Investigating dentists' decision making and patients' preferences in the prevention of dental caries

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The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others.

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Abstract

Aim: The aim of this study was to examine the decision making of dentists and patients in the prevention of dental caries in the UK and ROI.

Contribution: This was the first study to investigate such a theme using a DCE approach. A framework analysis was applied with qualitative data to develop two DCE surveys. Policy suggestions for increasing prevention were also offered from dentist, patient and dentist-patient relationship perspectives.

Methods: A mix of qualitative methods were used in an iterative process to develop separate DCE surveys for dentists and patients. Finally, 143 dentists were recruited through snowball sampling and 353 members of the general public were recruited through an online panels company and Facebook. Mixed logit models were used to measure preferences from their survey responses. Latent class models were applied to explore preference heterogeneity.

Results: The main model in the dentists' study highlighted the following points. 1. Dentists placed great importance on preventive advice for patients with an adverse dental condition. 2. They disliked providing restorative treatment to a patient with a mild caries condition. 3. They felt obliged not only to treat the lesion by intervention but also to offer a toolkit of advice which would be helpful to the patient to prevent future caries. 4. They chose treatment plans containing the least possible intervention in cases of mild caries condition, preferring to deliver more preventive advice instead of preventive and restorative care. 5. They had stronger preferences for delivering preventive advice to younger patients. Latent class modelling showed that female, part-time dentists, those with more years since graduation, individuals working in small, public or mixed private-public practices, those more frequently delivering preventive care, and dentists seeing a higher share of patients exempted from payment had a higher tendency towards preventive care. The main model in the patients' study underlined the following points. 1. Patients placed great importance on preventive treatment. 2. They preferred oral hygiene advice over dietary advice. 3. They preferred to see the dentist as opposed to a different dental professional and to avoid longer travel and waiting times. Latent class modelling demonstrated that older, unemployed, female patients, those with higher dental attendance, no private insurance, better education and with a less healthy oral profile were more likely to prefer preventive care.

Discussion: The use of a mix of qualitative methods assisted in the development of the two DCE surveys. Dentists preferred to deliver restorative care as well as preventive treatment and advice for patients with an adverse dental condition. They tended to offer more preventive advice but less restorative and preventive care for patients with a mild caries condition. Patients preferred preventive

treatment and oral hygiene advice while they were less inclined towards dietary advice. The welfare of patients was not worsened off to a great extent by whether a dentist or a different dental professional including a dental hygienist, therapist or nurse deliver preventive care. Checking for preference heterogeneity in both groups revealed that certain sociodemographic characteristics of dentists and patients were associated with a more prevention oriented behaviour.

Recommendations: DCEs using patient vignettes were successfully used to measure preferences of dental professionals in the delivery of care. DCEs were also a feasible way to evaluate the preferences of patients towards the prevention of dental caries in a way which had not been previously reported. A framework analysis of data collected in the qualitative phase of a DCE study is proposed to deal with problems in a targeted manner and improve understanding of the DCE survey. Specific guidelines could be designed prioritising the need of preventive treatment for all groups of patients. Policies should target at remunerating dentists more properly for preventive treatment so that they could be motivated to offer more prevention.

Implications of results: Preventive treatment could be assigned to a different dental professional including a dental hygienist, therapist or nurse without worsening off to a great extent the welfare of patients. Dentists could be trained to provide more information on the benefits of dietary advice as patients were less likely to prefer such advice. Focus of educational initiatives to enhance prevention should be placed on certain segments of the population instead of entire populations to permit a more efficient use of resources in preventive care.

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ADA	American Dental Association	23
AIC	Akaike Information Criterion	93
ART	Atraumatic Restorative Treatment	63
BIC	Bayesian Information Criterion	143
BWS	Best-Worst Scaling	40
CA	Conjoint Analysis	40
MNL(s)	Multinomial Logit Model(s)	63
DALYs	Disability Adjusted Life Years	16
DCE(s)	Discrete Choice Experiment(s)	36
D-DCE1	Dentist DCE First Draft	85
D-DCE2	Dentist DCE Second Draft	85
D-DCE3	Dentist DCE Third Draft	86
D-DCE-Final	Final Dentist DCE	83
DES	Dentist Exploratory Survey	84
DMFT	Decayed, Missing and Filled Teeth	18
DT	Decision Tree	43
EAA(s)	Endogenous Attribute Attendance	63
HRQoL	Health Related Quality of Life	18
ICDAS	International Caries Detection and Assessment System	86
LC	Latent Class	63
MLHS	Modified Latin Hypercube Sampling	93
MM	Markov Model	43
MXL(s)	Mixed Logit Model(s)	63
OHRQoL	Oral Health Related Quality of Life	18
P-DCE1	Patient DCE First Draft	98
P-DCE2	Patient DCE Second Draft	99
P-DCE3	Patient DCE Third Draft	101
P-DCE-Final	Final Patient DCE	96
PES	Patient Exploratory Survey	97
ROI	Republic of Ireland	15
RUT	Random Utility Theory	68
SG	Standard Gamble	39
TTO	Time Trade-Off	39
UK	United Kingdom	15
VAS	Visual Analogue Scale	39
WTP	Willingness to Pay	39
YLDs	Years Lived with Disability	16

1. Introduction

This chapter is divided in four parts. The first section describes the purpose of the Advocate project as part of which this study was implemented. The second part documents the societal and economic burden of dental caries as well as trends and implications from the progress of this oral condition. The next part deals with the definition of dental caries and description of oral health services for preventing the disease, while the fourth section explores the factors impacting dentists' and patients' preferences for dental care. The sixth section presents the features of oral health care systems in the countries under investigation, i.e. UK, United Kingdom and ROI, Republic of Ireland. Final section illustrates the research questions of this study and what are the implications of addressing these questions in behavioural and policy domains.

1.1 Advocate project

ADVOCATE (Added Value for Oral Care) was a project launched in 2015 and funded by the European Commission's Horizon 2020 program, aiming to build strategies for a system transition towards patient centred and prevention oriented oral health within health care systems (Leggett et al., 2017). The system should optimize the delivery of oral health to the population by prompting a transition to more preventive care and retaining an efficient balance between the restorative and preventive approaches in dental and oral health care. ADVOCATE was a partnership among six European Union member states, which included collaboration among universities, private insurance companies and state funded health care providers in the UK, ROI, the Netherlands, Denmark, Germany Hungary, and Aridhia, a biomedical informatics company based in Scotland (Leggett et al., 2017). Main objectives of the project consisted of an in-depth evaluation of oral health care systems in Europe to develop best system designs for oral disease prevention, identification of a set of measures to provide information on oral care delivery and oral health outcomes, appraisal of a feedback approach in dental practice which targeted to facilitate a transition toward preventive oral care delivery and economic evaluation of strategies to promote preventive oral health care and design of policy recommendations for oral health care systems (Leggett et al., 2017).

The project targeted on developing strategies that were based on extrinsic and intrinsic motivation of general dental practitioners (GDPs) to follow a more preventive oral health care approach. Extrinsic motivation relied on financial rewards and how methods of remuneration affected the delivery of high quality care and effective and efficient disease prevention (Birch, Stephen and Listl, 2015). Intrinsic motivation to lead clinical practice toward more prevention was induced by the provision of regular structured feedback to GDPs on the type and range of care that they delivered to the patients, relative to their peers (DePasque and Tricomi, 2015). This feedback targeted to increase awareness of variation in dental practice among GDPs and set a basis to stimulate the discussion on quality of care

and agreement on best practices in prevention. Investigation of dentists' and patients' preferences in the prevention of dental caries involved a part of this wider project to identify the factors that influenced the decision making of both stakeholder groups for prevention, evaluate them and initiate the discussion about the implications of the findings on policy recommendations to facilitate the transition towards a more prevention oriented oral health care system.

1.2 Global burden of untreated dental caries and other dental diseases

This part considers the global burden of dental caries and other oral diseases in a multidimensional approach touching upon societal and economic aspects.

Before presentation of findings though, it is necessary to define some outcome measures mentioned later which have been used to determine the impact of oral diseases on population's quality of life, involving years lived with disability (YLDs) and disability adjusted life years (DALYs). YLDs are calculated as prevalence of each dental condition, such as dental caries in each age group, sex, geography and year, multiplied by a corresponding disability weight derived usually from population surveys. The empirical evidence of the weights is thus stemmed from judgments of the general public about health severity rather than researchers themselves or health professionals. A Global Burden of Disease study defines disability linked with untreated symptomatic caries as "a toothache, which causes some difficulty eating. Provided that death as a direct outcome of oral diseases is rare, no mortality is usually assumed. DALY estimates which are computed as the sum of years of life lost due to the disease in addition to YLDs, are therefore based on YLDs only, in situations of oral conditions including dental caries. One DALY could be defined as a year of "healthy life" lost due to either premature mortality or disability and the sum of DALYs as the gap between the population's present health status and an ideal situation where the entire population live to an advanced age free of disease. (Murray et al., 2015).

1.2.1 Societal impact of untreated dental caries and other oral diseases

According to the Global Burden of Disease (GBD) 2010 study, prepared to generate estimates of the burden of 291 diseases and injuries in 1990, 2005 and 2010, oral conditions affected 3.9 billion people, with untreated caries in permanent teeth being the most prevalent condition evaluated for the entire GBD 2010 study (Marcenes et al., 2013). Global prevalence of dental caries was 35% for all ages combined, while oral conditions overall accounted for 15 million DALYs worldwide, equalling to an average health loss of 224 years per 100,000 population (Marcenes et al., 2013; Listl et al., 2015; Richards, D., 2013). DALYs tied to oral conditions raised by 20.8% between 1990 and 2010, primarily due to population growth and ageing (Marcenes et al., 2013). The observed increase in DALYs between 1990 and 2010 by 38.1 % due to untreated caries in permanent teeth was mainly attributed to population growth which was responsible for 33.9% of that increase assigning only 0.6 % of the rise to population aging. A similar Global Burden of Disease study conducted in 2015 illustrated that the most

prevalent condition globally remained once again untreated caries in permanent teeth with an age standardized prevalence of 34.1% affecting 2.5 billion people on average worldwide (Vos et al., 2016; Kassebaum et al., 2017). DALYs due to oral conditions overall increased by 64% between 1990 and 2015 to 16.9 million because of population growth and ageing offsetting decreases due to changes in age specific prevalence (Kassebaum et al., 2017s {Kassebaum, 2017 #9).

1.2.2 Direct and indirect costs of dental caries and other oral disease categories

A study building on the findings of the Global Burden of Disease 2015 study (Kassebaum et al., 2017), estimated that the direct expenditures due to dental diseases in 2015 amounted to approximately 14.3 billion dollars for the UK and 1.3 billion dollars for ROI or 220.6 and 293.7 dollars per capita respectively (Righolt et al., 2018). Direct costs were defined as overall expenditures for dental health care including public and private expenditures. Indirect costs were also approximated as productivity losses due to the three most common oral conditions, i.e. untreated caries in permanent teeth, periodontitis and tooth loss. Productivity losses due to caries in the UK were measured to be nearly 1.19 billion dollars representing a proportion of 14.2% of total productivity losses for all the three oral conditions which amounted to 8.4 billion dollars (Righolt et al., 2018). The same figure in Ireland accounted for 98 million dollars or 12.5% of total productivity losses attributed to caries, periodontitis and tooth loss together. Indirect costs were calculated by multiplying country specific GDP per capita values with DALYs estimates for untreated caries, periodontitis and tooth loss from the 2015 GBD study (Righolt et al., 2018). Untreated caries was found to be accountable for 12% of global productivity losses due to dental diseases (Righolt et al., 2018). Indirect costs due to dental diseases increased by 21% between 2010 and 2015 taking inflation into account (Listl et al., 2015), a fact that could be assigned to a number factors such as increases in worldwide productivity and the global population growth. Direct costs of dental care also showed an upward trend over the five years examining period (Listl et al., 2015), due to a variety of reasons including the prevalence and incidence of dental diseases, new treatment technologies, higher market prices, accuracy of cost estimates and the different types of dental care management. For example, dental reimbursement might have evolved less closely linked to monitoring of initial/untreated lesions but mostly focused on restorative treatment of even early lesions. Such studies demonstrating higher direct and indirect costs due to dental diseases over time led to the secure argument that oral prevention should be enhanced to eliminate the oral disease burden and reduce its economic impact on the population freeing up more resources that could be used elsewhere in the economy.

1.2.3 Impact of dental caries on quality of life

Dental caries is a multifactorial disease involving both biological and behavioural factors, such as diseases and medications, hypo salivation and impaired saliva defence functions, bacterial dysbiosis,

oral muscle activity, educational level, oral hygiene, smoking and socioeconomic status. Quality of life refers to an individual's perception of his or her position in life in the context of the culture and the values systems in which they lived and in relation to their goals, expectations, standards and concerns (Batista et al., 2014). Two measures of quality of life have been mainly reported across studies in examining the relationship between dental caries and life quality namely OHRQoL, Oral Health Related Quality of Life and HRQoL, health related quality of life (Baiju et al., 2017). It is unclear whether both instruments represented independent entities and it could be assumed that poor dental status could have a causal impact on OHRQoL and not vice versa, while a two way relationship may lie behind the association of dental caries and HRQoL, i.e. poor dental health may compromise life quality but non dental factors for HRQoL may also be linked with an increased risk of developing caries (Baiju et al., 2017). The impact of dental caries on OHRQoL and HRQoL of adults has been documented in many studies, with worse scores in those with poorer dental status (Batista et al., 2014; Broder et al., 2000; Santos et al., 2013; Åkesson et al., 2016). The traditional global index applied to measure caries in epidemiological studies, is DMFT (Decayed, Missing and Filled Teeth). This is a numerical count of affected teeth per individual gathered at either the tooth (DMFT) or the tooth surface level (DMFS)(Pitts et al., 2017). The count of DMFT for an individual or group declares their caries experience, i.e. as occurred by summing up the total of both past and current caries. A systematic review revealed a negative association between dental caries and HRQoL with individuals experiencing dental caries and higher DMFT scores showing worse quality of life in a variety of domains such as mobility, social relationships, usual activity, pain and discomfort (Haag et al., 2017). Such studies pointed to the fact that dental caries prevention should be at forefront of dental public health policy agendas to improve people's well-being as measured by quality of life indicators.

1.2.4 Dental caries as a lifelong and cumulative oral disease

Research has indicated that dental caries is a progressive and cumulative disease that initiates from adulthood even with exposure to fluoride through self-care products and water (Broadbent et al., 2008; Bernabé and Sheiham, 2014). Results from the Dunedin Longitudinal study revealed that children with <3 decayed, missing or filled tooth surfaces at age of 12 years developed 15 decayed, missing or filled tooth surfaces by the age of 32 years (Broadbent et al., 2008) and evidence from the United States demonstrated that on average one new carious surface occured per person per year in older adults (Griffin, S. et al., 2005). Moreover when researchers examined age, period and cohort trends in caries experience in the United States, Wales, England, Japan and Sweden, it was emphasized that although there happened a decline in dental caries experience over recent years, dental caries increased with age and that the most dental caries developed in adults (Bernabé and Sheiham, 2014). Hence it would be inappropriate to assume that few dental caries at a younger age was evidence of

good oral health in population throughout the life course. In other words, dental caries is a lifelong chronic and cumulative disease in which dental caries levels could be predicted through trend lines and tracked when environmental conditions remain relatively stable without any effective interventions (Bernabé and Sheiham, 2014; Sheiham, A and Sabbah, 2010). Researchers also stretched out the misdirected strategies of traditional dentistry which mainly focused only on children and fluoride use ignoring the evidence that despite wide scale availability of fluoride in toothpaste and water, caries rates increased steadily year by year as people aged, rendering the condition as a major burden in older ages (Slade et al., 2013). Hence protection of oral health into the older age should be the aim of oral health care professionals and policy makers especially provided that poor oral health in later life has been shown to negatively affect quality of life and be related to malnutrition and hospitalization (Sloane et al., 2013; Kruger and Tennant, 2016).

1.3 Dental caries and its prevention

Development of dental caries involves interactions between the tooth structure, the microbial biofilm formed on the tooth surface and sugars, as well as salivary and genetic factors (Pitts et al., 2017). The caries process development is dynamic; involves rapidly changing periods of tooth demineralization and remineralization, which if net demineralization happens over sufficient time, leads to the initiation of specific caries lesions at certain anatomical predilection sites on the teeth (Pitts et al., 2017). Protective factors assist remineralization and lesion arrest, while pathological factors trigger dental caries initiation and disease progression. The daily use of fluoride toothpaste was regarded by many authorities as the primary reason for the overall reduction of caries worldwide over recent decades. Research has shown that mean DMFT scores reduced in different countries between the decades of 70s -80s and 90s (Whelton, 2004). Reductions in prevalence rates of dentine carious lesions and DMFT scores worldwide were also noted between the decades of 90s and 00s (Frencken et al., 2017).

Traditionally, low caries prevalence has been noted in the developing countries, while the prevalence was higher in developed countries. This geographical pattern has become more complicated due to the speed of economic development and abrupt amendments in habits and diet in several countries. Even though there might have been sex or ethnic differences, they were less influential compared to contributors such as sugar consumption, lifestyle and economic differences.

The mechanisms and aetiology underlying the development of dental caries are increasingly well comprehended. These are best determined firstly from hard tissue associated factors, i.e. when the disease impacts the calcified dental tissues, and secondly from the microbiology or biofilm related aspects as drivers of the caries process if homeostatic imbalance is retained. However, due to the multilateral nature of the disease process, the factors are not unrelated. It should be emphasized though that caries would not occur in the absence of pathogenic dental biofilm and regular exposure to dietary carbohydrates, mainly free sugars (Moynihan, PJ and Kelly, 2014; Sheiham, Aubrey and James, 2015), and hence caries should be defined as a dietary-microbial disease (Zero et al., 2009). A contemporary framework of caries also involved consideration of how behavioural, social and psychological aspects as well as biological factors were engaged (Reisine and Litt, 1993; Fejerskov, 1997; Selwitz et al., 2007). In general, dental caries could be determined as a complex biofilm mediated disease that could be mostly assigned to behaviours including frequent ingestion of fermentable carbohydrates encompassing sugars such as glucose, sucrose, fructose and maltose, and poor oral hygiene in conjunction with insufficient fluoride exposure.

Preventing dental caries encompass a wide variety of care options which include those things done at home by patients in relation to the use of fluorides, dental hygiene, and diet, and those offered by dental professionals in terms of either preventive advice for patients to follow at home or preventive treatments conducted in the dental clinic.

Preventive advice relates to anything that helps to halt, slow or avoid the initiation of dental caries. Advice therefore may be offered about things that may protect the teeth e.g. removal of the biofilm through toothbrushing or interdental cleaning, or home use of fluoride or other preventive therapies within toothpastes or rinses to strengthen teeth against acid attack. Additionally, advice may include information about the avoidance or restriction of dietary sugars. Wider preventive advice for oral health maintenance may also include information on smoking and alcohol intake.

Preventive treatments offered in the dental clinic for caries could be considered to include application of topical fluoride; sealing of vulnerable tooth-surfaces and professional removal of calculus/plaque/staining. Not all of these are commonly offered to adult patients (e.g. fissure sealants) and professional tooth-cleaning has limited evidence of effectiveness on improving oral health (Singla et al., 2019)

Preventive advice and preventive treatments are offered either by a dentist or by another dental professional within the dental practice such as a hygienist or therapist. Below follows a detailed description of the main types of preventive treatment and advice used in the dental practice for prevention of dental caries.

1.3.1 Oral hygiene advice

Research demonstrated the critical role that tooth brushing and flossing exerted on controlling biofilm formation which constituted a main factor in caries initiation and progression. The evidence however advocating tooth brushing and flossing alone as a means for preventing dental caries was weak and contradictory (Hujoel, P. et al., 2006; Rozier, 2001). The benefit of tooth brushing could only be linked with the use of fluoride toothpaste at concentrations 1000 ppm F and higher (Walsh et al., 2010). The application of antimicrobial agents in the form of gels, mouth rinses and varnishes were not found associated with caries reduction effects with the one exception of chlorhexidine/thymol varnish every three months to diminish the incidence of root caries in adults (Rethman et al., 2011).

A systematic review of the literature showed a significant effect of oral hygiene education interventions in the reduction of mean plaque levels in schoolchildren(Stein et al., 2018). Plaque formation involved a main factor of caries. Interventions included oral health education activities: activities with lectures, albums, slides, leaflets, counselling, games, drawings, theatre, dieting guidance; oral health instruction referred to additional delivery of information concerning

toothbrushing methods and toothbrushing demonstration. Supervised daily toothbrushing using fluoride toothpaste was also linked to an improved caries status. Although some evidence was conflicting on the effectiveness of personal oral hygiene on the reduction of dental caries(Hujoel, P.P. et al., 2018), the mechanical removal of the biofilm from tooth surfaces with toothbrushes or interproximal cleaning devices is believed to prevent dental caries. Hence oral hygiene advice should consist an integral part of preventive care for dental caries.

1.3.2 Dietary advice

A recent systematic review showed that caries was much less likely to happen in the absence of dietary free sugar intake above the margin of 5% of energy intake (Moynihan, PJ and Kelly, 2014). This margin was accepted by the WHO guidelines (Liu et al., 2012). Below this margin individuals were of very low risk of developing caries. Despite the fact that literature indicated a positive outcome of dietary education interventions in reduced sugary beverages consumption, declined dental caries and lower DMFT scores, there was still limited evidence that one to one dietary interventions to lower sugar intake in a dental setting were effective (Harris et al., 2012). Nonetheless as it was underlined, controlling sugar consumption at the individual patient level consisted an important and justifiable part of caries prevention. Sugar consumption should be appraised in the dental chair and patients advised to diminish the frequency of sugar exposures in meals and to shift sugar containing foods and beverages with less cariogenic alternatives.

The importance was stretched that dental professionals should receive appropriate nutrition education through an updated dental curriculum encompassing the evidence based impact of dietary sugary on both general and dental health, information of current dietary guidelines on dental health, an understanding of food labelling and adequate knowledge in behavioural change theories to suggest dietary modification in individuals treated in dental practice (Moynihan, Paula et al., 2018). An improved nutrition education of dental professionals would provide dental teams with the skills and confidence to support their patients by recommending general healthier eating advice, involving how to limit free sugars intake (Moynihan, Paula et al., 2018). Hence a careful assessment of patients' dietary habits was recommended to investigate dietary practises and allow for an adaptation and optimisation of advice (Watt, R. et al., 2003). Guidance suggested the use of diet diaries for diet assessment in the dental practice (Dentistry, 2009). The process typically involved asking the patients to keep the diary for three consecutive days including at least one weekend day. They were asked to report type, amount and frequency of dietary intakes as well as timing of bedtime. This information included a concurrent account of dietary intakes as a common ground for discussions between dentists and patients and the identification of an appropriate diet plan (Watt, R. et al., 2003).

1.3.3 Fluoride

Fluoride in a broad variety of forms and delivery systems was shown to prevent dental caries. Community water fluoridation was the most cost effective public health means of preventing caries and has been espoused by many countries worldwide. However such a preventive measure may contradict with the theory of free choice. In addition its use in many parts of the world was restricted by infrastructural and political barriers. Fluoride toothpaste was the cornerstone of primary prevention and was the most widely accepted form of fluoride delivery globally for all stages of life. The effectiveness of fluoride dentifrices was reported in several clinical trials and systematic quantitative evaluations (Walsh et al., 2010; Twetman et al., 2003). The preventive effect of fluoride toothpaste was demonstrated to rise significantly with higher fluoride concentrations.

For individuals at higher risk of developing caries, fluoride mouth rinses were suggested in addition to fluoride toothpaste. Cochrane systematic reviews noticed that supervised use of fluoride mouth rinse by children was related with a clear decline in caries increment (Marinho, V.C. et al., 2016) and could also restrict dental caries irrelevant of exposure to water fluoridation (Marinho, V.C. et al., 2003b). There was a low amount of evidence of an anti-caries benefit for home use prescribed 5000ppm fluoride gel or paste use twice daily (Weyant et al., 2013). The ADA, i.e., American Dental Association, expert panel suggested their application for individuals at raised risk of developing caries aged 6 years and older and for individuals with root caries and in addition proposed the home application of high concentration fluoride mouth rinses at least weakly in 6-18 year olds contingent upon favourable evidence for both coronal and root caries in those older than 18 years based on experts' opinion (Weyant et al., 2013).

There was a mediocre level of evidence to advocate professionally applied topical fluoride therapies in higher risk subjects. Professional delivery of fluoride gels has been linked with an important decline in caries of 21% as measured by DMFS (Marinho, V.J.E.A.o.P.D., 2009). Use of fluoride varnishes two to four times a year in permanent teeth was bound with a significant reduction in caries through DMFS calculations on average by 43% (Marinho, V.C. et al., 2003a).

1.3.4 Dental sealants

Application of dental sealants for blocking the initiation and progression of dental caries on occlusal surfaces of permanent molars was supported by evidence in both clinical and school settings (Truman et al., 2002; Ahovuo‐Saloranta et al., 2016; Beauchamp et al., 2008). Provided their proven effectiveness, dental sealants constitutes one of the most underutilised preventive measures globally. Worries that a tooth with a partially lost sealant may lie at higher caries risk than unsealed teeth seemed to be ungrounded. In settings where caries prevalence is low and other means of prevention

arise effective, justification of sealants may be restricted to secondary prevention, while in environments where caries prevalence stays high or is surging, the application of sealants for primary prevention is still recommended.

1.4 Factors impacting preferences of dentists and patients for dental care

An investigation of the factors to engagement with dental care activities faced by both dentists and patients follows in this section.

1.4.1 Factors impacting preferences of dentists and dental care professionals for dental care

Despite the available evidence and guidelines on the effectiveness of interventions delivered in primary dental care, provision of preventive care was restricted (Spallek et al., 2010; Hopper et al., 2011). This fact was enhanced by studies which cited a number of barriers encompassing clinician associated factors such as dentist's views and attitudes, patient contributors including patient compliance and motivation, as well as organisational elements of health services covering lack of time and remuneration (Warnakulasuriya and Johnson, 1999; Skegg, 1999; Johnson, N., 2004; Stacey et al., 2006; Edwards, D. et al., 2006; Witton and Moles, 2013).

Studies exploring the reasons of this effect and assessing the views and attitudes of dental professionals in primary care settings were limited. Interviews with dental practice principals in Yorkshire on providing prevention in general dental services demonstrated a variety of barriers comprising of lack of financial remuneration, and underdeveloped professional skills (Dyer and Robinson, 2006). A separate study investigating which factors impacted the delivery of preventive care among private dentists in Australia, revealed that leadership was an important factor. The authors recommended that leadership permitted the allocation of time and resources towards general prevention, in conjunction with encouraging peer support and the generation of peer support networks (Sbaraini, 2012).

In studies focusing on factors restricting the provision of smoking cessation or alcohol advice, general dental practitioners reported lack of time and support from the wider professional team, insufficient training and lack of confidence or hesitation and reluctance to deliver alcohol advice and tobacco cessation support to their patients (McAuley et al., 2011; Lala et al., 2017; Csikar et al., 2015). Moreover, dentists were concerned about disturbing the dentist patient rapport (Macpherson et al., 2003). Authors conducting focus groups with GDPs practicing in south east England to investigate their role in smoking cessation underlined a range of other barriers involving a fatalistic perception towards smoking cessation and attitudinal patient opposition (Watt, R.G. et al., 2004).

Four focus groups carried out with dentists and dental care professionals, including dental nurses, working in NHS dental practices in north central London, explored the barriers for implementation of dental prevention (Yusuf et al., 2014). A following thematic analysis revealed distinct common patterns and links among the focus groups in relation to structural, professional and patient associated

factors exerting important influence on prevention provision in primary dental care settings. Similar findings on the hindrances for delivery of prevention by dental teams were supported by a large body of relevant studies (Witton and Moles, 2013; DeBate and Tedesco, 2006; Tomlinson and Treasure, 2006; Splieth et al., 2009).

Focus group sessions with a convenience sample of dentists and dental care professionals from dental practices in north central London demonstrated that structural components involved organisational issues with respect to lack of financial rewards, NHS bureaucracy, limited training and resources as well as a general lack of trust in the current dental system. Financial barriers were linked in particular to lack of financial incentives for prevention under the current NHS dental contract and its failure to recognize the significance of prevention. Lack of time and suitable space or facilities, concerns about excessive paperwork, restricted integration with wider NHS, lack of training on prevention, influences of other sectors, such as food manufacturers, advertising and food labelling and a limited role of dentists in clinical decision making due to authorities like PCT interfering with patient care were also classified into the structural barriers for prevention category (Yusuf et al., 2014). Clinician related factors comprised of ethical and professional obligations of dentists to provide preventive care and the guilt resulting from a constant conflict between satisfying this sense of responsibility and running a business. Lack of time and monetary incentives as well as the attitude of participants seemed to strongly affect the delivery of preventive advice to their patients among dentists and dental care professionals in England within the same class of factors (Yusuf et al., 2014). With regards to attributes of patient motivation and compliance, dentists expressed fatalistic views and usually perceived patients as being in control of and having their own understanding of their oral health. Hence dentists, believing they had limited control over their patients' behaviour, ultimately considered patients as responsible for practicing healthier behaviours, assigning a high priority to patient compliance and motivation as barriers to applying prevention. Lack of patient understanding and knowledge, language and communication problems as well as cultural differences also fell into the patient related prevention barriers group (Yusuf et al., 2014).

Research indicated the absence of additional dental care professionals from dental practices, such as dental therapists and dental hygienists, as an additional restrictive factor to the supply of preventive care, revealing that such practices presented a less prevention focused approach to oral health care provision requiring the dentist to perform all care instead of the most advanced treatments (Eaton et al., 2019). Practices with dental therapists appeared to perform more preventive work than those without such personnel available (Barnes et al., 2018).

1.4.2 Patient level factors affecting dentists' preferences for dental care

Other patient related factors apart from compliance and cooperation which were found to affect dental care delivery by dentists consisted of patient age, treatment needs and risk of caries.

1.4.2.1 *Patient's age*

The evidence for the impact of patient's age on dental treatment decisions was limited. It has been suggested that dentists delivered more preventive care to younger individuals (Tomlinson and Treasure, 2006). There was some evidence though showing no association between patient age and amount of preventive care delivered (Brennan and Spencer, 2005). Studies focusing on primary care use by young adults in the general medical field, found that these individuals infrequently received preventive health care. An analysis using a national US sample supported that close to 70% of visits of young adults to primary care settings did not incorporate preventive counselling (Fortuna et al., 2009). Furthermore, older studies demonstrated that patient age appeared to be associated with more aggressive restorative treatment decisions based on lesion depth (Nuttall and Pitts, 1990; Jensen et al., 1987; Bader and Shugars, 1992), while the proportion of existing restorations considered to be needing replacement by trained examiners was larger among older patients (Kroeze et al., 1990).

1.4.2.2 *Patient's risk of developing caries*

With respect to links between caries risk assessment and preventive care, research outcomes were divided. A stream of studies verified a positive relationship meaning that individuals at higher risk of developing caries typically received more prevention (Riley III et al., 2010) while a separate body of research pointed to a negative correlation with patients at lower caries risk having delivered enhanced prevention (Hänsel Petersson et al., 2016). Studies emphasized the need to identify those at high risk of developing caries through risk assessment and to provide them with the necessary preventive measures to cease the disease process (James et al., 2010; Gao et al., 2015), although there was contradictory evidence on the usefulness of preventive treatment with high caries risk groups (Hausen et al., 2000; Karabekiroğlu and Ünlü, 2017). A particular study noted that the application of fluoride varnish was more cost effective, in terms of costs per avoided incremental increase in DMFT score, in moderate and high risk groups compared to low risk individuals (Schwendicke et al., 2018). Provided that the minimal (minimum) intervention approach recently prevailed in the dental setting, a preventive philosophy with individualised risk assessment lied at the centre of treatment philosophy. Such a philosophy would entail limited restorative treatment for individuals at lower risk to develop caries.

1.4.2.3 *Patient's existing caries*

Guidelines provided essential information on the management of carious lesions based on the minimally invasive approach which has been established in dentistry(Banerjee et al., 2017). The

management of non-cavitated carious lesions could be further classified into two broader categories involving non-cavitated carious lesions and non-cavitated but radiographically extensive carious lesions (Banerjee et al., 2017). Evidence on the management of the first class of lesions suggested a non-operative approach using biofilm disruption/removal applying oral hygiene measures, such as regular tooth brushing with a fluoridated toothpaste (Hilgert et al., 2015), in conjunction with topical remineralisation therapies where the risk of caries for the individual was evaluated high or by delivery of therapeutic fissure sealants over the early lesions, mainly for occlusal pits and fissures (Griffin, S.O. et al., 2008). Occlusal lesions that seemed clinically non-cavitated but radiographically extended into the dentine might not arrest through biofilm control only. Research proposed that these lesions, belonging to the second class according to the division applied previously, could be therapeutically fissure sealed, but the sealant should be consecutively monitored as failure of the sealant may allow caries progression. In case that occurred, the tooth finally would also necessitate invasive restoration (Fontana et al., 2014; Wright et al., 2016).

1.4.3 Factors affecting patients' preferences for dental care

A significant body of research investigated the driving factors of dental care. Evidence from a mixed public-private setting in Ireland depicted that impediments to regular dental visits for the elderly group consisted the lack of perceived need for treatment and being edentulous, with expensive treatment and difficulties in access to downstairs surgeries being reported to a lesser extent (Shanahan and O'Neill, 2017). Dental costs, dental anxiety especially in relation to having a tooth drilled or a local anaesthetic injection and communication skills of the dentists emerged as important barriers to dental attendance in a mixed public-private setting in the UK (Hill et al., 2013). With regards to communication issues, some participants raised concerns that the dentist either did not listen to them or did not assign enough time to discuss their oral health and expressed less confidence in the dentist. Lack of provision of evening and/or weekend appointments was also indicated problematic. Further research targeting older people and their carers in a public-private setting in England and Wales suggested that communication and confidence in the dentist were crucial influences on dental attendance (Borreani et al., 2008).

A more recent study suggested that a lack of knowledge about prevention was an essential barrier for the self-care of patients in a mixed public-private setting in Denmark (Rosing et al., 2019). In addition, patients seemed to value preventive advice considering that dental team members should be responsible to provide this type of care. They recognized the need for oral health education from a young age as an early behaviour forming technique which would engage individuals with attending the dentist and maintaining good oral health from an early stage in life. Individuals reported over-treatment and irregular dental attendance as further factors restricting preventive care and recommended explicit guidance from dental professionals for improving oral health knowledge and involvement in a shared decision making process about their treatment options as facilitators to prevention (Rosing et al., 2019). Patients also felt that sometimes they were treated disrespectfully by the dental team member and perceived an "assembly line" mentality within the dental profession, lacking clear explanations of treatment options and essential communication and fearing treatments options were targeted at profit (Rosing et al., 2019). Lack of trust and reduced confidence constituted two additional factors preventing demand for prevention as reported by participants (Rosing et al., 2019).

An older study seeking the main barriers to regular dental attendance found that dental anxiety, costs of dental treatment, perceived need for dental care and lack of access to dental services constituted the contributing factors for not visiting the dentist regularly (Cohen, L., 1987). Time constraints to arrange time for dental attendance, past dental care experience and lack of insurance have also been mentioned as significant hindrances to dental care seeking (Bahramian et al., 2015; Buerlein et al.,

2011). Other indirect costs in the sense of expenses other than the dental treatment itself, involved transport to the practice costs, parking costs and time of appointment (Borreani et al., 2008). A number of studies also raised the issue of long waiting times to get a dental check-up appointment as a significant barrier to dental attendance (Paley et al., 2004; Belsi et al., 2013). Dental care access related issues for older individuals identified at all stages from booking the initial appointment to travelling to the practice and accessing the premises, encompassed both appointment system associated themes, including the inability to make appointments more than a few weeks in advance, and mobility problems such as lack of social support and isolation (Borreani et al., 2008). Limited utilisation of oral health services among older adults was attributed to specific barriers involving once again the cost of dental care, shortage of professionals, lack of knowledge and familiarity with the services provided as well as location of facilities (Williams et al., 1995; Mariño et al., 2002; Borreani et al., 2008).

1.5 Oral healthcare systems in the UK and ROI

This segment discusses the basic characteristics of oral health care systems in the UK and ROI with a focus on preventive care delivery. Main points involve sources of finance, dental attendance rates, out of pocket costs of preventive care for patients, payment systems for dentists and oral health surveys' primary findings in the two countries.

1.5.1 UK

Approximately 5.8 million people in the UK are supplied with artificially fluoridated water. Furthermore, it is estimated that a population of 330,000 individuals are supplied with water whose naturally occurring fluoride was at the optimum concentration levels for the dental health (BFS, 2013). This reflects a proportion of around 9.2% of UK population having access to either artificially or naturally occurring fluoridated water. Oral health care as well as general health care in the UK is provided by the National Health Service (NHS) financed through general taxation as well as some private care. Unlike general health care, oral health care is not state funded for all citizens. Under the NHS system, oral health care is provided fully free of charge only for certain groups of individuals, such as expectant mothers, children and adolescents and low-income individuals and partial reimbursement for the remaining general population. The availability of free oral health care varies between the constituent parts of the UK, for example free dental check-ups were available to all in Scotland. The UK has the second highest percentage of people visiting the dentist in the last twelve months (61%) among another nine EU member states, only behind Germany (81%)(Sinclair et al., 2019). Dental check-ups are considered as examination of teeth, gums and mouth and delivering advice on diet, smoking and alcohol use and teeth cleaning habits (Kino et al., 2017). This includes an important factor to the decrease in the burden of oral diseases, contributing to the early identification of oral issues and associated risk factors in order to enable timely intervention to restrict the progress of oral conditions in early stages or even prevent the initiation of the disease (Richards, W. and Ameen, 2002). Dental check-ups have also been linked to better oral health condition and higher quality of life (Montero et al., 2014; Sanders et al., 2006).

Dentists contracted by the NHS in England and Wales are remunerated on the basis of a bands system using units of dental activity (UDAs) which constitutes a hybrid contract combining capitation and fee per item features (Eaton et al., 2019; Hierons et al., 2017; Watson, 2010). Preventive services, both advice and treatment, are placed in Band 1 equalling to 1 UDA. Each UDA corresponds to some standard level of payment. It should also be noticed that irrespective of the type and the quantity of preventive services delivered, the dentist is entitled to the same payment linked to just 1 UDA. This underlines a lack of incentives for dentists to provide extra prevention in the form of either personalised advice or multiple treatments including application of fluoride varnish and dental

sealants. Dentists in Scotland are remunerated for providing preventive and restorative care on the basis of a fee per service system (NHS-SCOTLAND, 2021). Patients in England and Wales pay for dental services using a similar bands system (NHS, 2017; Wales, 2020). They need to pay £22.70 in England and £14.30 in Wales for oral examination and preventive care irrespective of quantity delivered. Scotland though operates exclusively within a fee per item system (Dental, 2019). Patients in Scotland are required to pay 80% of the cost of the NHS dental treatment up to a maximum of £384 according to a fee per item list (Dental, 2019). Oral examination is free of charge but patients are requested to pay for preventive care such as £8.12 for intensive instruction in the prevention of dental disease, including advice on diet and oral hygiene (Dental, 2019). Research focused on comparisons of dental treatment costs and fees from the perspective of the patient and dentist across European countries emphasized that UK stood among those offering the least expensive dental treatment (Klingenberger et al., 2015; Eaton et al., 2019).

