondary skeletal changes in SKN016 it is possible to produce a model of care in line with Tilley's (2012) 'bioarchaeology of care' methodology. The physical amputation of the limb would have required highly specialised care, pain management and surgical knowledge. However, the model of care will not consider the actual amputation of the limb as it is not possible to determine whether this was carried out at the Hospital of St James or prior to the individual's arrival at the hospital. Had the inmate been in the hospital shortly after the amputation then intensive and skilled care would have been required for pain relief, wound management and prevention of infection, in addition to which the patient would have undergone psychological challenges associated with the loss of a limb. After the initial healing process took place the individual would have required care and attention when learning how to carry out daily tasks such as maintaining hygiene, regaining mobility and learning how to recoup a level of independence, made even more difficult by the degenerative impacts of DISH. This would require the assistance of a skilled team of carers who were able to provide the time and patience that SKN016 would have needed. Once the individual gained a level of independence by learning how to function without the limb, mastering the use of crutches and overcoming the mental challenges they faced they may still require long-term care in a hospital institution. This is because they may not have been able to provide for themselves financially with job prospects demanding manual labour and relatively simple locomotion would not have been achievable, dramatically reducing their employability in the context of medieval England.

Figure 6.3.35: A depiction of a 'fighter'; with a bent-knee prosthesis and crutch for stability (*Arthurian Romance*, Beinecke MS 229, C. 1275-1300).

Causes of amputation in the medieval period include surgical intervention, trauma-related dismemberment and judicial punishment (Mays 1996, 107). Despite numerous medical conditions and injuries necessitating amputation, osteological evidence suggests surgical amputation was a rarity in medieval society (Roberts and Cox 2003, 251; Warrell 2003, 458; Magilton *et al.* 2008, 259). The scarcity of examples may result from recovery bias or misidentification in the archaeological record; for example, Buckberry (2014, 147) notes that, due to taphonomic damage to the end of amputated limbs and excavators unaware of bone morphology, cases of amputation go unidentified and thus are likely under-reported in the osteological and archaeological records. Furthermore, distinguishing medical amputation from traumatic amputation or amputation as judicial punishment is incredibly difficult given the common occurrence of new bone formation arising from infection and healing processes which gradually obscure the morphology of the site of amputation, the effects of taphonomic factors and a lack of historic documentation to indicate what we should expect from the form of injury arising from each of these processes. However, it is also possible that due to the dangerous nature and challenging procedure of surgical amputation that they were rarely carried out.

There are two examples of amputation to the lower limb from the comparative hospital sites employed in this thesis. The first example is from the Hospital of St Mary Spital, London, is also arguably the best comparison to SKN016 from the medieval archaeological record. The amputation was present in a skeleton recovered from a mass burial dating to 1230-1260 within the hospital site (Connell *et al.* 2012, 216). The individual was a male aged 26-35 years at death who had a healed amputation of the right lower leg (Connell *et al.* 2012, 216). As is seen in SKN016, the tibia and fibula terminated mid-diaphysis, in healed, rounded calluses, the bones had been cut approximately perpendicular to their long axes and the medullary cavities had healed over. Both amputations present with porotic lamellar bone and the formation of irregular spicules. The primary difference between the amputation at the Hospital of St Mary Spital and SKN016, is that the former does not present any signs of atrophy in the affected limb, which suggests not enough time had passed for the disuse of associated muscles to be evident in the skeleton and therefore it is unlikely the amputation took place many years before death (Connell *et al.* 2012, 216). The second example is from the Hospital of St Mary Magdalene, Winchester, from which an amputation of the left lower limb was recovered. The limb had been amputated through the distal part of the shafts with a tapering appearance to the distal tibia and ankylosis of the bones across the interosseous space. The tibia shows atrophy and the remodelled appearance of the ends of the amputated bones suggest the amputation took place sometime before death. Roffey and Tucker (2012, 175-6), report little evidence of infection inferring medical treatment was available at the time of amputation or complete remodelling of the infection occurred by the time of death. While both comparative amputations are similar to the amputation of SKN016 from the Hospital of St James, that from the Hospital of St Mary Magdalene, Winchester is associated to an individual with leprosy and therefore the overall state of the amputation from the Hospital of St Mary Spital, London offers arguably a more accurate comparison when considering the context of the amputation.

Transverse amputation, minimal osteophyte formation, regularity of the bone ends and a lack of ankyloses have been deemed suggestive of surgical intervention, and therefore these features might enable distinction of surgical amputation from other forms. Examples of transverse amputations from archaeological records outside of England include a skeleton from Verson, France (sixth to eighth century AD) with a healed amputation of the distal ulna and radius (Dastugue and Genrais cited in Mays 1996, 107); a healed forearm amputation from Sedment, Egypt (Brothwell and Moller-Christensen's 1963, 192-3); and a healed amputation of the right lower leg in an individual from medieval Odense, Denmark (Jakobsens (1978, 18-20). The authors all argue that right-angled amputation cuts and healed bone formation is suggestive of surgical intervention over trauma-related activities. However, over time new bone formation and successful healing of any amputation can result in the appearance described above. Because of such possibilities Inglemark

(1939) does not consider the clean cuts to her examples as a means to question traumatic amputation. Therefore, regarding skeletal evidence, it would be highly beneficial if the 'type' of instrument used could be inferred. The absence of saw marks would mitigate an interpretation of injury-related amputation. However, due to the osteophyte formation and bone remodelling of SKN016 it is not possible to observe any characteristics of the cut marks and therefore neither surgical nor traumatic amputation can be confirmed or ruled out through osteological analysis.

Amputation as the result of interpersonal violence or accident also proves difficult to confirm from the archaeological context of burial and skeletal remains of an individual. Therefore, historic records such as chronicles provide an insight into specific circumstances in which such events may have taken place. One such resource, from the later medieval period, is the *Calendar of Patent Rolls* (Edward 111 1327-1330, Membrane 27d). An entry from 12 February 1327 records the event of amputation via mob assault, in which the victim was tied to a tree and their right hand was amputated. Interpretations suggest that this act was the result of a personal feud (Mays 1996, 110).

By the mid-thirteenth century, dismemberment as a form of punishment was reserved for those who displayed open contempt for the king's court by interfering with its proper function (Mitchell 2004, 124). There are several reasons why the scenario of judicial amputation does not effectively explain the skeletal evidence from SKN016. The location of the cut itself, which was made through the shaft of the tibia and fibula, would have a high risk of death from infection or blood loss. This is not consistent with a practice designed to promote survival of the victim as a punitive action. Moreover, the gradual reduction in judicial mutilation during the medieval period makes it unlikely that SKN016 was afforded such treatment. Furthermore, amputation of the leg is neither documented as a form of corporal punishment, nor is it easily associated with a particular crime, as was the case for removal of the hand or the tongue (Mattison 2016, 265-300).

The identification of lower limb amputation is rare in the archaeological record. In the case of SKN016, and all archaeological cases, attempts to identify the cause or motivation for amputation via the osteological evidence alone is problematic. This is because skeletal indications of the original motivation for, and means of, amputation are no longer visible especially when the amputation has healed. In the case of SKN016 surgical amputation is the most probable, the reasons for which are evidenced in the characteristics of bone pathology, which suggest reasonably effective use of a prosthesis, and the context of burial within a medieval hospital.

6.3.4 Discussion of 'medical intervention and potential for long term, palliative and skilled care'

This research theme has addressed a broad suite of pathologies present within the Hospital of St James population which required different levels and forms of care, including the potential for provision of long term, palliative and skilled care. The application of Tilley's 'bioarchaeology of care' methodology within this research theme of 'medical intervention and potential for long term, palliative care skilled care' has enabled an exploration of the inmate's condition and consequentially revealed that a diverse range of care would have been required from the hospitals. Through compiling the analysis following Tilley's methodology it is evident that the hospital housed people with disease, infection, trauma and congenital disorders. This has allowed an interpretation of the skeletal profile on a case by case basis which then enables a broader understanding of the hospital and its inmates.

A prime example of the varying levels of care and pathology present within the hospital assemblage is that of trauma related injury. Through bioarchaeological analysis it is evident that trauma within the population varied as the impact these injuries had on the individuals involved differ greatly. For example, the impact of trauma to the skull and a fractured femur would have very different consequences and the time needed for recovery could drastically differ, as became apparent through the application of the bioarcheology of care methodology. Trauma in the Hospital of St James population included depression trauma to the cranium, vertebral fractures, femoral fracture, rib fractures, fractures of the arm and soft tissue injuries. The range and severity of trauma present is not typically associated with the communities of religious houses and monastic communities, due to their reduced involvement in dangerous physical activities, which are more likely to have been carried out by younger monks or lay brothers. Kerr's (2009, 32-3) work on life in the medieval cloister explains that is lay brethren and not the monks or cannons of the monastic community that carried out manual labour including farming, agriculture, building and repair works. Therefore, the broad occurrence of trauma-related injury at the hospital suggests the cemetery population contains a high proportion of previously active inmates who could have been members of the wider monastic community or from communities outside of the Abbey.