There has been a considerable rise in the UK for dental check-up visits as demonstrated in the adult dental health survey 2009-ADHS (Hill et al., 2013). Similar patterns were observed across all parts of the UK between 1991 and 2008 especially in the older age cohort of 65 year olds and over, with attendance rates advancing from 54.6% to 67.9% in England, from 47.9% to 65.8% in Wales and from 47.3% to 67.3% in Scotland (Vernekar et al., 2019). Research though, showed that these improvements were mainly attributed to an increase in utilisation of non NHS dental services (Vernekar et al., 2019). For this study non NHS dental services included a private dental check-up which was not obtained in NHS. In 2008 estimates revealed that around 20% of the population in England used a private dental check-up and 45% a NHS or a mixed NHS-private dental check-up. In Wales and Scotland, around 20% used a private dental check-up and 50% a NHS or a mixed NHS-private dental check-up. In Northern Ireland about 15% attended a private dental check-up and 50% a NHS or mixed NHS-private dental check-up. In relation to preventive care, those who recalled having received advice on oral hygiene instructions from the dental team increased from 63% in 1998 to 78% in 2009. In addition, the ADHS showed that inability to arrange an NHS dental check-up appointment ranged only by age with 10% of younger adults aged 25-34 years being more likely to fail to get an appointment, compared to just 4% of 65-74 year olds and 5% of 75-84 year olds (Hill et al., 2013). In the UK adult oral health care is provided in private dental practices, offices and clinics as well as public dental hospitals and community settings.

Promotion of oral health and prevention of oral disease are key aims for the National Health Service (NHS) in the UK. Government reforms of health service dentistry placed emphasis on the role of prevention in practice as a significant means for improving population oral health (Renson, 2002). In such an attempt, the department of health (DoH) issued a series of policy documents setting oral

health improvement and prevention as top priorities for primary care dental services (PHE, 2017) . One of the policy documents published by the Department of Health in September 2017 was titled "Delivering better oral health – an evidence-based toolkit for prevention", sent to each health service dental practice. It was composed by an expert working group in answer to requests from dentists for practical guidance to deliver effective prevention in dental practice. Updated editions of this document were published subsequently to ensure content was in accordance to up to date evidence. This publication was an important milestone as no national guidance was available up to that point in the UK and there has been an expectation that dentists would follow the suggestions/interventions for the benefits of patients.

There was a lack of evidence about dentists' attitudes on prevention and what the provision of prevention actually involved in reality (Fox, 2010). In addition, recent studies have illustrated that in terms of actual delivery, prevention in health service dental practice was variable, inconsistent and the interventions applied by dentists were not always based on evidence (Threlfall et al., 2007; Tomlinson and Treasure, 2006).

1.5.2 ROI

The ROI had a long history of water fluoridation anchored back to the 1960s with fluoridation debate in ROI involving the public quite actively (Nishi et al., 2017). Earlier evidence showed that 73% of the population have access to fluoridated water (Woods et al., 2017). There are two dental treatment schemes prevailing in ROI, the Dental Treatment Benefit Scheme (DTBS) for employers and employees paying social security contributions according to a pay-related social insurance system, and the Dental Treatment Services Scheme (DTSS) for medical card holders which is means tested (Nishi et al., 2017). Indicatively, eligibility criteria for a medical card holder requires weekly income below the income threshold of €184 per week for a single person up to 65-years old. Both methods pay for preventive care in the form of annual oral examination as well as covering some treatment costs (Nishi et al., 2017). Medical card holders have an upper limitation of two fillings per calendar year, any extractions required and urgent dental treatment. Oral healthcare treatment in both schemes is delivered by private independent dental practitioners (Sinclair et al., 2019). Ireland has a dentist density ratio of 6.1 dentists per 10,000 residents. On average 43%, of the entire population visit a dentist annually, with the same estimate for those aged 70+ years being at 30% (Woods et al., 2017). In 2014, 83% of expenses on oral health care stemmed from out of pocket payments by patients while it was estimated that 46% of the Irish population held private health insurance as of 2016 national data (Woods et al., 2017). Hence the system of oral health care in ROI is described by a hybrid model, where oral health care provision is a public/private mix. Dentists in ROI are remunerated on a fee per item schedule for offering respective treatments.

The latest national survey of adult oral health in Ireland was conducted in 2000/02 with results highlighting a considerable improvement in the level of oral health for adults in comparison to the previous study in 1989/90 (Whelton et al., 2007). Main trends suggested substantial reduction in the number of extracted teeth alongside an overall drop in caries irrespective of age and gender stratification (Whelton et al., 2007). Since 2010, limited resources led to restrictions on the public sector supply of dental services in Ireland. Financial coverage ensured by the two publicly funded schemes for the adult population had substantially diminished, raising the cost burden for the patients. For example public expenditure on the DTSS reduced sharply from €86.8 million in 2009 to €52.2 million in 2011 (exchange rate of £1 = €1.17) (OECD, 2021), even though the number of people entitled for treatment increased for the same period (Woods et al., 2017). The Irish Dental Association underlined that the number of oral examinations under the DTBS scheme slumped by over 30% between 2008 and 2011 (Woods et al., 2017).

The state funded system in the UK provides more or less free of charge oral health care to all children and adolescents (Sinclair et al., 2019), while the hybrid system of Ireland delivers the same type of care free of charge for all children up to the age of 16 years from the Public Dental Service (PDS) (Woods et al., 2017). Certain groups of adults encompassing nursing and expectant mothers, the elderly and others with low income, are entitled to either full or partial payment for oral health care by the state insurance systems in both the UK and ROI (Sinclair et al., 2019).

Differences in water fluoridation levels and rates of reported dental attendance between populations in the UK and ROI as well as the impact of a recession since 2010 in Ireland limiting financial coverage of dental services to a great extent, generated a scientific interest over whether preferences of dentists and the general public about prevention may actually differ between these countries.

1.5.3 Differences in extrinsic incentives of dentists in the UK and ROI

As shown above, there are some differences in the extrinsic incentives of dentists in the UK and ROI. Dentists in the UK are remunerated based on either a band system or a fee per item system with government reimbursing a part of their fees and patient charges. The dental system in Ireland is described by a mix of public/private oral health care provision, where the highest share of dentist fees and patient expenses are covered by out of pocket payments and private health insurance. Despite these differences, both dental systems are based on a mix of public/private oral health care provision.

The differences of these dental systems in terms of extrinsic incentives could affect to some extent dentists' preferences in delivering care. For example, dentists in the UK working under a Bands system and perceiving to be less properly remunerated for preventive care could be less prone for such type of care irrespective of the provided payment in comparison to their ROI counterparts operating in a

setting which is more heavily relied on out of pocket payments and private health insurance. Research evidence exploring the performance of dentists under different incentive forms revealed that both public and private professionals achieved similar results in caries treatment even after controlling for relevant background variables such as education or fluoridation levels (Andersen, 2009). Behaviour regulated by professional norms such as the delivery of oral hygiene instruction seemed to moderate the relationship between extrinsic incentives and performance, prompting both public and private dentists to perform equally in the provision of prevention despite the higher incentives in the private sector to reduce such care in favour of financial benefits (Andersen, 2009). It was also true that for less regulated by professional norms behaviour in dentistry such as the delivery of fissure sealants, sealants were used more frequently in the public sector than the private sector(Andersen, 2009).

This study attempts to measure dentists' preferences in delivering a mix of preventive and restorative care for dental caries in the UK and ROI. Provided that behaviours of dentists in relation to the provision of this care mix are highly regulated by professional norms and guidelines (Baâdoudi et al., 2019; PHE, 2017), differences in extrinsic motivations between the two dental care systems are not expected to influence the results of this study.

1.6 Research questions

This study discovers the decision making process of dentists and patients in relation to preventive dental care for dental caries.

Dentists study

1. The main determinants involved in the decision making process of dentists in the delivery of a mix of preventive and restorative care for dental caries using qualitative research methods.
2. Test the feasibility of applying a new analytical framework of qualitative data in the design of a DCE questionnaire to explore preferences of dentists for delivery of a mix of preventive and restorative care for dental caries.
3. The direction and importance of the main determinants influencing preferences of dentists for delivery of a mix of preventive and restorative care for dental caries.
4. Differences in dentists' preferences for the delivery of a mix of preventive and restorative care for dental caries by sociodemographic characteristics and practices.

Patient study

1. The main determinants involved in the decision making process of general public individuals or patients for receiving preventive care for dental caries using qualitative research methods.
2. Test the feasibility of applying a new analytical framework of qualitative data in the design of a DCE questionnaire to explore preferences of patients for receiving preventive care for dental caries.
3. The direction and importance of the main determinants influencing preferences of patients for receiving preventive care for dental caries.
4. Differences in patients' preferences for receiving preventive care for dental caries by sociodemographic characteristics and behaviours.

The dentist study attempts to explore the use of a DCE (Discrete Choice Experiment) with dentists. Understanding what are the main determinants in the decision making process of dentists in the delivery of a mix of preventive and restorative care and how these factors affect treatment delivery would provide useful insights on the policy actions needed to increase the supply of prevention. Testing the application of a new analytical framework for data which are collected through qualitative methods for the development of a DCE questionnaire could offer useful suggestions on the benefits of such technique for future behavioural science. Exploring preference differences of dentists by sociodemographic characteristics and behaviours would reveal whether certain profiles of dentists form common preferences in delivering a mix of preventive and restorative care so that tailored policies could be designed to enhance prevention supply. For example, educational initiatives and

information campaigns would be more effective with a certain profile of dentists who are less interested in providing preventive care rather than focusing on the entire dentist population.

The patient study seeks out to understand what the main determinants in the preferences of patients are in receiving preventive care for dental caries. Findings on the direction and importance that patients place on the main determinants of preventive care would allow the design of policies to increase demand for prevention. Testing the application of a similar analytical framework with data collected through qualitative methods for the development of a DCE questionnaire with patients, could offer useful suggestions on the benefits of such technique for future behavioural science. Investigating differences in patients' preferences by sociodemographic characteristics and behaviours would show whether certain profiles of patients form common preferences in receiving preventive care so that tailored policies could be designed to enhance demand for prevention. For example, educational initiatives and information campaigns would be more effective with a certain profile of patients who are less interested in receiving preventive care rather than focusing on the entire patient population.

The content of the following chapters is organised as follows. Chapter 2 deals with a review based on a systematic search of the literature which was divided into three parts to investigate dentist's preferences, patients' preferences and the patient-dentist relationship in the prevention of dental caries. Chapter 3 refers to the qualitative and quantitative methods used in this study. Chapter 4 reports the results of the qualitative and quantitative analysis. Chapter 5 includes the discussion of qualitative and quantitative findings of this study in comparison to the findings from the three literature review parts. Limitations and future suggestions are also documented in this chapter. Chapter 6 presents concluding remarks of this study.

2. Literature Review

This chapter is divided into two main parts. The first section includes the conduct of three literature reviews to explore the properties of the preference-based methods used in the dental field and provide the most appropriate method to answer the research questions of this study. The second section of this chapter involves the analysis of the DCE studies which were identified in the literature reviews to offer useful methodological approaches for the implementation of two DCEs with dentists and patients in this study.

2.1 Methods to assess decision making (preferences)

The process of deciding to use preference based methods to answer the research questions posed involved considering a wider range of methodologies. Briefly the pros and cons of different approaches were presented below.

I. Ethnography

The most direct way of assessing decision making might be to observe dentists or patients at the point when they make a decision. Ethnographic investigation has been used to explore treatment preferences in healthcare(Schiff et al., 2017). Direct observation of interactions could be a useful way to explore outward communications and body language but not to capture thought processes. This method though is time consuming and could only observe a small number of interactions. It would also be subject to social desirability bias as being observed as well as it needs skilled individuals in ethnography to undertake the observations and analysis. A further drawback of this techniques is associated to the sensitivity of the topic under investigation. Observing dentists in treating patients and probing them about their decision making in treatment delivery could trigger resistance by some professionals feeling that they are being assessed on how they perform their work. This could lead in higher levels of anxiety or defiance of individuals to participate in the study.

II. Ranking and rating questionnaires exploring decision making

This method refers to questionnaires asking participant to complete rating and ranking exercises to explore the impact of a number of factors on preferences (Bolt et al., 2018; Hiligsmann et al., 2013). Although this is a cheap, relatively easy technique which could reach a wide range of participants, it provides a limited depth of understanding preferences. This occurs as no numerical values are assigned to demonstrate the relative strength of each factor in preferences but the outcome of this exercise leads just to a ranking of the factors in terms of importance to participants. Validity of the technique is also questionable due to being subject to social desirability bias.

III. Interviews/focus group approaches exploring decision making

A number of studies have used these methods to investigate the effect of different factors in treatment preferences (Svedsater et al., 2017; Hiligsmann et al., 2013)–Interviews and focus groups offer a depth of understanding of the topic area due to a two-way interaction between researcher and participants. However they are time consuming, require skill and experience to conduct and analyse and usually use small numbers of participants. Another limitation of these techniques is that no values are assigned to the strength of preferences for each factor and hence only a relative comparison of the strength of factors is feasible at the end of analysis.

IV. Combined approaches exploring decision making

To combine the advantages of the methods mentioned before in exploring decision making and overcome their limitations the use of survey-based preference methods was suggested. Such methods usually apply qualitative approaches to establish factors of importance followed by quantitative methods to assess preferences evaluated by hypothetical choices.

2.2 Survey-based preference methods

Survey-based preference methods which enable a valuation of health services or states stem from the field of health economics analysis and include visual analogue scale (VAS), time trade-off (TTO), Standard gamble (SG), Willingness to pay (WTP) and DCEs. These methods are appropriate for determining priorities in health care policy from the perspectives of patients and clinicians since they reflect preferences for health services and states. In addition, similar measures are also applied in cost utility and cost benefit analyses using utilities or monetary valuation as the measure under investigation to allow for comparisons between different interventions and determine the most effective of those (Sendi, P et al., 2018). Here brief descriptions of those methods are demonstrated.

1. VAS

Researchers measure on a rating scale the desirability of a health state related to an intervention by requesting participants to locate the intervention on a scale with two endpoints that are associated with two fixed health states which are assigned preference weights of 1 and 0 respectively (Birch, S and Ismail, 2002). The health state under consideration for valuation is assigned a value according to its relative position on this 1-0 measurement scale.

2. TTO

The TTO estimates an individual's trade-off between health improvements and life expectancy. Participants declare their strength of preference for an intervention in terms of the time they are willing to sacrifice at the end of their expected lifetime in exchange for the improvement in health state attributed to the intervention. The greater the amount of future life expectancy an individual is prepared to forego, the stronger is their preference for the health state.

3. SG

SG estimates an individual's trade-off between a health improvement and the probability of survival (Birch, S and Ismail, 2002). Subjects declare their strength of preference for an intervention by the likelihood of survival they would give up or reversely the risk of death they would accept for the health state related to the intervention under evaluation. The individual selects between this health state and the uncertain expectation of immediate full health with a probability 'p' and instant death with probability '1-p'. Probability 'p' ranges until the participant is indifferent between the health state and the uncertain expectation. Utility of full health and death are set to 1 and 0 respectively with the utility of the health state being estimated by the indifference level of 'p' contingent upon the expected value function.

4. Self-report WTP

One alternative theory to elicit utility is through determining a monetary valuation (Birch, S and Ismail, 2002). A widely accepted monetary valuation technique is WTP where the respondent encounters a hypothetical scenario in which a health care intervention or health state is to be valued, and is asked the maximum they would be willing to offer for the intervention or to improve their health state. The WTP approach allows subjects to consider all aspects of an intervention in their valuation of that intervention.

5. DCEs-Conjoint Analysis (CA)-Best-Worst Scaling (BWS)

These three methods are presented together as they share some common characteristics in terms of choice presentation style and modelling assumptions for choice elicitation. Their values are also comparable across methods following statistical modification (Sever, Ivan et al., 2019b). DCEs are commonly used to evoke preferences of patients, to assign monetary values to the attributes of health care services and to predict the uptake of specific services. In the DCEs concept any good or service is described in terms of a number of characteristics or attributes, e.g. waiting time, remuneration of the treatment etc. The attributes receive different values which are combined to form different choice alternatives. Two or more alternatives are provided in each choice set, and participants are requested

to choose their preferred alternative. Their choices implicate implicit trade-offs between the levels of the attributes, they would be willing to make, which could be used to calculate the weight or relative importance people attach to various service attributes. When the out of pocket cost is included as an attribute, the marginal utility estimates from the DCE model could be converted in WTP estimates for improvements in the levels of other attributes.

CA is regarded as a less sophisticated case of choice elicitation, where participants are presented with hypothetical profiles of different attribute level combinations and requested to either accept or reject each profile (Kateeb, E. et al., 2016). Relative importance weights of attributes are estimated through CA. However, trade-offs between attributes could not be produced in a similar fashion to DCEs, as participant consider either acceptance or rejection of the profiles without basing their decision on sacrificing improvements in other levels.

A few types of BWS method are reported in the literature with the most distinct concept compared to a DCE approach being when respondents are presented with different hypothetical profiles and requested to choose the best and worst level in each profile (Sever, Ivan et al., 2019b). This type of BWS produces a ranking of attributes on a common interval utility scale providing importance values for all attributes except for one attribute which is used as the reference (Louviere et al., 2015). It also estimates attribute level utilities (scale values) which reflect the deviations in utility from the average impact of an attribute and sum to zero (Flynn et al., 2008). This method also permits estimation under different decision rule assumptions such that either participants choose the best–worst pair with the greatest utility difference from all possible pairs in a scenario profile or consider the best and worst choices separately assuming choices are made through a sequential process (e.g., selecting the best among all the attributes' levels in a set and then the worst among the remaining attribute levels) (Flynn et al., 2007). As it could be shown by the description of BWS, it does not provide trade-offs in comparison to DCEs as respondents only choose the best and worst attribute levels in each profile without basing their decision on sacrificing improvements in other levels.

To assess the features of the different survey-based preference methods which are used in the dental literature to explore preferences of patients and dentists, three separate reviews based on a systematic search of the literature were conducted. These reviews offered useful insights on the decision-making process of both participant groups about prevention and helped identify the most appropriate method for the aims of this study.

2.3 Aims of the three literature reviews

Three separate literature reviews were conducted to explore the use of preference-based methods in the field of dentistry from dentist and patient perspectives as well as investigate patient-dentist relationship.

1. Literature review on dentists' preferences in delivering a mix of preventive and restorative care for dental caries.
2. Literature review on patients' preferences in receiving preventive care for dental caries.
3. Literature review on patient-dentist relationship in the mix of preventive and restorative care for dental caries.

The first two reviews served to present dental papers in which a variety of preference methodologies with different characteristics were applied to research dentist and patient preferences about treatment of dental caries. At first level, such analysis disclosed the features of each preference methodology in the dental field so that the most appropriate method was selected to answer research questions of this study. At a second level, all the papers including the preferred method were collected and further scrutinised to provide insights into methodological aspects which helped the design of this study.

The third review facilitated this study by identifying additional parameters involved in the relation between dentists and patients when a mix of preventive and restorative care for dental caries was provided. Two reasons augmented the need of a separate third literature review. Firstly, the literature search on dentist preferences revealed a limited number of studies focused on the mix of preventive and restorative care for dental caries, hence more information on the subject was required. Secondly, all the resulting studies of the search on dentists' preference used a technique involving patient vignettes, i.e. the construction of hypothetical patient scenarios varying on a number of pre-specified patient characteristics. Therefore, a third review was considered necessary to reveal the most important patient characteristics accounted for by dentists when providing a mix of preventive and restorative care in order to be used in the dentist study.

2.3.1 Literature review on dentists' preferences in delivering a mix of preventive and restorative care for dental caries

The literature search was applied in the following databases: Ovid MEDLINE(R) 1946 to October 2021, Embase Classic+Embase 1947 to October 2021. The word search strategy of the review is presented in Appendix 1, page 235. The literature review findings are also shown in a flow diagram PRISMA in Figure 2-1.

Study eligibility criteria: Studies which used any of the following preference based methods with dentists: VAS, SG, TTO, DCEs, CA, BWS, decision tree (DT) and Markov model (MM). The identified studies which reported a DT or MM method were further screened to assess which technique was applied for measuring effectiveness. If effectiveness was measured in utility terms, the reported method was reviewed to verify whether it involved any of the pre-determined techniques, i.e. VAS, SG, TTO, DCE, CA and BWS. In case that none of those techniques was used for this purpose, the study was eliminated from further review.

Study exclusion criteria: Any paper considered eligible at the first level of review but reported a preference-based method in an area not related with management of caries such as endodontics or third molar surgery. Studies in endodontics were eliminated provided they focused on root caries condition at which level secondary prevention was of a lesser interest. Also, any articles which were not available in English.

Information of the resulting articles was synthesized in a table following a narrative approach and was presented by lead author, aim, country of study, setting, i.e., public or private, method of data collection, study design, type of population, intervention, comparison, dentists' factors, patients' factors, patients' factors which influenced dentists' preferences for restorative care and dentists' factors affecting their preferences for restorative care. No study was identified using any of the predetermined preference-based methods with dentists in the field of preventive care for dental caries. The summary table designed in two parts appears in Appendix 2, page 239 and Appendix 3, page 240.

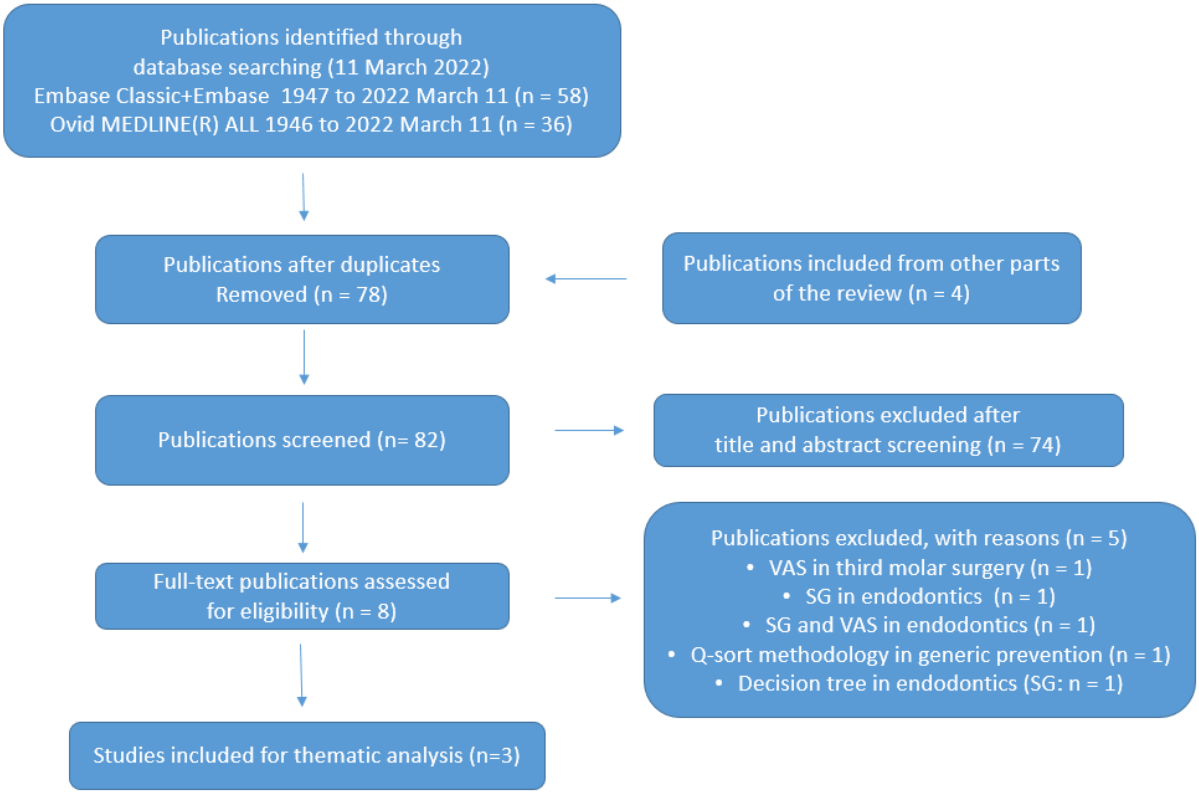


Figure 2-1. PRISMA diagram of literature review on dentists' preferences in delivering a mix of preventive and restorative care for dental caries

2.3.1.1 *Critique of identified studies on dentists' preferences in delivering a mix of preventive and restorative care for dental caries*

One limitation of the resulting studies was that none of them looked at preferences for the mix of different types of dental care including both restorative and preventive care. All three articles elicited preferences either for ART standing for atraumatic restorative care or for use of dental material in restorative care. In addition, all studies used paediatric dentists as the targeted population. This study aimed at general dentists' preferences for treatment of dental caries so previous findings were not generalizable to this population. Moreover, none of the studies was conducted in the UK or ROI. Further evidence was needed to evaluate preferences of dentist population in delivering a mix of preventive and restorative care in the UK and ROI.

2.3.2 Literature review on patients' preferences in receiving preventive care for dental caries

The literature search was applied in the following databases: Ovid MEDLINE(R) 1946 to October 2021, Embase Classic+Embase 1947 to October 2021. The word search strategy of the review is presented in Appendix 4, page 241. The literature review findings are also shown in a flow diagram PRISMA in Figure 2-2.

Study eligibility criteria: Studies which used any of the following survey-based preference methods with patients in dentistry: VAS, SG, TTO, WTP, DCE, CA, BWS, DT and MM. The identified studies which reported a DT or MM method were further screened to assess which technique was applied for measuring effectiveness. If effectiveness was measured in utility terms, the reported method was reviewed to verify whether it involved any of the pre-determined techniques, i.e. VAS, SG, TTO, DCE, CA and BWS. In case that none of those techniques was used for this purpose, the study was eliminated from further review.

Study exclusion criteria: "Any paper considered eligible but reported any of the survey-based preference methods in an area not associated with dental caries prevention such as prosthetics/endodontics, periodontics, dental benefit plans, third molar surgery other treatments and dental health states." Also, any article which was not available in English.

Information of the resulting articles was synthesized in a table following a narrative approach by lead author, aim, country of study, method of data collection, study design, type of population, intervention, comparator, variables of patients' factors, WTP for preventive care, patients' factors affecting WTP for preventive care and patients' factors influencing utility for preventive care. For studies reporting a WTP parameter in currency other than £, purchasing power parities were used (OECD, 2021) to convert all values into £ and allow comparison across regions.

The summary table designed in three parts appears in Appendix 5, page 246, Appendix 6, page 250 and Appendix 7, page 254.

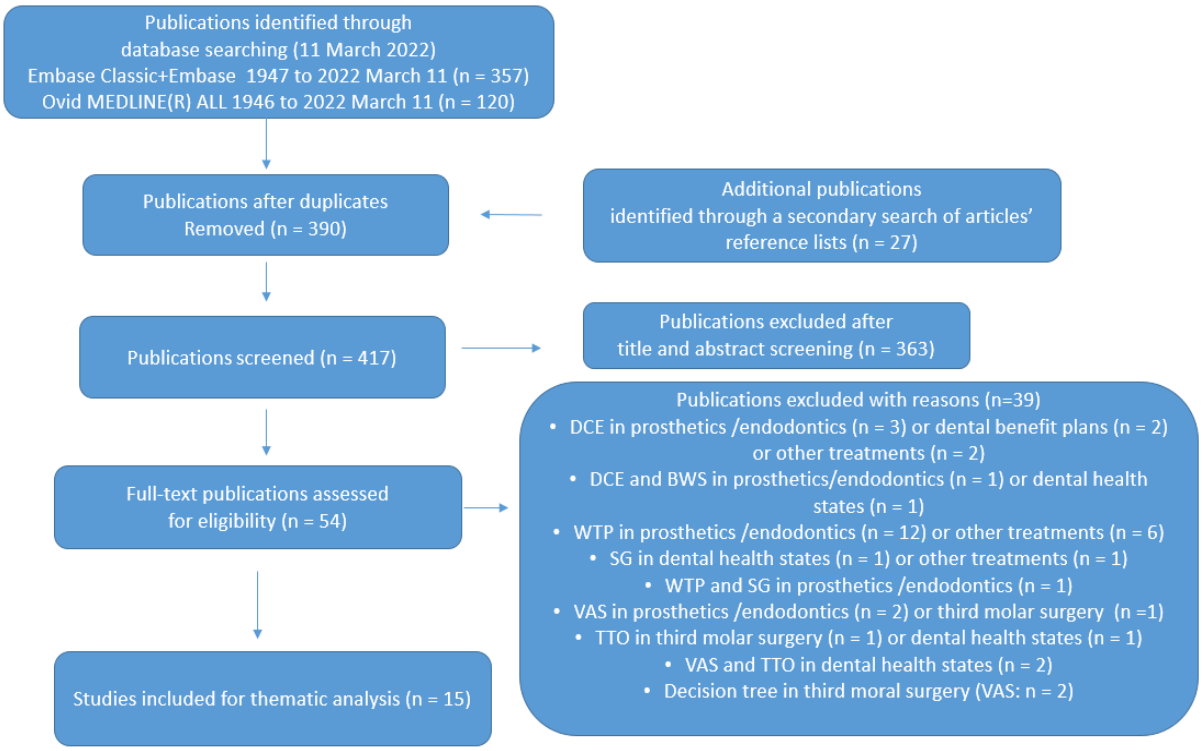


Figure 2-2. PRISMA diagram of literature review on patients' preferences in receiving preventive care for dental caries

2.3.2.1 *Critique of literature review on patients' preferences in receiving preventive care for dental caries*

Primarily, studies looked at preferences for a distinct type of preventive care such as oral hygiene advice, dental sealants, dental check-up appointment, dental care programs or fluoride varnish rather than exploring preferences for multiple types of preventive care within the same study. As a result, no direct comparisons between preferences for different types of preventive care could be drawn within the same study. Such comparison was only feasible across studies after the conversion of WTP measures in the same currency. In reality though there was a large variation in valuations across studies, even for the same type of preventive care such as oral hygiene advice, for which it varied between £15 and £78 (Boyers et al., 2021; Re et al., 2015). In other words, valuations were highly sensitive to the descriptions provided by the researcher for a particular type of preventive care or the country of the study. Hence, this survey was conducted to elicit patients' preferences for various types of preventive care and identify preference weights or WTP measures within the same context after controlling for care descriptions so that a more accurate comparison between different care types could take place.

In addition, valuations were mostly elicited for fixed scenarios of preventive care without accounting for preference sensitivity to differences in these scenarios. For example, a few studies described a preventive dental care program, or dental check-up appointment or an oral hygiene session with fixed

properties and elicited valuations only for these specific sessions (Harris et al., 2020; Oscarson et al., 2007; Pavlova* et al., 2004; Aljafari et al., 2015; Tuominen, 2008; Vermaire et al., 2012). This approach did not allow the measurement of how sensitive valuations were to changes in various factors of care, including its duration. This study tried to overcome this limitation by measuring respondents' preferences for varying scenarios of care.

Furthermore, four studies (Saadatfar and Jadidfard, 2021; Tianviwat et al., 2008a; Tianviwat et al., 2008b; Vermaire et al., 2012) used a population of parents to evaluate preferences about preventive care for their children instead of their own preferences. Another study (Walshaw et al., 2019) explored preferences of parents for preventive care delivered to their children and themselves separately, while one study (Tuominen, 2008) looked at preferences of first year medical and dental students. One additional study (Ryan and Miguel, 2003) was methodological and did not report any results in terms of preference weights or WTP measures. Obviously, findings of these studies were not generalizable to the general population as they were targeted at specific population segments. Only one study, explored preferences of general public individuals in the UK (Boyers et al., 2021). However, none of the studies was conducted in the ROI. This study looked at preferences of patients or general public individuals in receiving preventive care for dental caries in the UK and ROI.

2.3.3 Literature review on patient-dentist relationship in the mix of preventive and restorative care for dental caries

The literature search was applied in the following databases: Ovid MEDLINE(R) 1946 to October 2021, Embase Classic+Embase 1947 to October 2021. The word search strategy of the review is presented in Appendix 8, page 257. The literature review findings are also shown in a flow diagram PRISMA in Figure 2-3.

Study eligibility criteria: Articles investigating treatment decision making and practices of dentists when delivering a mix of restorative and preventive treatment for dental caries to adult population.

Study exclusion criteria: Identified studies which explored decision making or practices of dentists in any of following fields: prosthetics/endodontics, periodontics, orthodontics or oral surgery. Also, articles looking at decision making or practices of dentists with non-adult patients or measuring reliability, sensitivity or specificity. In addition, studies were excluded when investigated decision making or practices of dentists in generic prevention or repair/replacements by reasons or restoration related factors. Articles following longitudinal-comparison or intervention designs were also removed. Also, any article which was not available in English.

Information of the resulting articles was synthesized in a table format following a narrative approach by lead author, date, aim of study, country of study, data collection method, population type, setting (public or private), study design, problem, intervention, comparison, caries, patient and dentist related factors, shares of dentists choosing each type of treatment by caries factors and choice probability of each treatment type by dentist and patient factors. One study helped with the definition of themes in the analysis of literature review findings (Grembowski et al., 1989). The summary table appears in Appendix 9, page 259, Appendix 10, page 263, Appendix 11, page 267.

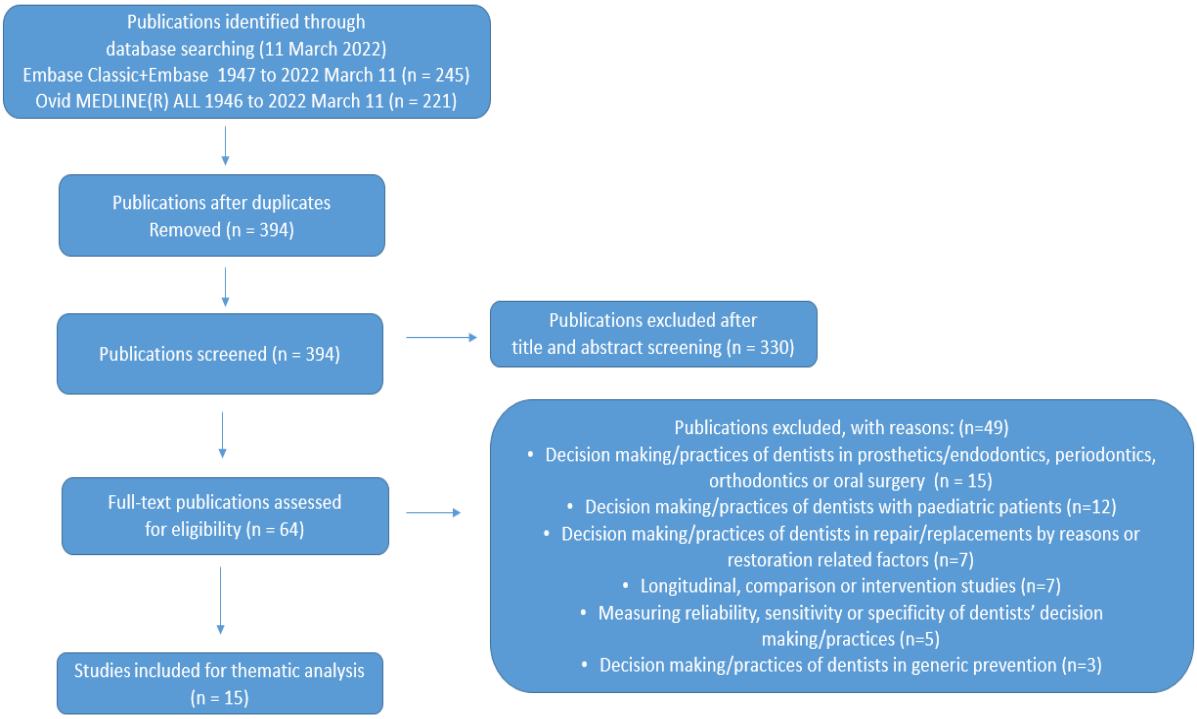


Figure 2-3. PRISMA diagram of literature review on patient-dentist relationship in the mix of preventive and restorative care for dental caries

2.3.3.1 *Critique of literature review articles on dentist-patient relationship in the preventive and restorative treatment of dental caries*

One limitation of the studies emerging from this review was that treatment preferences of dentists were collected as the most preferred treatment option among a prespecified range of options which included different types of preventive and restorative care. In practice though, dentists usually delivered a combination of treatments to each patient including both preventive and restorative care, even if this occurred in separate appointments. By restricting dentists to deliver only one treatment to a patient, although revealed their treatment preferences, it did not account for the potential of providing multiple treatments that the same patient needed. Hence, allowing for choice of multiple treatments would correspond more to real practice. This study addressed this limitation by allowing dentists to offer varying combinations of care to each patient.

Another limitation was the absence of a measure to indicate the relative value or importance of patients' characteristics in dentists' treatment preferences at an individual level. For example, most studies reported shares of dentists choosing different treatment types under varying scenarios of caries progression and caries risk (Gomez et al., 2014; Gordan et al., 2010; Gordan et al., 2009a; Gordan et al., 2009b; Gordan et al., 2012; Javidi et al., 2015; Kakudate et al., 2012; Mejàre et al., 1999; O'Donnell et al., 2013; Riley III et al., 2011; Traebert et al., 2005). However, a measure was lacking to quantify how changes in caries progression or risk would affect dentists' preferences for each treatment at an individual rather than an average level. This study focused on measuring the impact

of patients' characteristics on dentists' treatment preferences at an individual level using preference based methods.

In addition, only two studies included population of dentists in England, one aimed at exploring restorative intervention threshold decisions for occlusal and proximal carious lesions (Chana et al., 2019) and another study to investigate the factors that influenced decisions for repair over replacement treatment (Javidi et al., 2015). No study took place with dentist population in the UK or ROI. Hence this study explored treatment preferences of dentists in relation to the mix of preventive and restorative care in the UK and ROI.

2.4 Decision on the most appropriate method to investigate preferences of patients and dentists about prevention

The preceding three literature review parts led to the choice of DCEs as the most appropriate method in this study for the following reasons. Firstly, the choices presented in such an experiment reflected in a more realistic way the type of decisions individuals made when delivering or receiving preventive care. Rating treatment outcomes on VAS scales did not involve any trade-offs in decision making and provided less useful findings for policy setting (Brickley et al., 1995; Edwards, M.J. et al., 1999; Kvist and Reit, 2000; Liedholm et al., 2000; Schwendicke et al., 2016). In addition, individuals very rarely thought about a probability level of indifference between a gamble and a certain outcome (as required in a SG experiment) or the number of years they would be willing to sacrifice at the end of their life for a better health state (as required in an TTO experiment). In addition, all studies of SG or TTO with patient population which were identified in the literature review, were targeted on preference elicitation for specific dental treatments such as prosthetics/ endodontics and third molar surgery or oral health states (Balevi and Shepperd, 2007; Cohen, M.E. et al., 1990; Fukai et al., 2012; Fyffe et al., 1999; Fyffe and Kay, 1992; Ismail et al., 2004; Sendi, P et al., 2018). This entailed that such methods would be less useful in evaluating preferences for prevention given the vagueness when specifying a situation where the patient with no or limited health problems at present time, needed to think about future risks or time sacrifices for not following a preventive care intervention. As far as the dentist study was concerned a few studies were found using VAS or SG or Q-methodology to explore preferences of dentists for treatment delivery (Kvist and Reit, 2002; Lysell et al., 1995; Mileman and Van Den Hout, 2003; Reit and Kvist, 1998; Witton and Moles, 2015).

VAS scales and Q-methodology did not involve any trade-offs in decision making. SG studies evaluated preferences of dentists or dental students for endodontic treatment. Respondents were asked to assume a certain endodontic diagnosis and trade risk of tooth extraction presented in a gamble to receive endodontic treatment which would restore oral health. Using SG to measure preferences of dentists for the mix of preventive and restorative care for caries in this study was restricted by the various patient vignettes which would overburden participants with information on multiple scenarios varying on a few parameters such as age and caries risk. In addition dentists as happened with patients were not used to think about a probability level of indifference between a gamble and a certain outcome (as required in a SG experiment).

The review also revealed a few studies using self-report WTP to explore preferences of patients or general public members about dental care (Al Garni et al., 2012; Balevi and Shepperd, 2007; Dalanon et al., 2018; Esfandiari et al., 2009; Halvorsen and Willumsen, 2004; Leung and McGrath, 2010; Matthews et al., 1999; McKenna et al., 2016; Nair and Yee, 2016; Re et al., 2017; Sendi, Pedram et al.,

2017; Smith and Cunningham, 2004; Srivastava, A et al., 2020; Srivastava, Akanksha et al., 2014; Tada et al., 2021; Vernazza, C. et al., 2015; Widström and Seppälä, 2012) and dental prevention in particular (Harris et al., 2020; Oscarson et al., 2007; Pavlova* et al., 2004; Re et al., 2015; Saadatfar and Jadidfard, 2021; Tianviwat et al., 2008a; Tianviwat et al., 2008b; Tuominen, 2008; Vermaire et al., 2012; Vernazza, C.R. et al., 2015; Walshaw et al., 2019). This method was usually preferred over the traditional techniques such as SG and TTO to preferences elicitation in dental decision making, because of its higher sensitivity in small changes of an attribute and flexibility in asking individuals about their willingness to trade off income instead of length of life or risk of instant extraction for oral health benefits (Birch, S and Ismail, 2002). It was known that certain dental interventions did not contain significant risk of extraction. However, one major shortcoming of WTP technique was the wide range of information needed to enable participants to deliver meaningful WTP measures. Particularly, information was required in relation to the probabilities associated with different health profiles spanning both short and long term as well as careful and detailed descriptions of the intervention procedures. The suggested data collection process for estimation of self-report WTP was face to face interviewing under which the interviewer investigated and responded to individual's concerns and questions, and carefully managed the sequence and content of a WTP experiment.

The main aim of this study was to evaluate preferences of patients for prevention looking at the concept holistically in terms of involving different types of preventive treatments and other characteristics associated with prevention such as travel time to the dental office and waiting time. Using self-report WTP method to investigate patients' preferences for prevention in this manner would require a great deal of information which would increase the cognitive burden assigned to respondents and potentially lead the survey to fail. Furthermore, a further drawback of this method in this case would be its decreased sensitivity to changes in non-preventive care attributes such as travel time to the dental practice and waiting time for a dental appointment. For example, patients would face difficulties in deciding how much they were willing to pay to spare some travel time to the dental practice as this type of decision making was not usual in practice. In the dental study, dentist would likely be more reluctant to trade off income for the provision of care. Hence the application of self-report WTP method in the dentist study was also avoided. In addition, it would be more challenging for dentists to report the amount they were willing to accept or sacrifice for delivering a certain type of treatment for a patient vignette. Dentists felt responsible to provide the most suitable treatment according to patient needs and hence they might have regarded such decisions as inappropriate and less realistic. This was likely the reason that none of studies in the literature used the self-report WTP method with dentist population.

A few DCE studies were identified in dental literature to explore patient preferences about prevention, other treatments or conditions and dental benefit plans (Bakhurji et al., 2019; Barber, Sophy et al., 2019; Bech et al., 2011; Boyers et al., 2021; Cunningham, M. et al., 1999; Gaeth et al., 1999; Kateeb, E. et al., 2016; Kateeb, E.T. et al., 2014; Kiiskinen et al., 2010; Rogers et al., 2022; Ryan and Miguel, 2003; Sever, I. et al., 2018; Sever, Ivan et al., 2019c; Sever, Ivan et al., 2019b; Vennedey et al., 2018; Zhu et al., 2019). Two studies applied BWS method in combination to a DCE (Rogers et al., 2022; Sever, Ivan et al., 2019b). Three studies emerged using CA for dentist preferences (Bakhurji et al., 2019; Kateeb, E. et al., 2016; Kateeb, E.T. et al., 2014). As described earlier, see 2.2, p. 39, the main limitation of these methods were associated with a lower realistic ability in decision making as individuals were less likely to make decision in an accept/reject format followed in CA studies or choice of best/worst attribute level format in BWS. In addition these methods did not provide trade-offs as the choice formats did not allow respondents to base their decision on sacrificing improvements in other levels.

Overall, DCEs was the chosen technique in this study as it could replicate at a good level the conditions of realistic decision making of patients and dentists on prevention. The method is also appropriate for measuring preferences of an intervention with unknown or difficult to measure future risks such as those involved in prevention. DCE is sensitive to small changes in all attributes and permits elicitation of income trade-offs similarly to the self-report WTP method. In addition, it could manage information from multiple sources in a more effective way incorporating multiple attributes in hypothetical scenarios and requesting participants for one choice in each scenario instead of multiple WTP inputs for each attribute. DCE also reduces the impact of those who had the ability to pay more on WTP as the levels of the attributes are controlled by the researcher. Hence DCE was preferred over the other methods (SG, TTO, self-report WTP) to investigate preferences of patients and dentists about prevention.

A main contribution of DCEs is the estimation of strength of preferences for attributes describing a service such as dental prevention. This relates to information about statistical significance[1] of the attributes' factors, their direction (sign of the estimated parameter/factor) and their relative importance (i.e. size of the parameter). Strength of preference and relative importance of different attributes involved in decision making of patients and dentists for preventive treatment were estimated. Although the above information was useful, DCEs' real value derives from looking at the trade-offs between attributes, since this type of information could not be extracted from interviews or detailed focus-groups, nor from other preference-based methods as discussed earlier in this

[1] Statistical significance referred to the probability of a coefficient being zero standing below a prespecified confidence level such as 5% or 1%.

chapter. Trade-offs are useful because both dentists and patients would rarely have available the best levels of all factors significant to them (due to the fact of contrasting interests between dentists and patients and limited resources). Trade-offs estimation would allow the quantification of how much of an attribute the participant is willing to sacrifice to gain an improvement in another attribute. Trade-offs between attributes could be used to direct policies towards measures towards an increase in preventive care from a supply and demand perspective by identifying attributes which dentists and patients are willing to trade off for providing or receiving more prevention. DCEs also permits association of preference differences across participants, known as preference heterogeneity, with sociodemographic and behaviour variables of participants. Patients were shown to have diverse preferences for oral health interventions (Sever, I. et al., 2018; Vennedey et al., 2018; Zhu et al., 2019). In addition, studies revealed that ignoring preference heterogeneity would bias the utility coefficients provided by the DCE studies (Louviere and Meyer, 2017). However, there was limited research on preference heterogeneity of patients and dentists for preventive care. It is likely that certain sociodemographic characteristics of each group influence preferences in a systematic way. By identifying sociodemographic profiles of dentists and patients with distinct preferences for prevention, policy measures for raising prevention such as educational initiatives and information campaigns could target those groups less interested in prevention. This approach would increase their effectiveness and save resources from a societal perspective. This study tried to measure heterogeneity of dentists' and patients' preferences in prevention of dental caries.

2.5 Review of dental DCE-CA studies

Since the DCE studies conducted in the field of dental prevention with patient and/or dentist populations were of limited number, all DCE and CA studies in dentistry which were found in the literature review of dentists' and patients' preferences were analysed together to provide useful lessons in methodology for this study. Three studies were excluded from such analysis even though they used a DCE or CA design as they investigated preferences for dental insurance plans or dental health states and hence were outside the scope of this study which was focused on treatment preferences (Cunningham, M. et al., 1999; Gaeth et al., 1999; Rogers et al., 2022). The results of the analysis were synthesized using a narrative method and were presented in a tabulated format in Appendix 12, page 274, Appendix 13, page 278, Appendix 14, page 283, Appendix 15, page 287. The narrative approach was used to categorise the identified studies by authors, date, place of study, methods and variables used, how it related/helped this study, objective/study question, labelled vs. unlabelled design, framing of DCE question, number of choice alternatives, attributes and levels investigated, properties of experimental design, statistical model specification, marginal WTP estimates, tests of model specification and overall summary comments of the main contribution to the aims of this study. In addition, DCE attributes from the identified articles were classified into broader classes according to their content. A meta-analytic approach was also used to estimate mean WTP measures in studies where the cost coefficient was provided but WTP parameters were not reported. For studies reporting a cost attribute in currency other than £, purchasing power parities were used (OECD, 2021) to convert all values into £ and allow comparison across regions.

Thirteen articles were identified which explored the decision making of patients and dentists through DCE or CA analysis within a wide range of dental treatment services including periodontics, endodontics, hypodontia, restoration and prevention.

Four studies used five attributes, making it the most frequent number of attributes reported, followed by four attributes (n=3), see Figure 2-4. Figure 2-5 demonstrates the frequency of choice tasks number across studies. Most studies included either eight or nine choice tasks per respondent. In terms of survey administration methods, online surveys were most common (n=8), followed by paper and pencil surveys (n=4), see Figure 2-6.

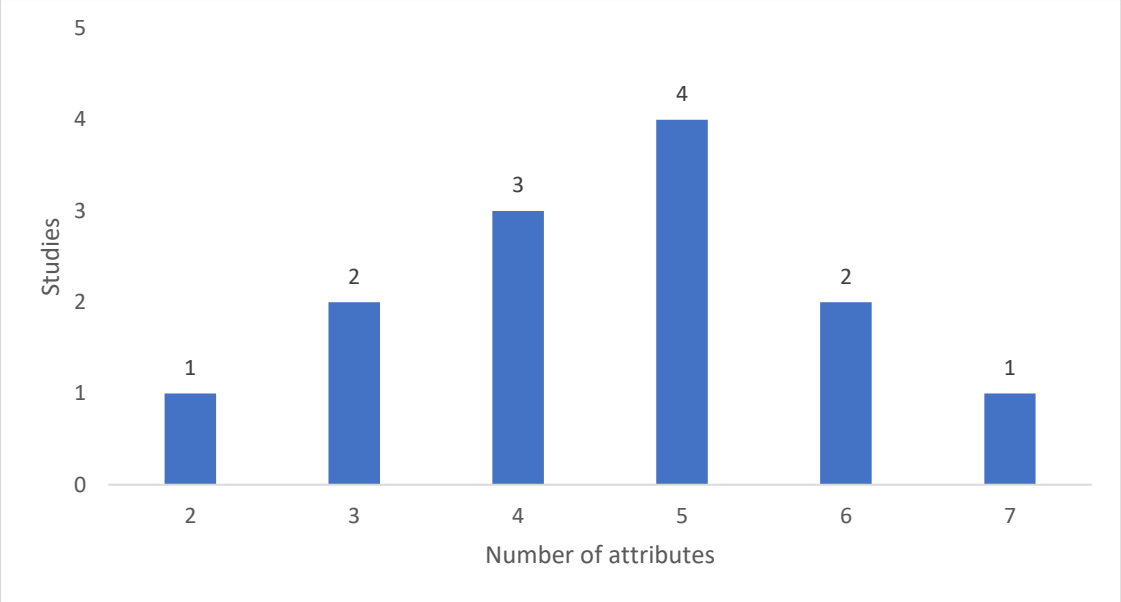


Figure 2-4. Number of attributes

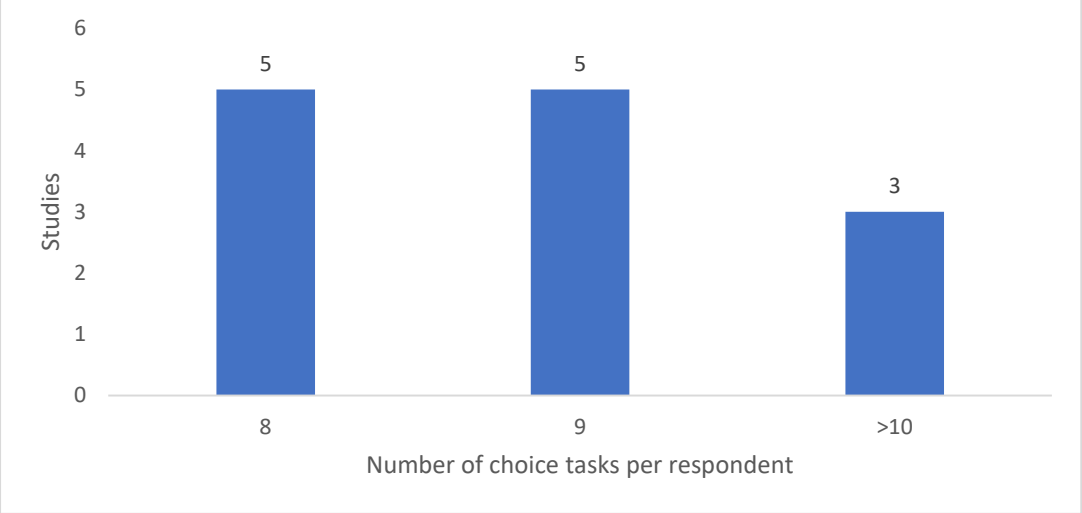


Figure 2-5. Number of choice tasks per respondent

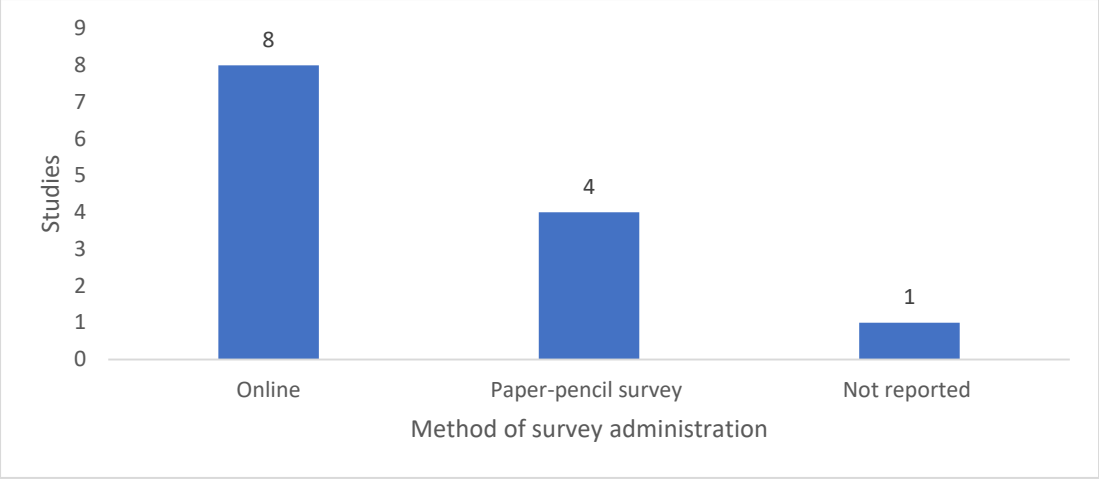


Figure 2-6. Method of survey administration

2.5.1 Qualitative methods for the development of dental DCE-CA surveys

An overview of the qualitative methods used in each study to identify the main attributes and levels, as well as develop a DCE survey follows.

A table summarising the methods used to identify the attributes and levels, and test the validity and acceptability of DCE instruments in a two-stage process is presented in Table 2-1. Most studies reported DCE development as a two phase process, involving the identification of attribute levels and testing of DCE face validity and acceptability. Two studies (Kateeb, E. et al., 2016; Ryan and Miguel, 2003) referred only to the methods utilised for the attribute levels identification phase, while one study (Bech et al., 2011) did not document any methods for either phase.

The most frequently applied method, reported eight times across studies for either stage of DCE development, was literature/systematic review (Bakhurji et al., 2019; Barber, Sophy et al., 2019; Boyers et al., 2021; Kateeb, E.T. et al., 2014; Ryan and Miguel, 2003; Sever, Ivan et al., 2019c; Vennedey et al., 2018; Zhu et al., 2019). The first method always served to the attribute levels identification phase. Pilot studies came in second place being used seven times(Bakhurji et al., 2019; Barber, Sophy et al., 2019; Boyers et al., 2021; Kateeb, E.T. et al., 2014; Kiiskinen et al., 2010; Sever, Ivan et al., 2019c; Zhu et al., 2019). Pilot testing was used exclusively for testing face validity and the acceptability of a DCE questionnaire in seven of the eight studies which employed it, with one study using it both for attribute development and survey testing (Sever, Ivan et al., 2019c). Cognitive or semi-structured interviews (Barber, Sophy et al., 2019; Boyers et al., 2021; Kateeb, E.T. et al., 2014; Vennedey et al., 2018; Zhu et al., 2019) and written or online reports (Barber, Sophy et al., 2019; Kiiskinen et al., 2010; Kateeb, E. et al., 2016; Vennedey et al., 2018) were positioned third and fourth in frequency terms, being implemented five and four times across studies respectively. Written and online information was exclusively used in attribute development while cognitive/ semi-structured interviews contributed to both stages in two out of five times (Barber, Sophy et al., 2019; Vennedey et al., 2018). In two of the remaining cases, interviews were applied only for testing DCE face validity and acceptability and in one case it served the attribute development phase (Zhu et al., 2019). Focus groups appeared in three articles, in two of which being used for both attribute development and instrument testing (Sever, Ivan et al., 2019c; Vennedey et al., 2018), while just used in attribute development in one study (Boyers et al., 2021). Expert groups and rating and ranking exercises were implemented in four studies (Barber, Sophy et al., 2019; Kateeb, E. et al., 2016; Kateeb, E.T. et al., 2014; Zhu et al., 2019) and two studies (Barber, Sophy et al., 2019; Kateeb, E. et al., 2016) respectively, both methods used only for developing levels.

Table 2-1. Methods of attribute selection and survey development

Authors	DCE development	Literature review	Expert groups	Written and online reports	Focus groups	Cognitive interviews	Pilot test	Rating and ranking
(Barber, Sophy et al., 2019)	Attribute identification	✓	✓	✓	-	✓	-	✓
	Testing DCE face validity	-	-	-	-	✓	✓	-
(Sever, Ivan et al., 2019c; Sever, Ivan, 2018; Sever, Ivan et al., 2019b)	Attribute identification	✓	-	-	✓	-	✓	-
	Testing DCE face validity	-	-	-	✓	-	✓	-
(Boyers et al., 2021)	Attribute identification	✓	-	-	✓	-	-	-
	Testing DCE face validity	-	-	-	-	✓	✓	-
(Vennedey et al., 2018)	Attribute identification	✓	-	✓	✓	✓	-	-
	Testing DCE face validity	-	-	-	✓	✓	-	-
(Kateeb, E. et al., 2016)	Attribute identification	-	✓	✓	-	-	-	✓

	Testing DCE face validity	-	-	-	-	-	-	-
(Kateeb, E.T. et al., 2014)	Attribute identification	✓	✓	-	-	-	-	-
	Testing DCE face validity	-	-	-	-	✓	✓	-
(Kiiskinen et al., 2010)	Attribute identification	-	-	✓	-	-	-	-
	Testing DCE face validity	-	-	-	-	-	✓	-
(Zhu et al., 2019)	Attribute identification	✓	✓			✓		
	Testing DCE face validity						✓	
(Bakhurji et al., 2019)	Attribute identification	✓						
	Testing DCE face validity						✓	
(Ryan and Miguel, 2003)	Attribute identification	✓						
	Testing DCE face validity							

2.5.1.1 *Strengths and limitations of current qualitative methodological practice for developing DCE-CA in the dental field*

The previous paragraphs provided a detailed summary of the qualitative methodological practice for developing DCEs in dentistry. Dental DCE papers normally reported information on the use of a wide range of qualitative methods in the attribute development and testing DCE face validity phases. Most articles followed a mixed methods approach, applying a wide range of qualitative methods including literature reviews, expert groups, written and online data, focus groups, cognitive interviews, rating/ranking exercises and pilot studies. This approach benefited from a diverse set of advantages from multiple methods. One study suggested an iterative process of attributes development combining multiple methods at the same time(Barber, Sophy et al., 2019).

However, the papers rarely reported an analytical framework applied to analyse the data generated by qualitative methods such as focus groups and cognitive interviews, or presented the results of such analysis in a systematic way. One paper documented the use of thematic analysis of qualitative data and depicted the results in a schematic figure (Boyers et al., 2021). Even in that article though, interview data were analysed descriptively, lacking a systematic method of analysis (Boyers et al., 2021). All the remaining articles reported the qualitative methods used without providing further details on the analytical framework applied. They also presented the results of such methods in a descriptive rather than structured manner, e.g. tabular format. This demonstrated the lack of a standardised practice for qualitative data analysis and reporting in dental DCE literature, which could ensure a minimum level of quality in the application of these methods.

A mixed methods approach in an iterative process was adopted in this DCE study for the attribute development and survey instrument face validity phases, following best practices of the literature (Barber, Sophy et al., 2019; Boyers et al., 2021). A thematic analysis approach was used on data collected from qualitative methods. This study also attempted to address the limitation identified above concerning the lack of a standardised practice for qualitative data analysis and reporting in dental DCE studies. It accomplished this by applying a specific analytical framework on data collected from interviews and focus groups, to facilitate analysis and provide a simple technique which could be replicated in future DCE studies in the dental or medical field.

2.5.2 Experimental design methods and statistical analysis of dental DCE-CA studies

This section investigates the methods applied across the identified dental DCE studies to derive the survey statistical design, the regression form adopted, best model fit and the software used for analysis.

2.5.2.1 *Experimental design*

Figure 2-7 shows the frequency of using different methods used to generate choice sets. Of the dental DCE studies identified in the literature, a majority (eight articles) used a D-efficient design (Barber, Sophy et al., 2019; Bech et al., 2011; Boyers et al., 2021; Sever, I. et al., 2018; Sever, Ivan et al., 2019c; Sever, Ivan et al., 2019b; Vennedey et al., 2018; Zhu et al., 2019), two studies used an orthogonal design (Kateeb, E. et al., 2016; Kateeb, E.T. et al., 2014), one study used random pairing (Kiiskinen et al., 2010), one study used a full factorial design (Bakhurji et al., 2019) and one study did not report the method used to create the choice sets (Ryan and Miguel, 2003). SAS software was most often used to generate designs, (n=4), followed by Ngene (n=3). Figure 2-8 displayed the frequency of each source across studies.

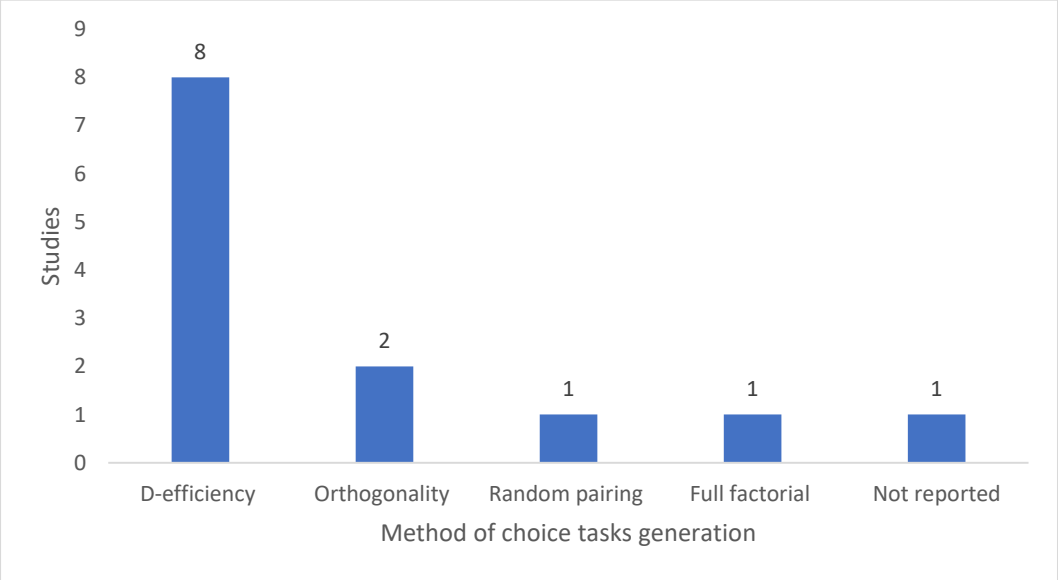


Figure 2-7. Method of choice tasks generation

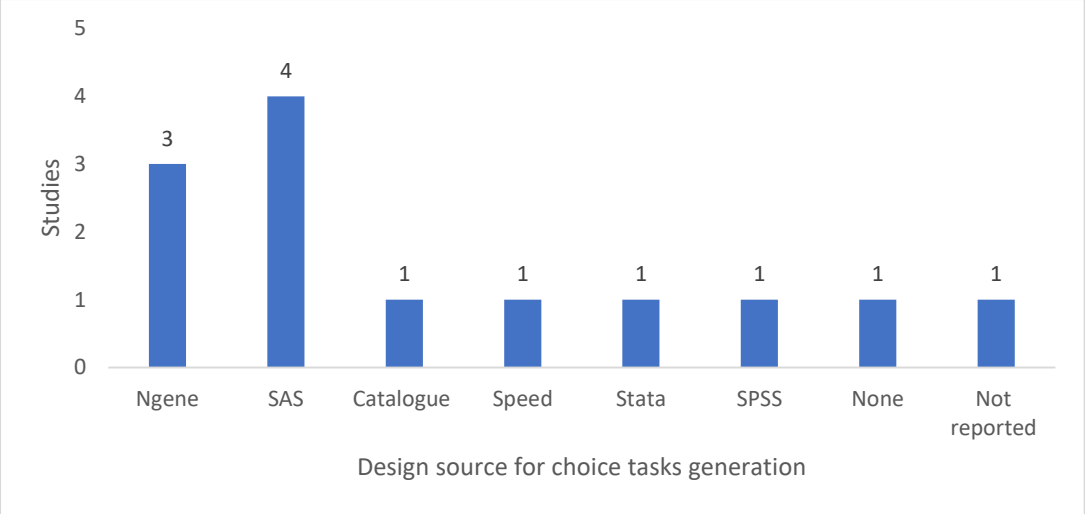


Figure 2-8. Design source for choice tasks generation

2.5.2.2 *Analysis of choice data in dental DCE-CA studies*

Figure 2-9 shows how often each model specification was used across studies. Although some studies used basic models, e.g. MNL standing for multinomial logit model, many studies used quite complex modelling approaches. There was also clearly not a one size fits all solution, since models were more appropriate in different studies depending on the data and aim of the study. The MNL (n=5), which assumed constant variance across respondents and the random parameter mixed logit model (n=4), which relaxed the former assumption by explicitly accounting for unobserved preference heterogeneity, were most commonly used. LC (Latent class) models were employed three times to explore heterogeneity in preferences. Endogenous attribute attendance (EAA) was applied twice to account for heuristics in patients' decision making and to investigate how such heuristics affected WTP estimates. Linear regression was applied twice when the dependent variable was continuous asking dentists about willingness to treat patients using ART (atraumatic restorative treatment).The error components logit was applied once to allow the alternative specific constant of treatment against no treatment choice attribute to be a normal random variable in one study. The probit model was used once to explain the behaviour of respondents regarding opt-out responses by individual and service characteristics. A heteroscedastic logit model was used once to relax the assumption of constant error variance across individuals and explore the influence of individual characteristics on the error variance. Nested logit model was reported once to check whether the treatment decision making process could be analysed as a two-phase process, firstly deciding whether treatment should be pursed and secondly choosing between treatments.

Figure 2-10 illustrates how many variables were modelled as random normal and lognormal variables, in mixed logit specifications. Four variables were modelled as following lognormal distribution

including, out of pocket cost (Vennedey et al., 2018) WTP for treatment explanation, WTP for staff behaviour, and WTP for waiting time in the office (Sever, Ivan et al., 2019c).

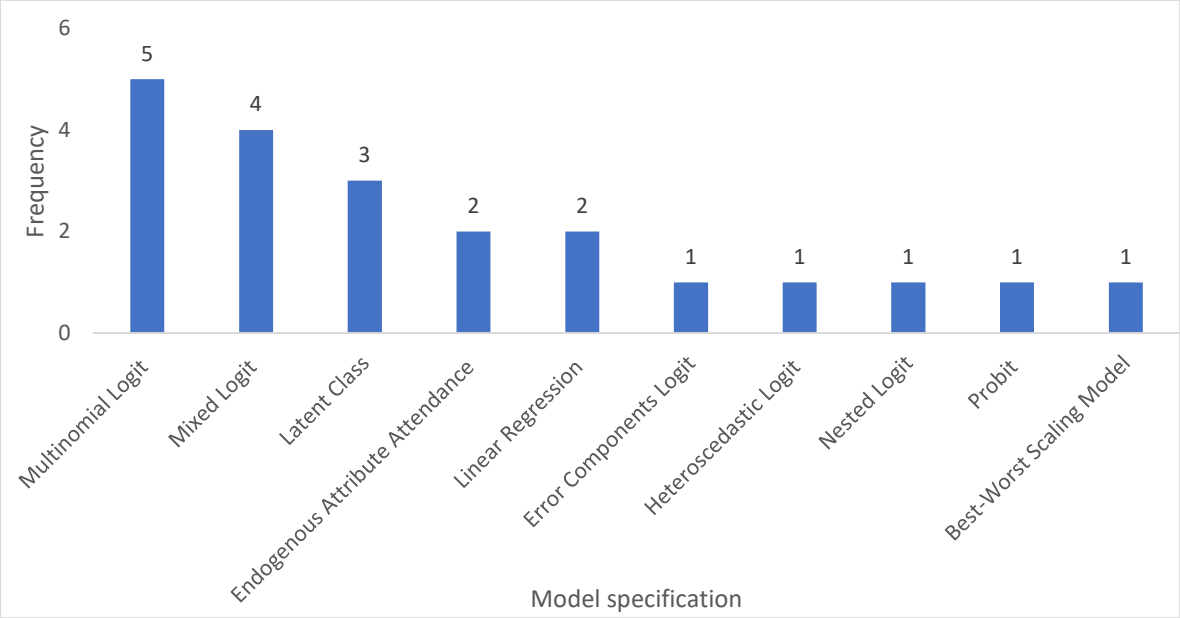


Figure 2-9. Model specifications for analysis of choice data

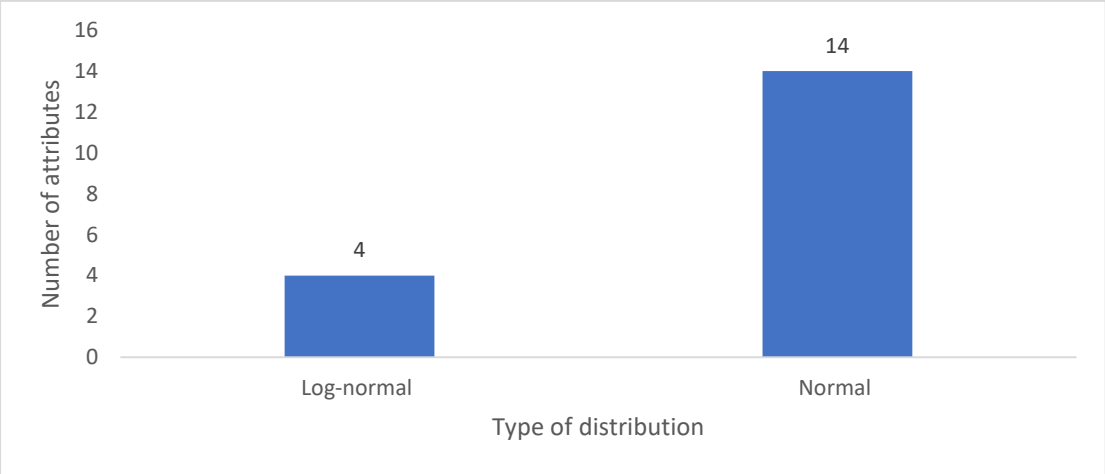


Figure 2-10. Number of attributes by distribution type in MXL specifications

2.5.3 Classes of attributes

The attributes included in the thirteen articles were classified into four broader categories, specifically outcome, process, patient characteristics and out of pocket cost attributes. Of the attributes included (n=64), 38 were classified as process attributes (59%), followed by 10 cost attributes (16%), eight outcome attributes (12.5%), and eight patient attributes (12.5%). Most studies (n=7, 64%) used attributes from two classes, process and cost (Bech et al., 2011; Kiiskinen et al., 2010; Ryan and Miguel, 2003; Sever, I. et al., 2018; Sever, Ivan et al., 2019c; Sever, Ivan et al., 2019b; Zhu et al., 2019). Three studies (27%) combined three attribute classes, namely outcome, process and cost (Barber, Sophy et al., 2019; Boyers et al., 2021; Vennedey et al., 2018). All three studies looking at dentists' decision making used only patient attributes (Bakhurji et al., 2019; Kateeb, E. et al., 2016; Kateeb, E.T. et al., 2014).

Process attributes reported across studies included type of treatment, choice of treatment or no treatment, frequency of visits, type of service (public or private), type of hospital, waiting time, availability of dentist in non-business hours, travel to the dental office and others encompassing existence of dental equipment such as x-ray machines, or options of costs refund and choice of dentist. Waiting time was the most frequent process attribute included (n=8) (Barber, Sophy et al., 2019; Kiiskinen et al., 2010; Ryan and Miguel, 2003; Sever, I. et al., 2018; Sever, Ivan et al., 2019c; Sever, Ivan et al., 2019b), followed by travel to the dentist (Bech et al., 2011; Kiiskinen et al., 2010; Ryan and Miguel, 2003; Zhu et al., 2019). Waiting time in the office was the most commonly used type of waiting time, included in five studies (Ryan and Miguel, 2003; Sever, Ivan, 2018; Sever, Ivan et al., 2019c; Sever, Ivan et al., 2019b; Zhu et al., 2019), followed by waiting time for an appointment, used in three studies (Barber, Sophy et al., 2019; Kiiskinen et al., 2010; Ryan and Miguel, 2003). Travel time (Kiiskinen et al., 2010; Zhu et al., 2019) and distance to the office (Bech et al., 2011; Ryan and Miguel, 2003) shared an equal number of two appearances as travel to the dentist. Choice of treatment or no treatment (Bech et al., 2011; Boyers et al., 2021; Kiiskinen et al., 2010), type of service (Sever, I. et al., 2018; Sever, Ivan et al., 2019c; Sever, Ivan et al., 2019b), and visit frequency (Barber, Sophy et al., 2019; Kiiskinen et al., 2010; Vennedey et al., 2018) appeared in three studies each.

Four effectiveness (Barber, Sophy et al., 2019; Boyers et al., 2021; Vennedey et al., 2018) and four adverse events attributes (Barber, Sophy et al., 2019; Boyers et al., 2021; Vennedey et al., 2018) were included as outcome attributes. Appearance was the most frequent effectiveness attribute, included in two studies (Barber, Sophy et al., 2019; Boyers et al., 2021), followed by tooth loss within next 10 years (n=1) (Vennedey et al., 2018) and function (n=1) (Barber, Sophy et al., 2019). Complaints/symptoms (Vennedey et al., 2018), bleeding (Boyers et al., 2021), discomfort (Barber,

Sophy et al., 2019) and problems during treatment (Barber, Sophy et al., 2019) were the adverse events attributes used.

The most frequent patient attribute was dental insurance (Bakhurji et al., 2019; Kateeb, E. et al., 2016; Kateeb, E.T. et al., 2014), followed by cooperativeness, and age, each included in two studies (Kateeb, E. et al., 2016; Kateeb, E.T. et al., 2014) and caries risk in one study (Bakhurji et al., 2019).

Ten studies used out of pocket costs (Barber, Sophy et al., 2019; Bech et al., 2011; Boyers et al., 2021; Kiiskinen et al., 2010; Ryan and Miguel, 2003; Sever, I. et al., 2018; Sever, Ivan et al., 2019c; Sever, Ivan et al., 2019b; Vennedey et al., 2018; Zhu et al., 2019). No other attributes regarding costs were reported.

2.5.4 Validity of dental DCE-CA studies

The number of studies that applied different validity tests are presented in Figure 2-11.

Most studies (n=8) applied continuity tests, referring to compensatory decision making (Bech et al., 2011; Boyers et al., 2021; Kateeb, E. et al., 2016; Kateeb, E.T. et al., 2014; Kiiskinen et al., 2010; Sever, Ivan et al., 2019c; Sever, Ivan et al., 2019b; Zhu et al., 2019). Continuity refers to the assumption of unlimited substitutability between attributes (McIntosh and Ryan, 2002), i.e. for any pair of attributes, it is assumed there always exists some level of improvement in one attribute that could compensate an individual for a deterioration of the other attribute, while leaving the respondent on the same indifference curve. Such tests involved checking for always choosing left or right option, known as straight lining, or always choosing the opt-out alternative, or always choosing a specific label in case of a labelled experiment. All these practices were identified as straight lining effects in this study. Continuity tests also controlled for respondents always selecting the alternative with the best level of a particular attribute independently of the levels of other attributes, which could also signify the absence of trading behaviour.

Two studies (Sever, Ivan et al., 2019c; Sever, Ivan et al., 2019b) applied a EAA model accounting for attribute non-attendance effects. This model relaxed the assumption of fully compensatory behaviour and explicitly accounted for the fact that participants may consider only a subset of attributes when making choices (Hole, 2011). The studies fit an EAA model to specifically account for non-attendance to the cost attribute, so that WTP measures deriving from different models, including mixed logit in WTP space, conditional multinomial logit and EEA, could be compared. This approach was motivated by the fact that respondents might have disregarded the cost attribute in a state funded healthcare context.

Fewer studies (n=3) reported tests to confirm internal theoretical validity (Barber, Sophy et al., 2019; Sever, I. et al., 2018; Sever, Ivan et al., 2019c). Such tests constituted an assessment of whether coefficients appeared to move in compliance with prior expectations.

Tests for preference monotonicity (non-satiation), were less frequently reported, with only one study (Vennedey et al., 2018) including a dominance task to assess such behaviour. Monotonicity tests assume that more is always preferred to less (Lancsar and Louviere, 2006). The infrequent use of such tests in dental DCE papers could reflect concerns that these tend to be passed so that they are relatively weak tests of validity. Furthermore, a study (Lancsar and Louviere, 2006) reports that preferences appearing to be “irrational” may in practice be in line with some form of rationality. It is argued that it is unlikely that all responses considered as “irrational” are indeed so because of several factors underlying what seems “irrational” to researchers. These involve shortcomings in the design

and application of choice experiments, participants' learning effects resulting from a gradual preference formation via learning about the trade-offs they are prepared to make and about the task itself and inconclusiveness of the available tests which could mislabel rational responses as "irrational"(Lancsar and Louviere, 2006). In additional some individuals may pay more attention in answering the choice tasks at the start of the questionnaire than at the end of it. Hence to delete such responses could lead to removal of valid choice responses which may drive to biased results and reduced observations on which to base statistical tests (Lancsar and Louviere, 2006). It is also suggested that non-traders deleted previously in some DCE datasets, are of particular interest since they have strong preferences on at least one attribute and evidence supports that RUT, i.e., random utility theory, could cope with such preferences (Lancsar and Louviere, 2006). These may be the reasons why the only study including a dominance test used all responses in the final analysis irrespective of passing the test (Vennedey et al., 2018).