Similarly, chronic conditions found among the cemetery population could have had varying impacts on the care the hospital provided. For example, osteoarthritis can manifest in a light discomfort to extreme pain and immobility (Lespasio *et al.* 2017, 2). Therefore, the patients could require short term stays at the hospital or permanent residence if the condition prevented the completion of daily tasks. Individuals suffering from DISH and ankylosing spondylolysis can have very few symptoms or can suffer from neurological deficits and sudden onset paraplegia, which would be skeletally visible if long term (Wilson and Jaspan 1990; Goto *et al.* 1995). Such individuals would require daily assistance due to the pain related with the condition and their ability to partake in daily activities such as prayer and physical work would be compromised. The diet and lifestyle associated with the religious population of medieval society has further contributed to the association of DISH and the religious. In their investigation of DISH, Rogers and Waldron (2001, 362) emphasise the high consumption of saturated animal fats and alcohol by religious communities in medieval England. A prime example is the account of food offered to the monks at Christ Church, Canterbury which consisted of approximately 16 dishes accompanied by beer, ale, claret, new wine, mead and mulberry wine (Bishop 1983). The recurring presence of DISH in the archaeological remains of such populations emphasises the possibility that the population of the Hospital of St James contained members of the religious community.

Moving on from the trauma related pathologies, the cases of non-specific infection also demonstrate an extended level of care required by the Hospital of St James to its inmates. The cases of osteomyelitis and infected ulceration of the tibia demonstrate the housing of individuals with ongoing and worsening conditions. These infections would have manifested in debilitating pain and open wounds which required cleaning on a daily basis (Miettunen *et al.* 2009, 2; Pham, and Scott, 2007, 65; Akoh 2017, 134-5). Once the initial infections had cleared then the hospitals would have had to work to fight off any secondary infections as well as helping the individual to function with potentially reduced mobility in their effected limb. For example, through applying Tilley's bioarcheology of care method to the individual with an infected ulceration of the tibia, it was established that care could have been required for anything from 6 months to fight the initial infection up to a lifetime depending on whether the infection recurred and on the level of mobility the individual was left with. Similarly, the case of trans-tibial amputation represents an individual at the hospital who was likely to have required ongoing care following amputation. This is the one example of known surgical intervention in the skeletal population, however, as outlined in Chapter 2, the occurrence of medical intervention taking place within medieval hospitals was extremely rare, let alone the occurrence of such an extreme intervention as amputation. Therefore, it is not possible to take this individual's presence as evidence of surgical practice at the Hospital of St James.

The rarest, and arguably the pathology with the biggest impact on the individual, present in the skeletal assemblage was the case of synostotic scaphocephaly in SKN059 (aged 6-7 years at death, recovered from Area A). Individuals with this condition can require constant supervision due to the potential for the patient to suffer seizures, to lose their sight and hearing and their inability to carry out simple tasks such as feeding themselves (Romine and Reynolds 2004; Flores-Sarnat 2002). These conditions would have required greatly differing forms of care, one of which would have been required from birth and all for the reminder of the individual's life. It is possible that children with such conditions were given to the hospital due to the level of care required and their parents/carers inability to provide this. The presence of this individual presents an extremely strong argument for the function of the hospital to provide long-term care for the sick poor of medieval society, regardless of the large amount of resources they may take up.

In summary, the discussion of 'medical intervention and potential for long term, palliative care skilled care' at the Hospital of St James has revealed the potential for long-term care and the potential for varying degrees of skilled care. It is apparent from the range of pathologies that long-term care was likely required, involving a community of carers to provide continued assistance to the inmates and their ailments. The individuals would have called for provision of food, water, shelter, bedding, massage and possibly re-positioning of the body. Having identified long term conditions and conditions with worsening effects such as DISH, rheumatoid arthritis and synostotic scaphocephaly, it is probable that the level of care increased over time as the individuals became less mobile and experienced greater levels of stiffness, pain and disability. In these instances, the degree of skilled care would have increased and may have called for more specialised assistance.

6.4 Summary

The palaeopathological analysis of the hospital population revealed an interesting profile of disease, infection, trauma and congenital disorders. An examination of these conditions has provided evidence for both minor and serious conditions. The three discussions held under each research theme have given context to the types of pathologies present and the inferences of care that can be drawn from them.

The palaeopathological conditions present in the assemblage reveal information about the type of care provided and the length of time inmates are likely to have spent in the hospital. In the cases of environmentally and nutritionally induced conditions, short-term care would have been required to overcome ailments by a change in environment and improved diet. However, it is important not to assume that inmates were in the hospital as a result of these skeletally visible ailments. For example, the presence of those with cribra orbitalia and porotic hyperostosis may have had more pressing ailments which are not skeletally visible or may have been admitted for being destitute or aged. The presence of chronic conditions may result in inmates being housed for sporadic periods of time when conditions 'flared up'. The pathologies which demonstrate markers of lifestyle have been utilised here to assess the activity levels of those at the hospital. By doing so, skeletal analysis revealed a combination of pathologies linked to medieval monastic lifestyles and conflicting pathologies which are indicative of physically active lifestyles. This osteological investigation revealed support for the idea that the population at the Hospital of St James was a mixture of monastic and lay individuals.

It is the occurrence of multiple conditions with the potential to be life altering which reveals the most about the hospital's provision of care. For example, the case of DISH, rheumatoid arthritis and synostotic scaphocephaly would have called for long-term care of both adult and non-adult members of the community. Furthermore, tending to ever-worsening physical impairment and developmental delays shows the dedication of the hospital to the inmates and speaks to the length of care they would have been willing to offer. The misaligned and multiple bone fractures would have caused ongoing pain and a reduction in physical mobility, in turn would require daily assistance to carry out simple tasks. Furthermore, these conditions, as well as many others discussed in this chapter, would prevent the inmates from working and therefore they could not provide for themselves outside of the hospital's care.

In summary, the application of the three research themes have revealed the overall health of the population, their lifestyles and the potential for both long- and short-term care at the Hospital of St James. Through the application of Tilley's 'bioarchaeology of care', it is evident that the hospitals offered care on both short- and long-term basis, as well as differing levels of care depending on the pathology. Some ailments may have called for simple provisions of food and shelter while others would require wound treatment, rehabilitation and constant assistance.

7

Contextualisation of the Hospital of St James non-adult population

Chapter 5 established the size of the non-adult community at the Hospital of St James to be statistically significant compared to other contemporary hospital populations. The large population of non-adults, among an adult community compatible with that of a monastic house, requires further exploration to explain this unusual pattern. In order to explore the high prevalence of children at the Hospital of St James this chapter will introduce the position of children in later medieval society. It will go on to discuss the socioeconomic influences which may have altered the position of children and led to the housing of them within religious institutions. In addition to these socioeconomic motivations for leaving a child in the care of the religious, the discussion will also consider education and disability as relevant factors. It then goes on to discuss the processes by which children were admitted to, and housed by, religious communities and the benefits this brought to the wider community. Finally, the discussion will move to the significance of the location of the Hospital of St James, the influence this location had on both the non-adult and adult population and the contextualisation of the hospital's population demographic profile.

7.1 The concept of age and a child's position in later medieval society

The concept of age in past populations has been a topic of debate among historians, archaeologists and biological anthropologists. Traditionally these arguments have resulted in children being viewed as 'small adults' and nothing more, and the stance that there was a distinction between ages. Phillipe Ariès (1962), in his work *Centuries of Childhood* argued that the concept of family, and particularly children, was held in the ancient world but was lost to the Middle Ages until its resurgence in the sixteenth century. Further arguments in support of this state that the sentimental concept of family is a modern view, that children were socially inconsequential and that they only became a valuable asset when they were sent out to work, at approximately seven years of age (Richè, 1979 as cited in Boswell 1984, 17). While it is accepted that the distinction of children is not what it is in modern society, scholars such as Herlihy (1978) and Shahar (1990) object to the harsh stance of Ariès, despite the understanding that the economic and social challenges of the 'Dark Ages' would have altered the role of children (Herlihy 1978, 118; Shahar 1990, 1-2). Furthermore, the distinction of children has been proven in the presence of toys such as miniature cookware, weapons and figurines; the Portable Antiquities Scheme alone has identified 102 artefacts dating between 1000 and 1600AD which have been ascribed the object type 'toy' (Harper 2017, 3). The finding of such objects and their interpretation brings to question the perceived role of children in later medieval society.

The study of age and development in past societies has, until relatively recently, been subject to mismanaged and confused definitions. This is largely due to the impingement of modern western concepts of age based firmly on the chronological development of an individual in both social and legal frameworks (Penny-Mason and Gowland 2014, 164). Furthermore, osteological studies focus on determining the chronological age of skeletal remains, but this may in fact be unbeneficial in studies concerning the social context of an individual's existence. A further issue that arises in this area of study is the mismanaged and conflicting categorisation of age by authors, this is best represented in timeline of age assessments illustrated by Penny-Mason (2014, 165 Figure 1). Instead of a constrained structure, age should be considered as a complex construct which can be considered in terms of chronological age (time elapsed since birth), biological age (physical growth) and social age (culturally constructed) (Halrow and Tayles 2008, 192).