Two studies explored whether the axiom of completeness was satisfied (Boyers et al., 2021; Ryan and Miguel, 2003). Completeness reflects whether the individual has a well-defined preference between any two possible alternatives. One study (Ryan and Miguel, 2003) focused on completeness comparing results in relation to this axiom among three different services including a dental check-up appointment, supermarket and a bowel cancer-screening test. Overall, the study concluded that similar levels of preference completeness were observed for all services, irrespective of the respondent's familiarity with a service. Another study simply used a repeated choice task, known as a consistency test, to check for similarity of responses by each individual (Boyers et al., 2021). However, the authors reported that respondents failing the consistency test were not excluded from the estimation sample. A possible explanation could be attributed to the fact that seemingly "irrational" preferences may in reality be compatible with some form of rationality, following non-exclusion of respondents failing monotonicity tests as a good practice (Lancsar and Louviere, 2006). More details about this effect were reported in the previous paragraph

Tests of external validity are particularly useful because stated preferences from DCEs could be compared with revealed preferences. However, there is little scope to apply tests of external validity, especially if DCEs are used in the context of state funded health care provision. None of the studies used an external validity test, with three of them explicitly reporting as the reason for not using such a test the fact that individuals did not pay at the point of consumption in a state-funded healthcare context, and hence no comparison with revealed WTP was feasible (Sever, I. et al., 2018; Sever, Ivan et al., 2019c; Sever, Ivan et al., 2019b).

None of the studies reported tests of transitivity and regularity axioms. Transitivity rules out the possibility of preference cycles (McIntosh and Ryan, 2002). For example. if an individual after facing a pair of goods A and B and expressing a preference for A over B, is then encountered with another pair of goods, A and B-,where B- is inferior to B in at least one attribute level, then the individual should choose A over B-. Regularity, also known as Sen's expansion and contraction property, refers to the axiom that if option A is preferred to option B in choice set 1, then if a second set contains options A, B and C, it could not be the case that the probability of choosing B was higher in set 2 (Lancsar and Louviere, 2006). The absence of such tests could be explained by an increased cognitive burden on respondents if they are included on top of design choice tasks. In addition, it is argued that seemingly "irrational" preferences may in reality be compatible with some form of rationality and hence excluding respondents failing such tests may not always be the best practice (Lancsar and Louviere, 2006).

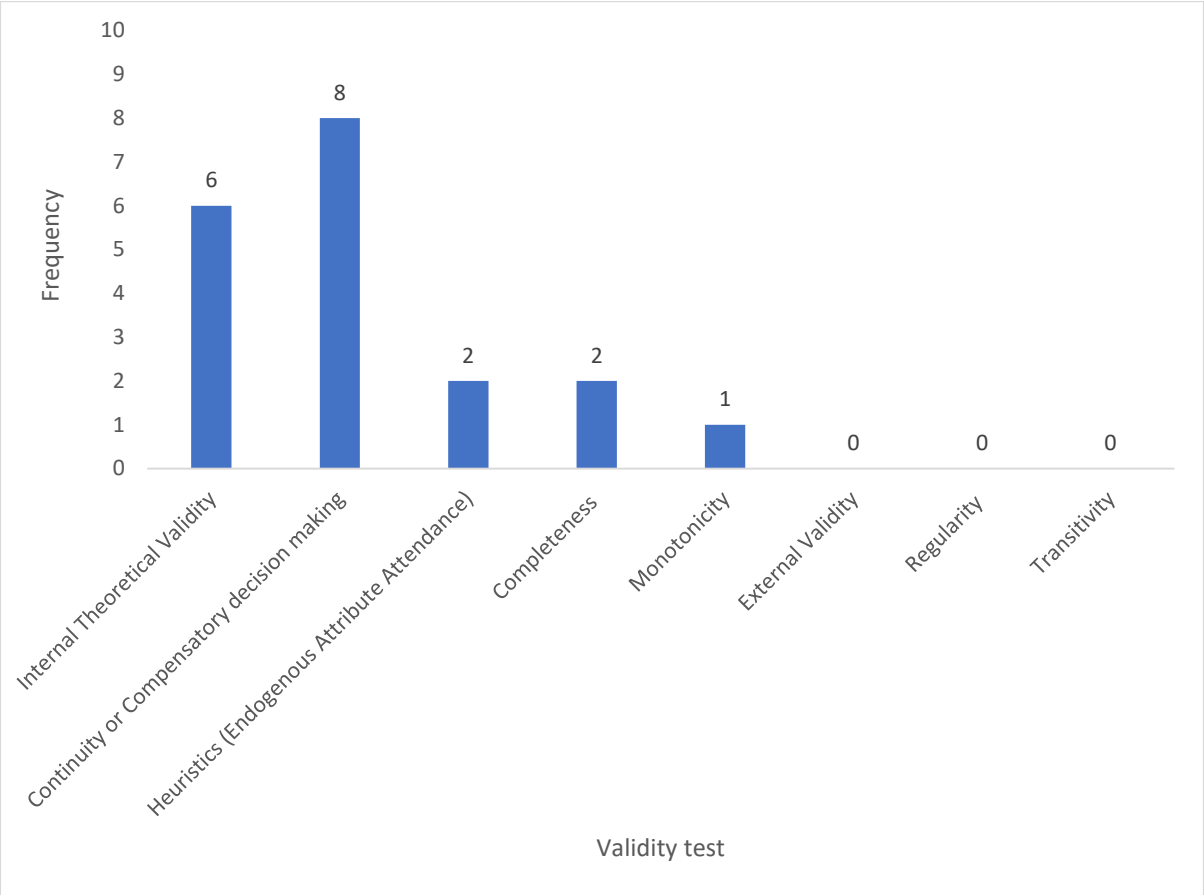


Figure 2-11. Validity tests

Internal theoretical validity was tested in this study by comparing signs of preference and WTP coefficients with prior expectations. This would confirm that the preference model was valid, and participants answered the choice tasks in a logical manner. As one of the aims of this study was to explore trade-offs between attributes for dentists and patients which would lead to appropriate policy

measures to increase dental prevention, it should be ensured that trading behaviour occurred in both DCE surveys. Compensatory decision making was assessed by identifying respondents always choosing the alternative option presented at a fixed position and those always selecting the alternative with the best level of a particular attribute independently of the levels of other attributes. Attribute non-attendance was tested in the patient DCE study but not in dentist DCE study as the main model in the dentist DCE included interactions, and it would be challenging to disentangle preference heterogeneity from attribute nonattendance effects. Dominance, repeated regularity and transitivity tests were not implemented to keep cognitive burden at a lower level, as the literature supported that failure in such tests would not necessarily indicate that respondents answered the choice tasks in an irrational manner (Lancsar and Louviere, 2006). Furthermore, tests of external validity were not applied in this study because a stated funded oral care system in the UK and ROI did not allow for comparison of stated preferences with revealed preferences.

2.5.5 Quality assessment of dental DCE-CA studies

The 10 point checklist created by ISPOR was implemented to appraise the dental DCE studies on a range of 10 dimensions or quality markers (Bridges et al., 2011; Barber, S et al., 2018). Each of the 10 dimensions was comprised of three indicator questions which were scored 0 for incomplete and 1 for complete inputs, leading to a maximum score of 30. Data elicitation and quality performance was evaluated in terms of satisfying these 10 dimensions. Five studies were excluded from quality assessment analysis because they explored methodological aspects of DCEs and hence were ineligible for review following the 10-point checklist (Bech et al., 2011; Kiiskinen et al., 2010; Ryan and Miguel, 2003; Sever, Ivan et al., 2019c; Sever, Ivan et al., 2019b). The scores of quality assessment by study and by ISPOR dimension are presented in Table 2-2.

Scores for the remaining studies (n=8) varied between 15 and 23. Most studies (n=7) were similarly scored with a maximum difference range of 2 points. The other study scored 18 points. Most studies scored at least 1 point per dimension except for two studies. These studies failed to meet the criteria for statistical analyses and model estimation. This could be explained by the fact that none of them provided information on whether sample respondent characteristics matched population characteristics to ensure generalisability of findings, or applied any tests for quality of responses or accounted for issues of clustering and subgroups analysis in their models.

The dimension assigned the highest total score, i.e. the sum of scores across all studies, was data collection plan, which had 23 out of a maximum score of 27 points. Data collection plan dealt with the collection of appropriate respondent information, definition of attributes and levels, and motivation of respondents by setting the burden of data-collection instrument at an appropriate level. Research question and choice design as well as construction of tasks followed in the second place both scoring 21/27. Definition of research question and choice design involved articulation of testable hypotheses, mention of study perspective and explanation for using DCE-CA to answer the research question. Construction of tasks related to justification of number of attribute in each task, number of profiles in each task and inclusion of an opt-out or status-quo alternative.

The two dimensions which were assigned the lowest total scores across studies were statistical analyses and model estimation, scoring just 12 out of 27 points, and preference elicitation, scoring 15 out of 27 points. Description of statistical analyses and model estimation criteria was provided in the second paragraph of this page. Preference elicitation was associated with the reasoning for using a DCE choice format over other available formats such as BWS and rating/ ranking exercises and inclusion of other qualifying questions on top of choice tasks to explore strength or confidence of preferences.

Table 2-2. Quality assessment of dental DCE studies

Quality assessment scores by study	(Sever, I. et al., 2018)	(Vennedey et al., 2018)	(Barber, Sophy et al., 2019)	(Boyers et al., 2021)	(Kateeb, E.T. et al., 2014)	(Kateeb, E. et al., 2016)	(Zhu et al., 2019)	(Bakhurji et al., 2019)	**Total dimension score**
Research question and choice design	2	3	3	2	3	3	2	3	21
Choice of attributes and levels	2	3	2	3	3	1	3	1	18
Construction of tasks	3	1	3	3	3	3	3	2	21
Choice of experimental design	3	3	2	3	2	2	3	1	19
Preference elicitation	1	2	2	1	2	3	1	2	14
Data collection instrument	2	2	3	2	2	2	2	2	17
Data collection plan	3	3	3	3	3	3	2	3	23
Statistical analyses and model estimation	1	2	0	3	1	2	3	0	12
Results and conclusions	3	1	2	2	2	2	2	2	16
Study presentation	2	3	2	2	2	2	2	2	17
Total quality score	22	23	22	24	23	23	23	18	

2.6 Research gap as resulted by the literature reviews findings

The literature review presented in this chapter revealed that none of the articles investigated preferences of dentists or patients in prevention of dental caries using a DCE experiment. This study explored the most important attributes influencing decisions of patients in receiving preventive care for dental caries. It also investigated the most influential factors which affected the preferences of dentists in delivering a mix of preventive and restorative care for dental caries. Two DCEs were developed to fill this gap in the literature by estimating dentists' and patients' direction and strength of preferences for attributes of dental caries prevention, as well as trade-offs between these attributes.

The literature review indicated that DCE was the most appropriate method for preference analysis with patients. The review also offered useful benchmark findings on patients' preferences for dental caries prevention. These findings were related to preference direction and a range of WTP for preventive care treatments which were compared with results of this study to test validity. Furthermore, the review provided similar results for non-treatment attributes including waiting time and travel time to the dental office. This review also elicited information on patients' characteristics which were shown to influence their preferences for prevention of caries. These findings were compared with LC results in this study associating patients' sociodemographic characteristics and behaviours with preferences for preventive care.

In addition, the literature review suggested that DCE was the most appropriate method for preference analysis with dentists. The review also provided information on patients' characteristics which were influential in decision making of dentists. Dentists' preference direction for preventive and restorative treatment with different patients varying on factors such as risk of caries, caries condition, age etc. found in the literature were compared with results of this study to confirm validity. The review also provided information on dentists' characteristics and practices which were shown to influence their preferences for preventive and restorative care. These findings were compared with LC results in this study associating dentists' sociodemographic characteristics and practices with preferences for treatment of dental caries.

Furthermore, the literature review guided the analysis in terms of methodological considerations including decisions regarding the most appropriate methods to develop the attribute levels and ensure face validity of the DCE surveys, generate choice tasks, analyse the choice data and confirm the DCE assumptions by applying tests on choice rationality and trading behaviour.

3. Methods

This chapter is split into three sections. The first part deals with wider factors which are common in a DCE study including objectives, methods of attributes development, labelled or unlabelled design, response format and blocking the design. The second part displays the methods used to develop the dentist DCE questionnaire and analyse the preference data. The third part presents the methods used to develop the patient DCE questionnaire and analyse the preference data.

3.1 Considerations in the application of a DCE in dentist and patient studies

The dentist DCE study tried to answer the following questions. 1. What is the relative importance for service attributes of dental care depending on patient characteristics? 2. Whether preferences for dental care are characterised by heterogeneity and whether potential heterogeneity could be explained by individual characteristics of dentists. Study population of the dentist study were dentists practising in either the UK or ROI. This study investigated preferences of dentists for delivering preventive and restorative care for dental caries. A mixed private-public setting approach was adopted. The dentist DCE asked participants to choose between treatment plans for dental caries to be delivered to hypothetical patients presented in the form of descriptive vignettes. Outcomes of dentist DCE study were preferences for service attributes and how they changed in response of patient characteristics. Service attributes included preventive treatment, preventive advice, restorative treatment and income. Patient characteristics attributes consisted of age, risk of developing caries and caries condition as depicted through medical photographs. The clinical outcomes of treatment plans were not explicitly stated. A discrete forced choice design was used in this study where dentists were invited to choose between two profiles in each task with no-out option. Participants could abstain from answering the choice tasks.

The patient DCE study tried to answer the following questions. 1. What is the WTP for service attributes of dental care? 2. Whether preferences for dental care are characterised by heterogeneity and whether potential heterogeneity could be explained by individual characteristics of patients. Study population of the patient study were patients or members of the general public in either the UK or ROI. The patient DCE asked participants to choose between dental check-up appointments. A mixed private-public setting approach was adopted. The outcomes of the patient DCE were preferences for service attributes, specifically oral hygiene advice, dietary advice, preventive treatment, the type of dental provider who delivered treatment, transport time to the dental office, waiting time to get the appointment and out of pocket costs for the dental check-up. The clinical outcomes of dental appointments were not explicitly stated. A discrete forced choice design was used in this study where patients were invited to choose between two profiles in each task with no-out option. Participants could abstain from answering the choice tasks.

3.1.1 Qualitative methods for elicitation of attributes and development of a DCE survey

According to the literature, an attribute should have three basic elements: being important to patients/respondents, being 'plausible' and capable of being traded (Ryan, 1996). Four basic principles should be considered in attribute development to ensure rigorous and reliable DCE results.

- Attributes selected should incorporate all those that might have been significant for an individual in reaching to a decision within a specific context, as ignoring important attributes in the DCE may distort findings (Lancsar and Louviere, 2008).
- Attributes could not be too close to the underlying subject that the DCE is examining. For example, when investigating patient preferences for prevention none of the attributes should be identical to the concept of prevention itself, such as the inclusion of a distinct attribute reflecting choice of pursuing prevention.
- It should be ensured that no single attribute or any of its levels would have a dominant effect on participants' decisions. Such an effect would violate the RUT assuming that there is a non-zero possibility of selection for every alternative (Flynn et al., 2008).
- Attributes should be strictly intrinsic to the service only and not dependent on respondents' personality, as well as able experimentally to be manipulated by intervention.

To develop a complete list of attribute levels a range of qualitative methods have been suggested. First, literature search is a useful method to generate a list of potential attributes for inclusion in the DCE (Hiligsmann et al., 2013), even though it is rare that a literature search alone suffices to obtain all the desired information for the attribute development process (Coast et al., 2012). Expert opinion is usually employed to refine the attribues and their levels which resulted from literature reviews, expert groups and interviews (Abiiro et al., 2014). Confidence ratings, pilot surveys, rating/ranking exercises and review of published materials are also deployed to enhance the validity of attribute development process in DCEs (Barber, Sophy et al., 2019; Coast et al., 2012). Further qualitative work, including focus groups and cognitive interviews, allow the researcher to explore the views of those directly affected by a decision in a manner that is directly relevant to the topic. In addition such methods reduce the potential for misspecification of attributes through over-dependence on the views of experts or researchers (Coast et al., 2012). A key strength of qualitative methods is being able to collate important contextual data alongside quantitative preference data (Vass et al., 2017). As the literature suggested, the most prominent method for the success of such experiments is a multistep mixed methods process (Coast et al., 2012; De Brún et al., 2018; Rydén et al., 2017; Mathijssen et al., 2018). During such a process, a mix of methods are employed to collect raw data, reduce data, remove inappropriate attributes and use the correct wording for the attributes (Helter and Boehler, 2016).

The combination of multiple methods in an iterative process under which data collection and analysis proceeded concurrently, with iterations not being preselected in either size or scope ensures that attribute development process is benefited from a wide range of strengths offered by various methods.(Coast et al., 2007; De Brún et al., 2018). The research transitions from one iteration to another until due to framework analysis conducted up to that point, emerging themes changes the target of questioning (Coast et al., 2007). Each iteration involves one of the pre-described methodologies, i.e. literature reviews, expert groups, focus groups, cognitive interviews, confidence ratings and analysis of published data until attributes, levels, questionnaire structure and content is saturated enough and no new emerging theme could develop out of any new iteration, e.g. the common themes are being constantly repeated without any new information arising. Several questionnaire versions evolve during these iterations based on constant updating, resulting from the qualitative methods applied to each version intended to improve validity and reliability of the DCE (Coast et al., 2012).

Previous studies emphasized the lack of rigor in conducting and documenting attribute development while underlined that biased or useless results of a DCE were inevitably more probable when the process for developing attributes missed a detailed, meticulous and rigorous approach (Coast et al., 2012). Literature generally recognised four distinct stages engaged with the attribute development process including raw data collection, data reduction, removing inappropriate attributes and wording of attributes (Coast et al., 2012).

Hence, a mixed methods iterative process was followed in both the dentist and patient DCE studies to facilitate elicitation of attributes and development of the DCE survey.

3.1.2 Labelled versus unlabelled experiments

A fundamental issue that occurs in stated preference experiments is whether to treat the alternatives' names as labels, i.e. using a labelled experimental design, or to use an unlabelled design (Jin et al., 2017). Experiments with labelled alternatives are usually applied to convey additional information regarding the tangible or intangible qualities of alternative options (Jin et al., 2017), which are not addressed by the presented attribute levels. For example using brand names of a service as labels in a DCE experiment would have connotations associated with these brands, such as in relation to perceived quality or loyalty linked with a specific brand. Different treatments of alternatives' names have further ramifications in the design and presentation phases of the experiment (Jin et al., 2017). In the labelled design method, alternatives' names are faced as labels and alternatives with different labels stem from different candidate alternative sets. (Jin et al., 2017; Ramsay et al., 2018).

There are benefits and restrictions in both approaches. In a labelled experiment, the number of alternative options in a choice set normally equals the number of distinct names of alternatives (Jin et al., 2017). Such an effect would result in a larger number of alternatives in the choice set as the number of distinct alternatives' names rise, inducing overburden and difficulties in the choice making process (Jin et al., 2017). At the other end of the spectrum, the unlabelled design method provides flexibility with respect to the number of alternatives presented in the choice set, which could reduce choice complexity, especially when the alternatives have a large range of distinct names (Jin et al., 2017).

Furthermore, in a labelled design the choice set has one alternative for each distinct name, which is not desirable when respondents always select an option based on the alternatives' names prohibiting trading behaviour. This attribute non-attendance effect was reported in the dental literature (Sever, Ivan et al., 2019c). However, under the unlabelled design method, where alternatives' names are treated only as attributes, the generated choice set could incorporate more than one alternatives having the same name (Boyers et al., 2021). Unlabelled designs motivate respondents to select an alternative by trading off attribute levels, which is advocated from a non-market valuation approach (Mitchell and Carson, 2013). Hence, the main issue with the labelled presentation style is that some respondents base their responses wholly or largely on the alternatives' names, ignoring or paying less attention to the actual attribute levels associated with the alternatives (Jin et al., 2017). The literature confirms that individuals often use heuristics or information processing strategies when making choices (Scarpa et al., 2009; Hess and Hensher, 2010) instead of maximising the utility derived from selecting an option in relation to the non-selected available options. It also reveals evidence that a proportion of individuals make their choices merely on the basis of the alternative's label (Doherty et al., 2013).

Researchers suggest that specific benefits of unlabelled designs are that they do not necessitate the identification and use of all alternatives in the universal set of alternatives, as far as the attribute levels suffice broadly to represent all alternatives (De Bekker-Grob et al., 2010). They consist of a more robust method for not violating IID assumption, which entails that error terms are independent and identically distributed between alternatives, as alternatives in unlabelled designs are less correlated with the attributes in comparison to the labelled experiments (Hensher et al., 2005). In labelled experiments for example, correlation between alternatives and attributes is usually explicitly inserted by the researcher in the design estimation, i.e. by exclusion of illogical attribute level combinations, which may not be necessary for unlabelled designs. Contrary to this, the merits of applying labelled DCEs includes that they tend to be more realistic in certain situations and less abstract so that the

responses are associated to greater extent with real preferences structure (De Bekker-Grob et al., 2010).

To enhance trading behaviour and restrict use of heuristics or information processing strategies among respondents in decision making, an unlabelled design was preferred in both the dentist and patient DCE studies.

3.1.3 Forced choice versus inclusion of an outside/opt out option format

The most common approach to analysing DCE responses is based on the RUT (Louviere et al., 2000; de Bekker-Grob and Chorus, 2013), which assumes that respondents choose rationally and select the scenario that provides the highest personal utility, which means that participants only select the opt-out if none of the presented scenarios is more attractive than the opt-out (Karni and Schwartz, 1977). Research demonstrates that using a forced perspective, i.e. forcing respondents to opt-in, could induce bias as they would not always make the same selection in real life (Dhar and Simonson, 2003; Krosnick et al., 2002). In such forced choice situations, people who would rather opt-out are prone to randomly choose either scenario from a choice task or select the most safe, least extreme scenario (Luce et al., 1999; Dhar and Simonson, 2003; Krosnick et al., 2002). Consequently, the standard error of the attribute estimates rises while the external validity is reduced (Krosnick et al., 2002; Dhar and Simonson, 2003).

In practice, other incentives than achieving maximum utility may prevail when participants make their choices (Boxall et al., 2009; Iyengar and Kamenica, 2006). This leads to the hypothesis that only a subgroup of respondents act solely according to RUT, just defined above, when selecting the opt-out option. Additional research reveals that individuals choose the opt-out alternative to protect themselves from making poor choices, as they perceive negative outcomes from taking action. In other words, the perceived negative outcomes of opting-in but choosing an inferior alternative are worse than the negative outcomes because of inactivity, i.e. by not making a choice (Ritov and Baron, 1992). Such conclusions are also validated by others (Boxall et al., 2009; Meyerhoff and Liebe, 2009) and specifically a theory which proposes that if people decide to make a choice, the inclination to opt-out increases as the trade-off becomes more difficult and the decision at hand obtains emotional burden (Luce et al., 1999). This fact suggests that people select to opt-out to evade decision making involving difficult trade-offs. Other studies show that choice task complexity in terms of a large number of choice situations per choice task, or comparable choice situations in terms of their attractiveness, would drive to more opting out (Dhar and Simonson, 2003). Summing up, it appears that individuals select to opt-out more often if they need to decide about a complex emotionally charged topic, choice tasks are difficult, scenarios are intricate and no scenario is clearly superior. This

way respondents seem to minimise their effort and decrease internal conflict triggered by “negative” or challenging decision making (Veldwijk et al., 2014).

On the other hand, the literature confirms that if the objective of the study is mainly to estimate marginal rates of substitution among attributes and compare the significance of attribute levels in choice experiments, an opt out option would be unnecessary and instead forced choice tasks should be applied (Ben-Akiva et al., 2019). This is in contrast to studies aiming to predict the likely adoption of a new intervention, treatment, service or medication through market shares, where the opt-out option is required to create realism in the sense that participants are not urged to choose between the experimentally designed alternatives and could instead opt out (Ben-Akiva et al., 2019).

Research shows that when comparing attribute estimates and relative importance between a forced-choice dataset and an opt-out dataset, there are not notable differences in the relative order of the attributes (Veldwijk et al., 2014). However, statistically significant differences are observed in WTP measures for certain attributes (Veldwijk et al., 2014). These differences are attributed to the fact that the independence of irrelevant alternatives (IIA) assumption for forced-choice data does not hold in unforced data (Dhar and Simonson, 2003). It is argued that if this assumption held, including an opt-out would bring no change to the study outcomes as it would take equal proportions of all attribute estimates and hence inclusion of the opt-out would not be needed for the accurate prediction of a participants’ preferences and trade-offs (Dhar and Simonson, 2003). It is proved though that adding an opt-out option to a forced choice model disproportionately alters study results, since this option competes more with one scenario than the other in the same choice task (Shafir et al., 1993), confirming invalidity of the IIA assumption for forced-choice data in the unforced choice sets.

Relaxing the IIA assumption in modelling forced choice dataset by allowing for random estimates through fitting a MXL model, could provide more similar findings in terms of attribute estimates and WTP measures whether including an opt-out option or not. It is noticed that differences in attribute estimates and WTP values between a forced-choice dataset and an opt-out dataset are not statistically significant and that their confidence intervals overlap when attribute estimates are modelled as random parameters (Sever, Ivan et al., 2019a; Veldwijk et al., 2014). Therefore, fitting a model on forced choice dataset which allows for random parameters such as a MXL specification would allow for valid estimation of preference and trade-off coefficients more like using an unforced choice dataset.

To maximise effort in making choices among respondents and decrease internal conflict triggered by “negative” or challenging decision making, a forced choice format was preferred in both studies. This format also led to simpler choice tasks and improved efficiency by inhibiting opting-out and

encouraging participants to trade between attributes. MXL specifications were used in both studies to allow for valid estimation of preference and trade-off coefficients.

3.1.4 Colour coding

An extensive part of the literature demonstrates that participants in DCE surveys sometimes simplify the choice tasks by ignoring one or more of the presented attributes (Lagarde, 2013; Erdem et al., 2015). This could lead to biased preference estimates and meaningless WTP measures if not adequately controlling for it. To restrict such behaviours and maximise the chances of respondents paying full attention to the available attributes, there are a number of techniques such as colour coding. Colour coding and visually informative presentations could be utilised to decrease the level of task complexity and therefore reduce the need for choice heuristics (Hawley et al., 2008; Hauber et al., 2010). Related research finds that the introduction of colour coding decreases dropout rates and increases attribute attendance in a DCE evaluating different dimensions of health states (Jonker et al., 2018). Colour coding was applied in both the current studies.

3.1.5 Experimental design

The design of a conjoint experiment determines the number of choice scenarios offered to each subject, the nature and number of options on each scenario, the number of attributes and attribute levels presented for each option and the design of the choice profiles or sets of the options placed in each scenario (Ben-Akiva et al., 2019). The levels of the attributes of the options provided in different choice scenarios can be chosen to maximise the chances of distinguishing statistically the weights that participants assigned to the different attributes, avoiding misidentification issues resulting from multi-collinearity problems, i.e. high correlation between the different attributes (Ben-Akiva et al., 2019). In the current work, the emphasis was on ensuring that choice scenarios were realistic and included adequate independent variation in the attributes so that the influence of each attribute on choice could be isolated statistically. The classical statistical literature on experimental design targets the analysis of variance and underlined orthogonality properties that allow simple computation of main and interaction effects, and treatments that provide minimum variance estimates (Ben-Akiva et al., 2019). Designs that decrease some measure of sampling variance under specified model parameters such as the determinant of the covariance matrix for "D-efficiency"[1] are applied in market research (Ben-Akiva et al., 2019).

A D-efficient design could be applied to set up choice scenarios based on minimising the sampling variance of specified parameters (Kessels et al., 2011; Bridges et al., 2011). This approach reduces the

[1] D-efficiency referred to a measure used in DCEs to provide information of a statistical design. D-efficiency of a statistical design was estimated by minimizing variances and covariances of parameter estimates based on a-priori assumptions of model specification.

full range of choice scenarios of a complete design named as full factorial design down to a more manageable level called fractional factorial design which permits the inclusion of all relevant effects by also lowering the cognitive burden suffered by each participant in the decision making process. A D-efficient design was estimated in both studies.

3.1.6 Blocked designs

Blocked designs could be estimated in a DCE. Blocks are surveys encompassing different sets of choice tasks e.g. presenting different combinations of attribute levels where participants are randomly assigned to each block (Vanniyasingam et al., 2016). In other words, blocks are partitions of the choice questions, usually equal in size, in the experimental design that include a limited number of choice questions for each participant (Johnson, F.R. et al., 2013). For example, if the experimental design has 50 choice tasks, they could be split into five blocks of 10 questions each. Each respondent would then be randomly assigned to one block and complete only the choice questions in that block instead of the entire design.

Blocking is a useful tool to increase the range of information collected by respondents' answers to the different sets of choice tasks, as usually an experimental design would contain more choice questions than the researcher wishes to ask each respondent. It also promotes response efficiency by reducing the level of complexity which rises as the number of choice tasks faced by each individual increases (Bech et al., 2011; Johnson, F.R. et al., 2013). For example, a study investigating the most preferred knowledge translation approaches among individuals employed at addiction agencies, uses close to a thousand blocks, i.e. 999, of 18 choice tasks each to design 53,946 hypothetical scenarios out of 967,296 possible level combinations, resulting from sixteen attributes with four levels each, i.e. 4^{16} (Cunningham, C.E. et al., 2012).

On the other hand, a limitation of this approach is that the desirable statistical properties of the experimental design, such as minimum correlations among attribute levels or minimum sampling variance of specified parameters, does not necessarily hold for individual blocks (Johnson, F.R. et al., 2013).

A blocked design was used in both studies.

3.2 Dentist DCE

To explore the preferences of dentists for delivering oral disease prevention within a DCE framework, there initially arose the need to identify the main attributes of the mix of preventive and restorative care, given the critical role dentists had in delivering such care. In this study, the methods to determine these attributes involved a review based on a systematic search of the literature, expert groups, cognitive interviews and confidence ratings. These were described in turn in the following sections.

A review based on a systematic search of the literature which is presented in chapter 2 provided an initial list of attributes (De Brún et al., 2018). A variety/mix of qualitative methods were subsequently applied in a multiple stage process during which a number of draft DCE questionnaires were designed and tested with qualified dentists. Such an approach ensured rigorousness, increased face validity, as well as the reliability of the final DCE questionnaire.

Figure 3-1 illustrates the multiple draft questionnaire versions developed and the qualitative methods used to design and test these versions, leading eventually to the final dental DCE questionnaire. Circular boxes contain the qualitative methods used and the number of participants in each method, while squared boxes depicted the multiple emerging questionnaire versions.

The data collected from the qualitative methods of interviews and focus groups were analysed using a qualitative coding technique to identify the sources of problems and revise the DCE survey in an appropriate way. For this reason the Classification Coding System (CCS) was used to categorise problems into categories (Rothgeb et al., 2007). This particular framework used the headings of the four stage cognitive response model: a) comprehension and communication, b) retrieval from memory, c) judgment and evaluation and d) response selection (Tourangeau, 1984). The problems raised by each qualitative method were classified into the four stage model by applying the CCS in order to deal with them in a targeted and well organised way, producing an appropriate DCE instrument to explore the decision making of dentists in delivering a mix of preventive and restorative care.

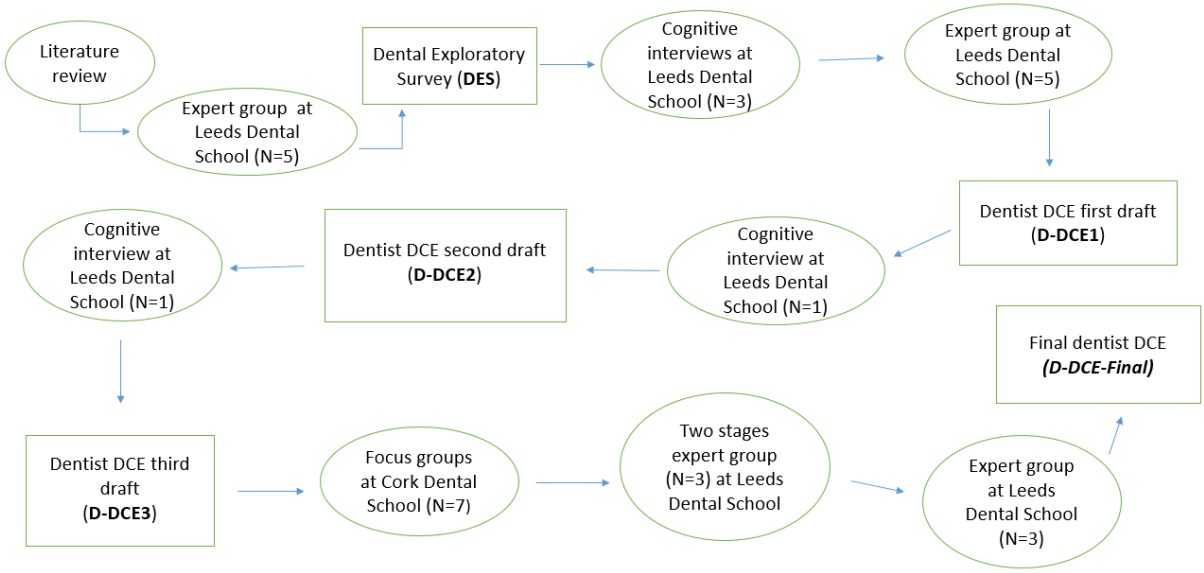


Figure 3-1. Steps leading to final dentist DCE (D-DCE-Final)

Below is a detailed description of the process depicted in Figure 3-1.

3.2.1 Review based on a systematic search of the literature

A review based on a systematic search of the literature which was implemented in chapter 2 revealed the main factors influencing dentists' and patients' preferences in the mix of preventive and restorative care. The first part examined dentists' preferences in delivering a mix of preventive and restorative care and the second part investigated patients' preferences in receiving preventive care. The third part looked at the factors influencing dentist-patient relationship in the delivery of a mix of preventive and restorative care. A separate review of studies identified in the first two parts which focused on DCE-CA research in the dental field as a whole and not specifically in caries prevention was also implemented. The review contributed to the design of a preliminary attributes list for dentist DCE study. Word search strategies appear in Appendix 1, Appendix 4 and Appendix 8. Data analysis tables of this review are reported in Appendix 2, Appendix 3, Appendix 5, Appendix 6, Appendix 7, Appendix 9, Appendix 10 Appendix 11, Appendix 12, Appendix 13, Appendix 14, Appendix 15.

3.2.2 Expert group

An expert group discussed the findings of the literature review in a one hour session to determine a preliminary list of attributes containing important factors to dentists for delivering a mix of preventive and restorative care. The team also decided about any additional attributes which despite not been found in the review, should be included in the survey so that their impact on dentist preferences could be tested. The experts group consisted of five academics: two dental public health researchers, two health economists and one psychology specialist.

3.2.3 Dentist Exploratory Survey (DES)

The preliminary list of attributes was incorporated into an exploratory survey to evaluate their significance on dentists' preferences in delivery of care through a ranking exercise Appendix 16, page 291. Another purpose of this survey was to prompt participants to suggest an appropriate range of levels for each attribute and identify a suitable choice context. The exploratory survey was administered in one to one cognitive interviews with dentists at Leeds Dental School.

Beyond the ranking exercise, dentists were separately requested to rank some patient level characteristics such as age, income, type of dental insurance, education, first language, dental history, medical history, risk of developing caries and caries depth in terms of how these characteristics would impact their decisions in provision of care. At the end of the survey, dentists were invited to propose plausible maximum, intermediate and minimum levels for quantitative attributes.

Three face to face cognitive interviews were conducted with dentists recruited from project members' contacts at Leeds Dental School in the form of administering survey questions while concurrently collecting additional verbal information about the survey responses. This verbal information was used to assess the quality of the answers and to contribute to understanding whether the attributes yielded the information that the author intended (Beatty and Willis, 2007; Buers et al., 2014; Drennan, 2003; Levine et al., 2005; Meitinger and Behr, 2016; Priede and Farrall, 2011; Rothgeb et al., 2007; Watt, T. et al., 2008).

Interviews took place at the investigator's office and lasted for approximately an hour each. During each session, participants were encouraged to think aloud about each section of the questionnaire, verbalising all of their thoughts. The main goal of this exercise was to collect feedback on how participants understood and interpreted the attributes and which choice context would be more appropriate. No probing was conducted since it was judged critical that participants expressed their concerns in relation to the attributes with the minimum possible intervention, which could have diverged the focus from a genuine report of the interpretation process. Problems with potential attributes identified during the interviews were classified according to the Classification Coding Scheme developed by researchers (Rothgeb et al., 2007) into a) comprehension and communication, b) retrieval, c) judgement and evaluation, and d) response selection issues.

3.2.4 Experts group

An expert group discussed the findings of the dental interviews to determine a list of attributes which could be used in a draft version of dentist DCE survey. The group also explored design features for the DCE, which led to the first draft of the dentist DCE (D-DCE1) (Appendix 17, page 293). The group consisted of five academics: two dental public health researchers, two health economists and one

psychology specialist. They conversed about the problems identified in the ranking exercise, established an appropriate choice context and constructed a list of attributes and levels relating to preventive and restorative care after removing the attributes which were emerged as problematic in the ranking exercise.

3.2.5 Dentist DCE first draft (D-DCE1)

The expert group discussions produced the first draft of the dentist DCE (D-DCE-1), see Appendix 17, page 293. The instrument offered two choice tasks of different treatment plan options, varying in a set of attributes, for patient vignettes described by four features including age group, caries depth, risk of developing caries and time available for treatment. Only two choice questions were used at this stage as the main purpose involved an in-depth focus on survey design elements, and not a quantitative analysis. There was a need to observe whether dentists could respond to these hypothetical choice questions and which further factors they considered to be important in the decision-making process.

A cognitive interview was conducted with one dental practitioner, recruited from project members' contacts at Leeds Dental School. The interview lasted for approximately 45 minutes in the dental practitioner's office at Leeds Dental School, and the respondent went through the D-DCE1 questionnaire thinking aloud to the main researcher who was concurrently asking emergent and spontaneous probes. Probes involved questions such as "How well did you understand each scenario?"; "Do the scenarios seem to be realistic according to your experience?"; "Is there any attribute missing from the scenarios that would influence your decision about which treatment plan to choose?"; "Do you consider the patient level characteristics important enough to guide you to a well justified selection of a treatment plan?".

After the end of this interview, the questionnaire was updated in response to feedback.

3.2.6 Dentist DCE second draft (D-DCE2)

The second draft of the dentist DCE provided two choice tasks of treatment plan options for patient vignettes. Patient vignettes included the characteristics of age, risk of developing caries, available treatment time and a photograph of caries severity. Treatment attributes involved time for preventive and restorative treatment, time for preventive advice, dental provider of preventive care and income. To see how the questionnaire was structured see Appendix 18, page 295.

A face to face cognitive interview was carried out with another dental practitioner recruited from project members' contacts at Leeds Dental School which lasted for approximately 45 minutes. The interview was once again structured in a think aloud format and the probes deployed by the main researcher were similar to those of the previous cognitive interview. Probes contained the following

questions: “How well did you understand each scenario?”, “Do the scenarios seem to be realistic according to your experience?”, “Is there any attribute missing from the scenarios that would influence your decision about which treatment plan to choose?”, “Do you consider the patient level characteristics important enough to guide you to a well justified selection of a treatment plan?”.

An update of the questionnaire based on feedback occurred after this interview.