According to Penny-Mason's (2014) representation of age, childhood could span from two to eighteen years of age in medieval culture (figure 7.1.1). Children's culture is represented in a scattering of references in chronicles, medical collections, coroner's reports and literary works. Written accounts of the daily life of children are scarce, and for the lower classes those accounts which do exist are often written by ecclesiastics who had little experience of family life (Hanawalt 1977, 2-3). The interpretation of age in medieval England is therefore understood in relation to social age based on 'rites of passage' such as the point of weaning, schooling, confirmation and apprenticeship (Orme 1994, 578). From around six years of age medieval children began to interact with the adult world, and much like today they were introduced via household duties and increasing independence. It is via accounts of these activities that the transition into adulthood is taken.

The position of children in medieval society lacks further clarity as legal documentation does not specifically address the needs or considerations that should be given to children. Instead, the rights of children were considered under other legal headings as and when they affected or applied to children (Goldberg 2000, 18-9). For example, no separate book in the *Corpus iuris canonici* or the *Corpus iuris civilis* considered the rights of children (Helmholtz 2007, 41). However, children were acknowledged when canon law asserted ecclesiastical jurisdiction over children based on the church's responsibility towards the *miserabiles personae*, or those who could not protect themselves (Helmholz 2007, 41). Canonists justified the intervention of the church in legal matters applying to those in need, including children, widows, and pilgrims, via biblical extracts such as Psalm 10:18, which asks God to "bring justice to the orphan and the downtrodden". Intervention of the Crown in matters affecting the homeless, poverty-stricken and sick, including children, did not take place until the introduction of Poor Laws in the sixteenth century (Penny-Mason and Gowland 2014, 170). Thus, prior to the Dissolution, management of those in poverty was a role that fell to the religious systems of poor relief.

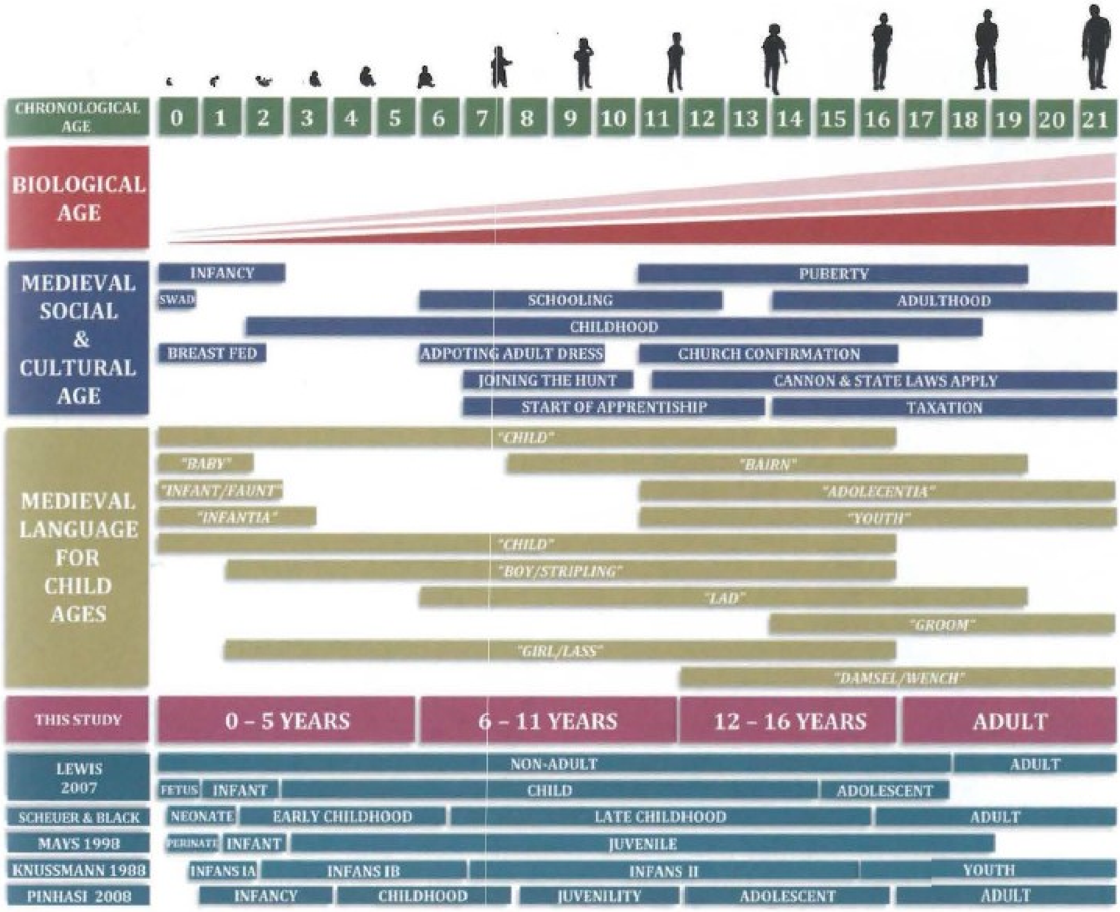

Figure 7.1.1: Defining chronological, biological and social age by Penny-Mason (2014, 165).

One setting in which there was a definite distinction made between children and adults was in the religious world. This distinction was exemplified by the concept of original sin, stating that a child is hindered with sin through no fault of their own and only once they reach maturation and are confirmed in the church are they responsible for their sin (Shahar 1990, 1-2; Kuefler 824). As well as social age, this interpretation considered the significance of biological age, as official recognition of maturation by Church and State was done so at the time of puberty (Dyer 2000, 134). Recognition of this age marker was documented in religious confirmation, taxation, work-related laws and the implementation of canon and state laws from the age of 11 years.

By the eleventh century, a child's first interaction with religion was their baptism.

The concern of original sin corrupting individuals and risking time in purgatory meant that baptism needed to be undertaken as soon as possible (as discussed in Chapter 3). From approximately 12 years of age confirmation marked the child's ascent into adulthood, entering the church as a full member and from this point boys could enter the monastery and receive their formal education (Orem 2001 216, Mays 2009, 181; Alexander-Bidon 1999, 121; Lett 1999, 51; Constable 2004, 348).

7.2 Social and economic influences on childcare

The eleventh to thirteenth centuries saw improved social, economic and health status across Europe (as discussed in Chapter 1), resulting in an increase in population from approximately 25 million in AD 950 to 75 million in AD 1250 (Gottfried 2010, 16). This rapid growth resulted in the overcrowding of growing urban centres, the transmission of communicable diseases and shortages of food (Gottfried 2010, 17; Bolton 1980, 72). Over the course of the thirteenth and fourteenth centuries, the outbreak of famine and plague worsened living conditions (Roberts and Cox 2003, 225). Living standards declined from 1250 due to an over-cultivation of wheat and subsequent soil exhaustion, as evidenced in the decline of seed yields and agricultural productivity (Schneider 2014, 66; Gottfried 2010, 25). The fourteenth century also saw the appearance of the Black Death, which caused a significant decline in the population by one third to one half, between the years 1348-9, which impacted the economic, social and political landscape (Clark 2007, 115; Bailey 1996, 9; Bolton 1980, 46; McKintosh 1988, 219). Between the 1340s and 1370s, England's economy decreased by 35 percent, in the last quarter of the fourteenth century the modest recovery plummeted, and as late as 1500 it remained at 15-35 percent below its pre-plague level (Campbell 2016, 355). Therefore, until the late fifteenth-century economic growth and prosperity fluctuated continuously with little in the way of sustained growth.

The social and economic instabilities discussed above would have altered the role and wellbeing of children in later medieval society (Herlihy 1978, 118; Shahar

1990, 1-2). Throughout Europe adults struggled to sustain themselves, let alone a family, and thus in a time of periodic famines and plagues the plight of the poor was viewed as justification to relinquish one's responsibility for a child (Boswell 1988, 256). This could take place via abandonment or oblation. The survival of the impoverished, defined as those in life-threatening deprivation, in the Middle Ages has been largely attributed to charity in the way of alms-giving and poor relief as provided by the church (Dyer 1989, 234). This relief aided parents in poverty by providing a safe residence to leave children and a system in which to place them. Children were entirely reliant on the charity of the monastic houses who in some cases would provide them with food and shelter (Boswell 1988, 256). However, in times of poverty, even the charitable offerings provided by the religious suffered significantly; for example during the famine of 1315-18, Bolton Priory cut provisions to the sick poor from £10 per year prior to 1314 to just £1 3*s.* in 1317-8 (Snape 1926, 112-8). Regardless, the housing of children in monasteries and related institutions continued.

7.3 The processes by which children were placed into religious care

During the Middle Ages, it was not uncommon to find accounts of children housed in and among religious communities. Reasons for this included education, training in the religious way of life, care of the abandoned and orphaned, and the welfare of the infirm or disabled. While the hospital was not a monastery per se, it was run along monastic lines with the primary aim of providing care to the needy. This care also extended to the young and therefore the following explores the idea that a large number of non-adults housed is a reflection of the hospital providing alms to a younger demographic of society.