3.2.7 Dentist DCE third draft (D-DCE3)

After the completion of the fifth cognitive interview, the list of attributes was revised and a D-efficient blocked design was estimated, of two blocks of eight choice scenarios, leading to D-DCE3 draft questionnaire (Appendix 20, page 298 and Appendix 21, page 304). The package called “choiceDes” was used within R statistical software to generate the design based on the D-efficient criterion for optimisation. Treatment attributes included plan income with four levels of £30, £55, £70, £85, time for preventive treatment with four levels of 0, 3, 5, 7.5 minutes, time for preventive advice with four levels of 0, 3, 8, 12 minutes and time for restorative treatment with four levels of 0, 15, 25, 35 minutes. Main effects were considered for the design estimation process. Sixteen patient profiles were generated in a second step by combining the levels of patient related attributes using a random process in R software. Patient related attributes involved patient’s age group with three levels of 18-35, 35-55 and 55+ years old, risk of developing caries with three levels of low, moderate and high risk and caries photographs with three levels of ICDAS, i.e., International Caries Detection and Assessment System for ICDAS 1-2, ICDAS 3-4 and ICDAS 5-6 caries condition (Ekstrand et al., 2018). The design was included in the D-DCE3.

Two focus group sessions were held at the University of Cork in Ireland. The first session was comprised of the main researcher and three qualified dentists at Cork University Hospital who participated in a 2 hour round table discussion led by the main researcher on the topic of the first block of pilot DCE questionnaire, (Appendix 20). The second session involved four qualified dentists from the same university hospital also engaged in a 2 hours round table discussion moderated by the main researcher in relation to responding to the second block of pilot-DCE questionnaire (Appendix 21). The researcher asked dentists to fill out the DCE questionnaire and subsequently give their thoughts about each section, discussing with each other as to how they understood the choice scenarios and selected the options using an unstructured discussion format.

The use of spontaneous and emergent probes was once again deemed critical to clarify any specific issues arising during the discussion. Probes involved questions such as “How well did you understand each scenario?”; Do the scenarios seem to be realistic according to your experience?”; “Is there any attribute missing from the scenarios that would influence your decision about which treatment plan

to choose?"; "Do you consider the patient related characteristics important enough to lead you to a well justified selection of a treatment plan?". Other emergent and spontaneous probes incorporated questions such as "In how many visits would you usually complete a treatment plan?"; "Do you often split prevention and restoration centred visits?"; "Would you trade-off between preventive and restorative dental procedures within a time constrained treatment plan?"; "What would you sacrifice to have more time to deliver prevention?" After each probe was delivered by the researcher, multiple participants could provide answers or argue about the response delivered by another respondent, depending on their willingness to take part in the discussion for each probe. The researcher kept notes of the discussions and responses to probes as a means of recording information.

At the end of the questionnaire, participants were asked to rate on a scale from 1 (highly disagree) to 7 (highly agree) four statements. The statements were: "I understood the questions"; "I understood the attributes of each scenario"; "The scenarios were realistic"; "All the important information I was needing to decide was there". This occurred so that the researcher would have the opportunity to assess participants' understanding of the DCE questionnaire.

3.2.8 Expert group to resolve issues with D-DCE3

A two-stage expert discussion group was used to decide on the appropriate sets of photographs and radiographs for patient vignettes. This occurred as focus groups' Irish participants claimed that to be able to make trade-offs between preventive and restorative care across choice sets, photographs had to show cases of early caries extending up to the enamel and not the dentine level. Otherwise they stated they would always choose the option with the longest restorative treatment irrespective of preventive care, leading to dominance choice effects. Firstly, a group of experts including the main researcher and an academic dentist screened a number of documents to compile an extended list of photographs depicting various levels of caries in the enamel and up to a limited exposure into the dentine. The session lasted for an hour and the list was produced from a sample of dental articles and presentations. Articles and presentations were already in the possession of the first academic dentist. At a second stage the main researcher and, to reduce selection bias, a different academic dentist assessed the extended list of photographs in a 1 hour session to conclude on a final set of five pairs of photographs, showcasing different levels of caries detected primarily in the enamel. These five photograph pairs, as shown in Figure 4-1, page 131, represented the levels of the caries severity attribute which was included in each patient vignette alongside the attributes of patient age and risk of developing caries.

3.2.9 D-DCE-Final

Finally an expert group meeting was held at Leeds Dental School, including a health economist and two dental public health researchers in a one hour session. The group decided on the sociodemographic questions to be included at the end of the survey and some final minor amendments to the DCE questionnaire. A block of the D-DCE-Final appears in Appendix 25, page 312. Ethical approval for D-DCE-Final was granted from the ethics committee of University of Leeds.

3.2.10 Survey statistical design of D-DCE-Final

A D-efficient design was created using Ngene with zero priors. Ngene is specialised software for constructing DCE survey designs (Ngene, 2018). The design is presented in Appendix *23*, page 309. Treatment attributes include plan income with three levels of £20, £40 and £60, time for preventive treatment with three levels of 0, 4 and 8 minutes, time for preventive advice with three levels of 0, 6 and 12 minutes and time for restorative treatment with three levels of 0, 15 and 20 minutes. Main effects were considered in the design estimation process. A few restrictions were imposed to make the choice sets realistic. The restrictions were determined based on feedback from the focus groups at Cork Dental School. These involved setting payment level to £20, i.e. its lowest level, in each choice set where no restorative care was provided and varying the payment levels between £40 and £60 in each choice set where restorative care was delivered. The estimation of a blocked design led to nine blocks of eight choice tasks, or 72 total choice tasks between two alternative options. The syntax code of the design is presented in Appendix 22, page 308.

At a second step, 72 patient vignettes were created, by randomly combining the levels of patient related attributes. Patient related attributes consisted of age with three levels of 24, 55 and 75 years of age, risk of caries with three levels of low, moderate and high risk and caries photographs with five levels of caries severity. The five photographs appear in Figure 4-1, page 131. The 72 patient vignettes were matched with the 72 design choice sets using a random process in R software.

3.2.11 Survey administration

Jisc Online Surveys was used to develop the dentist DCE questionnaire. The University of Leeds provided a free registration status with this company at the time of the study and its platform was used to upload the DCE questionnaire.

The survey was administered using snowball sampling. Recruitment was done by emailing key contacts of dental networks in the UK and ROI with an invitation to participate in the DCE survey. For more information on the recruitment process see page 134. To estimate a required sample size for the dentist DCE study a rule of thumb was used (Johnson, R. and Orme, 2003) suggesting that the sample size necessary to estimate a main effects model (i.e. one with no interactions between attributes) depended on the number of choice tasks (t), i.e. 8, the number of alternatives (a), i.e. 2, and the number of analysis cells (c), which for a main effects model is the largest number of levels for any attribute, i.e. 3. The rule of thumb is that the sample size, N, should satisfy

$$\mathrm{N} > 500c/(t \times \alpha)$$

Given the features of the dentist DCE this formula gave a minimum sample size of 94 participants. The healthcare DCE literature often employed rules of thumb to generate estimates of minimum sample size requirements (de Bekker-Grob et al., 2015).

The main disadvantage of using a rule is that such rules are not necessarily accurate or reliable. However, other approaches such as parametric estimation is not suitable as it focuses on choice probabilities without dealing with the issue of minimum sample size requirements in terms of testing for specific hypotheses based on the parameter estimates generated (Louviere et al., 2000).

In the latest attempts to generate parametric based minimum sample size formulas, testing for hypothesis of DCE estimates being different than zero necessitated information on effect size and the variance-covariance matrix of parameters prior to their estimation which made things more complicated (de Bekker-Grob et al., 2015).

Therefore given the exploratory nature of the study on producing the strength of preference estimates rather than predicting probabilities for the uptake of specific alternatives with good accuracy, and the limitations of parametric approaches testing for hypothesis of parameters being different than zero, sticking to the rule of thumb provided a good opportunity for a minimum sample size calculation for the dental DCE study.

3.2.12 Analysis

The econometric analysis of the DCE data was grounded in RUT. The utility of individual *n* from choosing alternative i among J possible alternatives in choice situation t is decomposed into a systematic component V_{nit} and a random component ε_{nit}.

Equation 3-1. $\boldsymbol{U_{nit}} = V_{nit} + \varepsilon_{nit} = \beta' X_{nit} + \varepsilon_{nit} \;\; i \in \{1,2, \dots J\}$

Where $\mathbf{x}_{ij}$ is a vector of choice attributes, and β is a vector of preference parameters. The random term is assumed to be independently and identically distributed according to the type I extreme value distribution. Different models could be applied to estimate Equation 3-1. For example, the multinomial logit (MNL) model assumes independence of irrelevant alternatives and preference homogeneity, meaning that each choice is independent from any other task and preference estimates are equal across respondents (Train, K.E., 2009). The probability that individual *n* chose alternative i under the MNL model is specified as:

Equation 3-2. $P_{ni} = \frac{e^{X'_{ni}\beta_n}}{\sum_i^J e^{X'_{ni}\beta_n}}$

The MXL relaxes the restrictive assumptions of independence of irrelevant alternatives and preference homogeneity (Train, K.E., 2009). The probability that individual *n* chose alternative i under the MXL model is specified as:

Equation 3-3. $P_{ni} = \int_{\beta_n} \frac{e^{X'_{ni}\beta_n}}{\sum_i^J e^{X'_{ni}\beta_n}} f(\beta_n)\beta_n$

Its strength lied in accounting for unobserved preference heterogeneity or random taste variation by assuming a random distribution for model coefficients. It also allowed for unrestricted substitution patterns and correlation in unobserved factors over time (Train, K.E., 2009). For example, the ratio of MXL probabilities P_i/P_j depends on all the data including attributes of alternatives other than *i* and *j*. This meant that a ten-percent probability reduction for one alternative need not imply (as with logit) a ten-percent proportional increase in each other alternative (Train, K.E., 2009).

Both the MNL and MXL models were used with choice data in this study but the MXL specification was preferred for its advantages as described above.

With two patient attributes of three levels and one patient attribute of two levels, as well as four treatment attributes, a full interaction model would lead to 18 (3^2*2^1) * 4=72 parameters for 18 potential patients, represented by all level combinations of patient attributes. Given this high number of parameters, a reformulation of the utility equation was performed to reduce the number of

estimable parameters. The new equation included a term associated with a reference/baseline patient vignette, represented by the most extreme levels of the patient related attributes, specifically a 75 years of age patient, with high risk of developing caries and more severe caries as shown in the photographs, Figure 4-1. The four treatment attributes were then interacted with this term of the baseline patient, leading to four parameters for the reference patient case. Five different interaction parameters were added to each of the four reference case treatment terms using dummy coded variables to capture the change in preferences between treating the baseline case and each of the interaction parameters reflecting various levels of patient attributes. These involved a 24 years of age patient, a 55 years of age patient, a low caries risk patient, a moderate caries risk patient and a patient with caries photographs from the least severe group of cases, Figure 4-1. This specific reformulation reduced the number of potential parameters to six for each treatment attribute leading to a total number of 24 estimable parameters. The equation form of the main model is presented in Equation 3-4, page 93.

Equation 3-4. $$\boldsymbol{U} = [b_{prev\_con\ (high\_caries\_risk\_75\_years\_old\_pics\_group\_A)^{1}} + b_{prev\_low\_caries\_risk} * low\_caries\_risk + b_{prev\_moderate\_caries\_risk} * moderate\_caries\_risk + b_{prev\_24\_years\_old} * 24\_years\_old + b_{prev\_55\_years\_old} * 55\_years\_old + b_{prev\_pics\_group\_B} * Pics\_group\_B] * preventive\_treatment\_time + [b_{prev\_a\_con\ (high\_caries\_risk\_75\_years\_old\_pics\_group\_A)^{2}} + b_{prev\_a\_low\_caries\_risk} * low\_caries\_risk + b_{prev\_a\_moderate\_caries\_risk} * moderate\_caries\_risk + b_{prev\_a\_24\_years\_old} * 24\_years\_old + b_{prev\_a\_55\_years\_old} * 55\_years\_old + b_{prev\_a\_pics\_group\_B} * Pics\_group\_B] * preventive\_advice\_time + [b_{rest\_con\ (high\_caries\_risk\_75\_years\_old\_pics\_group\_A)^{3}} + b_{rest\_low\_caries\_risk} * low\_caries\_risk + b_{rest\_moderate\_caries\_risk} * moderate\_caries\_risk + b_{rest\_24\_years\_old} * 24\_years\_old + b_{rest\_55\_years\_old} * 55\_years\_old + b_{rest\_pics\_group\_B} * Pics\_group\_B] * restorative\_treatment\_time + [b_{inc\_con\ (high\_caries\_risk\_75\_years\_old\_pics\_group\_A)^{4}} + b_{inc\_low\_caries\_risk} * low\_caries\_risk + b_{inc\_moderate\_caries\_risk} * moderate\_caries\_risk + b_{inc\_24\_years\_old} * 24\_years\_old + b_{inc\_55\_years\_old} * 55\_years\_old + b_{inc\_pics\_group\_B} * Pics\_group\_B] * income$$

A MXL estimated via simulated maximum likelihood with 100 Modified Latin Hypercube Sampling (MLHS) draws was fitted on the full sample choice data treating all 24 constant and interaction parameters as continuous and random. The code used to produce this model was provided in Appendix 26, page 329. A normal distribution was assumed for all parameters. An iterative process was applied to improve the model based on AIC, i.e., Akaike Information Criterion. The parameter with the lowest t-statistic was removed from the model of 24 constant and interaction parameters and a new MXL was estimated with the remaining 23 terms. This process continued by removing each time an additional term using the t-statistic criterion and re-estimating a new model with a reduced number of parameters equal to minus one from the previous model. The process stopped when the final model was estimated with just one term. Overall, 23 different MXLs were estimated plus the full model using all 24 parameters. Each model was run with 100 MLHS draws. The best model specification was decided based on AIC. The selected model specification was then re-run with an increased number of draws, i.e., 4000 draws.

3.2.12.1 *Latent class*

The amount of preference heterogeneity in the delivery of a mix of preventive and restorative care was examined using a latent class (LC) model.

[1] Preference coefficient for each additional minute of preventive treatment with the most challenging patient described as a patient of high caries risk, 75 years of age and a caries condition depicted in group A photographs, i.e. the group of most severe caries cases.
[2] Preference coefficient for each additional minute of preventive advice with the most challenging patient.
[3] Preference coefficient for each additional minute of restorative treatment with the most challenging patient.
[4] Preference coefficient for each additional unit of income with the most challenging patient.

A LC model has an important advantage over a MXL, as it could link decision-making heterogeneity to observable individual characteristics (Hess, 2014). The typical specification relies on a parameterisation of the class allocation probabilities on sociodemographic variables, meaning that the class allocation probabilities and the implied sensitivities vary as a function of these individual characteristics (Hess, 2014).

At this phase of the analysis, patient related attributes were not included in the LC and only sensitivities of treatment attributes were assumed to vary between classes as a function of individual characteristics.

LC use discrete distributions to model preference heterogeneity across respondents by identifying the groups of respondents with distinct preferences. The LC membership is usually associated with sociodemographic characteristics and attitudes of individuals Z_n. The probability that individual n chooses j_{th} alternative is defined as the product of class membership probability and probability of choosing alternative j conditional on class membership.

Equation 3-5. $$P_{ij} = \sum_{k=1}^{K} \left[\frac{e^{Z'_n\gamma_k}}{\sum_{k=1}^{K} e^{Z'_n\gamma_k}}\right]\left[\frac{e^{X'_{nj}\beta_k}}{\sum_{j=1}^{J} e^{X'_{kj}\beta_k}}\right]$$

Where K is the number of identified latent classes. Parameters β_l represent marginal utilities of each attribute conditional on class membership, i.e. the class-specific parameter estimates. The number of classes is not specified in advance, but based on statistical and theoretical criteria.

In this study, the selection of the optimal number of classes was guided by the AIC and by the parsimony and policy relevance of results. A stepwise method was used to specify the number of latent classes through estimation of separate models by increasing each time the number of classes by one class. The AIC of the new model was then compared to that of the last model until no further improvement to the criterion was achieved, i.e. up to the point when the AIC increased with the addition of the last class. The sociodemographic variables which were used to determine latent class membership derived from the literature review parts on dentist-patient relationship and dentist preferences. These comprised practice size, practice mix, i.e. private versus public, frequency of fluoride varnish, dietary advice and fissure sealants delivery with adult patients, gender, work status, i.e. part-time versus full-time or overtime, percentage of exempt from payment patients and years since graduation.

The equation form of LC is presented in Equation 3-6.

Equation 3-6. $$U = [delta + gamma_{working\ with\ fewer\ than\ 3\ dental\ professsionals\ in\ the\ practice} * working\ with\ fewer\ than\ 3\ dental\ professionals\ in\ the\ practice + gamma_{100\%\_private\_or\_mainly\_private} * 100\%\_private\_or\_mainly\_private + gamma_{freq\_fluoride\_varnish\_always\_or\_usually} * freq\_fluoride\_varnish\_always\_or\_usually + gamma_{freq\_dietary\_advice\_always\_or\_usually} * freq\_dietary\_advice\_always\_or\_usually + gamma_{freq\ fissure\ sealants\_always\_or\_usually} * freq\ fissure\ sealants\_always\_or\_usually + gamma_{female} * female + gamma_{years\_since\_graduation} * years\_since\_graduation + gamma_{working\_part\_time} * working\_part\_time + gamma_{75\%\_or\_more\_exempt\_from\_payment} * 75\%\_or\_more\_exempt\_from\_payment] * [b_{prev} * preventive\_treatment\_time + b_{prev\_a} * preventive\_advice\_time + b_{rest} * restorative\_treatment\_time + b_{inc} * income]$$

3.2.12.2 *Quantitative tests to check for key assumptions underlying the DCE*

The assumption that individuals answered choice tasks in a rational manner was explored in the dentist DCE study. Attribute dominance was also assessed to check whether any attribute dominated in the decision making process.

The assumption of logical responses was tested by excluding protest respondents, identified as straight-liners (those choosing either always the left or right hand option) and those always choosing the option with lower income, as such responses were considered inconsistent. A separate model was run with the reduced dataset and the findings were compared with results of the main model. If the models were similar, it would mean that the existence of seemingly inconsistent respondents was limited without impacting the results, pointing to the validity of the main model.

Attribute dominance was also tested by identifying participants who always chose the option which was better according to a single attribute. This occurred to check whether any attribute dominated in the decision-making process. However, individuals who demonstrated this behaviour were not removed from the full dataset to repeat analysis. The reason was that in each survey there were always situations with no level difference in the attribute being tested for dominance effects. Hence retaining these participants in the dataset still offered the opportunity to measure their trade-offs between other attributes.

3.3 Patient DCE

A multistage iterative process using a mix of qualitative methods was used to identify the factors influencing the preferences of the general public for receiving preventive care, and to develop a patient DCE questionnaire (Coast et al., 2012; De Brún et al., 2018).

The qualitative methods consisted a review based on a systematic search of the literature, focus groups, a ranking survey, expert groups, and face to face cognitive interviews in an iterative process. During this process, a number of different questionnaire versions were developed and tested. For an overall picture of the multiple steps involved, see Figure 3-2.

The same Coding Classification System applied in the dentist DCE was used to analyse data from the interviews and focus groups by categorising the emerging problems into groups according to the four stage cognitive response model (Rothgeb et al., 2007; Tourangeau, 1984). This way, solutions were targeted and well suited to each identified issue, leading to improved face validity of the DCE instrument.

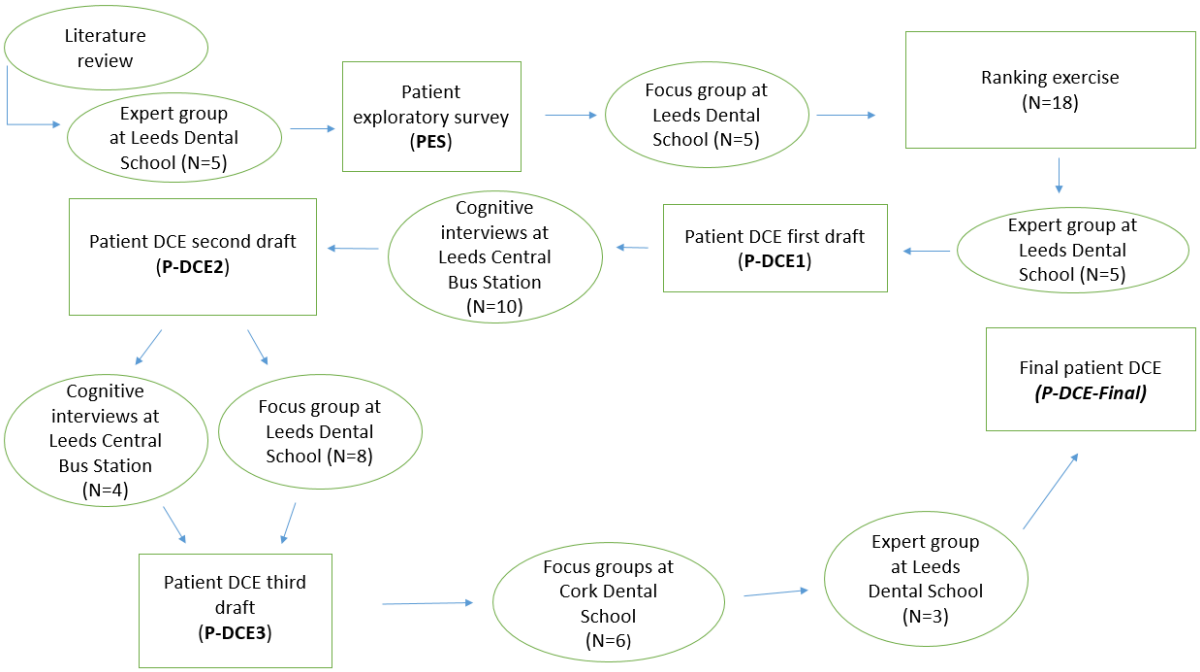


Figure 3-2. Steps leading to final patient DCE (P-DCE-Final)

There follows a detailed description of the development process illustrated in Figure 3-2.

3.3.1 Review based on a systematic search of the literature

A review based on a systematic search of the literature in three parts was implemented to reveal the main factors influencing dentists' and patients' preferences in the mix of preventive and restorative care. The findings of this review were presented in chapter 2.The first part examined dentists' preferences for delivering a mix of preventive and restorative care and the second part investigated

patients' preferences for receiving preventive care. The third part looked at the factors influencing dentist-patient relationship in the delivery of a mix of preventive and restorative care. A separate review of studies identified in the first two parts which focused on DCE research in the dental field as a whole, and not specifically in caries prevention, was also implemented. The review contributed to the construction of a preliminary attributes list for the patient DCE study. Word search strategies of the review appear in Appendix 1, Appendix 4 and Appendix 8. Data analysis tables are reported in Appendix 2, Appendix 3, Appendix 5, Appendix 6, Appendix 7, Appendix 9, Appendix 10, Appendix 11, Appendix 12, Appendix 13, Appendix 14, Appendix 15.

3.3.2 Expert group

An expert group discussed the findings of the literature review to compile a preliminary list of attributes for preventive care in a one hour session which took place at Leeds Dental School. The experts group consisted of five academics: two dental public health researchers, two health economists and one psychology specialist. The group revised the list and agreed on the removal of certain attributes which were less relevant from a policy perspective. The team also decided about any additional attributes which in spite of not been found in the review, should be included in the survey so that their impact on patients' preferences could be tested.

The attributes of the preliminary list created by the expert group were included in an exploratory questionnaire to test their importance to patients and identify levels for these attributes.

3.3.3 Patient exploratory survey (PES)

A focus group session was organised with five members of the UK general public to consider how the attributes on the preliminary list would affect their preferences about dental visits, and to provide suggestions on the potential levels that each attribute could take (see Appendix 27, page 340).

The questionnaire began by asking participants "what factors are important to you when visiting the dentist, in order to maintain a healthy mouth?" Following this question, a number of factors identified in the literature review were presented to them, alongside descriptions in the form of either a short summary or explanatory text. A range of levels were also included for some of the attributes, to facilitate the initiation a discussion about suggestions for appropriate levels.

Individuals were contacted by email via the Leeds Dental School research participant pool. The session took place at Leeds Dental School and lasted for 30 minutes. The discussion was organised in an unstructured format and open questions were asked about how each potential attribute would affect their preferences for dental attendance as well as to propose a range of numerical values and descriptions for the quantitative and qualitative attributes identified in the literature search. Participants were also requested to suggest any additional factors important for a dental visit which

were not presented in the preliminary survey. The PES led to a revised list of important attributes for dental attendance.

3.3.4 Ranking exercise

The lead researcher revised the attributes list used in the PES by removing attributes people thought weren't important and adding those suggested as missing. A survey was developed using this list to quantify the importance of each attribute and elicit appropriate attribute levels, see Appendix 28, page 342. Members of the general public were then identified through an email list at Leeds Dental School and invited by email to participate in an online survey to rank a list of attributes in terms of how significant they perceived them to Individuals were requested to assume they had to register with a new dental practice described by a number of attributes related to a typical dental check-up appointment, and to suggest a range of minimum to maximum values for the numeric attributes, e.g. out of pocket costs. They were also asked to propose the best and worst case scenarios for categorical/qualitative attributes, e.g. provider's communication skills, person providing prevention and availability of family appointments. The questionnaire was designed and administered using Jisc Online Surveys.

3.3.5 Expert group

An experts group comprised of five academics, two dental public health researchers, two health economists and one psychology expert discussed the results of the PES in an unstructured discussion in a session lasting for one hour at Leeds Dental School. The group decided on a list of attributes and levels, determined the appropriate choice context, and explored presentation style issues about the alternative options.

3.3.6 Patient DCE first draft (P-DCE1)

The Patient DCE1 questionnaire was developed based on feedback from the expert group (Appendix 29, page 344). It involved two choice scenarios. Introductory instructions described the aim of the survey as "looking at what features people prefer when signing up to a new dental practice". Participants were invited to choose between two hypothetical dental practices providing two alternative dental check-up appointments described by different levels of the attributes. The two choice tasks were followed by asking participants to rate questionnaire on four dimensions: how well they understood the questions, how well they comprehended the features of each practice, how realistic the hypothetical dental practices were and to what extent all the important information needed was there. Participants were requested to rate each statement on a Likert scale from 1=highly disagree to 7=highly agree. At the end of the questionnaire, a number of open questions asked whether there was any missing information and what additional attributes/factors would affect

individuals' choices for a dental check-up appointment were incorporated in the last section of the questionnaire.

Ten face to face cognitive interviews were conducted to assess how participants responded to the patient DCE1 questionnaire. Each interview lasted around 5 minutes on average. Random respondents were recruited by the main researcher at Leeds Central Bus station and asked to describe their thoughts in a think aloud exercise while answering the questionnaire. People from a wide range of age and gender demographics were recruited during three separate research visits. Both thinking aloud and probing exercises were used to identify potential problematic issues with regards to the questionnaire. Probes involved questions of the type "Do you encounter a similar choice context when deciding to visit the dentist for a dental check-up appointment?", "Are there any additional attributes you consider as important for a dental check-up visit", "Would you make any trade-offs between the attributes, such as longer appointments at a higher cost?", "What other trade-offs would you be willing to undertake"?

3.3.7 Patient DCE second draft (P-DCE2)

Following analysis of the interviews, the questionnaire was revised, leading to the patient DCE2 questionnaire version (see Appendix 30, page 347). The instrument involved two choice tasks to choose between two alternative dental check-up appointments described in terms of six attributes. Rating questions were also provided requesting participants to evaluate the instrument on a scale ranging from 1=strongly disagree to 7=strongly agree in relation to four dimensions: comprehensibility of choice questions and alternative options, how realistic choice scenarios were and information sufficiency. The last part of the questionnaire involved open questions probing for difficulties in understanding as well as for missing information and attributes which would be critical in choices.

The questionnaire was used in four face to face cognitive interviews conducted with random respondents at Leeds Central Bus Station and a focus group consisting of six individuals from the general public at Leeds Dental School. In both cases, participants were requested to answer the questionnaire by hand.

Four individuals at Leeds Central Bus station identified at random by the researcher were invited to participate in a think aloud exercise by reading each question and simultaneously voicing out their thoughts about answering. Each interview lasted for 6 and a half minutes on average. Similar probes as in previous interviews were used to explore whether the hypothetical choice context reflected real decision-making conditions about dental attendance and the inclination of respondents to make trade-offs between attributes. Probes included questions of the type "Do you encounter a similar choice context when deciding to visit the dentist for a dental check-up appointment?", "Are there any

additional attributes you consider as important for a dental check-up visit", "Would you make any trade-offs between the attributes such as longer appointments at a higher cost?", "What other trade-offs would you be willing to undertake"?

The focus group was comprised of eight individuals who were recruited from a pool of research participants at Leeds Dental School and invited to take part in a focus group discussion moderated by the main researcher in an unstructured format as well as completing the questionnaire by hand. The session lasted for half an hour. The researcher read instructions and questions aloud before asking respondents to raise any concerns, objections or misunderstanding topics in a conversational style. Individuals were asked whether hypothetical scenarios replicated conditions of a real choice context about a dental visit and if so, whether options included all the important attributes they would usually consider when visiting the dentist for a dental check-up appointment. They were also prompted to suggest additional attributes which would be important to them in such a decision. Discussion also took place in relation to the confidence rating exercises and open questions in the final part of the questionnaire. When the discussion ended, respondents were requested to fill out the questionnaire by hand.

3.3.8 Patient DCE third draft (P-DCE3)

A D-efficient survey design with two blocks of eight choice sets each was generated using the package "choiceDes" in R statistical software. The design is presented in Appendix 31, page 350. Attributes included out of pocket costs with three levels of £50, £75 and £100, travel time to the dental office with three levels of 15, 30 and 45 minutes, time of dietary advice with four levels of 0, 3, 6 and 9 minutes, time of oral hygiene advice with four levels of 0, 3, 6 and 12 minutes, preventive or fluoride varnish treatment with four levels of 0, 3, 5 and 7.5 minutes, waiting time with four levels of 0, 1, 10 and 15 days, type of dental provider for preventive care with two levels of the dentist and an alternative dental professional encompassing either a dental hygienist or therapist or nurse, email reminders of the appointment with two levels of yes or no and online booking option with two levels of yes or no. Main effects were considered in the design estimation process. The instructions, confidence rating statements and open questions were retained from the previous questionnaire versions (see Appendix 32, page 351). The instrument was tested at two focus group sessions held at University of Cork in Ireland, with each session using a unique questionnaire block. Out of pocket cost levels were presented in Euros which is the national currency of ROI.

Two focus groups were held at the University of Cork in Ireland. Each session lasted for one hour. Both sessions consisted of three individuals, all academics, representing a convenience sample of the general public, with none of them being a dentist. The discussion was organised in an unstructured format in which the main researcher initially read aloud the questionnaire asking individuals to claim any ambiguities about the questions up to that point. Subsequently they were prompted to complete the questionnaire and voice out their thoughts on how they addressed each section in a conversational style. They began with how they understood instructions, responded to each choice question separately, rated the relevant statements and finally answered the open type questions. The main researcher moderated the discussion.

3.3.9 P-DCE-Final

A final experts group consisting of the main researcher and two Dental Public Health specialists was gathered to comment on the findings of the Irish focus group sessions and determine the questionnaire's final layout, adjust wording of instructions, validate the choice context and attributes, as well as decide on which sociodemographic questions should be incorporated into the instrument. Discussion within the expert group drove to the P-DCE-Final questionnaire (see Appendix 37, page 366). Ethical approval for P-DCE-Final was granted from the ethics committee of University of Leeds.

3.3.10 Survey statistical design

A D-efficient design was estimated using N-gene. The design is presented in Appendix 35, page 362. Attributes included out of pocket costs with three levels of £20, £35 and £50, travel time to the dental

office with three levels of 15, 30 and 45 minutes, time of dietary advice with three levels of 0, 5, and 10 minutes, time for oral hygiene advice with three levels of 0, 6, and 12 minutes, time for preventive or fluoride varnish treatment with three levels of 0, 4 and 8 minutes, waiting time with three levels of 1, 10 and 15 days, type of dental provider for preventive care with two levels of the dentist and an alternative dental professional encompassing either a dental hygienist, therapist or nurse. Main effects were considered in the design estimation process. A blocked design was estimated leading to nine blocks of eight choice sets or 72 total choice scenarios. No restrictions for attribute levels combinations were imposed. The syntax of the design is given in Appendix 34, page 361.

3.3.11 Survey administration

Two versions of the patient DCE questionnaire were developed. Both included the same questionnaire content but varied in the way of eliciting answers.

The first version involved uploading the questionnaire on Jisc Online Surveys platform. The University of Leeds provided a free registration status with this company at the time of the study and its platform was used to develop the first version of the DCE questionnaire.

The second version concerned an online questionnaire application which was developed using R Shiny Appendix 45, page 394. It incorporated interactive features in the form of customised graphs generated in real time while participants completed the questionnaire. The graphs mapped an individual's answer to questions to aggregate statistics estimated on data collected from the full sample participants up to that time. To initiate of the process random data was used to ensure that the few first respondents would also obtain a customised graph. The application illustrated here was developed on the basis of open source tools using packages such as Shiny, "dplyr" (Wickham H, F.R., 2016), "ggplot2" (Wickham H, C.W., 2016) and "tidyr" and could therefore run on most systems with sufficient memory to apply basic java-based applications. The approach of designing an online questionnaire using Shiny features in R software was adopted to generate an interactive questionnaire application which could engage more participants to complete the survey based on reciprocating effects. In particular, respondents were able to receive extra information about caries preventive behaviours in the form of statistical information through customised graphs after completing the survey, which compared their answers to those of other individuals who responded to the same questions. This was expected to improve response rates and grow the total sample size. The online questionnaire ran in a traditional analysis workflow, whereby the statistical procedure underlying the model was performed in the background of the application, invisible to the user, updating reactively with the user's inputs (Wszola et al., 2017). The model output was transformed to a visual tool on a graphical front end via Shiny. The benefit of the Shiny application framework lay in its reactive programming features, linking input and output data in such a way that changes to the input triggered updates to the output area without the need to refresh the program, allowing users to effortlessly explore the data (Wszola et al., 2017). An additional advantage of reactive binding between dynamic inputs and outputs facilitated front-end users to interact with data without needing any knowledge of the R language (Wszola et al., 2017). Instead, users were presented with pre-built widgets in the form of slider bars, input and drop- down boxes reflecting inputs that would immediately adapt linked outputs in the forms of figures and charts.

The Jisc Online Surveys version was administered through an online panels company. The company "Research Now SSI" was used to recruit a representative sample of 200 individuals in the UK and 100 people in ROI. Individuals under 18 years of age were excluded, and the sample was representative in terms of gender and geographic region of the UK and the ROI. For this DCE survey, 200 individuals out of a panellist pool of 450,000 members in the UK and 100 out of 80,000 panellists in Ireland were recruited to complete the survey. The average amount offered to each participant to fill in the survey was £0.70, as the cost per individual varied across the different panels.

The Shiny questionnaire version was administered through Facebook. The two main ways to recruit participants via Facebook were through paid targeted advertisements and peer referral or snowballing sampling approach (Batterham, 2014; Close et al., 2013; Johnson, K.J. et al., 2014; Kosinski et al., 2015; Pedersen and Kurz, 2016). An online questionnaire application link was administered through Facebook using its targeted advertising features. The snowball sampling approach was also aimed indirectly by the provision of customised interactive graphs with the goal of engaging more individuals to take part in the survey. This could be implemented by prompting individuals who participated in the survey on the first instance, to post the graphs on their Facebook account inviting their online friends to fill it in to obtain similar visualisations. Three Facebook targeted advertisements of an overall cost of £300 were employed to push a post with the link of the online questionnaire application and a message asking participants to share the link with their Facebook friends, to Facebook users in the UK and ROI. Thirty nine individuals were recruited through Facebook with average cost per participant estimated at £7.7.

The merits of combining two modes in the administration of the patient DCE questionnaire included enhanced data quality through diversification of sample base and over recruitment of less represented groups such as unemployed and less educated individuals.

3.3.11.1 *Minimum sample size*

To estimate the required minimum sample size for the patient DCE study the same rule of thumb was used as in the dentist study (Johnson, R. and Orme, 2003) suggesting that the sample size necessary to estimate main effects depends on the number of choice tasks (t), the number of alternatives (a), and the number of analysis cells (c), which when considering main effects is equal to the largest number of levels for any of the attributes. The formula is:

$N>500c / (t \times \alpha)$

Given the features of the patient survey this formula resulted approximately 94 participants which was a rough estimate of the minimum sample size required to estimate a main effects model. Given the exploratory nature of the patient DCE study, which aimed at estimating the strength of

preferences for the available attributes and WTP measures, rather than calculating probabilities of the uptake of specific preventive measures by individuals, this non-parametric approach was regarded as sufficient, as parametric calculations would require additional information, e.g. effect sizes and variance-covariance matrices involving priors (Louviere et al., 2000; Rose and Bliemer, 2013).

3.3.12 Analysis

Econometric analysis of the DCE data is grounded in RUT. The utility of individual *n* from choosing alternative i among J possible alternatives in a choice situation t is decomposed into a systematic component V_{nit} and a random component ε_{nit}, see Equation 3-1, page 91.

The random term is assumed to be independently and identically distributed according to the type I extreme value distribution. Different models could be used to estimate Equation 3-1, page 91. For example, the MNL assumes independence of irrelevant alternatives and preference homogeneity, meaning that each choice is independent from any other task and preference estimates are equal across respondents (Train, K.E., 2009). The probability that individual *n* chooses alternative i under the MNL model is specified in Equation 3-2, page 91.

The MXL which was applied in this study relaxes the restrictive assumptions of independence of irrelevant alternatives and preference homogeneity (Train, K.E., 2009). The probability that individual *n* chooses alternative i under the MXL model is specified in Equation 3-3, page 91.

Its strength lies in accounting for unobserved preference heterogeneity or random taste variation by assuming a random distribution for model coefficients. It also allows for unrestricted substitution patterns and correlation in unobserved factors over time (Train, K.E., 2009). For example, the ratio of MXL probabilities P_i/P_j depends on all the data, including attributes of alternatives other than *i* and *j*. This means that a ten-percent probability reduction for one alternative need not imply (as with logit) a ten-percent probability proportional increase in each other alternative (Train, K.E., 2009).

Including a cost coefficient in the experiment allows for the estimation of marginal WTP measures revealing how much respondents would be willing to pay for an improvement in other attributes. Marginal WTP could be derived using the following equation:

$$\text{Equation 3-7. } WTP_i = -\frac{\beta_{attribute}}{\beta_{cost}} \quad (3)$$

Applying a MXL in preference space and specifying the cost attribute as randomly distributed may lead to the distributions of WTP which are heavily skewed and/or may not have defined moments (Hess and Train, 2017; Hole and Kolstad, 2012). Fixing the cost coefficient, as is often done in the literature, avoids this problem. However, it would imply a constant marginal utility of income which is an unrealistic assumption (Sever, Ivan et al., 2019c). On the other hand, estimating the model in WTP

space rather than in preference space may be a convenient solution to the problem and recent studies recommend that this may produce more realistic WTP estimates (Hole and Kolstad, 2012; Train, K. and Weeks, 2005).

To estimate a model in WTP space, the standard utility expression of Equation 3-1, page 91 is rearranged in such a way that the coefficients represent the WTP estimates (Train, K. and Weeks, 2005).