The earliest known legislation regarding the entrance of children to the monastic life comes from Basil of Caesarea (d. AD 379), whose primary concern was the entrance of boys, whose parents were still alive, into monastic communities (DeJong 1996, 18). Basil's legislation was disseminated through the West via Rufinus' abbreviated translation it was this abbreviation of Basil's work which led to the misunderstanding that the parental vow of a child was irrevocable (DeJong 1996, 18). In actual fact, the original legislation stated that only a vow taken in adulthood was irrevocable and could only be made if voluntary and after much deliberation (DeJong 1996, 19).

While Basil of Caesarea provides the earliest record of a child's entry into monastic life, the Benedictine Rule and literature dealing with issues such as the adoption of children into the religious life introduced the concept of child 'oblation'. Oblation was the donation, or offering, of a child into the guardianship of a monastery, at which point all parental rights over the child were relinquished and the child was expected to remain in the monastery for life (Boswell 1984, 255). The act of oblation was brought under scrutiny in the early twelfth century for reasons discussed below, and the housing of children among the religious became linked with education and novice training in the later medieval period. However, the offering of children is known to have continued in a number of monastic communities. For example, in 1282 the archbishop of Canterbury urged the nuns of Stratford-at-Bow near London to veil young girls as nuns. Mary, the ninth child of Edward I, was given to Amersbury Priory in 1285 when she was seven and Katherine, the daughter of Sir Guy de Beauchamp entered Shouldham Priory at the age of six in 1359 (Orme 2006, 257). Therefore, the care of children by religious communities continued and this charity provided a safe residence for children in need (Dyer 1989, 234; Boswell 1988, 256). The age at which a child was given via the act of oblation is most widely thought to be around six or seven years, whilst monastic records also occasionally account for the presence of newborns (Orme 2001, 66). The maximum age of an oblate is believed to have been fifteen years, for the Rule of St Benedict considered fifteen to be the age at which children no longer needed special discipline and custody (DeJong 1996, 28). At the Hospital of St James, the largest proportion of non-adults were aged 6-11 years at death (n= 38, as outlined in section 5.3), this falls in keeping with the age at which children were admitted to monasticism under the act of oblation. Furthermore, the sudden decrease to just eight individuals aged 12-17 years further reflects the progression of oblates to full members of the religious community. Regarding the non-adults under the age of the 6 years, it is possible that these children were in the care of the hospital as their parents were not in a position to care for them and they believed being brought up by a religious community was the best option for them. Regardless of age, the hospital community may have felt a responsibility to provide care and housing to the very young as part of their role in providing alms to those in need.

The Rule of St Benedict provides the only precise instruction for the entry of children into the monastic community via oblation, which influenced Augustinian practices (Green 1997, 37). The rule emphasised the lasting status of the vow made by parents.

> *"Regarding the sins of nobles and of the poor who are offered. If a noble person offers his son to God in the monastery, if the child is still young, let his parents draw up the document (petito) we have already discussed, and enfold the hand of the boy in the alter together with the offering and offer him in this manner. As far as their possessions are concerned, the document in question should contain their solemn oath never to give him anything nor provide him with the opportunity to possess anything- either themselves, or through an intermediary, or in any other way; if they do not wish to do this but rather, for their soul's sake, would like to give alms to the monastery, let them make an offering of which- if they choose- they may retain the usufruct. Thus, let all roads back be cut off. So that the boy has nothing further to look forward to that might, as we know from experience, tempt him and – God preserve us! – lead him to damnation. Let poorer people do likewise. But those who really have no possessions at all should simply draw up the document and offer their son with the offering in the presence of witnesses."*

Regula Benedicti, c. 59. (DeJong 1996, 26)

The strict nature of St Benedict's approach to child oblation has been questioned, for under the rule, submission of an adult is a drawn-out process of self-profession which is entirely missing from a child's admission as outlined above. Adult newcomers were discouraged from entering the monastery, being refused admission for days and only once they had persisted were they permitted entry, after which months of probation were required before the novice was allowed to make his threefold vow to the monastery (Parry 1984, 91-3).

The practice of oblation faced criticism by monastic leaders in the early twelfth century, due to the idea that the vow was made quickly and irrevocably on behalf of the child (DeJong 1996, 1). The concerns around the age of oblation and the act being made on their part led to a debate of the permanency of their residence in monasticism (Orme 2006, 256). Uncertainty surrounding the practice ultimately led to a change in the monastic rules surrounding oblation in its named form at least in the twelfth century (DeJong 1996, 1; Orme 2006, 256). While the act of oblation may have officially gone out of practice, the care, education and training of children in religious communities and monastic houses did not cease at this time (Orme 2006, 257). Members of the religious community still had a duty of charitable devotion, children were still orphaned, and education remained a significant part of the religious community's work.

Regulations for oblates outlined by Ulrich of Cluny (c.1029 – 1093), a Cluniac reformer, demonstrated the stern conditions in which children were to follow the rigorous liturgical life of the monastery. For example, they were to only speak when granted permission and should a boy commit an offence in chanting the Psalms, they were required to inform on themselves and each other. Anyone found to conceal such an infraction would be whipped along with the perpetrator (Boswell 1988, 305). Oblates often took on apprentice-type roles within the monastery in order to prepare them for future religious life. Irrespective of their apprentice-role, all oblates were educated and versed in monastic discipline under which they received an education and literate training (Constable 2004, 348). The extent of their education was often determined by their monastic house. For example, Latin literacy was necessary for the Opus Dei and therefore their education in literacy was great (Ziolkowski 2018, 125; DeJong 1996, 127).

Following the technical abolition of 'oblation', monasteries took a greater role in lay education. Lawson and Silver (1973, 62) argue that it was this abolition which led to larger Benedictine houses forming song schools and grammar schools in the fourteenth century. The schools of all orders were formed partly as a work of charity and partly to serve the interests of the monastery. The Augustinian houses had arguably always held a greater interest in educating the masses and had been able to do so through their serving in lay parishes (Lawson and Silver 1973, 32). From benefactions of the twelfth century, Augustinians became custodians of schools acquired through estate donations and provided schools by their own accord for children of local communities. These Augustinian houses, in particular, have been found to have housed the sons of gentry for education in line with novice practice, but did so to the detriment to the sanctity and solitary of religious life (Lawson and Silver 1973, 32). Additionally, almonry schools were established for the education of 10 to 20 boys including sons of well-to-do tradesmen and yeomen of the area. These schools were often afforded by the students giving personal service to the religious house in payment for education (Lawson and Silver 1973, 62).

While the form of these religious schools varied, it is widely agreed that the schooling of children involved their living in the institution in which they were educated and undertaking daily tasks there to solidify their position as part of that community (Ferzoco and Muessig 2001, 23). The main form of religious education and liturgical training was to prepare students in ritual and monastic discipline (Boynton 2000, 16). Thus, given that the primary concern of education supplied by the religious was still the training of novices and future secular clergy, its motivations were clearly the same as those that had driven the practice of oblation in earlier centuries (Lawson and Silver 1973, 63).

While the age profile of the non-adult population at the Hospital of St James sits in line with the age of oblation, it also coincides with significant points in the life course of later medieval children. The non-adult population of St James drops significantly around the age of 12 years, from 36 to just eight individuals. This significant change in the population falls convincingly close to the age at which children could enter the monastery as a novice, aged approximately 12 years and the age at which they could attend universities including Oxford and Cambridge, from approximately 14 years of age. For the children that may not have joined the monastery as novices or attended university, it is possible that they re-entered society at this point as they were thought to be of an age at which they could find employment. With regard to the children under the age of five years, it is not clear who within the community at the Hospital of St James would have cared for them. There is evidence from numerous hospital cemeteries that very young non-adults were housed and cared for within medieval hospitals; including but not limited to St Bartholomew, Bristol; St John, Cambridge; St Nicholas, Lewes; St Mary Magdalene, Winchester; St Mary Magdalene, Partney and St Mary Spital, Lon- don (Hookway and Squires 2020, 44-5). At the Hospital of St James it is possible that the nine adult females present in the cemetery population helped to care for the very young and that members of the lay community, who were not captured in the cemetery excavations, worked within the hospital to provide the care and provisions needed to raise the non-adult population. Considering this, it seems more than a possibility that the hospital's usual role was expanded to incorporate the care of children, whether they were abandoned for reasons of ill-health, to enter the religious life, to relinquish parental rights, or as a result of being orphaned. Therefore, the cemetery would provide burial to both the sick and infirm occupants of the hospital and sick and orphaned lay children. However, they may also be providing a service to a community of children who were destined for monastic life but were yet to enter the monastery and thus not afforded burial within the Abbey's cemetery.

Whether the hospital was housing children who were to take up life in the religious order or those being schooled by the brethren, the hospital's location within the outer precinct of Thornton Abbey provides a meaningful and practical environment for this to have taken place in. In either case, children could be placed under monastic supervision, with ease of access to their training in the monastery, without having to permit them residence in the cloister and therefore maintaining its sanctity. Furthermore, this ensured quasi-monastic habitation for the canons whose duty it was to oversee the children's upbringing. Indeed, as discussed above with regards to the adult population of the hospital, the Abbey would be a persistent feature in the surrounding landscape and would have the same influence on the cognitive and emotional perspectives of the young housed in the hospital. But in this case, as well as acting as a reminder of the sanctity of religion and the importance of one's relationship with God, it also provided an insight into the future life of those entering the monastery. Continuing the hypothesis that the non-adult population excavated at the Hospital of St James represents a community of children preparing to enter monastic life, a further inference can be made regarding the location of the hospital. The hospital's location on the threshold of, but physically separated from, the inner monastic precinct can be interpreted as an echo of a child's position in religious communities; they were neither part of the secular nor the religious world, instead they are in a transient position where they stood on the interface of both worlds.

This interpretation of a child's transient position within a religious community correlates with Penny-Mason's (2012, 165) analysis of social age, where he identified a number of years it took for a person's position in society to transition from childhood into adulthood. This introduction to adulthood varied from taking on household chores and adult dress to undertaking apprenticeship and being confirmed by the church. More specifically from the age of six to nine adult dress would be adopted, from six to twelve schooling would take place and from six to thirteen apprenticeships would start (Penny-Mason 2014, 165). It is via these such activities that children transitioned into adulthood, however the full independence which is normally associated with adulthood was not possible for people of this age group. Therefore, these non-adults were interacting in activities and work associated with adulthood but at an age at which they were not recognised as part of the adult community and therefore can be interpreted as in a position between adulthood and childhood. This echoes the sentiments discussed below in section 7.7, that individuals below the age of fifteen years were separated from the adult community of monastic houses until they had the time and understanding to internalise the values of monastic life (DeJong 1996, 149).

7.4 Motivations for placing children into religious care

Parental motives for choosing that a child be brought up within a religious community were undoubtedly diverse and would have varied from religious merit, personal gain, alleviation from the impacts of poverty, and the welfare and education of the child. Given this, the following discussion considers, in addition to the social and economic instabilities discussed, five potential explanations for the high proportion of non-adults at the Hospital of St James.

The first motivation was religious merit that giving over a child to the religious life would bring to the parents. For example, parents were commended for giving their child the opportunity to enter the monastic world and a honorable vocation. It was believed that in doing so, parents were commending their children to a virtuous life, albeit one of sacrifice for the child (Boswell 1988, 22).

The second motive was more exclusive to the gentry, who accounted for just 10 percent of England's population at the time (Boswell 1988, 256). Over the course of the eleventh and twelfth centuries, legal, social and cultural structures in Europe produced mechanisms by which the maintenance of the estate was the responsibility and right of a single heir. Until this point an estate would be divided among all legitimate children, thus resulting in the need to reduce the number of legitimate children in a family to maintain the status of an estate. From the thirteenth century in England, this was established through lawful systems of primogeniture, whereby the eldest son automatically inherited the majority of the estate titles (Jamoussi 2011, 14). Consequently, prior to the thirteenth century the gentry had developed a well-established a system of donating children to monastic institutions as a means to maintain the family estate and financial well-being.

The third motivation was the impact of poverty and the housing of children in religious houses as a means of charitable relief. Giving a child to a religious community offered a laudable option by which parents could relinquish their responsibility for a child, while being assured the child would be fed, clothed and housed (Boswell 1988, 239; 1984, 13). In times of periodic famine and plague, the plight of the people was viewed as justification enough for desertion of offspring (Boswell 1988, 256). Such desertion was not a selfish act, instead, it was an act for the welfare for the child; during a mid-twelfth century famine in the Vendôme region of France, mothers were reported to be 'throwing' their babies at the door of monasteries as a way of ensuring their survival (Lynch 1976, 41-57).

The fourth motivation was that donation of children to the religious was viewed as the most practical means of desertion, for it offered a resource by which parents could relinquish their responsibility in order to go on pilgrimage and in return no longer bore accountability since the act was permanent (Goldberg 2000, 1923). In some instances, the parents were required to make a donation to the monastery along with their child, which could be expensive, but was significantly cheaper than raising the child themselves. Therefore, the parent benefited not only financially but also in pious rewards.

The fifth and final motivation was the presence of disabled and infirm children and the lack of support provided to parents in later medieval society. It is possible that parents who could not personally care for a child due to their physical or mental impairment used the religious relief system as a means to ensure they were looked after. Furthermore, in line with Metzler's (2011) work on the experience of disability in the later medieval period, one must consider the economic situation of a person, their ability or inability to work for a living, and the provision of charitable measures for them in society. Taking this into consideration, a non-adult who had experienced disability through either a congenital impairment or accidental trauma could have a significant impact on their ability to work and to learn a trade. If this was the case, then that child's caregiver may come to the conclusion that the best course of action and most promising future for the child would be in one of the religious houses. Those with disabilities being accepted into the monastic life also included adults.

The *Patrologia, Series Latina*, which compiled the works of the Church Fathers from Tertullian in 200 AD to the death of Pope Innocent III in 1216, stated that 'any who are lame or crippled, deaf or dumb or blind, hump-backed or leprous, or who have any defect which would make them less desirable in the secular world, could be offered as monks with the most pious vows' (Lynch 1976, 41). This action spared parents from the burden of supporting children even in later life, freed resources for the other children and provided the disabled with the security of the monastic community. As a result, complaints surfaced about the number of physically or mentally disabled children disturbing the monastery's daily life (Boswell 1984, 22). The Chronicle of the Abbey of Andrés in the diocese of Arras, France recorded the reaction in 1161 of the new abbot to have been 'shocked and frightened at the deformity of the flock for some were lame, crippled, one-eyed, cross-eyed, blind, and missing a limb; and almost all of these were of noble stock [...] The devoted man fulfilled: for through thirty-two years and more in which he rules this place he never permitted anyone to be a monk who had any defect in any part of his body' (Lynch 1976, 45). At the New Minster, Winchester, it was noted that between 1030 and 1070, of 41 new admissions to the house, 35 (or 85 percent) were oblates, and even in the following century, there were three boys to every five adult recruits (Boswell 1988, 297). The extent to which oblation of the disabled was being carried out is further evidenced in the observations of Ulrich of Cluny, in the second half of the eleventh century. He remarked that the growth in the number of 'handicapped monks' given to the monastery 'not for sake of God' but for the sake of their parents was exponential (Constable 2004, 348). Similarly, in the twelfth century, Peter the Venerable, himself an oblate, brought attention to the number of oblates being admitted to the Benedictine monastery at Cluny. His concern for the situation led to the prohibition of oblation without the express permission of the abbot (Boswell 1998, 299).

It would seem then, that Ulrich of Cluny's comments that 'anything born of honest and pious motivations can, indeed, be turned to bad use, and this holy institution has been corrupted by greed' were somewhat harsh, but substantiated (Boswell 1988, 298).Monastic houses were potentially taking responsibility for a large number of individuals with disabilities from the start of the medieval period and this practice was well established in monastic houses by the end of the Middle Ages. Furthermore, DeJong (1996, 168) suggests that those with a disability were somewhat predisposed to monastic life and that their placement in the monastery was not a means of discarding children, for a monastic life provided an environment in which the physically disabled could excel without the pressures of everyday lay life. DeJong's argument stems from the presence of oblates brought up in the cloister of the Abbey of St Gall, Switzerland, who were given the nick-names of 'the Stammerer' and 'the Cripple' yet are recorded as being among the intellectual elite of their given communities (DeJong 1996, 168).

From the palaeopathological analysis of the skeletal population from the Hospital of St James it is evident that the hospitals cared for individuals with debilitating injuries. For example, from the non-adult population SKN050 had extensive osteomyelitis of the left ulna and SKN059 presented with synostotic scaphocephaly. With this in mind if it is the case that the Hospital of St James was housing individuals with impairments for life, then a similarity can be drawn between the actions of the Hospital of St James and the actions of earlier religious communities who took in oblate's in centuries previous.

A further motivation to give a disabled child over to the church was the belief that they were born of sinful actions. For example, a child's disability could be considered the direct consequence of parent's violating rules such as not engaging in conjugal relations during menstruation, throughout Lent or on Sundays, or, children being born outside of wedlock (Prayer 1984, 127-8; Boswell 1988, 260). Thus, the abandonment of children became a response to the concept of parental culpability.

Whilst there is little specific literature on the abandonment of disabled children to monastic communities after the twelfth century, it is reasonable to suppose that the need for care and relief of such children did not come to an end with the formal demise of oblation. The presence of such children in the care of the religious is evidenced through the skeletal remains of the physically impaired. For example, non-adult remains recovered from the Hospital of St Mary Spital, London were recorded to have cranial hypoplasia, limb and joint hyperplasia, tuberculosis, and treponematosis to name just a few and as explored in Chapter 6, non-adults with skeletal evidence of disability were recovered from the Hospital of St James.

In addition to the skeletal evidence, documentary sources confirm that many hospitals housed abandoned or orphaned children for prolonged periods of time and again the Hospital of St Mary Spital, London is a prime example of this. Originally founded for the care of the elderly, sick and infirm the hospital extended its charity to poor wayfarers, women in childbirth and their offspring (Thomas et al.