Equation 3-8. $$\boldsymbol{U_{nit}} = V_{nit} + \varepsilon_{nit} = -a_n\, p_{nit} + \beta'_n\, X_{nit} + \varepsilon_{nit} = -a_n\, p_{nit} + (a_n\, wtp_n)'\, X_{nit} + \varepsilon_{nit}$$

Where p_{nit} denotes the out of pocket cost attribute, and wtp_n or marginal WTP for attributes is estimated as the ratio of an individual specific attribute coefficient β_n to the remuneration coefficient a_n i.e. $wtp_n = \frac{\beta_n}{a_n}$. The researcher is hence able to directly estimate the distribution of WTP for an attribute.

A normal distribution was assumed for the coefficients for travel time, dietary advice, hygiene advice, preventive treatment, waiting time, seeing the dentist provider for preventive care and out of pocket cost.

The final model equation using the attributes of this study is presented in Equation 3-9.

Equation 3-9. $$\boldsymbol{U} = -a_{cost} * cost + a_{cost} * (wtp_{travel\_time} * travel\_time + wtp_{dietary\_advice\_time} * dietary\_advice\_time + wtp_{hygiene\_advice\_time} * hygiene\_advice\_time + wtp_{preventive\_treatment\_time} * preventive\_treatment\_time + wtp_{waiting\_time} * waiting\_time + wtp_{dentist\_provider} * dentist\_provider) + \varepsilon$$

3.3.12.1 *Choice of money as payment vehicle*

The articles identified in the literature review of chapter 2 were further screened for which payment vehicle was used. One study investigated preferences for periodontal disease treatment among a sample of patients with the condition and a sample of faculty and staff at a dental school in Canada, using dental insurance premiums as a payment vehicle (Matthews et al., 1999). It was shown that subjects were willing to pay more for coverage for themselves than for others. Another study applied two different payment vehicles when looking at preferences of randomly selected dentate adults for dentine regeneration treatment in the US, asking participants for out of pocket costs if they were uninsured or an additional insurance premium if they were insured (Birch, Stephen et al., 2004). Results from this study displayed no difference in the shares of individuals considering a positive WTP for the procedure between the insured and uninsured groups. A separate study used three different payment vehicles to examine the preferences of dentate individuals in Canada about mandibular two-implant overdentures (Srivastava, Akanksha et al., 2014). These consisted of out of pocket payment, private dental insurance coverage as a one-time payment, or additional taxes through government

coverage. The findings demonstrated that a higher share of individuals were willing to pay for mandibular two-implant overdentures through out of pocket payment or private insurance coverage, compared to the public funded program. It was also found that respondents were willing to pay less in yearly taxes than in premiums for private health insurance. Furthermore, researchers in another study on preferences of dentate individuals in Canada about mandibular overdentures found a similar outcome (Srivastava, A et al., 2020). At any given remuneration point, more respondents were willing to pay for mandibular overdentures through private insurance than public programs with the same benefits. It was argued that such an effect was the result of negative perceptions towards higher tax payments or a lack of confidence in the effectiveness of a public program (Birch, Stephen et al., 2004). In addition, this could also derive from the participants' attitudes about what governmental programs could provide as compared with private insurance, as well as their perceptions of the uncertainty about getting the disease (Srivastava, A et al., 2020).

Four articles explored the general public's or patients' preferences about preventive care interventions through WTP measures, using out of pocket costs as the payment vehicle, in public or mixed public and private settings in the UK or England (Boyers et al., 2021; Harris et al., 2020; Vernazza, C.R. et al., 2015; Walshaw et al., 2019). In addition, a few other studies used a similar approach to evaluate preferences on prevention in public settings outside the UK (Oscarson et al., 2007; Pavlova* et al., 2004; Saadatfar and Jadidfard, 2021; Tianviwat et al., 2008a; Tianviwat et al., 2008b; Tuominen, 2008). A few other articles also used out of pocket payments as a payment vehicle in the investigation of preferences about dental treatment not relevant to prevention in mixed public and private settings in Croatia and China (Sever, I. et al., 2018; Sever, Ivan et al., 2019c; Sever, Ivan et al., 2019b; Zhu et al., 2019).

A limitation in relation to using out of pocket costs as the payment vehicle in the patient DCE study referred to the provision of biased WTP estimates. Bias would relate to the fact the WTP measures estimated under a state funded system in this study did not reflect the true WTP measures in the absence of such system. Despite this limitation, there was scarce evidence in the literature on differences in WTP measures when using out of pocket payments and private insurance payments as the payment vehicle. In addition, using out of pocket payments as the payment vehicle in dental preference research seemed to be a common practice.

3.3.12.2 *Latent class*

An LC model was fitted on the patient DCE data to account for different groups of preferences, similar to the approach in the dental DCE study. For further information on LC see 3.2.12.1, on page 93 and Equation 3-5, page 94.

The LC models were estimated in preference space rather than in WTP space as for the main model. The reason was that the best performing model out of three classes showed a positive out of pocket cost coefficient for two classes.

The selection of the optimal LC model in terms of number of classes and most appropriate covariates associated with classes, was guided by the AIC and the parsimony and policy relevance of results.

A step-wise method was used to specify the optimal number of classes through estimation of separate models and by increasing each time the number of classes by one class. The AIC of the new model was then compared to that of the last model until no further improvement to the criterion was achieved, i.e. up to the point when the AIC started increasing with the addition of one class. In addition to comparing the models on AIC, the parsimony and policy relevance of the obtained model solutions was also considered in the choice of final number of classes following a common practice in the dental literature (Sever, I. et al., 2018).

The LC membership probabilities were predicted by sociodemographic variables. The sociodemographic variables which were tested for association with classes were elicited from the review based on a systematic search of the literature in this study. These included gender, age, frequency of dental visits, sugar consumption, country of residence, perceived oral health, purpose of last dental visit, type of dental insurance, education and type of employment.

The equation form of LC is presented in Equation 3-10.

Equation 3-10. $$U = [delta + gamma_{freq\_of\_dental\ visits\_every\_six\_months} * freq\_of\_dental\ visits\_every\_six\_months + gamma_{planned\_treatment\_last\_visit} * planned\_treatment\_last\_visit + gamma_{emergency\_treatment\_last\_visit} * emergency\_treatment\_last\_visit + gamma_{0-1\_sugar\_beverages\_per\_day} * 0 - 1\_sugar\_beverages\_per\_day + gamma_{age} * age + gamma_{female} * female + gamma_{living\_UK} * living\_UK + gamma_{living\_UK} * living\_UK + gamma_{private\_insurance} * private\_or\_partially\_private\_insurance\_scheme + gamma_{university\_education} * university\_education + gamma_{umemployed} * unemployed + gamma_{average\_or\_poor\_perceived\_oral\_health} * average\_or\_poor\_perceived\_oral\_health] * [b_{cost} * cost + b_{travel\_time} * travel\_time + b_{dietary\_advice\_time} * dietary\_advice\_time + b_{hygiene\_advice\_time} * hygiene\_advice\_time + b_{preventive\_treatment\_time} * preventive\_treatment\_time + b_{waiting\_time} * waiting\_time + b_{dentist\_provider} * dentist\_provider]$$

3.3.12.3 *Methods used to test the DCE assumptions quantitatively in the final analysis*

The assumptions that individuals answered choice tasks in a rational manner and traded across all attributes were explored in the patient DCE study. Attribute dominance was also assessed to check whether any attribute dominated the decision making process.

The assumption of logical responses was tested by excluding protest respondents, identified as straight-liners (those choosing either always the left or right hand option) and those always choosing the option with either higher out of pocket costs, longer waiting time, or longer travel time for a dental check-up, as such responses were considered inconsistent. A separate model was run with the reduced dataset and the findings were compared with results of the main model. If the findings were similar, it would imply that the existence of seemingly inconsistent respondents was limited without impacting the results, pointing to the validity of the main model.

To assess the extent to which individuals traded across the attributes, attribute non-attendance (ANA) was investigated using a strategy which was common in the literature (Lagarde, 2013). The strategy aims to explore the extent to which attribute non-attendance is an issue in the dataset. This was done by estimating seven consecutive two class LCs where respondents were either assumed to have attended to all attributes (class 1) or to have ignored one attribute (class 2). The estimated parameters across the two classes were otherwise constrained to be equal to each other. This specification permitted the estimation of a model where preferences across individuals could only vary in the information processing rule they applied. For these seven models, a Bayes' formula was used to calculate the posterior estimates of the individual-specific class probabilities of belonging to group 2, that is, ignored one attribute, conditional on the observed sequence of T choices.

The logit choice probability function of choosing one particular alternative from J alternatives for an individual n belonging to a specific class k could be written as:

Equation 3-11. $$P(y_{nt} = 1|class\ k) = P_{nt}|k = \frac{e^{X'_{ntj}\beta_k}}{\sum_{j=1}^{J} e^{X'_{ntj}\beta_k}}$$

The probability that an individual n belongs to class k out of a total of K classes is given by:

Equation 3-12. $$H_{nk} = \frac{e^{\gamma_k}}{\sum_{k=1}^{K} e^{\gamma_k}}\ , k = 1, \dots, K\ and\ \gamma_k = 0$$

The Kth parameter vector is normalised to zero to ensure identification of the model (Greene and Hensher, 2003). The log-likelihood function to be maximised was hence the sum over individuals of the log of the expectation over classes of the joint probability of the sequence of T choices:

Equation 3-13. $$lnL = \sum_{n=1}^{N} lnP_n = \sum_{n=1}^{N} ln \sum_{k=1}^{K} H_{nk} \prod_{t=1}^{T} P_{nt|k}$$

After retrieving the parameter estimates, Bayes' formula is applied to estimate the posterior estimates of the individual specific probabilities $\widehat{H}_{k|n}$, conditional on the observed sequence of T choices (Greene and Hensher, 2003).

Equation 3-14. $\widehat{H}_{k|n} = \frac{\hat{P}_{n|k}\hat{H}_{nk}}{\sum_{k=1}^{K}\hat{P}_{n|k}\hat{H}_{nk}}$

Even though each class k could be defined by a vector β_k, the analyst could impose restrictions on these parameters. In this case, the aim is to check whether participants has chosen to ignore certain attributes which is equivalent to constraining the coefficient linked to a particular attribute to zero (Hess et al., 2013).

Attribute dominance was also tested by identifying participants who always chose the option which was better according to a single attribute. This occurred to check whether any attribute dominated in the decision making process. However, individuals who demonstrated this behaviour were not removed from the full dataset to repeat the analysis. The reason was that in each survey there were always situations with no level difference in the attribute being tested for dominance effects. Hence retaining these participants in the dataset still offered the opportunity to measure their trade-offs between other attributes.

4. Results

The results of qualitative methods for the development of the dental and patient DCE questionnaires are presented first, followed by the quantitative results from the DCEs in each case.

4.1 Qualitative analysis of dentist study

The results of the qualitative methods used to develop the D-DCE-Final questionnaire are presented in this section.

4.1.1 Literature review findings on potential attributes

The literature reviews of the dentist-patient relationship and dentist preferences resulted in several attributes of secondary preventive care which were categorised into process, patient related and income attributes. (See the data extraction tables for more information on the literature review parts in Appendix 2-Appendix 3 and Appendix 9-Appendix 11). No outcome attributes were identified in the search. Process attributes included preventive treatment using fluoride varnish or fissure sealants, preventive advice, restorative treatment, time for prevention, time for restorative treatment, training on caries management and prevention of caries, dental material for restorative treatment, and diagnostic tools for caries. Patient related attributes involved age, income, education, ethnicity, level of interest or cooperation with treatment, type of dental insurance, caries risk, caries depth (enamel-dentine) and dental history. Expected annual income was used as an income attribute.

4.1.2 Expert group findings

The expert group decided to remove three process attributes, namely training on caries management, materials of restorative treatment and diagnostic tools for caries prognosis. The primary reason was difficulty in measuring and controlling the levels of these attributes in a dental practice setting.

The group suggested the addition of the following process attributes involving demonstration of brushing and flossing, scale and polish, type of dental provider performing the preventive work, administration work, payment system used and existence of a system for recording and measuring preventive services.

Demonstration of brushing and flossing was a special type of oral hygiene advice, and the group was interested to explore dentists' preferences for it since it was policy relevant. Scale and polish was a non-prevention activity usually involved in conjunction with preventive and restorative treatment in the dental office.

It was also discussed that payment system may impact provider behaviour with fee for item/service and risk based fixed fee capitation being the most frequent payment schemes. For example, a Cochrane study documented that the use of fissure sealants is more frequent in children by dentists

in FFS (fee for service) remuneration systems than in capitation schemes (Brocklehurst et al., 2013). In contrast, other studies have found a greater deal of preventive care and fewer restorations in a capitation systems compared with FFS (Andås and Hakeberg, 2016; Johansson et al., 2007).

The group recommended the inclusion of administrative barriers since it has been shown to influence participation rates in dental public system for dentists in US (Borchgrevink et al., 2008). In a study exploring the effects of some US states outsourcing administrative responsibilities associated with patient education and claims processing, positive outcomes included increases in the numbers of participating providers and improvements in oral health care utilization of patients (Borchgrevink et al., 2008).

Furthermore, the group noticed that a quality assurance and measurement system for dental prevention could be a contributing factor to the delivery of such type of care (Rosing et al., 2019).

Another potential attribute of prevention which was identified by the group was the type of dental professional delivering prevention. Challenges faced by many people in accessing oral health services had fuelled the discussion of how alternative dental providers such as dental hygienists could be utilised to improve the oral health of communities (Catlett, 2016; Mishler et al., 2018). In the US, dental hygienists worked in various settings, and contingent upon the State Practice Act were subjected to varying levels of supervision (Pervez et al., 2016). In particular, every state permitted some treatments being provided without the supervision of a dentist such as administration of prophylaxis, fluoride and sealants (Catlett, 2016).

The team recommended two adjustments to the patient related attributes. It was suggested that ethnicity be replaced with the proxy of patient's first language, as potential communication problems with patients with English as a second language was more relevant. A patient's medical history was also added as a missing attribute, as it could potentially affect dental decision making.

In relation to attributes' levels presentation, the group argued that showing levels of treatment attributes in time units could facilitate the understanding of the survey and permit higher flexibility in responses as the dentists could choose from a wide range of response options offering different level combinations of preventive and restorative treatment, as compared with mutually exclusive treatment options. Such an approach was more useful in accounting for the high variance of treatment decisions among dentists.

The preliminary list of attributes relating to dentists' preferences for secondary prevention as resulted from the literature review and expert group is given in Table 4-1.

Table 4-1. Preliminary list of dental attributes

Process attributes	**Descriptions**
Preventive treatment	Fluoride varnish and fissure sealants
Preventive advice	Dietary advice
Restorative treatment	Fillings
Time	Procedure time for restorative treatment, preventive treatment and preventive advice
Training on caries management and prevention*	Ongoing professional education on caries management and prevention
Materials of restorative treatment*	Use of amalgam versus resin based material
Diagnostic tools of caries*	Use of tools such as dental explorer for detecting caries or testing visually without specific tools.
Oral hygiene advice**	Demonstration of brushing and flossing
Scale and polish**	Procedure for removing plaque
Type of dental provider**	Either a dentist, or dental hygienist, or dental therapist or dental nurse
Administration work**	Time of administrative work for example to record the procedures to declare level of activity for remuneration purposes.
Payment system/method**	Salary based or capitation or fee for service.
System of recording and measuring preventive services**	A separate system devoted in its entirety for prevention measurement and remuneration purposes.
Patient related attributes	
Age	Age of the patient
Income	Income level of the patient
Education	Education level of the patient
Ethnicity or first language	Ethnicity of the patient
Level of interest in treatment or cooperation with treatment	Interest of patients for prevention.
Type of dental insurance	Public or private insurance.
Caries risk	Level of caries risk.
Caries depth	Caries on the enamel or dentine level
Dental history	Number of past fillings
Medical history	Other medical conditions such as diabetes or cardiovascular disease
Payment attribute	
Expected annual income	Expected annual income of dentists

**attributes removed by the expert group*

***attributes added by the expert group*

4.1.3 DES (Appendix 16, page 291)

The results of three cognitive interviews in which participants completed the dental exploratory survey were classified into four groups by applying framework analysis. Problems with potential attributes are presented according to framework category in Table 4-2, page 118.

The majority of issues by problem category belonged to the response selection class (48%), where observations referred primarily to mismatching response categories as well as changes in the wording of the process and patient related attributes. The second largest problem class was retrieval from memory items (28%), relating in particular to unavailable information about the choice context and some process attributes. Comprehension problems (17%) mostly concerned erroneous assumptions about the timing of preventive and restorative care delivery in the dental office and the dental professional applying the different types of treatments. Judgment or evaluation problems accounted for only 7% of total issues.

4.1.3.1 *Comprehension issues*

All participants indicated that they found the instructions of Question A (Appendix 16, page 291) complicated, a fact likely attributed to the task's lack of realism, in that linked preventive care delivery was linked to a decision about which dental practice to take a new job in. It was suggested that in an actual decision-making context of treating a patient, the importance of treatment procedures will depend on the specific patient case. One respondent proposed that the phrase "from the perspective of preventive work" should be added to the instructions of Question A.

In Question B, one dentist stated that even if they possessed knowledge about patients' income and education level prior to treatment, there should still be an assumption of constant compliance in relation to patients' preventive behaviour. This item was placed in this group as it was related to an erroneous assumption according to the problems classification framework.

In Question C respondents emphasized that scale and polish was usually applied by a dental hygienist at separate appointment to restorative treatment. This showed a potential contradiction in dentists' minds when deciding about the delivery of both preventive and restorative treatment at the same dental appointment. These issues were classified in the comprehension group due to fact that they were based on the erroneous assumption that both treatments were delivered by the same person at a single dental appointment.

4.1.3.2 *Judgment/evaluation issues*

In Question B, one respondent appeared confused when ranking factors based on their importance in decision making about delivering preventive treatment. In Question C, participants encountered difficulties in providing suggested levels for each attribute, and regarded the task as highly complex, with a lack of information about the choice context and patient characteristics. Hence, some abandoned the activity part way through until such information was available to them to facilitate the answering process.

4.1.3.3 *Retrieval from memory issues*

In Question A, retrieval from memory issues included suggestions for more information relating to the expected annual income attribute in the form of rough estimates, as well as the source of the income, e.g. NHS or private practice. Similar problems related to the payment system, with individuals requesting greater detail about how each system, i.e. capitation, fee per service or salary, was linked to the amount of preventive service provided. In addition, more information was requested about the robust evaluation system for prevention. Respondents wanted to know more about the specifics of such systems in practice, and whether this mechanism would be directly linked to payments. Furthermore, they added that the attribute of a robust system measuring prevention was difficult to

conceptualise. One participant requested more information about what activities administrative work involved.

In Question B, participants recommended splitting question B into three different parts, each addressing a specific procedure, i.e. brushing and flossing demonstration, fluoride varnish and fissure sealants separately, rather than using just one question encompassing all treatment and advice elements. This was classified as a retrieval from memory item, as additional information was required to give a complete answer. The reasoning was that the same factors might be prioritised in a different way contingent upon the preventive procedures they concern. For example the patient's age might be relevant for demonstrating tooth brushing and flossing techniques due to the fact younger age patients might be more receptive to dental advice, whereas the same factor might be ranked lower with regards to a different preventive care measure such as fluoride varnish delivery, where medical history might be more important.

In Question C, the main issues were requests for more detailed information about the choice context within which dentists were asked to suggest the range of attribute levels. Dentists strongly suggested a choice context of a dental appointment or treatment plan within which participants would be requested to propose minimum and maximum values for each quantitative attribute. Another dentist also emphasized the clarity provided to participants of a hypothetical dental appointment choice setting consisting of alternative options described by the time spent on preventive and restorative treatments for a patient case. The respondents also felt somewhat confused about determining these values in an arbitrary way without patient specific information, as discussed in previous paragraphs. It was therefore decided that a reference patient case would have made the choice situation a lot clearer to participants. One individual also stated that more information was needed regarding expected annual income, as this would differ based on the type of dental contract (e.g. between principal and associate dentists).

4.1.3.4 *Response selection issues*

In Question A, participants suggested that the attributes were presented in an "illogical order". Dentists proposed replacing the term "dental provider" with "having additional support such as dental hygienists, therapists and nurses" to assist with brushing/flossing demonstration, advice and preventive treatments. In addition, despite the literature indicating that dentists were more likely to deliver preventive care for individuals with higher interest in prevention (da Silva Tagliaferro et al., 2020), interview participants pointed out that it was unlikely they would know in advance of seeing a patient how compliant they would be in following dental advice, and hence recommended that this attribute be excluded. Further suggestions followed relating to the wording of some attributes.

Individuals suggested prefacing each attribute with the phrase “Having the time to be able to demonstrate” each procedure to make response categories clearer.

In Question B, respondents stated that they would not know about the patient’s income, general medical condition, type of dental insurance and educational background in advance of treating a given case, indicating that these response categories contained wrong and mismatching units. A respondent recommended that the attribute of English as a patient’s first language be substituted for a patient’s fluency in English to make the response category clearer.

In Question C, one respondent asked for ranges of potential levels to be provided instead of empty boxes so that dentists would have some idea about the typical minimum and maximum average time spent on each procedure before providing their inputs. All three dentists proposed splitting scaling and polishing and drilling and filling, as they reflect separate procedures. They also suggested substituting the words “drilling and filling” with the term “restorative/oral treatment” as this was more precise. Separating fluoride varnish and fissure sealants treatments was also proposed by respondents, as they represent distinct treatment options with distinct features. Adding the phrase “having the time to be able to demonstrate” to the time-related attributes was suggested by two participants.

Generally, dentists were unwilling to rank attributes in terms of importance without a dental appointment or treatment plan context, as this seemed incompatible with the choices they were being asked to make within the common dental practice activities.

Table 4-2. Framework analysis of cognitive interviews with ranking exercise (Appendix 16, page 291)

Questions	**Problems by category**				**Total**	**Total %**
	Comprehension	Retrieval from memory	Judgment/Evaluation	Response Selection	Total number of problems by question	Percentage of total problems by question
DES	5	8	2	14	29	100%
Percentage of total problems by category	17%	28%	7%	48%	100%	

4.1.4 Expert group leading to D-DCE1

The expert group discussed the themes identified by the framework analysis in order to resolve the multiple issues which arose. Group members first agreed that ranking attributes and suggesting minimum and maximum range attribute levels potentially led to a large number of issues, as dentists had difficulties in responding to hypothetical situations they had never encountered before.

Expected annual income, payment system, existence of a robust system for measuring oral prevention activity and administration work attributes were all excluded from the attributes list due to high variation in how these attributes were interpreted by dentists. For example, a robust system for measuring preventive treatment activity was understood in different ways by different participants in terms of the specifications that such a system would incorporate.

The patient related attributes of education, income, type of dental insurance, medical history and first language were eliminated. One reason was dentists' concerns that assigning treatments contingent on such characteristics would imply that all patients with such characteristics would follow or continue to follow the same behaviour indefinitely, which participants were uncomfortable with. In addition, participants suggested there would be difficulty in acquiring knowledge about these characteristics at the time of examining a patient. The patient attribute of dental history was also excluded due to high correlation with risk of developing caries.

The only patient level attributes retained were the patient's age, risk of developing caries and caries depth, as dentists expressed no concerns about the availability of this information at the time of treating a patient.

The total time available for treatment was also incorporated as a separate attribute, to capture the importance of the time pressure faced by dentists. This topic was also emphasized by interview participants when assessing the importance of treatment attributes.

It was reported that fissure sealants (Ahovuo-Saloranta et al., 2016; Wright et al., 2016) were not frequently applied to prevent dental caries in the adult population. As the focus of this study was adult prevention, dental sealants as part of preventive treatment attribute was excluded. A scale and polish procedure was also removed as it was mostly regarded as care for prevention of periodontal disease (Lamont et al., 2018; Ramsay et al., 2018), and the focus of this study was caries prevention.

Two separate process attributes were included which described situations where different dental professionals, e.g. dental hygienists, dental therapists or dental nurses, instead of dentists, delivered preventive treatment and advice.

The expert group also decided how to present DCE choices to participants. It was confirmed that the choice task should show two alternative treatment plans for a particular patient vignette, described in terms of four attributes: age, risk of developing caries, caries depth and available time for treatment. Choosing between different treatment plans was judged to be a more appropriate choice context than choosing between dental appointments, because dentists suggested that preventive and restorative treatments are normally delivered at different dental appointments. Thus choosing between treatment plans was more realistic, facilitating the understanding of the choice tasks and enhancing the realism of the decision making situation.

The team determined an indicative range of levels for each attribute following common sense and experience, which was judged sufficient at this early stage of DCE development.

4.1.5 Cognitive interview with dentist D-DCE1 (Appendix 17, page 293)

Framework analysis of the interview following a coding classification system was again implemented. Findings of this analysis are presented in Table 4-3, page 124.

4.1.5.1 *Comprehension issues*

The participant stated that preventive treatment is usually applied at the first patient visit, while patient compliance and need for further prevention are assessed at a second visit, while restorative care takes place at subsequent visits if required. It was suggested that dentists would not make trade-offs between prevention and restoration because "these procedures normally happen in separate appointments". This problem was based on the erroneous assumption by the dentist that prevention and restoration of the treatment plan should be delivered at the same appointment. Moreover, it was suggested that the instructions should report that the study "explores dentists' preferences relating to the mix of preventive and restorative treatment" instead of simply referring to "preferences relating to a balanced mix of preventive and restorative treatment", an issue also categorised as comprehension.

4.1.5.2 *Retrieval from memory*

The respondent suggested that restorative treatment should be accompanied by a stronger sign of the severity or size of caries requiring restoration. The respondent mentioned that additional evidence could take the form of photographs of the teeth requiring restorative treatment, showing the condition of dental caries. An additional concern was that the time spent on restorative treatment is dependent on the surface treated and the type of material used e.g. amalgam versus composite, and hence the participant indicated the need for additional information on these features. It was also suggested that attributes relating to the size and type of restoration, medical history, affordability and level of cooperation of the patient should be incorporated into the choice scenarios. The individual reported a reluctance to sacrifice any other attributes to obtain more time for preventive treatment, since this process is delivered "per patient needs" and varies depending on "patient understanding and compliance". The respondent though later reported that he "would like to mix and match both plans but had chosen with where his majority of preferences lied", implying that some trade-offs between attributes had been made.

4.1.5.3 *Response selection issues*

The participant reported that the levels of the payment attribute did not correspond to realistic hourly payment levels.

4.1.5.4 *Judgment/evaluation issues*

The respondent was confused about how to allocate the remaining time after delivery of treatment plan and how to share the payment with the other dental professionals, based on their time contributions to the treatment plan.

4.1.6 Changes to D-DCE1 leading to D-DCE2

D-DCE1 was updated to resolve the issues which emerged in the framework analysis. Changes included adding a photograph to each scenario as an additional patient related attribute which showed an occlusal surface with various levels of caries determined using the ICDAS framework (Ekstrand et al., 2018). The ICDAS is a well-established caries classification scheme measuring caries severity. The addition aimed to facilitate dentists' selection of a treatment plan and addressed participants' concerns that there was insufficient evidence to be able to judge the amount of restorative care required. Definition of caries depth was removed from the vignette descriptions, as caries severity was represented by the clinical photograph. Available time slots for treatment were also revised downwards to 40, 50 and 60 minutes from 1, 1.5 and 2 hours respectively, to allow for less free time after adding up all treatment timings, and to deal with the participants' confusion about how to allocate the extra time after treatment plan delivery. In addition, the two attributes specifying who delivered preventive advice and preventive treatment were merged into one attribute, i.e. the same dental professional delivering both types of care, to simplify the choice situation that dentists were faced with. Wording of instructions was amended according to the feedback from the previous interview round. These changes led to the design of DCE-2 questionnaire (Appendix 18, page 295.

4.1.7 Cognitive interview with D-DCE2 (Appendix 18, page 295)

Feedback was now collected the with D-DCE2 questionnaire. Findings of this analysis are presented in Table 4-3, page 124.

4.1.7.1 *Comprehension issues*

Incorporating photographs seemed to improve understanding of the DCE choice tasks. The main problems which arose were some complex syntax issues. It was also suggested that the hypothetical nature of the questionnaire should be highlighted in bold in the instructions section.

4.1.7.2 *Retrieval from memory*

The lack of a corresponding radiograph next to each photograph was raised as an issue, as dentists use this type of evidence in their treatment plan decisions.

4.1.7.3 *Judgment/evaluation*

The attribute available time for treatment still triggered much confusion as to how to spend the resulting extra time after summing up treatment timings. Moreover, the attribute of dental provider

for preventive treatment and advice confused the respondent, who was unsure about what share of the payment would correspond to themselves and what share should be allocated to the alternative dental professional.

4.1.7.4 *Response selection issues*

Concerns were raised regarding the levels of payment attribute, which were stated to be relatively high, exceeding existing payment levels in an NHS contracted practice for comparable treatment activities.

Table 4-3. Framework analysis of cognitive interviews with D-DCE1 and D-DCE2

Questionnaires	**Problems by category**				**Total**	**Total %**
	Comprehension	Retrieval from memory	Judgment/Evaluation	Response Selection	Total number of problems by questionnaire	Percentage of total problems by questionnaire
Dental-DCE1	2	8	2	1	13	68%
Dental-DCE2	2	1	2	1	6	32%
Total number of problems by category	4	9	4	2	19	100%
percentage of total problems by category	21%	47%	21%	11%	100%	

4.1.8 Changes to D-DCE2 leading to D-DCE3

The framework analysis of the interview with D-DCE-2 led to the removal of the following attributes: dental professional for preventive care and available time for treatment. Radiographs were added alongside the corresponding photographs showing caries.

Overall, treatment attributes included time for preventive treatment with four levels, 0, 3, 5 and 7.5 minutes, time for preventive advice with four levels, 0, 3, 8 and 12 minutes, time for restorative treatment with four levels, 0, 15, 25 and 35 minutes. Payment levels were revised downwards following suggestions at previous interview rounds. The new levels were €30, €55, €70 and €85.

Patient attributes involved risk of developing caries, photograph/radiograph pairs showing various levels of caries and patient's age group. Each attribute was described by three different levels: low, moderate and high risk of developing caries, photographs and associated radiographs corresponding to ICDAS 1-2, ICDAS 3-4 and ICDAS 5-6 caries classes and age groups of 18-35, 35-55 and 55+ years of age.

The design of D-DCE3 is illustrated in Appendix 19, page 297.

4.1.9 Focus groups with D-DCE3 (Appendix 20, page 298 and Appendix 21, page 304)

The main results of the two-focus group sessions at the Cork Dental School with regards to D-DCE3 were demonstrated in this section. Three dentists participated in the first session and four dentists took part in the second session.

4.1.9.1 *Framework analysis of two first focus group sessions with the D–DCE3 questionnaire*

Problems explored during the focus group session were categorised according to the same classification framework used above, grouping problems into comprehension, retrieval from memory, response selection and judgment/evaluation items. For an aggregate picture of problem numbers by class see Table 4-4, page 127.

4.1.9.1.1 Comprehension issues

Some syntax problems were investigated in the survey's instructions. These issues were grouped in the comprehension category according to framework analysis. Other problems encountered by individuals included the perceived connection of the risk of developing caries with the presented photographs and radiographs, as it was not clear to them that the risk measure referred to an assessment of generic oral conditions in the entire mouth instead of the specific tooth appearing on the photographs. An explicit explanation was required on what the risk of developing caries referred to, i.e. the full mouth or the tooth shown in the photographs. One participant found it difficult to understand whether preventive treatment was applied just to the tooth shown in the photographs or

the entire mouth, a problem rated as comprehension relevant in relation to a vague term in instructions.

4.1.9.1.2 Retrieval from memory items

One respondent suggested the inclusion of more examples in the descriptions section as to which specific preventive services should be included into the preventive treatment attribute, such as fissure sealants treatment. This implied the need for greater detail in the relevant description section, categorised as a retrieval from memory item.

One respondent also requested to know by which method the risk of caries development was ascertained, indicating that further details on this issue should be reported. A description of how the risk of developing caries was evaluated was judged necessary in the descriptions section. A request for greater detail about the method of measurement for caries risk was classified as retrieval from memory concerning missing information that should be added to the attributes' description table.

More information was also requested about the dental materials being used, whether assistance from another dental professional was available, for example in demonstrating brushing techniques, the provision of X-rays in patient vignettes, what features the preventive advice attribute would involve, e.g. delivering advice based on a guidelines leaflet given as handout at the time of seeing the patient, or whether preventive advice content "is entirely up to each dentist and their staff?" to decide. Furthermore, participants asked for additional patient medical and dental history, specifically dry mouth, medication, regular attendance, socioeconomic status, patient compliance, oral hygiene, dietary habits as well as other patient attitudes to be included in the patient vignettes. Participants also suggested that they would be willing to provide more preventive treatment if they were allocated more time within longer appointments. These additional issues regarding patient level missing information to make treatment plan choices more realistic were categorised in the retrieval from memory group.

4.1.9.1.3 Response selection problems

An important problem resulting from the analysis of respondents' choices pertained to the unwillingness of dentists to trade preventive care, in terms of preventive treatment and advice, for restorative care, based on the presented photographs. Individuals expressed concerns that the extreme severity of caries appearing on some photographs did not allow them to choose any other option than the one with the highest restorative treatment.

An additional issue identified in this group related to the income attribute, with dentists being generally unwilling to trade income for other attributes, as depicted by frequent choices of higher income treatment plans.

Table 4-4. Framework analysis of focus groups with D-DCE3

Questionnaires	**Problems by category**				**Total**
	Comprehension	Retrieval from memory	Judgment/Evaluation	Response Selection	Total number of problems
D DCE3	3	14	0	2	19
Percentage of total problems by category	16%	74%	0%	11%	100%

4.1.9.2 *Responses to choice scenarios of D-DCE3*

A descriptive analysis of choices was proposed to show whether dentists traded between the attributes. In five out of eight choice scenarios in the first block (Appendix 20, page 298) respondents always chose the same dental treatment plan, i.e. second, first, second, first and second alternatives for questions 2, 4, 5, 7 and 8 respectively. On choice tasks 2 and 4 dentists opted for the higher payment level of €85 and more time for restorative treatment for ICDAS 3-4 and ICDAS 5-6 surfaces respectively, appearing less motivated by the provision of more prevention, especially in question 2. In question 4 participants opted for alternative A, preferring to deliver longer preventive and restorative care for higher income. In questions 5 and 7, which featured ICDAS 1-2 and ICDAS 3-4 surfaces, individuals selected the options involving more time for preventive treatment and advice despite that payments were lower and time for restorative treatment was equal or longer. Agreement in question 8 was achieved with everyone reporting they had no other choice than to select the option with at least some restorative care, given the cavity's severity depicting an ICDAS 5-6 rated surface. In question 1, two out of three individuals chose the first option, trading off more prevention for less restorative care and income, possibly driven by the age of the patient who was over 55. In question 3, the majority of dentists selected option B involving more preventive advice, more restorative treatment, i.e. 35 minutes against no time, and €25 higher income. Whereas potentially considering the young age of the patient in the same scenario, one participant chose the option A with no intervention. Finally in question 6, two dentists went for option B for an ICDAS 5-6 rated surface of a 18-35 years old patient with low risk of developing caries, favouring more preventive and restorative care in total for the same payment level, likely accounting for the cavity's serious condition and the young age of the patient.

In relation to choices of second block of D-DCE3 (see Appendix 21, page 304), individuals selected the same option in six out of eight choice scenarios. In questions 1, and 3-7, the same option was always chosen specifically A, B, B, A, A and A respectively. In general, whenever individuals made the same decisions, they seemed to select the more expensive options with longer restorative treatment, preventive treatment and advice, as happened in questions 1, 3, 5 and 6 involving ICDAS 3-4, 5-6, 3-4 and 3-4 occlusal surfaces respectively. As far as patient cases were concerned, in all these scenarios, the vignettes represented the entire range of age groups and caries development risk profiles, revealing a relative tendency of dentists' preferences for delivering more preventive and restorative treatment at any given surface for higher incomes, irrespective of the patient's age or risk of carries development. Overall agreement among all respondents was also achieved in question 4, where everyone opted for plan B which featured more time for preventive and restorative treatment at the same remuneration level for an ICDAS 5-6 occlusal surface of an 18-35 year old patient with moderate

risk of developing caries, in line with the evidence above. Moreover in question 7, everyone chose plan A, giving up €30 of income to provide an extra 3 minutes of preventive treatment and 3 minutes of preventive advice to a 35-55 year old patient with a less severe caries condition rated as ICDAS 1-2 and with moderate risk of caries development. Such findings indicated that in younger patients with less severe caries, dentists were willing to deliver more prevention at a lower income. Question 2 illustrated a less severe caries condition of an over 55 patient with high risk of caries development, prompting three out of four individuals to opt for option A. This meant they were willing to trade €15 of their income to provide more restorative treatment to the patient. This could be partially explained by the patient's age and risk of caries making it a more challenging case. Finally in question 8, half of the dentists selected option A whereas the other half option B. A possible explanation for this split could be that for some participants, decreased caries severity, in conjunction with the low risk of caries development, justified more prevention compared to restorative care, even at a lower income, with the other half potentially considering restorative treatment and income as the main motives for choosing the reverse approach as the most suitable treatment plan option

4.1.9.3 *Confidence ratings of D-DCE3 questionnaire*

The statements describing the understandability of questions and treatment plan attributes were rated 6/7 and 5.7/7 respectively, indicating that participants understood the meaning of the DCE's content to a good extent. Statements on how realistic the presented scenarios were and whether all the important information was presented scored 4/7 and 4.3/7.

4.1.10 Changes of D-DCE3 leading to D-DCE-Final

A review of published documents was used to resolve a number of issues which emerged from the two focus group sessions at Cork Dental School in relation to the attribute levels. The revisions to the levels were explained in detail in the following paragraphs.

4.1.10.1 *Revisions of risk of developing caries levels and patient's age levels*

One additional problem considered at this stage was the definition of the caries risk measure, which was linked to the presented photographs rather the generic oral health condition of the patient by most participants. It was necessary to define this risk indicator as reflecting a wider measure associated with conditions present in the entire mouth and not specifically connected to the tooth appearing on photographs. A relevant description section was hence added in the table of attribute descriptions, stating that the risk of caries was assigned three separate levels, i.e. low, moderate and high as determined by a set of criteria directly elicited from the ADA's Caries Risk Assessment form (ADA, 2020). Therefore dentists were told that patients were classified into the high risk group if they presented at least one of the following symptoms: frequent or prolonged consumption of sugary foods and drinks between meal exposures per day, three or more carious lesions or restorations in last 36

months, teeth missing due to caries in the past 36 months, severe dry mouth (xerostomia). Patients with at least one of the following symptoms were placed into the moderate caries risk category; no fluoride exposure, no previous established dental record consisting of regular dental care in the dental office, special health care needs impeding taking care of their own oral health, eating disorders, medications that reduce salivary flow, drug/alcohol abuse, one or two new carious lesions or restorations in last 36 months and visible plaque. Everyone else with no such symptoms was classified as low caries risk. The values of the age attribute were set to 24, 55 and 75 years of age.

4.1.10.2 *Revisions of restorative treatment levels*

The levels of the restorative treatment attribute were set to 0, 15 and 20 minutes, reflecting a need for shorter restorative treatment based on the new set of photographs which presented less severe caries conditions (see below).

4.1.10.3 *Revisions of payment levels*

Another concern was in relation to payment values. Dentists in the focus groups showed a preference for higher remuneration. To avoid the payment attribute dominating treatment plan choices, its levels needed to be revised. The range of payment levels was set to £20, £40 and £60. The lowest payment level of £20 was assigned only to treatment plan options containing no restorative care, while in options featuring restorative treatment, the payment level was either £40 or £60 to make payment levels more realistic.

4.1.10.4 *Revisions of photograph pairs*

A new set of five photograph pairs was agreed by a two stage expert group and divided into two severity groups. They are illustrated in Figure 4-1, page 131.

The final treatment and patient attributes and levels for the dentist DCE are given in Table 4-5.

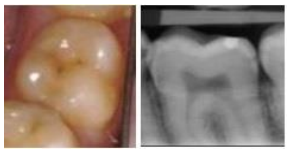
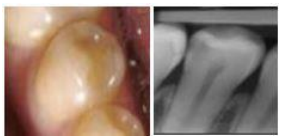
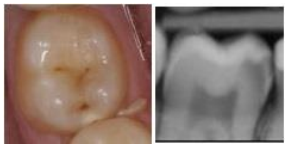
First Group of photographs - Severe caries conditions	Second Group of photographs - Less severe caries conditions
A. 	D. 
B. 	E. 
C. 	

Figure 4-1. Final sets of photograph pairs as elicited from a two stage expert group

Table 4-5. Treatment and patient attributes of D-DCE-Final

Patient vignettes' attributes	Levels
Age in years	24, 55, 75
Risk of developing caries	low, moderate, high
Pairs of a radiograph and photograph	
Treatment plan attributes	**Levels**
Time for preventive treatment in minutes	0, 4, 8
Time for preventive advice in minutes	0, 6, 12
Time for restorative treatment in minutes	0, 15, 20
Payment in £	20, 40, 60

4.1.11 Experts group for the final layout of D-DCE-Final (Appendix 25, page 312)

Three individuals participated in this final experts group at Leeds Dental School. Amendments to the layout and wording adjustments were made, and sociodemographic questions were added, resulting in the D-DCE-Final questionnaire. Nine blocks of eight questions each were created. The actual design of attribute levels and correlations between attribute levels are presented in Appendix 23, page 309 and Appendix 24, page 311. An example dentist DCE questionnaire is presented in Appendix 25, page 312.

4.2 Quantitative analysis of dentist- study

Results from the dental study are shown below.

4.2.1 Sociodemographic characteristics (Overall N=143, UK N=109, ROI N=30)

Snowball sampling was used to reach the dentist population. Snowball sampling refers to recruitment of participants into behavioural health studies using respondent driven sampling which utilises peer network structures to have members of dental organisations recruit other members into studies (Pedersen and Kurz, 2016). Key contacts from dental organisations in the UK and ROI were sent an email which explained the aim of the study and included a link to the dentist DCE questionnaire. The email informed recipients that the purpose of the project was to understand dentists' preferences for delivering preventive and restorative care, and asked them to share the DCE questionnaire with their dentist contacts. If the key contacts were clinically active, they were also asked to complete the questionnaire themselves. The dental organisations contacted in the UK were the BDA (British Dental Association), IADR (International Association of Dental Research), BACD (British Academy of Cosmetic Dentistry), FGDP (Faculty of General Dental Practice), PHE (Public Health England), iHV (Institute of Health Visiting), NHS England, NHS Wales, NHS Scotland, BOHF (British Oral Health Foundation), Department of Health and Social Care, Health Education England, Department for Education and dental departments at the University of Leeds, King's College London, University College London and University of Manchester. Commercial companies in the field of dental care were also contacted, specifically Colgate, GlaxoSmithKline UK Limited and Procter & Gamble. Key organisations in the ROI included Health Services, Irish Dental Association, Cork University Dental School and Hospital, Dental Health Foundation, OHPARG (Oral Health Policy Academic Research Group) and the Central Statistics Office. Commercial organisations in the ROI consisted of Calcivis, Vhi Healthcare, Laya Healthcare, Health Intelligence Ireland, Software of Excellence, Aerona Software and Panara Dental Practice. Due to the use of snowball sampling in the recruitment of dentists, the total number of participants invited could not be identified.

Table 4-6, page 136 presents sociodemographic information about all participants. Most participants were male (53%). They were most commonly between 45 and 59 years of age (48%) and belonged to the principal-providing performer job contract group (41%), followed by the associates' class (24%). Half of participants worked full time, and around a third only delivered NHS or public service activity. Most primarily saw adult patients (60%), and 39% had less than a quarter of their patients exempt from payment. Around half of participants worked in England, 15% in Wales, 10% in Scotland and 2% in Northern Ireland. Around a fifth of dentists (21%) worked in the ROI. In terms of preventive care activity questions, most respondents usually delivered tooth brushing advice (45%) and dietary advice (42%) but sometimes demonstrated tooth-brushing (46%). Most dentists sometimes applied fluoride

varnish (62%) or fissure sealants (56%) to adult patients, and always checked for existing fissure sealants (53%). Most dentists received their qualification from a UK institution (69%), followed by an EU university (25%). Dentists worked in the same practice with an average of six dental nurses and three other dentists. Dental hygienists and therapists collaborated less frequently with sample dentists. Participants had on average 22.5 years since their graduation. The statements describing the understandability of questions and treatment plan attributes were given mean rates of 5.2/7 and 5.1/7 respectively. Statements on how realistic the presented scenarios were and whether all the important information was presented were given mean scores of 4.1/7 and 3.7/7. Sociodemographic information is also provided by country of practice for UK and ROI separately in the same table.

Table 4-6. Socio-demographics of dentists (Overall N=143, UK N=109, ROI N=30)

Sociodemographic variables	**Full sample (Frequency)**	**Full sample (Frequency %)**	**UK (Frequency %)**	**ROI (Frequency %)**
Gender				
Female	65	45	43	50
Male	76	53	55	50
Other/Prefer not to say	1	1	1	0
Missing	1	1	1	0
Age group				
18-29	14	10	12	3
30-44	46	32	33	27
45-59	69	48	45	60
60-74	12	8	8	10
Missing	2	1	2	
Job contract description				
Principal/Providing-Performer	59	41	44	33
Associate	35	24	29	10
Partner	8	6	6	7
Provider only	18	13	8	30
Other	18	13	13	17
Missing	5	3	0	3
Working status				
I work full time (35 hours per week)	71	50	50	50
I work part time (<35 hours per week)	48	34	13	23
I work more than 35 hours per week	23	16	37	27
Missing	1	1	1	0
Mix work				

Mixed (>25% and <75% - NHS or public dental service share)	23	16	14	23
Mainly NHS or public dental service (75-100% - NHS or public dental service share)	45	31	39	7
Mainly private (0-25% - NHS or public dental service share)	19	13	13	17
100% NHS or public dental service	48	34	30	43
100% Private	5	3	3	7
Missing	3	2	1	3
Number of dentists by under 18 years of age patient shares				
1 - 24%	86	60	67	43
25 - 49%	24	17	18	10
50 - 74%	10	7	8	3
75% or more	22	15	6	43
Missing	1	1	0	0
Number of dentists by exemption from payment patient shares				
1 - 24%	56	39	43	30
25 - 49%	30	21	22	20
50 - 74%	17	12	14	3
75% or more	38	27	21	47
Missing	2	1	0	0
Location of practice				
Wales	22	15	20	
England	70	49	64	

Scotland	14	10	13	
Northern Ireland	3	2	3	
ROI	30	21		100
Missing	4	3	0	0
Frequency of tooth brushing advice				
Always	49	34	34	30
Usually	64	45	44	53
Sometimes	26	18	21	10
Never	1	1	1	0
Missing	3	2	0	7
Frequency of tooth brushing demonstration				
Always	11	8	8	3
Usually	48	34	29	50
Sometimes	66	46	50	37
Never	13	9	12	0
Missing	5	3	1	10
Frequency of dietary advice				
Always	33	23	26	10
Usually	60	42	39	57
Sometimes	43	30	33	23
Never	1	1	1	0
Missing	6	4	2	10
Frequency of fluoride varnish application				
Always	8	6	7	0
Usually	19	13	15	7
Sometimes	88	62	59	80
Never	22	15	18	3
Missing	6	4	1	10

Frequency of fissure sealants delivery				
Always	1	1	0	3
Usually	7	5	4	7
Sometimes	80	56	55	63
Never	49	34	39	17
Missing	6	4	2	10
Frequency of checking existing fissure sealants				
Always	76	53	55	43
Usually	28	20	21	17
Sometimes	23	16	15	23
Never	11	8	8	7
Missing	5	3	1	10
Location of dental qualification				
EU	36	25	7	90
UK	98	69	85	7
Non-UK-EU country	8	6	7	0
Missing	1	1	0	3

4.2.2 Main model

A MXL with 15 coefficients was fitted on sample data and the results are illustrated in Table 4-7, page 142. The process which yielded to removing the remaining coefficients of the main model specification reported in Equation 3-4, page 93 is explained on page 92 and briefly in the footnote provided on page 140. The findings of both a MNL and MXL model including all 24 parameters of the main model specification in Equation 3-4, page 93 are presented in Appendix 38, page 383 and Appendix 39, page 385. The reasons for choosing a MXL over MNL model are described on page 90. The R code which was used in the estimation of MXL with all 24 parameters is reported in Appendix 26, page 329. The constant terms gave participants' preferences when shown a patient vignette with all attributes at baseline levels. The baseline vignette was as follows: A patient of 75 years of age, with high risk of developing caries and a serious caries condition. This vignette was considered the most challenging profile that could be formed from the set of patient attributes. The interaction terms depicted how respondents' preferences for treatment attributes varied if choosing for a patient vignette which differed from the baseline on a given patient attribute. For an algebraic expression of the utility function including the constant and interaction terms see Equation 3-4, page 93.

Empty entries in Table 4-7, page 142 indicate an absence of impact of the corresponding patient-related factors on dentists' preferences. Such empty entries resulted from applying an algorithm which removed terms in a stepwise process, eliminating one at a time, based on the lowest robust t-ratio statistic, until the AIC was minimised. The algorithm was initially applied on the full model including all 24 coefficients and yielded an AIC of 1324.58. The ninth step of the algorithm produced the model shown below with the lowest AIC. Purchasing power parities in the UK and ROI as of 2019, when data collection occurred, were used to convert income levels expressed in € for ROI participants into £ (€1=£0.83)(OECD, 2021).

4.2.2.1 *Preventive treatment*

Dentists demonstrated a positive preference for longer preventive treatment to the baseline patient vignette. They were also more likely to provide preventive treatment to a moderate caries risk patient compared to the baseline patient. A mild caries condition seemed to negatively influence preferences for preventive treatment, as participants were less likely to choose longer treatment for a patient with a mild caries condition compared to the baseline patient. Increased preferences for delivering preventive treatment to a moderate risk patient compared to the baseline patient was significant at the 5% level. However, low caries risk, as well as younger age did not influence dental preferences about preventive treatment compared to the baseline patient.

Variation in preferences for preventive treatment was higher when dealing with the baseline patient vignette compared to preference variation for interaction parameters.

4.2.2.2 *Preventive advice*

Respondents had a significantly positive preference for longer preventive advice for the baseline patient vignette. They also preferred to give longer preventive advice to 24 and 55-year-old patients compared to the baseline vignette. However, dentists were less likely to deliver longer preventive advice to patients at a low and moderate risk of caries compared to the baseline patient. Preference coefficients for preventive advice to the baseline patient vignette and for the interaction terms regarding low caries risk and younger patients were all statistically significant different from zero at the 5% level. On the other hand, the coefficient for mild caries did not seem to affect preferences for preventive advice. Variation in preferences for preventive advice was higher when treating a moderate caries risk patient compared to preference variation for the baseline patient vignette and the other interaction parameters.

4.2.2.3 *Restorative treatment*

Respondents opted to deliver longer restorative treatment to the baseline patient. In addition, dentists were more likely to provide restorative treatment to a younger patient compared to the baseline patient vignette. However, they were less prone to deliver restorative treatment to patients at a moderate risk of caries or those with a mild caries condition compared to the baseline patient vignette. Preference coefficients for the baseline patient and for the interaction terms for moderate caries risk, 24 years of age and mild caries condition differed significantly from zero at the 5% level. A low caries risk did not appear to impact dental preferences about restorative treatment compared to the baseline patient case.

A higher variation in preferences for restorative care was observed when treating a 55 years old patient compared to preference variation for the baseline patient vignette and the other interaction parameters.

4.2.2.4 *Income*

Individuals preferred a higher income over a lower income with the baseline patient case, in line with expectations. Except for a mild caries condition, where participants placed a lower emphasis on the payment they received, preferences for income were not influenced by patient's age or risk of caries compared to the baseline patient. The coefficient for income for the baseline patient vignette was significantly different from zero at the 5% level, but the interaction term for mild caries condition was not found to be statistically significant.

Variation in preferences for income was higher when dealing with the baseline patient case compared to preference variation for the interaction parameter of mild caries condition.

Table 4-7. Dental MXL with interactions of patient attributes

Treatment level attributes	Patient attributes	Parameter mean	Robust SE	CI-95%		Robust SE	CI-95%
Preventive treatment	Constant	0.027	0.030	(-0.032, 0.087)	0.184***	0.046	(0.095, 0.274)
	Moderate caries risk	0.087**	0.043	(0.002, 0.171)	0.063	0.056	(0.046, 0.172,)
	Low caries risk	-[7]	-	-	-	-	-
	55 years of age	-	-	-	-	-	-
	24 years of age	-	-	-	-	-	-
	Mild caries condition	-0.063*	0.037	(-0.135, 0.008)	0.121	0.069	(0.015, 0.257)
Preventive advice	Constant	0.194***	0.039	(0.118, 0.269)	0.087	0.046	(0.002, 0.177)
	Moderate caries risk	-0.091*	0.047	(-0.182, 0.001)	0.151***	0.054	(0.045, 0.258)
	Low caries risk	-0.133***	0.037	(-0.206, -0.061)	0.057	0.052	(-0.045, 0.158)
	55 years of age	0.119**	0.047	(0.027, 0.212)	0.101	0.063	(0.023, 0.225)
	24 years of age	0.077**	0.034	(0.010, 0.144)	0.029	0.049	(0.067, 0.125)
	Mild caries condition	-	-	-	-	-	-
Restorative treatment	Constant	0.161***	0.053	(0.058, 0.264)	0.089	0.058	(0.024, 0.202)
	Moderate caries risk	-0.070***	0.018	(-0.105, -0.035)	0.007	0.028	(0.047, 0.061)
	Low caries risk	-	-	-	-	-	-
	55 years of age	0.084	0.057	(-0.027, 0.196)	0.294**	0.114	(0.071, 0.517)
	24 years of age	0.049**	0.020	(0.010, 0.087)	0.046	0.025	(0.004, 0.096,)
	Mild caries condition	-0.149**	0.063	(-0.273, -0.025)	0.024	0.060	(0.093, 0.141,)
Income	Constant	0.045***	0.012	(0.022, 0.068)	0.046***	0.015	(0.018, 0.075)

[7] Where no coefficient is reported, it means that this patient characteristic does not affect dentists' preferences for the corresponding treatment attribute. The process which was followed for dropping these coefficients is described in 3.2.12. This is based on estimating multiple models in a stepwise process after removing each time the coefficient of lowest robust t-static until the final model is estimated with one parameter. All parameters were assumed to follow normal distributions. A hundred MLHS draws were used in the MXLs. The best model specification was finally selected based on minimisation of AIC.

	Moderate caries risk	-	-	-	-	-	-
	Low caries risk	-	-	-	-	-	-
	55 years of age	-	-	-	-	-	-
	24 years of age	-	-	-	-	-	-
	Mild caries condition	-0.037	0.025	(-0.086, 0.012)	0.018	0.020	(0.021, 0.057)
Log-likelihood	-619.65						
Number of responses	1128						
Sample size	143						
AIC	1299.29						
BIC (Bayesian Information Criterion)	1450.14						
***(at 1% significance level), **(at 5% significance level), *(at 10% significance level)							

In relation to the research question of the main determinants of dentists' preferences, dentists were more likely to provide preventive treatment to the most challenging patient and someone with moderate risk of caries. They were less likely to offer preventive care to a patient with mild caries condition. Looking at the positive coefficients for preventive treatment, individuals were willing to sacrifice a share of their income for offering such care to every patient except for someone with a mild caries condition. As for preventive advice, dentists were more likely to deliver this type of care to the most challenging patient and younger patients, while they had a lower tendency for advice with lower caries risk patients. However, focusing on the positive coefficients for preventive advice, they were willing to sacrifice a share of their income for delivering advice to every patient. With regards to restorative care, dentists were more likely to provide restoration to the most challenging patient and younger patients while they were less likely to offer restorative care to moderate caries risk patients and those with a mild caries condition. Looking at the positive coefficients for restorative care, dentists were willing to sacrifice a share of their income for delivering more care to every patient except for a patient with moderate caries risk and a mild caries condition.

4.2.3 Quantitative tests of DCE assumptions

The results of a MXL using the reduced dataset after removing straight liners and those always opting for the option with lower income are provided in Appendix 40, page 387. One participant was identified as a straight-liner. Three individuals always chose the option of lower income. The results of the full and reduced dataset models were similar indicating that the main model behaved well. This meant that accounting for inconsistent respondents did not affect the results and hence all participants were included in the main analysis.

As for attribute dominance, a higher share of participants, including 15% of the sample, always chose the alternative offering a longer preventive advice session. Around 6% of individuals always selected the option providing a higher income. The shares of respondents who always chose the option which was better in each attribute are reported in Appendix 41, page 389.

4.2.4 LC

The LC model with three classes provided the smallest AIC. This model also produced reasonable groups of estimates in terms of more distinct differences between the groups and hence it was chosen as the main LC model.

Gender, years since graduation, practice size, mix of practice, percentage of patients who were exempted from payment, frequency of fluoride varnish, frequency of fissure sealants, frequency of dietary advice and working part time were associated with class allocation probability function, as shown in Table 4-8, page 148. The choice of these sociodemographic variables was based on the literature review parts on the dentist-patient relationship and dentist preferences. Working in a smaller practice (defined as fewer than three individuals), more frequently applying fluoride varnish and fissure sealants to adult population, more frequently delivering dietary advice, being female, having more years since graduation, working part time and seeing a higher share of exempt from payment patients increased the probability of belonging to Class 1, which accounted for 45% of the sample. Working in a private practice significantly decreased the probability of belonging to Class 1. All sociodemographic parameters were significant at predicting class 1 membership at the 5% level except for frequency of dietary advice, gender, working part time and years since graduation. Members of this class had higher preferences for preventive and restorative treatment, as well as preventive advice, and a lower preference for higher income. On the other hand, members of class 2, consisting of around 46% of the sample, were somewhat less sensitive to preventive advice compared to class 1, preferred more restorative care and a higher income, and were more likely to have an aversion to preventive treatment. Applying fluoride varnish more frequently, working in a private practice, being female, working part time, seeing a higher share of exempt from payment patients and having more years since graduation increased the probability of belonging to class 2. However, working in a small practice and more frequently delivering dietary advice and fissure sealants decreased the probability of belonging to class 2. Fluoride varnish frequency and seeing a higher share of exempt from payment patients were significant on predicting class 2 membership at 5%. Class 3 comprised 8% of the sample participants. The individuals of this class tended to dislike longer preventive treatment, preventive advice and restorative treatment, while they were in favour of higher income.

The LC results verified that most dentists, including 91% of the sample, were more prone to deliver preventive advice, in agreement with base model. Individuals were also more likely to provide restorative care, confirming the base model's results. As for preventive treatment, LC findings were mixed, with only 45% of dentists willing to deliver this type of care. This also confirmed the base model results, which showed lower preferences for this care. A majority of respondents, i.e. 54% of the

sample, were motivated by a higher income, validating positive income preferences overall in the base model.

Table 4-8. Results of LC with socio-demographic variables defining class membership

	Class 1	Robust SE	Class 2	Robust SE	Class 3	Robust SE
Preventive treatment	0.059**	0.030	-0.007	0.018	-0.173*	0.089
Preventive advice	0.158***	0.019	0.062***	0.013	-0.188***	0.070
Restorative treatment	0.017	0.018	0.014	0.015	-0.317***	0.082
Income	-0.017	0.011	0.019***	0.007	0.098***	0.035
Intercept	-2.305	1.455	0.196	1.095	0	-
Small practice (Less than 3 individuals)	13.793***	1.760	-2.435	2.055	0	-
Mix of practice (private or mainly private practice)	-14.838***	2.274	1.330	1.144	0	-
Frequency of fluoride varnish (always or usually)	13.004***	2.177	12.008***	1.622	0	-
Frequency of dietary advice (always or usually)	0.710	1.363	-0.751	0.829	0	-
Frequency of fissure sealants (always or usually)	16.336***	1.302	-0.0001	0.0003	0	-
Gender (female)	2.228*	1.270	1.704*	1.016	0	-
Part time dentists	2.576	1.633	0.645	1.108	0	
Higher share of exempt from payment patients	14.670***	2.665	13.007***	2.065	0	
Years since graduation	0.037	0.046	0.052	0.033	0	
Class size	45%		46%		8%	
Log-likelihood	-561.4133					

Number of responses	982
Sample size	124
AIC	1186.83
BIC	1343.29
***(at 1% significance level), **(at 5% significance level), *(at 10% significance level)	

In relation to the research question on variation in preferences according to dentists' sociodemographic and practice characteristics, the following was observed. Female dentists working in a smaller, mixed or public practice, more frequently applying fluoride varnish and fissure sealants to the adult population, more frequently delivering dietary advice, having more years since graduation, working part time and seeing a higher share of exempt from payment patients were more likely to provide preventive treatment and advice as well as restorative care and had a lower tendency for higher income. Female dentists more frequently applying fluoride varnish, less frequently delivering dietary advice and fissure sealants, working in a larger or private practice, working part time, seeing a higher share of exempt from payment patients and having more years since graduation were more likely to deliver preventive advice and restorative care while they were less likely to provide preventive treatment. These individuals preferred a higher income.

4.3 Qualitative analysis of patient study

The results from a range of qualitative methods, including a literature review, a ranking and rating exercise, confidence ratings and a variety of focus groups and cognitive interviews used to develop the patient DCE questionnaire to investigate preferences about preventive care, are presented in this section.

4.3.1 Literature review findings on potential attributes

The attributes which were identified in the literature review of chapter 2 are given in Table 4-9, page 153. Tooth loss, aesthetics appearance and function were categorised as outcome attributes. Adverse event attributes included complaints and symptoms, problems during treatment, bleeding and discomfort. Preventive treatment, preventive advice, frequency of dental check-up visits, committed time in prevention, dental insurance, travel time, waiting time, type of setting or hospital, co-payment refund option, perceived oral health, dentist's communication skills, dentist's availability outside business hours, choice of dentist and state of waiting environment were classified as process attributes. Out of pocket costs was the cost or payment vehicle attribute.

4.3.2 Expert group for developing a PES

The attributes which emerged from the literature review were reviewed by the expert group to compile a preliminary list of attributes, see Table 4-9. The team decided to exclude outcome attributes and adverse event attributes from the list, as it was thought complex to determine outcomes of preventive care with high degree of accuracy, adverse events from preventive care were considered mild. As for the process attributes, the team considered a few attributes as less relevant from a policy perspective because of limited control over manipulating their levels. Such attributes included perceived oral health, dentist's availability outside business hours, choice of dentist and condition of waiting environment. The group agreed that service provision type varying between a private and public dentist service should also be removed from the list for two reasons. Firstly, it would lead to less trade-offs given a potential high difference in out of pocket costs between a private and a public dentist service. Secondly, it was considered that preferences for preventive care were less sensitive to the type of service provision because of lower treatment urgency. The team approved the addition of an attribute describing different types of dental professionals delivering preventive treatment in the preliminary list. The aim of inclusion was to explore whether patients' preferences for preventive care varied by the type of dental professional providing the care, among the dentists, dental hygienists, dental therapists and dental nurses. The remaining attributes were included in the PES.

Table 4-9. Preliminary list of attributes

Attributes	Descriptions
Outcome attributes	
Tooth loss*	Tooth loss as a result of no treatment.
Aesthetics *	Level of oral or teeth cleanliness.
Appearance *	Improved versus compromised oral or teeth appearance.
Function *	Improved versus compromised oral or teeth function.
Adverse events	
Complaints and symptoms*	Complaints and symptoms about treatment.
Problems*	Problems during treatment.
Bleeding*	Bleeding of gums.
Discomfort*	Discomfort with treatment.
Process attributes	
Preventive treatment	Dental sealants or fluoride varnish.
Preventive advice	Oral hygiene advice.
Visiting the dentist	Frequency of dental check-up visits.
Committed time in self prevention	Time spent on brushing teeth.
Type of service provision*	Public or private.
Travel time	Travel time to the dental office.
Waiting time	Waiting time to get a dental appointment or waiting time at the dental office.
Co-payment refund option	Co-payment was refundable by the public service system.
Perceived oral health*	Poor, average, good or excellent perceived oral health.
Dentist's communication skills	A dentist who explained treatment procedure and outcomes in a clear and patient friendly manner.
Availability outside business hours*	Potential for weekend appointments.
Choice of dentist*	Choice of a personal dentist who always saw the patient.
State of waiting environment*	How clean and tidy the waiting environment of the dental office was.
Type of dental professional**	Dentist, dental hygienist, therapist, nurse who delivered the treatment.
Cost attributes	
Out of pocket costs	Out of pocket costs for treatment.

*removed by the expert group team

**added by the expert group team

4.3.3 Focus group with PES (Appendix 27, page 340)

Five members of the general public took part in the focus group at Leeds Dental School. Respondents proposed a range for the out of pocket cost related to a dental appointment of between £20 and £50. It was stated that 40 minutes would be the maximum acceptable time to reach a dental practice, either by driving or public transport, and 10 minutes was a reasonable minimum time allowance. They indicated that waiting time for an appointment could vary between 24 hours, one month, six months or even a year, as the visit was not urgent. Regarding provider advice, individuals reported they would prefer a confident dentist with a good reputation who was willing to listen to the patient and showed genuine interest in a patient's oral health. In terms of a provider's communication skills, there was a strong preference for a gently spoken, empathetic dental specialist who provides clear explanations of his/her diagnosis and advice would be strongly preferred. Regarding alternative dental providers, participants indicated that they were willing to trade-off a longer dental check-up visit, say for 2-3 minutes, if the preventive treatment was delivered by a non-dentist provider, such as a dental hygienist, dental therapist or dental nurse. Incorporating both preventive care and restorative treatment in a single dental appointment was identified as a missing attribute. The provision of group appointments with all family members able to attend on the same day was raised as an additional important benefit that could potentially improve dental attendance.

The main researcher classified the themes emerging during this focus group session, and at a later stage applied framework analysis. A summary of the problems identified in the focus group is given in Table 4-12, page 161. Most issues were categorised as retrieval from memory, with response selection representing the second most frequent category.

4.3.3.1 *Comprehension-communication*

There were no comprehension or communication issues raised.

4.3.3.2 *Retrieval from memory*

Respondents reported that the initial question should refer to features of a particular dental practice they were about to register with, instead of simply asking for generic factors targeted at improving dental attendance. Another main issue associated with retrieval from memory themes was that individuals requested greater detail in the descriptions of preventive care. In particular, they requested more contextual information about what preventive advice involved in terms of materials, delivery methods and its scientific efficacy. Participants mentioned that such information would help them make choices contingent on this factor more decisively. In relation to out of pocket expenses, subjects requested more details regarding the reference period of these costs, although the task description clarified that expenses were related to a single dental visit. Furthermore, participants asked about payment frequency, and what dental insurance scheme options were available in order

to be able to decide on plausible levels for the attribute. In addition, respondents wondered whether committed time in prevention was only linked to preventive care at the appointment, emphasizing a need for additional information on this attribute.

4.3.3.3 *Judgment-evaluation*

Individuals found the process of recommending levels for the co-payment option for a dental appointment to be highly complex. They associated it very closely with out of pocket expenses.

4.3.3.4 *Response selection*

Participants suggested the inclusion of an additional attribute about availability of family appointments. Mismatching response categories also emerged, with individuals regarding multiple dental visits per year and preventive treatment being irrelevant to their preferences for increasing prevention focused dental attendance.

4.3.4 Changes to PES leading to ranking exercise

The lead researcher revised the attributes list used in the PES by removing the attributes people thought weren't important and adding those suggested as missing. The updated list of attributes included out of pocket expenses, provision of family appointments, travel time to reach the dental practice, dental provider's communication skills, time for dietary advice and time for hygiene advice, alternative dental provider to deliver preventive care, i.e. dentist or dental hygienist or therapist or nurse and waiting time for the appointment. Co-payment option was excluded from further analysis as it triggered confusion among respondents. Preventive treatment and multiple dental visits per year were also left out due to individuals being uncertain that such features were critical in their preferences about preventive care. The ranking exercise was developed based on the revised list of attributes to provide information on general public's attribute rankings in terms of importance and to suggest potential levels for the attributes.

4.3.5 Data analysis of ranking exercise (Appendix 28, page 342)

The online ranking survey was completed by 18 individuals. Results are presented in Table 4-10, page 156. Out of pocket costs was the highest rated attribute, with an average score of 5.61, followed by waiting time for the appointment (5.28), alternative dental provider for prevention (5.17), time of hygiene advice (5.11), provider's communication skills (5.06), transport time to reach the practice (4.28), time for dietary advice (4.17) and finally the provision of family appointments (3.89). The mean suggested minimum and maximum attribute levels are shown in Table 4-11, page 157, as well as the final values suggested.

Table 4-10. Analysis of responses to the ranking exercise[8]

Attributes Ranking Exercise								
	Number of participants assigning the associate order number							
Order number	Out of pocket	Family appoint	Transport time to reach the practice	Communication skills	Time of dietary advice	Time of hygiene advice	Alternative dental provider	Waiting time for appointment
1	1	7	3	2	4	2	1	2
2	0	2	2	3	2	0	3	2
3	2	0	2	1	3	4	0	2
4	2	2	2	1	1	2	3	1
5	4	1	4	1	1	1	3	2
6	2	0	2	4	1	3	1	1
7	2	2	0	1	5	1	3	1
8	5	4	3	5	1	5	4	7
Total number of participants	18	18	18	18	18	18	18	18
Overall score	101	70	77	91	75	92	93	95
Average score	5.61	3.89	4.28	5.06	4.17	5.11	5.17	5.28

[8] Overall score was calculated by multiplying the number of individuals assigning each ranking score by the associate ranking score and taking the sum across all scores.

Table 4-11. Range of levels from ranking exercise (N=18)

Attributes	**Actual level averages**	**Suggested levels**
Out of pocket costs (£)		
Max	92.2	100
Intermediate	49.8	50
Min	12	20
Transport time (minutes)		
Max	32.4	45
Intermediate	18.7	30
Min	5.9	15
Time of dietary advice (minutes)		
Max	7.1	9
Intermediate	4.7	6
Min	3.6	3
Time of hygiene advice (minutes)		
Max	12.9	12
Intermediate	6.8	6
Min	4.1	3
Waiting time (days)		
Max	14.3	15
Intermediate	8.6	10
Min	0.8	1

4.3.6 Expert group leading to P-DCE1

Five researchers contributed to the expert group session at Leeds Dental School which lasted for one hour. Its members agreed to exclude provider's communication skills and provision of family appointments from the list of attributes. It was considered implausible for the general public to be knowledgeable about a provider's communication skills prior to the dental check-up visit in a real choice setting, while the availability of family appointments was thought to represent a less important factor in individuals' preferences due to the fact it was rated low in the rating exercise. The expert group decided to include fluoride varnish delivery as a preventive treatment attribute. A level of zero minutes of prevention was added for the following attributes: dietary advice, hygiene advice, fluoride varnish delivery and waiting time for appointment in order to explore the effects of a larger range of values on participants' preferences. The group also decided that the decision-making context of choosing between dental check-up appointments at two different dental practices varying in the attributes, would be suitable for exploring patients' preferences for preventive.

4.3.7 Interviews with P-DCE1 (Appendix 29, page 344)

The results from evaluating patient DCE1 questionnaire through ten interviews at Leeds Central Bus station follow in this part.

4.3.7.1 *Framework analysis of answers to the P-DCE1*

Framework analysis results with respect to interviews with 10 individuals using P-DCE1 at Leeds Central Bus Station were illustrated here. .A summary of the problems identified in the interviews is given in Table 4-12, page 161.

4.3.7.1.1 Comprehension issues

One respondent stated that found it difficult to distinguish between the roles of a dental hygienist and a dental therapist, and that further explanation on this was necessary.

4.3.7.1.2 Response selection issues

Two individuals reported factors not captured by the attributes that might be important to their choice: Word of mouth or reputation of the dental professional i.e. "How other people rated it on experience" and the option of online booking for the dental check-up appointment, saving the time of calling on the phone. Specifically, the respondent mentioned "Can I book online dental app/check-up or is it phone only, or an app for phone?" Another participant stated that "the facility location", i.e. where the dental check-up will take place was a significant factor not captured by the attributes. One participant suggested an increase in the number of dental specialists to decrease the waiting time to reach the dentist, providing an anecdote about a relative who encountered difficulties in booking a short dental appointment when they needed it. This comment pointed to a potential need for revision of waiting time levels.

4.3.7.2 *Responses to choices questions of P-DCE1*

A descriptive analysis of choices was purposed to show whether patients traded between the attributes. All ten participants had opted for dental practice A in the first question, a choice indicating that they were possibly tempted by longer preventive treatment and advice despite the fact that the cost of that dental check-up appointment was higher and a dental hygienist delivered both preventive advice and treatment as opposed to the dentist in dental practice B. Moreover, the inclusion of text/email reminders proved to be important factor in the decision of all participants as to which dental practice to register with. In choice scenario 2, 8/10 of respondents chose dental practice B which provided longer preventive care at a lower cost, shorter travelling time to the practice and the option of text/email reminder, with only waiting time for an appointment being longer compared to dental practice A. Overall it can be inferred that respondents preferred more time for preventive treatment and advice, as well as the inclusion of text email reminders, being willing to pay more to rejoice these benefits, which included a positive sign of the assumptions of the research questions, i.e. individuals seemed willing to make trade-offs between out of pocket cost and time attributes to receive more preventive treatment and advice.

4.3.7.3 *Confidence ratings of P-DCE1*

Participants assigned high scores, ranging from 6.1 to 6.7 where 7 meant strongly agree and 1 meant strongly disagree to the statements: the questionnaire was easy to comprehend, the features of practices were easy to understand, the hypothetical dental practices were realistic and that the information needed to make a choice was presented.

4.3.8 Changes to P-DCE1 leading to P-DCE2

The patient DCE1 questionnaire was updated into the patient DCE2 version. The updated version presented respondents with two new hypothetical choice situations with revised attribute levels. Revisions occurred to the levels of all attributes to produce more balanced choice tasks in which at least three of seven attributes of either alternative option were improved compared to those of the other option. The degree of improvement for each attribute was judged on findings from the analysis of choice responses to the patient DCE1 questionnaire and qualitative work. For example, participants showed a preference for longer preventive care, lower cost, shorter waiting and travelling time and provision of text/email reminders. Such amendments would prompt individuals to put extra effort into choosing a dental check-up appointment. The reason for this presentation of choice scenarios was to explore whether under more marginal choice circumstances, participants would continue to make trade-offs between different attributes. Moreover, a section related to a more succinct description of different dental specialties' roles was included in the questionnaire. This was introduced as participants reported difficulties in distinguishing between responsibilities of certain groups. Role

descriptions were drawn from the UK Scope of Practice (Council, 2009), however they were kept quite generic so as not to confuse the respondents.

4.3.9 Interviews and a focus group with P-DCE2 (Appendix 30, page 347)

Four individuals were interviewed face to face at Leeds Central Bus Station. A further six respondents later took part in a focus group at Leeds Dental School.

4.3.9.1 *Framework analysis of P-DCE2*

The results of framework analysis in relation to the interviews and focus group are presented here. A summary of the problems identified in both is given in Table 4-12, page 161.

4.3.9.1.1 Response selection issues

Participants reported some factors relevant to decision-making that were not captured by the attributes. These were the dental professional's reputation, referred to as "Word of mouth recommendations", "Word of mouth" and "Online Reviews/Trustworthiness", personal circumstances e.g. "home and work convenience" and living location. One individual mentioned that even though they found all seven attributes important, they felt that the out of pocket cost attribute was the main driver of choices.

4.3.9.1.2 Comprehension issues

The term 'out of pocket costs' was regarded as difficult to understand by two participants and the term "cost of dental attendance" was proposed as a replacement. One respondent said that the descriptions of the attributes presented prior to the choice questions were "somewhat confusing". In addition, they suggested that the word "hypothetical" in the instructions be replaced by "imaginary", reporting that the previous term sounded relatively vague.

Table 4-12. Framework analysis of focus groups and cognitive interviews with PES, P-DCE1 and P-DCE2

Questionnaires	**Problems by category**				**Total**	**Total %**
	Comprehension	Retrieval from memory	Judgment/Evaluation	Response Selection	Total number of problems by questionnaire	Percentage of total problems by questionnaire
PES	0	5	1	3	9	43%
P-DCE1	1	0	0	4	5	24%
P-DCE2	3	0	0	4	7	33%
Total number of problems by category	4	5	1	11	21	100%
Percentage of total problems by category	19%	24%	5%	52%	100%	

4.3.9.2 *Responses to choices questions of P-DCE2*

A descriptive analysis of choices was performed to show whether patients traded between the attributes. The patient DCE2 questionnaire appears in Appendix 30, page 347. In the first question, choices were divided among participants, with four of eleven respondents opting for alternative A, while within the second choice task all participants chose alternative B. A more focused look at the second choice task showed that people were very sensitive to the out of pocket costs of £100, which made them unwilling to select alternative A, even though it was superior in 4/7 attributes including longer time for dietary and hygiene advice, shorter waiting time for an appointment as well as the provision of text/email reminders compared to the alternative B. Hence participants appeared quite sensitive to higher costs and levels of the cost attribute should be considered for revision.

4.3.10 Changes to P-DCE2 leading to patient P-DCE third draft (P-DCE3)

One additional attribute was included in this questionnaire compared to P-DCE2 questionnaire associated with the online booking option. The levels of out of pocket cost attribute were also revised to reduce levels differences from £20-£50-£100 to £50-£75-£100. This happened to restrict its dominance effect in decision making process as previous interviews and focus groups revealed. The attribute levels used in the design of two blocks of eight paired choice sets each were cost, travel time of 15, 30 and 45 minutes, time for dietary advice of 0, 3, 6 and 9 minutes, minutes for hygiene advice of 0, 3, 6 and 12 minutes, time for preventive treatment being represented by 0, 3, 5 and 7.5 minutes, waiting time for the appointment described by 0, 1, 10 and 15 days, text/email reminders and online booking option, with the last two attributes being assigned 1 for yes or 0 for no values. P-DCE3 was designed to check how participants would interact with statistical design choice tasks and assess how they understood the instrument overall. The actual design of P-DCE3 questionnaire appears in Appendix 31, page 350.

4.3.11 Focus group sessions with P-DCE3 (Appendix 32, page 351 and Appendix 33, page 357)

This section details the outcomes of analysing the two focus group sessions with respect to the P-DCE3. Three participants participated in the first focus group, and another three individuals were present at the second focus group session, both held at Cork Dental School.