1997, 104). Furthermore, liturgical records from monasteries document the presence of children and the disabled in hospitals across the medieval world. For example, 'handicapped monks' were recorded to have lived at the Benedictine monastery in Cluny, France (Constable 2004, 348), and in 1282 the Prioress of Stratford at Bow voiced her resistance to inmates who were too young and deformed to be housed in the religious community (Cockburn, King and McDonnell 1969, 157-8). These cases show that, despite lay and ecclesiastic opinion condemning the widespread practice of oblation in early medieval England, the practice of placing children into monastic care was still prevalent into the fourteenth century. Throughout the available literature concerning the act of oblation there is no distinction made between the admittance of a healthy child and the admittance of one with health conditions or impairment.

7.5 The benefits of children to the monastic community

Not only did the housing and educating of children meet the requirements of the monastic community to offer alms to those less fortunate, but it also provides several benefits to the host community. These included economic gain from the donations made upon oblation, which could vary from material goods to monetary payment depending on the family's wealth, as well as longer-term recruitment for the monastic community.

Upon 'donation' to the monastery, parents were encouraged to make an economic contribution to the house. As outlined in the *Regula Benedicti*; '[if parents] for their soul's sake, would like to give alms to the monastery, let them make an offering'. Such offerings were usually given as a gift of land or money, however, if the family could not afford such a donation then the signing over of their child was gift enough. Thus, the monastic community's wealth increased both economically and through the number of its number of inhabitants.

There were some advantages to recruiting the young (DeJong 1996, 126); they made for superior recruits over adult *conversi* as they received adequate literacy training which meant they were immersed in religious texts and could go on to staff the *scriptorium*. Individuals who entered the monastery as adults were far less likely to have been literate to the same level as child oblates or novices. The training in literacy and the moral education they gained from life within the monastery made children raised in the religious community eminently qualified for the priesthood (DeJong 1996, 141-2). Consequently, the housing of children had many benefits for the religious community, children would have had minimal exposure to the sins of secular life and could be educated in the monastic way of life without having to break the habits formed in a life outside the monastery.

7.6 A child's position within a religious house

While the presence of children brought great benefit to the monastic community, both child novices (those educated in the monastic community) and oblates (those educated by and given over to the monastic community) are believed to have been symbolically and physically separate from the monastic communities in which they were housed and trained. This is arguably a reflection of their transient status; for the novice having not yet made their vow into the community, and for oblates, the uncertainty surrounding the permanence of the vow made on their behalf.

The consequent separation of children in the monastery from the professed community of the house dates back to the ninth century. Hildemar's commentary (c.830s-40s) notes all those below the age of fifteen years were separated into the *ordo infantum*, in which they would remain until they had sufficiently internalised the values of monastic life (DeJong 1996, 149); only then were they permitted to join the monastic community in its entirety. Furthermore, the monastic rule made under Basil of Caesarea states that children, in particular oblates, were to be brought up within a separate area of the monastery, and that they were not yet part of the wider community (DeJong 1996, 19). While it is not expected that monastic communities in the later medieval period would follow such early rules, it is plausible to consider that later practices would still be influenced by their predecessors. An account from the Hospital of Bury St Edmunds, dating to the fifteenth century, recalls the purchase of mattresses for the young who shared quarters with the sick (Rawcliffe 2002, 50). Whilst it is possible that these children were caring for the sick in return for board and lodging, it seems more likely that they were housed in the infirmary as a means to distinguish and physically distance them from the monastic community. The *ordo infantum* and separate housing represented a transitional period or environment in which a child was only partially integrated into the monastic way of life; during this time, they were still on the periphery of the religious world both physically and spiritually.

7.7 The Hospital of St James' location within the precinct of Thornton Abbey

The transient position of the non-adult community, being that they were neither part of the secular nor the religious world (discussed in section 7.3 and 7.6), is reflected in the location of the hospital standing on the interface of the monastic and lay communities. The location of the hospital is therefore a further source of evidence used to explain the hospital's use in later medieval society.

The hospital and its cemetery stand on the highest, and therefore most visible, piece of land in the Abbey complex. This area of raised land is approximately 2 metres higher than the surrounding landscape, which is on average just 5 metres above sea level (figure 7.7.1). Being granted this location in the monastic landscape, the hospital was visible to any visitors and passers-by to the Abbey and advertised the Abbey's almsgiving through the hospital. Furthermore, the hospital provided the Abbey's community with a reminder of those living in poverty and ill health. Although the Augustinian Rule allowed canons greater freedom to interact with communities outside the monastery, the hospital provided a constant reminder of, and means by which, the community could fulfil their pious obligations (Butler and Given- Wilson 1979, 45-6). The hospital's position within the Abbey's precinct also enforced a constant reminder to the hospital community of the importance of Christianity. The Abbey and its cloistral complex would have stood in plain sight of those housed within the hospitals, its dominance over the landscape was a reflection of God's omnipresence and a reminder of leading a pious and faithful existence. This was of great importance to a community of the ill and infirm due to the medieval belief that ill health was a reflection of one's soul and linked heavily to sin (Bottomley 2002, 9).

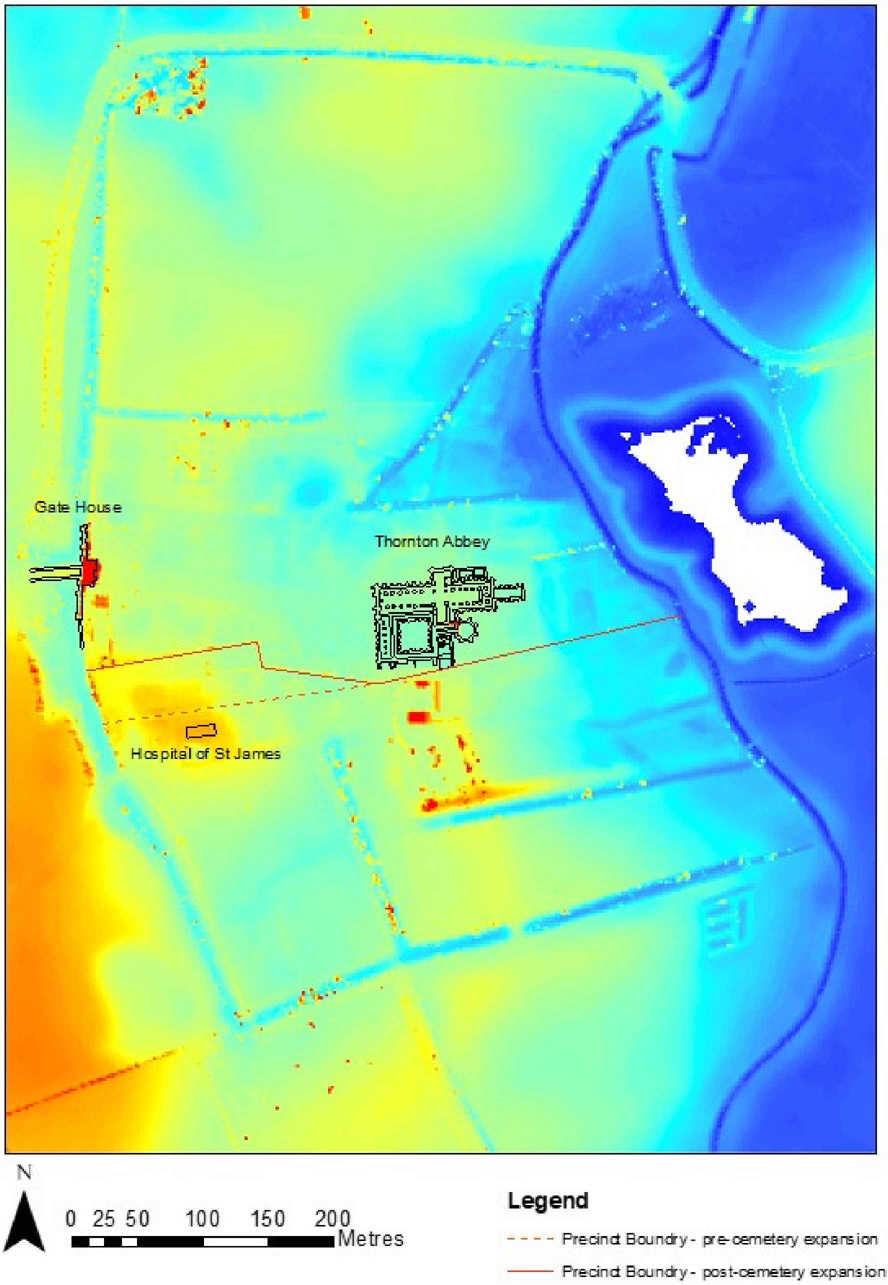

Figure 7.7.1: Lidar image of Thornton Abbey's estate topography. Note that the Hospital of St James is situated on the highest area of land within the Abbey's estate. Based on map data from the Department of Environment, Food and Rural Affairs. England: © Environment Agency copyright and/or database right 2015. All rights reserved.

Being positioned on the threshold of, but physically separated from, the inner precinct of the Abbey reflects the potentially transient position of the hospital's inmates. For example, the location can be interpreted as representative of a disabled person's position in society, whether they be non-adult or adults. Metzler (2011, 48) expressed that a person with an impairment was being neither properly healthy and well nor sick or diseased either, and thus were in a state of 'limbo' in regards to their health and abilities. Furthermore, the potential position of the non-adult inmates between both the religious and lay worlds is reflected in the hospital's location. The proximity of the hospital to the cloister would have enabled the non-adults and religious personnel of the hospital to maintain a relationship with the Abbey and facilitate the development of their spiritual affiliation with the monastic community. Furthermore, as discussed in Chapter 2, the hospital's position in the outer precinct provided both physical and spiritual protection to the cloistered community. In addition to protecting the Abbey's inhabitants from the political and economic duties of the monastery, the hospital also protected it from its social responsibilities. One way in which it did so is by removing the housing of non-adults in the house's care to a location where they would not interrupt the daily running and sanctity of the inner precinct.

Furthermore, the Abbey's role as a centre for political, economic and social activity placed the purity of the cloister in jeopardy, as the receiving of visitors including pilgrims, artisans, aristocrats, and even royalty was unavoidable. A solution to preserving the sanctity of the inner precinct from unnecessary secular pollution was careful utilisation of the outer precinct. Rather than visitors to the Abbey using the main gatehouse which fed directly into the inner precinct, the outer precinct had a separate access route (figure 2.7.1). Archaeological excavation as well has historical documentation has shown that the outer precinct contained in addition to the Hospital of St James, a stable and guest house. By facilitating amenities and activities vital to the survival, function and charitable efforts of the Abbey, the outer precinct protected the sanctity of the inner precinct. Activities in this area were presumably under the supervision of the canons but enabled them to remain separate from the primary religious function of the institution. The significance of the hospital's elevated position and its role in the outer precinct of Thornton Abbey has been further discussed in Chapter 5 in conjunction with an analysis of the hospital's population.

7.8 Summary

This chapter has provided a contextualisation of the high presence of non-adults at the Hospital of St James. The chapter introduces the position of non-adults in medieval society, drawing upon of the key concepts of scholars such as Nicholas Orme and Bennjamin Penny-Mason who were engaged in the study of medieval children and childhood. By doing so it is established that from the age of around 6 years the 'medieval child' entered a phase of transition from childhood into adulthood to which there is no one defining end point (Penny-Mason 2014, 165). At this age a child took on more responsibility and some form of either work or schooling; this could include their confirmation into the church and consequently for some the start of life within a monastic community.

This chapter goes on to explore the socio-economic status of later medieval England and considers the impact of challenging situations including population fluctuations, famine and plague faced at the time. Through this, a discussion on the provision of alms and poor relief has taken place drawing upon the works of Dyer (1989) and Boswell (1988). The relief available to parents struggling to sustain their families was offered by the religious community, more specifically the charity of monastic houses who would provide food, shelter and care to those in need including the non-adult population. An evolution in the care provided for children orphaned to religious communities following the famines and plagues of the fourteenth century is analogous with the changing nature of hospitals throughout the medieval period (as discussed in Chapter 2).

While the practice of child oblation had been abolished by the end of the twelfth century this was a significant practice in medieval society and one that could not simply come to a sudden end as the need for childcare and education continued. Therefore, this chapter explored the practice of child oblation and the motivations behind a child being given over to a monastic community for care. This exploration was made with the understanding that oblation had come to an end under that term, but a similar process may have taken place to fit the needs of the time. Within this thesis oblation is utilised as a comparison due to the fact that the population demographic at the Hospital of St James is comprised of an adult male bias accompanied by a large number of non-adults. The housing of these non-adults alongside a male population is compatible to that of monastic houses. This social contact between the non-adults and adults in a monastic house would be similar to their contact in a hospital where the ill and infirm were cared for by a community of a monastic order with child oblates.

The concept of children being placed within the hospital due to its proximity to the Abbey and the potential engagement of children in this monastic community is further explored through an examination of the location of the hospital within the outer precinct of Thornton Abbey. As discussed, the position of the hospital at the interface of the inner and outer precincts would facilitate the housing of non-adults, referred to as the *ordo infantum,* in a way analogous with the guidelines set out by Hildemar (c.830s-40s) for children who were either training for a life of monasticism or being educated within a monastery. This chapter has gone on to discuss how the hospital's location may have been seen as a reflection of the transient position of its inmates; for example those housed at the hospital for being infirm were neither ill nor healthy and anyone housed in the hospital whilst being educated in the Abbey were neither part of the religious nor the secular worlds. The hospital and its cemetery stood on the highest piece of land within the Abbey's complex, this made the hospital visible to any visitors and therefore advertised the Abbey's charitable practices, furthermore this visibility of the hospital acted as a reminder to the Abbey's community of the plight of those living in poverty and ill health. The reverse of this is that the hospitals view of the Abbey emphasised the medieval belief that any ill-health was related to the states of the soul and therefore their relationship with religion. All of which was achieved whilst maintaining a distance between the Abbey and its interaction with the secular world, which maintained the sanctity of the inner precinct.

The previous two chapters have discussed and explored the demographic profile and palaeopathologies of the hospital population. This has led to the idea that the population was linked to the monastic community at Thornton Abbey via more than just the hospital's location. The following chapter draws together the findings of this thesis and summarises how this has developed our understating of the Hospital of St James at Thornton Abbey. The chapter will go on to make suggestions for future research, regarding both the future potential for the study of late medieval hospital demographic profiles and the skeletal assemblage from the hospital.

8

Conclusions

This thesis aimed to examine the population of the Hospital of St James and did so by analysing the skeletal assemblage and compiling comparative data from contemporary hospital populations from across England. In particular, this research set out to investigate the cemetery population including the demographic composition and palaeopathological profile of the skeletal assemblage, as well as establishing an understanding of the hospital's role considering its physical location on the edge of the monastic setting of Thornton Abbey. This has been addressed through a combination of bioarchaeological analysis and interpretation of the hospital in the context of later medieval England.

This conclusion will give a brief summary of the findings of this thesis, addressing each of the original aims and drawing a conclusion of what has been discovered. This will be followed by suggestions for future research which could expand upon the research undertaken in this thesis and consider the comparison of hospitals from across Europe.

8.1 Conclusions from the analysis of the Hospital of St James

The primary aim of this thesis was to provide a broad contextualisation of the Hospital of St James at Thornton Abbey. The thesis set out to achieve this through an investigation of the hospital's cemetery population, drawing on comparisons to medieval populations from hospitals, lay and monastic communities. This approach has allowed the investigation to encompass a broad spectrum of archaeological data and knowledge that can contribute to our interpretation of the remains of the Hospitals of St James. Without the documentary records to reveal the hospital's original intended function, establishing its use was dependent on material remains.

The first step in contextualising the Hospital of St James was to undertake an overview of the institution of hospitals in medieval England, the people they housed, and the uses to which they were put. The review carried out in Chapter 2 revealed that the hospitals of medieval England had complex and variable functions. The principles upon which they were founded and the care they provided was heavily based on Christian ideals and influenced by the needs of the poor and infirm. However, it was quickly established that hospitals did not allow entry to anyone in need; strict conditions were put upon admittance such as restrictions on the housing of females and particularly those who were pregnant. Furthermore, children were often excluded from hospitals altogether. For those permitted entry into the hospitals, care could vary from one night's rest to a lifetime in the care of the hospital. This overview of the medieval hospital revealed the flexible and evolving nature which makes establishing their use exceptionally challenging.

The second aim of the thesis was to characterise the burial practices employed at the Hospital of St James. This was achieved via an examination of grave form, skeletal placement and analysis of the phases of cemetery use and as a result a picture of the hospital interaction with the dead was established. Examination of the burial practices at the Hospital of St James established that for the most part, the customs employed here are in line with that of hospital cemeteries from across medieval England. The exception to this were the coterminous burials which forms a distinct phase within the cemetery and are possibly testament to the care and burial of individuals during a time at which a spate of fatalities took place as the result of famine or disease. A further feature of exploration into burial practice was the distinction of religious and lay members of the population, after examination of grave form there is no apparent difference in burials treatment at the Hospital of St James. There was, however, difference in the graves afforded burial within the hospital's chapel. Amongst these was Richard de W'perton, whose burial within the hospital consolidates the hospital's relationship with the religious community.

Having established the burial customs of the hospital, the third aim was to compare and contrast the demographic profile of the population of the Hospital of St James. The demographic analysis revealed that the cemetery population at the Hospital of St James followed an overall attritional mortality profile. Within this profile, there were two distinct inconsistencies, the first of which was the definite bias in male adults and the second was the high number of non-adults. The population was statically compared to nine comparative hospitals, the closest comparison was St Mary Spital, London, as discussed in Chapter 5. Results of further statistical analysis proved the population of St James had a mortality and survivorship rate more comparable to medieval monastic populations then lay populations. This opposes traditional thinking that medieval hospital populations would be more reflective of lay statistics as it is lay people who the hospitals are thought to have cared for. However, the Hospital of St James does not confirm to this idea, and the analysis suggests that instead the hospital was comprised of a mixed community. This study has demonstrated that the employment of demographic analysis and comparison are vital tools in the discovery of populations with relatively little historical context. Without carrying out these statistical comparisons the population's similarity to a monastic community would not have been established and the discussions carried out in Chapter 7 surrounding the placement of children in such a community would not have been explored to the same depth.

The fourth aim was to explore the paleopathologies to investigate the ailments of inmates and to establish the type of care being provided by the hospital. This has proven to be an integral element of this thesis and was achieved through an investigation of the osteological material and through the application of Tilley's 'bioarchaeology of care' methodology (Tilley 2012). This investigation revealed a broad corpus of conditions covering disease, infection, trauma and congenital disorders. The paleopathologies were addressed under three research themes of 'health and stress markers', 'markers of activity and lifestyle' and 'medical intervention and potential for long term, palliative and skilled care'. This established that the population at the Hospital of St James had a health profile similar local communities and contemporary hospital communities. The second research theme provided evidence to support the idea that the hospital housed people from both a monastic and lay background through the skeletal markers of lifestyle. The final research theme revealed the most about the term and level of skilled care that was required of the hospital. It is evident from the conditions observed and the application of Tilley's 'bioarchaeology of care' that the inmates would have required care on both short- and long-term bases. Some ailments may have called for simple provisions of food and shelter while others would require more skilled cared such as wound treatment, rehabilitation and constant assistance. Overall, having established the range of pathologies present and the levels of care they would require it became clear that part of the hospital's role was to take care of the sick and the infirm.

The final aim was to explore the large proportion of non-adults present at the Hospital of St James. As has been established through the osteological and demographical analyses the hospital assemblage contained an unexpectedly large number of non-adults. The presence of this non-adult community would have undoubtedly influenced the hospital's use and therefore was a key consideration in the interpretation of the Hospital of St James. Having established that the non-adult population was of significance, Chapter 7 first set out to establish the position and treatment of children in medieval society, establishing that from the age of 6 a child started their transition into adulthood (Penny-Mason 2014, 165). The non-adult population at the Hospital of St James was largely dominated by those aged 6-11 years at death. The demographic profile has therefore demonstrated that this hospital allocated its resources to the care and housing of non-adults past their infancy. The care of children, and especially those aged 6-11 years, by the hospital has parallels to the earlier practice of child oblation in which a monastic community would take on the responsibility of raising surrendered children to become part of the monastic community themselves. As discussed in Chapter 7, the hospital's removal from the inner precinct facilitated the segregation of children from the true monastic community as was outlined by Hildemar's *Ordo Infantum* (DeJong 1996, 149). This chapter also explores that one potential factor in children being given over to monasteries was their being affected by health issues such as learning disabilities and physical impairments. The hospital setting, therefore, provided an environment in which such children could be provided with the daily care and assistance needed, whilst providing training in the monastic way of life which was arguably the most secure and practical vocation for people with disabilities in the later medieval period.

The location of the hospital further supports the function of the hospital as a quasi-monastic establishment. Being situated within the Abbey's precinct, the hospital provided a prime location for those living in neither the religious or secular world. For example, as discussed in Chapter 2, members of the monastic community who were no longer capable of carrying out the daily routine have been recorded to have relocated to life in hospitals which enabled them to maintain their religious vocation while lessening the austereness of their daily functions.

Overall, the present study has brought together several lines of evidence and methods of analysis to further our understanding of the Hospital of St James. The role of the medieval hospital is greatly complex and varies from institution to institution, which makes establishing the use of a hospital even more complex especially when there are no written documents to allude to the hospital's use as is the case at the Hospital of St James. The hospital's cemetery population has proven to be the most valuable element for investigation; the demographic profile of the hospital has revealed its affiliation with a religious community and a unique function of the hospital in housing non-adults. The analysis of paleopathologies has successfully been utilised to determine that the hospital provided forms of short- and long-term palliative care to its inmates. The hospital provides an excellent example of an institution of wider monasticism which cannot be categorised into one form of institution. The role of the hospital in society and the function of individual hospitals were evidently far too complex to be ascribed to a strict system of classification.

8.2 Recommendations for further research

The potential for future research following the outcomes of this thesis are numerous, and beyond the scope of this current thesis. They are categorised here into two broad areas: the potential for further study into the demographic profile of the late medieval hospital and the potential for additional analysis of the skeletal assemblage.

8.2.1 Future potential for the study of late medieval hospital demographic profiles

The potential for the further study of the demography of medieval hospitals lies in the expansion of geographical scope. The scope of this study was necessarily limited to the exploration of English hospitals as this provided the most meaningful and comprehensive comparative investigation that was possible within the timescale. Having established and demonstrated a statistical method by which the investigation of hospital demographic profiles should be explored in this thesis, it is now possible to expand the geographic scope of the study to include European assemblages, which was not feasible in the time scale of this research project.

With regards to the Hospital of St James, this expansion would have the primary aim of identifying hospitals with comparable population demographics. However, a broader stance would look to examine the demographic profile of as many hospitals as possible for which statistical comparisons can be made. Programmes of hospital establishment in Christian society throughout Europe are based on similar systems of charitable efforts as seen in England. Furthermore, the results of this investigation contribute exploration of the housing of children in the hospitals of medieval society.

The expansion of the study to include European sources regarding the practice of oblation is far greater than that of the English sources alone.

8.2.2 The future potential of the skeletal assemblage from the Hospital of St James

The skeletal assemblage from the Hospital of St James has enormous potential for future research, far exceeding the scope of this project. This research project has looked extensively at the demography and pathologies of the population and applied these to an interpretation of the social structure of the hospital establishment. However, much more potential lies in the scientific investigation of the skeletal remains.

Firstly, establishing the biological sex of non-adult skeletal remains was not attempted in this research project due to the problems of assessing sex from prepubescent skeletal morphology, as discussed in Chapter 4. However, the Hospital of St James was interpreted as an institute for a dominant male adult population, therefore it would be intriguing to determine whether the non-adult population followed the same bias towards males or whether the restriction of biological sex was not inclusive of non-adults. Considering the large sample of non-adults with permanent dentition within the assemblage it would be possible to apply methods of discriminant function analysis based on dimensions of tooth crowns (Aris *et al.* 2018). Alternatively, aDNA analysis looking for the presence/absence of the Y chromosome, to determine biological sex could be carried out providing aDNA has survived the burial environment (Brown 2000, Smith *et al.* 2001; Buckberry 2018, 66). Although costly, this method of sex determination is far more reliable than the morphological analysis of biological sex in non-adults which is subject to inter- and intraobserver error as well as population variation and the effects of environments factors on morphological development (Buckberry 2018, 66). Establishing the biological sex of the non-adult population enables discussions regarding the interaction of the (quasi-)monastic population with the non-adults, leading further into an understanding of the role of non-adults in the hospital's community. Having a fuller picture of the non-adult population would also allow greater discussion of the potential for a community of child novices being housed at the Hospital of St James and their future associations with Thornton Abbey.

Second, the application of aDNA analysis to the cemetery assemblage has the potential to identify congenital diseases. This would enable the question of whether the Hospital of St James offered long-term care to individuals who experienced pathological changes from birth. There is some suggestion of this with the skeletal impairment of the individual with scaphocephaly. Furthermore, aDNA can be applied to identify the presence of infectious diseases among the skeletal population. Such analysis has already been carried out on a sample of the mass interment which successfully identified the presence of *Yersinia pestis* (Willmott *et al.* 2020). In the case of the hospital, it would be interesting to test for infectious diseases such as tuberculosis, leprosy and syphilis. Identification of such diseases among the population has the potential to greatly expand our understanding of the population's general health and the reasons why they may have been inmates of the hospital. However, such analysis is very costly and due to the lack of osteological evidence of such diseases within the population targeted analysis could not be undertaken.

Thirdly, application of isotope analysis has the potential to investigate the origins of the St James population. Considering the rural location of the Hospital of St James, it is unclear where the inmates of the hospital originated from and why such a large cemetery was required when local church cemeteries were available for burial requirements. Identifying the geographic origins of both the adult and non-adult population has the potential to reveal if certain segments of the cemetery population were originating from a specific geographic zone and how far afield hospital inmates originated from. From this, it may be possible to gain an understanding of why these people were entering the Hospital of St James.

8.3 Concluding remarks

In conclusion, this investigation of an archaeological assemblage of skeletal remains demonstrates that there is a lot that still remains unknown about hospital practices in late medieval England. This research has uncovered a unique demographic profile of a medieval hospital population through extensive statistical analysis which suggests our current framework for classifying medieval hospitals is too restrictive to accommodate the complexity of such institutions. In addition to contributing to our understanding of the late medieval hospital, this research has further established the relationship of the religious community and the hospital setting via the housing of children and the location of the hospital on the border of the inner monastic precinct. To understand the role of the Hospital of St James, it was assessed in the wider context of later medieval society, the establishment and function of medieval hospitals and the position of children in the unique communities of hospitals. Whilst there are many opportunities to further this research, this thesis has clearly demonstrated the value of the study of cemetery populations in broadening our understanding of the hospital's role in medieval society.

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