4.3.11.1 *Confidence ratings of P-DCE3*

Confidence ratings confirmed that the instrument and attributes were well understood scoring 6.4/7. The statement about the information sufficiency received 6.3/7 while the lowest ranked statement regarding how realistic ability of the hypothetical practices was assigned an average of 5.4/7. The declining trend of scores in all statements as compared to P-DCE1-Q and P-DCE2-Q can be attributed to the fact that respondents had to complete eight choices instead of only two in the previous versions. Moreover, the fact that the choice tasks were now computer generated meant that independence of attribute levels was accounted for, which might have increased the complexity of decisions and likely contributed to lower rating scores.

4.3.11.2 *Framework analysis of focus groups with P-DCE3*

The results of framework analysis in relation to two focus group sessions at Cork Dental School are demonstrated below and in Table 4-13, page 165.

4.3.11.2.1 Comprehension issues

Framing issues were detected by respondents about the wording of introductions, and suggested that the phrase “hypothetical dental practices” should be highlighted in bold letters to underline the hypothetical character of the check-up appointment. Individuals had difficulties in understanding the

statement “Assume the practices are identical apart from the described features”. With respect to role descriptions, they reported that the distinction between dental therapists and hygienists was quite vague, and that dental nurses usually had only a supportive role to the dentist in Ireland, assisting with technical issues or standing at the reception desk of the practice without providing any sort of treatment or advice. Some also reported being unaware of the fact that dental therapists existed as a separate dental profession in Ireland.

4.3.11.2.2 Retrieval from memory issues

Individuals recommended that the choice context should be rearranged to present two distinct check-up appointments, both incorporating the dentist’s involvement at the start of the appointment to apply scale and polish procedures lasting for 15 minutes overall. This emerged as a necessary condition since participants informed that a dental check-up appointment in Ireland was definitely perceived to include some scale and polish otherwise it was regarded as a “waste of time”. Moreover, individuals suggested that description of preventive treatment should include more examples of procedures apart from just fluoride varnish, for which there was uncertainty over whether such a treatment was needed due to the high perceived fluoridation level in the country. In addition, respondents requested greater detail in relation to the description of dietary advice, such as the provision of guidance through a personalised diet program which is delivered as handout to the patient upon the end of appointment.

4.3.11.2.3 Response selection

Participants mentioned the reputation of the dental provider, waiting time at dental practice on the day of appointment and the dental provider’s availability after working hours, such as on weekends, as additional attributes of high importance to them when choosing a practice for a dental check-up appointment. Individuals pointed out that values of the attribute “time for dietary advice” were high compared to the short consultation often received from the dentist within a dental check-up appointment. Furthermore, participants proposed that the dental provider attribute should be described by two levels, distinguishing between dentists and dental professionals in general including hygienists, therapists and nurses, a step required to diminish mind burden of participants in interpreting job descriptions. Out of pocket cost was once again shown to be a dominant factor of choices with individuals preferring less expensive visits over more improvements in the other attributes. Respondents emphasised that a zero level for waiting time was meaningless since the visit’s purpose was a dental check-up and not urgent appointment. Moreover, it was proved that text/email reminders as well as the online booking option appeared to have only a limited impact on patients’ preferences for a dental check-up visit.

Table 4-13. Framework analysis of focus groups with P-DCE3

Questionnaires	**Problems by category**				**Total**
	Comprehension	Retrieval from memory	Judgment/Evaluation	Response Selection	Total number of problems
P-DCE3	3	3	0	9	15
Percentage of total problems by category	20%	20%	0%	60%	100%

4.3.11.3 *Analysis of responses to choice scenarios of P-DCE3*

A descriptive analysis of choices was used to show whether patients traded between the attributes (Appendix 32, page 351 and Appendix 33, page 357). Answers from the first block are presented in this paragraph. In the first question, two out of three individuals chose dental practice B, showing a willingness to accept more travel time to the practice and less hygiene and dietary advice in exchange for paying 50% less for the check-up appointment. Question two indicated a majority of respondents selected practice A, paying €25 less and receiving more preventive care overall. The fact that none compared to one day of waiting time for the appointment did not appear to change the choice decision was a sign that zero value should be excluded from the waiting time attribute. In addition, the provision of email reminders did not seem to compensate for a €25 cost increase of the appointment. In question 3, 2/3 participants chose the least expensive option obtaining more preventive care in total, while in question 4 the same proportion opted for practice B valuing more the chance of a cheaper and more prevention oriented check-up as opposed to one offering shorter travel time in combination with an online booking option. Question 5 showed the majority of individuals leaning towards practice B because of lower cost, delivery of dental hygiene advice and an opportunity for both reminders and online booking options. In all three remaining choice sets, individuals agreed on the same options, i.e. dental practice A, B and A respectively. This depicted an overall tendency towards lower out of pocket costs at the expenses of more waiting time for an appointment. Overall individuals seemed willing to receive preventive care from an alternative dental professional such as a dental nurse over a dentist if they were compensated by lower out of pocket costs for the appointment.

In relation to choices in the second block, all three individuals selected the same option in five out of eight questions, namely 1 and 5-8. Question 1, page 357, involves a choice task in which dental practice A provided a less expensive check-up appointment and longer preventive care in total, shorter travel and waiting time as well as text/email reminders in comparison to dental practice B. Preventive care was delivered by a dentist in practice A as opposed to a dental nurse in practice B. In the remaining common choice scenarios, individuals seemed to prefer less expensive options, especially when combined with receiving more preventive care and at the expense of longer travel time to reach the practice, and the absence of email reminders and online booking options. Moreover, participants generally appeared not to value time for dietary advice, believing that they already possessed sufficient amount of knowledge on the diet subject or could seek for relevant information online, as they stated at the focus group session. Text/email reminders and online booking were not found to be important determinants of preferences for a check-up appointment in most scenarios. Hence it was considered that their omission would not have a significant impact on choices. The only preferred

alternative involving a higher appointment cost was in question 6, in which a higher out of pocket cost was exchanged for less travel time, waiting time for an appointment, and the provision of both email reminders and online booking options.

In questions 2-4, the majority of individuals selected the least expensive options favouring cost in exchange for shorter time for preventive care, longer waiting time for the appointment, no text/email reminders and no online booking. Individuals were found to value higher the time seeing the dentist for preventive activities compared to dealing with other dental professionals, but still appeared willing to see other professionals if they were able to pay less. Distinction between a therapist and hygienist did not seem to affect decisions, whereas in question 6, everyone justified their decision of dental practice A claiming that time with a therapist was perceived more valuable in relation to time spent with dental nurse.

4.3.11.4 *Confidence ratings of P-DCE3*

Average confidence ratings remained high across all four dimensions demonstrating a good level of understanding the choice tasks, sufficient realism in the scenarios and sufficiency of information.

4.3.12 Changes to P-DCE3 leading to P-DCE-Final

Preventive care attributes were reduced to three levels each, instead of four. The aim was to reduce the level of complexity of the choice scenarios by eliminating large differences between attribute levels. The dental provider attribute had two levels: dentist and dental professional. This was due to participants' inability to distinguish between different alternative dental providers. Furthermore, the values of the out of pocket cost attribute were revised downwards to be between £20, £35 and £50. This was done as out of pocket cost appeared to dominate choices at higher levels. The value of 0 days was removed from the waiting time attribute as participants did not seem to distinguish between the two lowest levels. The attributes of text/email reminder and online booking option were removed due to the fact that participants did not regard them as important. The choice context was updated to always incorporate a dentist's involvement at the beginning of the dental check-up appointment, to deliver a scale and polish session lasting for 15 minutes, which was perceived as a required condition by individuals in ROI. Other minor changes in wording and presentation were made to improve comprehensiveness of the DCE questionnaire. In the attribute descriptions' section, dietary advice content was augmented to include a personalised diet plan given as a handout at the end of the appointment, recommended as an influential factor by participants of the focus group sessions. This analysis drove to the final list of attribute levels of the P-DCE-Final. These are shown in Table 4-14, page 169.

4.3.13 Experts group for the layout of P-DCE-Final (Appendix 37, page 366)

Three individuals participated in the final expert group at Leeds Dental School. Layout amendments and wording adjustments were made, and sociodemographic questions were added, resulting in the final patient final DCE questionnaire. Nine blocks of eight questions each were created. The design of P-DCE-Final is shown in Appendix 35, page 362.Correlations between attribute levels in the final design appear in Appendix 36, page 365.

Table 4-14. Attributes of patient final DCE (P-DCE-Final)

Attributes	Levels
Travel time to reach the practice in minutes	15, 30, 45
Amount of dietary advice in minutes	0, 5, 10
Amount of hygiene advice in minutes	0, 6, 12
Amount of preventive treatment in minutes	0, 4, 8
Waiting time for the appointment in days	1, 10, 15
Dietary advice, hygiene advice and preventive treatment are provided by	dentist or dental professional consisting of either a dental hygienist, or therapist or nurse
Cost of a dental check-up in £	20, 35, 50

4.4 Quantitative analysis of patient study

Sociodemographic information for the full sample and subsamples of individuals in the UK and the ROI are presented in this section. Results of the main model in WTP space, quantitative tests for DCE assumptions, subgroup analysis and LC in preference space are also reported in this section.

4.4.1 Sociodemographic characteristics (Overall N=353, UK N=237, ROI N=116)

Overall, 353 individuals completed the DCE questionnaire of which 44% were male and 56% were female (Table 4-15, page 171). Most respondents (37%) belonged to the 25-44 age group. The majority (88%) were white. Half belonged to the service class and nearly 20% to the routine non-manual workers class. The third most frequent professional class was never worked or long term unemployed. In terms of education, 39% had a university degree with individuals of prevocational and vocational education combined, comprising 53%. Over half (57%) of respondents lived in England, with 33% living in the ROI, 5.4% in Scotland and 3.7% in Wales. Among participants living in England, the South East of England was better represented at 16%, while the North East of England was the least frequently reported region. Around 56% of respondents stated that they do not mind visiting the dentist, while 35% dread it. Around half of respondents have never smoked. A majority (65%) of participants had visited the dentist less than a year ago, of whom 64% went for a dental check-up or examination and around 20% went for planned treatment. About half the sample visit the dentist every 6 months, with the second most frequent interval reported being every one year by 20% of respondents. Just under half of the individuals (46%) perceived their oral health as average, while 31% judged it to be good. Statements on understandability of choice tasks were provided a mean rate of 6.3/7. Statements on sufficient realism in the scenarios and sufficiency of information were given mean scores of 5.5/7 and 6/7 respectively.

Table 4-15. Socio-demographics of full sample patients (N=353)

Gender	**Frequency**	**% Frequency**
Female	198	56
Male	155	44
Missing	0	
Age groups		
18-24	44	12
25-44	129	37
45-59	78	22
60-74	85	24
75 & over	6	2
Missing	12	3
Ethnicity		
White	312	89
Other	5	1
Asian/ Asian British	24	7
Mixed/ Multiple ethnic groups	8	2
Black / African / Caribbean / Black British	4	1
Missing	0	
Professional category		
Service class: professionals, administrators and managers; higher grade technicians; supervisors of non-manual workers	172	50
Non-skilled workers: semi- and unskilled manual workers (not in agriculture etc.)	39	11
Routine non-manual workers: routine non-manual employees in administration and commerce; sales personnel	67	19
Never worked or long term unemployed	48	14
Small properties and artisans and so on, with and without employees	15	4

Agricultural labourers or farmers and smallholders: agricultural and other workers or other self-employed workers in primary production	6	2
Missing	6	
Education level		
Secondary school (left school after age 14 without qualification)	34	10
Pre-vocational / vocational education	116	33
University (Bachelor, Master and doctoral degree)	137	39
Vocational qualification (qualification in higher education)	54	15
Primary education (elementary school / left school at age 11-14)	4	1
No education	2	1
Prefer not to say	4	1
Working status		
Full time work (35 hours per week)	148	42
More than 35 hours per week	3	1
Part time work (less than 35 hours per week)	68	19
Unemployed	130	37
Missing	4	1
Living area		
England	203	58
Wales	13	4
Scotland	19	5
Ireland	117	33
Missing	0	
Level of enjoyment from dental visit		
Don't mind	197	56

Dread	122	35
Enjoy	34	10
Missing	0	
Smoking status		
I am a current smoker	76	22
I am a former smoker	101	29
I have never smoked	169	48
Missing	7	2
Sugar consumption (frequency of consuming sugar beverages)		
0-1 time per day	257	73
2-3 times per day	72	20
4 or more times per day	16	5
Missing	8	2
Last visit		
Less than 1 year ago	228	65
2 or more years ago	56	16
1 to less than 2 years ago	56	16
I can't remember	8	2
I have never attended	2	1
Missing	3	1
Reason of last visit		
Check-up, examination or cleaning	225	64
Emergency treatment	34	10
Planned treatment (eg. routine filling or extraction)	66	19
Other	8	2
I do not know	8	2
Missing	12	3
Frequency of dental visits		
Every 6 months	167	47
Only in pain/emergency	22	6
Every 1 year	72	20

Less often	34	10
Every 2 years	44	12
Missing	14	4
Perceived oral health condition		
Average	162	46
Good	109	31
Poor	47	13
Excellent	31	9
None left	4	1
Missing	0	

Comparing participants living in the UK and ROI, the samples were similar across some variables such as gender, professional category, working status, payment for dental treatment, smoking status, sugar consumption, level of enjoyment for visiting the dentist and perceived oral health (Table 4-16, page 176). A higher proportion of ROI participants (48%) reported paying for treatment completely out of pocket, compared to 35% of the UK sample. In addition, 7% of UK participants reported not paying at all for their dental treatment in comparison to 11% of ROI participants.

The subsamples differed across some participant characteristics, including age, time of last visit to the dentist, reason for last dental visit and frequency of dental visits. The UK sample was somewhat older, with approximately 56% being 45 or over, compared to 31% in the ROI sample. Nearly three-quarters (72%) of UK participants reported having visited the dentist less than a year ago compared to 49% of ROI individuals, and the purpose of the last visit was a check-up appointment for 75% of UK participants, compared to 52% of ROI participants. Over a quarter (27%) of ROI individuals said that planned treatment was the reason for their last dental visit, in contrast to 15% of UK participants. Over half (57%) of UK participants reported visiting the dentist every six months, with 21% reporting visiting once every two years or less often or only in pain or emergency, with corresponding figures of 27% and 45% for the ROI sample.

Table 4-16. Socio-demographics of patients living in ROI (N=116) and UK (N=237)

Sociodemographic-variables	**ROI**	**UK**	
Gender	**Frequency %**	**Frequency %**	**Fisher exact test p-value**
Female	58	55	
Male	41	45	
Prefer not to say	1	0	
Missing	0	0	0.67
Age groups			
18-24	13	12	
25-44	50	30	
45-59	16	25	
60-74	14	29	
75 & over	1	2	
Missing	6	2	0.009***
Professional category			
Agricultural labourers or farmers and smallholders: agricultural and other workers self-employed workers in primary production	2	2	
Never worked or long term unemployed	9	16	
Non-skilled workers: semi- and unskilled manual workers (not in agriculture etc.)	15	9	
Routine non-manual workers: routine non-manual employees in administration and commerce; sales personnel	16	20	
Service class: professionals, administrators and managers; higher grade technicians; supervisors of non-manual workers	49	48	
Small properties and artisans and so on, with and without employees	5	4	
Missing	3	1	0.55
Education level			
Secondary school (left school after age 14 without qualification)	11	9	
Pre-vocational education	22	38	
University (Bachelor, Master and doctoral degree)	43	36	
Vocational qualification (qualification in higher education)	19	13	
Primary education (elementary school / left school at age 11-14)	3	2	
No education	0	0	
Prefer not to say	0	1	
Missing	1	1	0.22
Working status			
Full time work (35 hours per week)	51	37	
More than 35 hours per week	2	0	
Part time work (less than 35 hours per week)	15	21	

Unemployed	29	40	
Missing	3	2	0.12
Payment for dental treatment			
Partially (covered by the NHS or a public medical scheme)	27	35	
Completely by myself	47	35	
I do not pay	7	11	
Partially (covered by a private insurance scheme)	7	4	
I do not know	5	4	
Private insurance scheme	7	9	
Missing	0	0	0.44
Smoking status			
I am a current smoker	23	20	
I am a former smoker	31	27	
I have never smoked	44	50	
Missing	2	2.5	0.78
Sugar consumption (frequency of consuming sugar beverages)			
0-1 time per day	63	76	
2-3 times per day	26	17	
4 or more times per day	7	3	
Missing	3	3	0.19
Last visit to the dentist			
Less than 1 year ago	49	72	
2 or more years ago	21	13	
1 to less than 2 years ago	22	12	
I can’t remember	6	2	
I have never attended	2	0	
Missing	2	0	0.006***
Reason of last visit to the dentist			
Check-up, examination or cleaning	52	75	
Emergency treatment	12	8	
Planned treatment (e.g. routine filling or extraction)	27	15	
I do not know	4	1	
Other	5	1	
Missing	0	0	0.009***
Frequency of dental visits			
Every 6 months	27	57	
Only in pain/emergency	7	6	
Every 1 year	20	21	
Less often	16	7	
Every 2 years	22	8	
Missing	8	2	0.0001***
Enjoyment level from dental visit			
Don't mind	55	56	
Dread	37	33	
Enjoy	8	11	
Missing	0	0	0.72

Perceived oral health condition			
Average	46	46	
Good	34	29	
Excellent	4	11	
Poor	16	12	
None left	1	1	
Missing	0	0	0.34
***(at 1% significance level), **(at 5% significance level), *(at 10% significance level)			

4.4.2 Main model

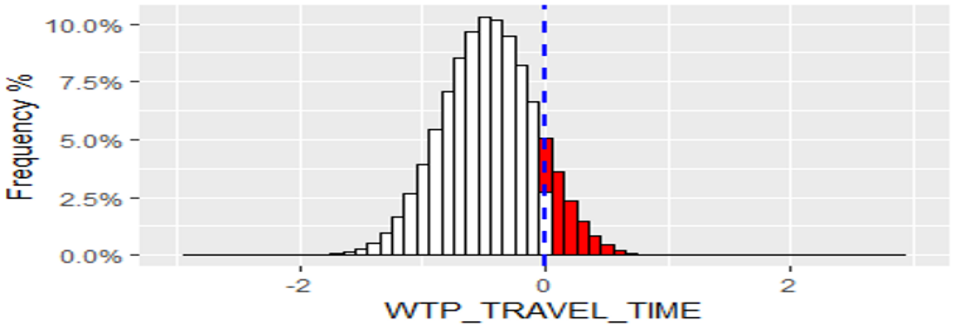
A MXL was estimated in WTP space using the full patient sample and the results are presented in Table 4-17, page 180. The equation form of the MXL specification in WTP space is presented as Equation 3-9, page 106. Participants were on average willing to pay £0.46 to avoid each additional minute of travelling time to the practice and were willing to pay an extra £0.73 to reduce the time between booking and attending the appointment by one day. In terms of preventive care, participants were willing to spend £0.33 for each extra minute of dietary advice, £0.96 for each minute of hygiene advice and £1.64 for an extra minute of preventive treatment. These results showed that patients preferred longer preventive treatment the most, followed by longer hygiene and dietary advice. Individuals were also willing to pay £5.23 to have preventive care delivered by a dentist rather than an alternative dental professional. All WTP coefficients except for dietary advice and seeing the dentist for preventive care were statistically significant at the 1% level.

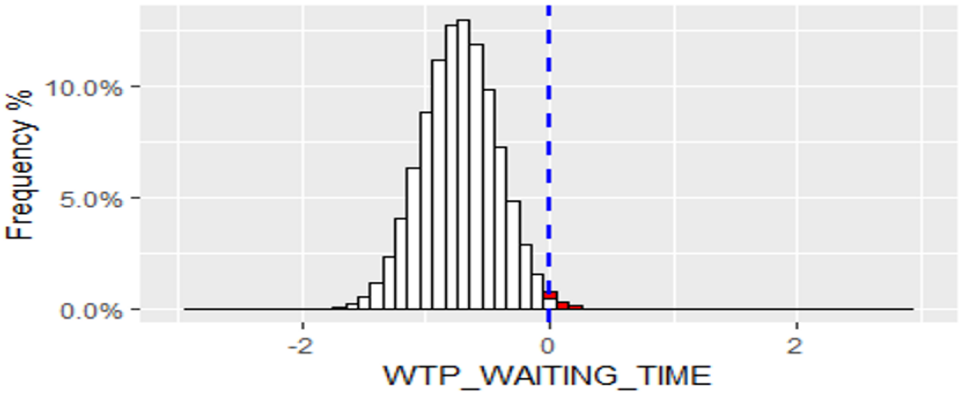
Figure 4-2, page 182 illustrates the findings regarding variation in WTP coefficients and the proportion of patients with a positive WTP, following technical guidance in the literature (Train, K.E., 2009). Most participants, 88%, were willing to pay some amount to spare an additional minute of travel time to the dental office. Even more individuals, 99%, were willing to pay some amount to spare an additional day of waiting to attend a dental-check-up appointment. The variation in payments for travel time was slightly higher than that for waiting time. As far as the preventive care attributes were concerned, it was found that 95% of participants had a positive WTP for each additional minute of hygiene advice, making hygiene advice the attribute of preventive care with the highest share of individuals willing to pay for it. Dietary advice had the second highest share of individuals willing to pay for it with 88% of subjects having a positive WTP estimate. Fewer individuals, i.e., 85%, were willing to pay for each additional minute of preventive treatment. It was revealed that a higher WTP for preventive care attributes was also associated with larger heterogeneity, i.e., standard deviation of the estimates, with a higher variation in payments for each additional minute of preventive treatment compared with hygiene and dietary advice. As for the option to see the dentist for preventive care, it was noticed that 65% of individuals were willing to pay some amount to acquire this provision. In addition, the largest variation in preferences across all attributes was observed in the option to see the dentist for preventive care.

Table 4-17. Patient MXL in WTP space-full sample participants (N=353)

Dental check-up attributes	**Estimate**	**SE**	**95% CI**	**σ**	**SE**	**95% CI**
Out of pocket cost[9]	-0.062***	0.006	(-0.074, -0.050)	0.046***	0.005	(0.036, 0.057)
WTP parameters	**WTP mean**	**SE**	**95% CI**	**σ**	**SE**	**95% CI**
Travel time to reach the practice	-0.462***	0.064	(-0.588, -0.337)	0.385***	0.097	(0.195, 0.576)
Dietary advice	-0.331*	0.176	(-0.676, 0.015)	0.279	0.398	(0.501, 1.059)
Hygiene advice	-0.962***	0.173	(-1.302, -0.623)	0.591*	0.341	(0.077, 1.259)
Preventive treatment	-1.642***	0.307	(-2.244, -1.040)	1.588***	0.389	(0.825,2.351)
Waiting time for the appointment	-0.731***	0.138	(-1.001, -0.460)	0.305	0.442	(0.561, 1.172)
Seeing the dentist	-5.228***	1.801	(-8.759, -1.697)	13.666***	3.676	(6.460, 20.872)
Number of responses	2821					
Sample size	353					
AIC	2904.77					
BIC	2988					
***(at 1% significance level), **(at 5% significance level), *(at 10% significance level)						

[9] Purchasing power parities in the UK and ROI as of 2019, when data collection occurred, were used to convert out of pocket cost levels expressed in € for ROI participants into £ (€1=£0.83).


Frequency %
10.0%
7.5%
5.0%
2.5%
0.0%
-2
0
2
WTP_TRAVEL_TIME


Frequency %
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5.0%
0.0%
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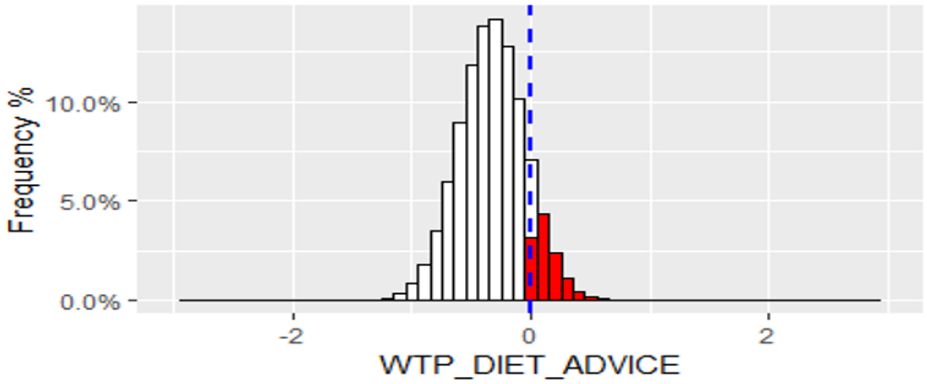
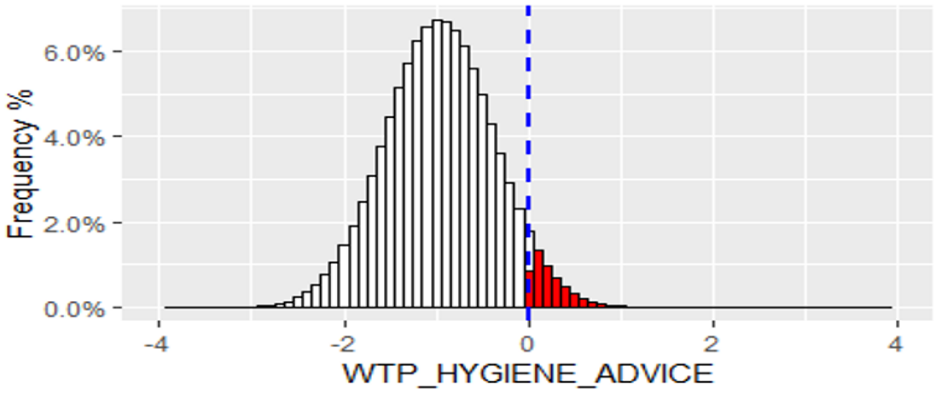
0
2
WTP_WAITING_TIME


Frequency %
10.0%
5.0%
0.0%
-2
0
2
WTP_DIET_ADVICE


Frequency %
6.0%
4.0%
2.0%
0.0%
-4
-2
0
2
4
WTP_HYGIENE_ADVICE

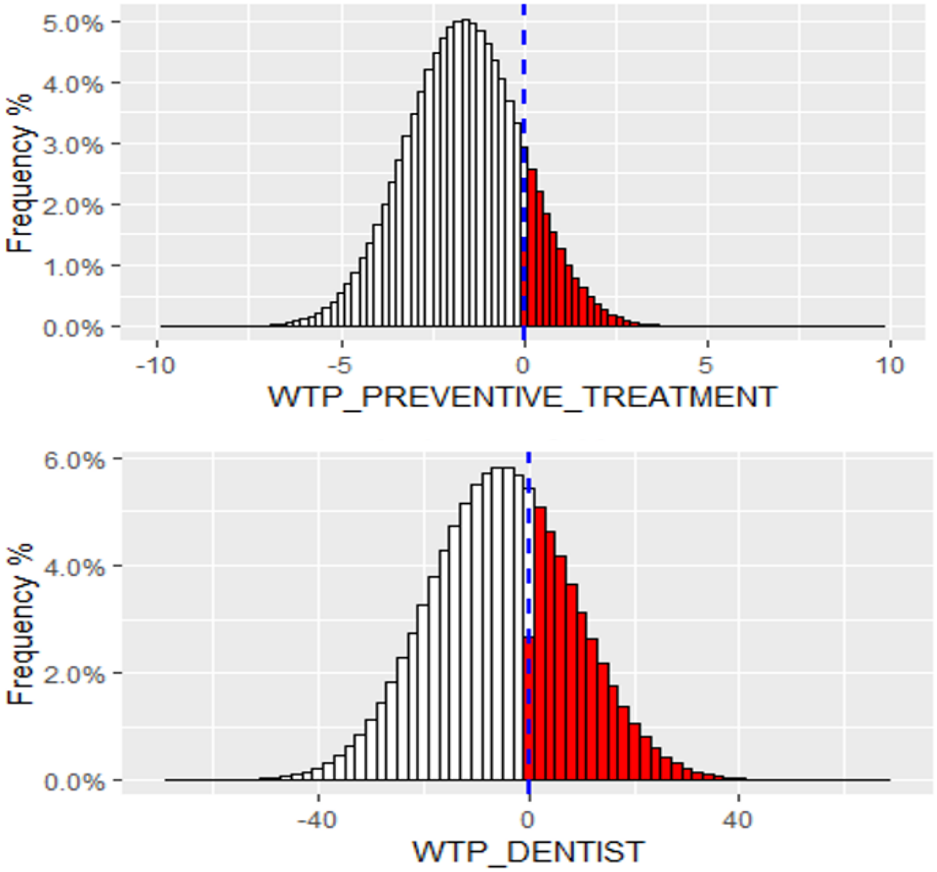


Figure 4-2. Distributions of WTP estimates

In relation to the research question of the determinants of patients' preferences for preventive care, it seemed that individuals had a higher preference for dietary advice, oral hygiene advice and preventive treatment. On average, patients appeared to rank preventive treatment higher in their preferences followed by oral hygiene advice and dietary advice as shown by the WTP measures for these treatments. They also tended to dislike higher out of pockets costs, longer travel time to the dental practice and longer waiting time for the check-up appointment. Participants were willing to pay a small amount for seeing the dentist for preventive care in comparison to a different dental professional.

4.4.3 Quantitative tests of DCE assumptions

A second MXL was run in WTP space after removing respondents with inconsistent answers from the full datasets to test the stability of findings in the main model. A total of eight respondents always chose the alternative presented to them on either the left or right side, i.e. straight-liners. These individuals were considered to spend less effort on their responses and hence were removed. It was also revealed that six individuals always picked the dental check-up option offering a higher cost. As this behaviour is contrary to the expectation of a preference for lower out of pocket costs, these individuals were excluded. In addition, nine participants preferred the alternative with longer waiting time across all choice tasks they were presented with. Four individuals always selected a dental check-up with a longer travel time to the dental office. One individual fell in both categories and hence removed just once. Subjects belonging to these groups were also removed, as they showed preferences contrary to prior expectations for shorter waiting and travel time. Overall, 26 participants were deemed inconsistent in their answers and were excluded from the main dataset. (Note that one subject preferred both longer waiting times and travel times, so that the sum of respondents over exclusion categories is one more than the total number of respondents excluded).

Results of the MXL in WTP space with the reduced dataset are presented in Appendix 42, page 390. Overall, the reduced dataset model was confirmatory of the full data model, with findings in both models being similar in terms of WTP and standard deviation estimates. This proved the stability of the main model findings. It also showed that the full dataset model was appropriate and hence no respondents were removed from main analysis.

The results of testing for attribute non-attendance are shown in Table 4-18, page 185. Class membership probabilities for seven two class LC were estimated to investigate the extent to which individuals may have ignored each of the attributes. It was found that there was large heterogeneity in non-attendance patterns across attributes. With regards to preferences for out of pocket costs, model 1 showed that around half of respondents may have ignored out of pocket costs (44%). According to model 2, the majority of participants were likely to have ignored travel time (65%). In relation to dietary and oral hygiene advice, models 3 and 4 demonstrated that none or very few individuals may have ignored these attributes, i.e., 0% and 4% respectively. However, nearly half of participants would have ignored preventive treatment (50%). As for waiting time, fewer participants may have ignored this attribute, at 22.24% of the sample. On the other hand, with respect to seeing the dentist rather than an alternative dental professional, nearly all respondents seemed to have been inclined to ignore this attribute, making up 96% of the sample. It was worth noting that given the high mean and standard deviation for this coefficient in the main model, this result indicated that the ANA model was just picking up preference heterogeneity. In addition, a significant standard deviation for coefficients of out of pocket costs, travel time and preventive treatment in the main model showed that the ANA model captured preference heterogeneity for these attributes as well, likely assigning it to higher non-attendance effects. For more information on this argument look at section 5.4.7, page 212.

To depict further the heterogeneity of decision rules adopted by individuals, histograms are also provided representing the distribution of individual class probabilities of belonging to class 2 in each of the seven models, i.e. the class which ignored a particular attribute. The graphs are presented in Figure 4-3, page 186. The graphs confirmed that for dietary advice, oral hygiene advice and waiting time, decision rules seemed relatively homogenous. The distributions of class probabilities were right skewed, revealing that fewer participants were likely to have ignored these attributes. By contrast, the graphical representation of the individual probabilities to have ignored type of dental professional demonstrated a left-skewed distribution, which verified that most participants would ignore this attribute. Finally, the remaining histograms for preventive treatment, out of pocket cost and travel time looked more like uniform distributions, indicating greater heterogeneity in decision patterns with regards to these attributes.

As for attribute dominance, a considerable share of respondents including 29% of individuals always selected the option providing a lower out of pocket cost. Fewer participants always chose the option showing a shorter travel time (21%) or longer preventive treatment (17%). The shares of respondents who chose the option which was better in one attribute are reported in Appendix 43, page 391.

Table 4-18. Average proportion of respondents who ignored one attribute

Model	Attribute assumed to have been ignored in the second class	Average class membership (%)
Model 1	Cost	44.49%
Model 2	Travel time	64.60%
Model 3	Dietary advice	0%
Model 4	Oral hygiene advice	4.45%
Model 5	Preventive treatment	49.86%
Model 6	Waiting time	22.24%
Model 7	Seeing the dentist	95.91%

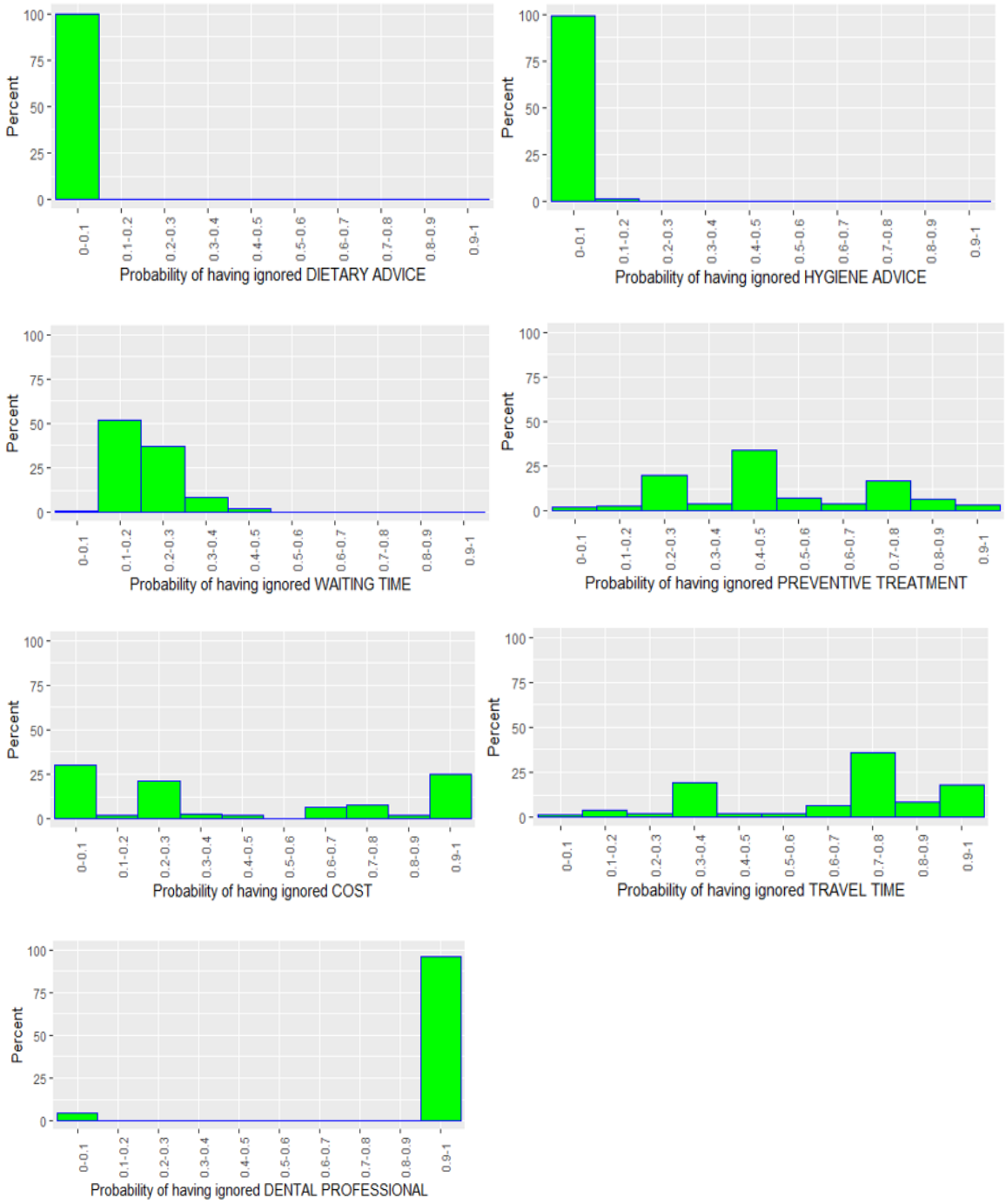


Figure 4-3. Distribution of individual probabilities of having ignored one attribute (computed separately for seven LCs)

4.4.4 Subgroup analysis

Two separate MXLs were estimated using the UK and ROI samples to explore differences in preferences across these populations (Table 4-19, page 188 and Table 4-20, page 189). Results from both models in terms of coefficient means and standard deviations using 4000 MLHS draws are presented in these tables. Irish participants were willing to pay a larger amount of money for longer preventive treatment, £2.62, versus £1.40 for their counterparts in the UK. However, they were less willing to pay for dietary advice compared to participants in the UK, having an insignificant WTP of £0.07 versus a significant WTP of £0.49 in the UK. Individuals in both countries had a similar and significant WTP for oral hygiene advice of £1.06-£1.08. To avoid an additional minute of travelling time to the practice and one day of waiting time between booking and attending the check-up appointment, individuals in ROI were willing to pay relatively more than UK participants. In particular, they were willing to pay £0.63 and £1.26 to avoid an extra minute of travelling and an additional day of waiting time at a significant level, compared to £0.46 and £0.55 for UK participants, also having a WTP for indirect costs at a significant level. As it was seen, participants in the ROI seemed willing to pay more than twice the amount of UK respondents to avoid a day of waiting time for the appointment. Furthermore, individuals in the ROI were willing to pay a higher amount, £7.46, to see a dentist rather than an alternative dental professional for preventive care compared to participants in the UK who were willing to offer just £4.36. However, both WTP measures were not significant at 5% level.

With regards to preference heterogeneity, individuals in the UK showed a higher variation in preferences for preventive treatment and out-of-pocket costs at a significant level. Irish individuals tended to have a significantly higher preference variation for preventive treatment, travel time, seeing the dentist and out-of-pocket costs.

Table 4-19. Patient MXL in WTP space- UK participants (N=237)

Dental check-up attributes – UK	**WTP mean**	**SE**	**95% CI**	**σ**	**SE**	**95% CI**
Out of pocket cost	-0.070***	0.010	-0.090, -0.050	-0.049***	0.006	-0.061, -0.038
Travel time to reach the practice	-0.465***	0.094	0.280, 0.649	-0.290*	0.167	-0.618, 0.038
Dietary advice	-0.493**	0.216	-0.916, -0.070	-0.005	0.050	-0.104, 0.094
Hygiene advice	-1.065***	0.229	-1.514, -0.617	-0.525	0.434	-1.375, 0.325
Preventive treatment	-1.403***	0.376	-2.140, -0.667	-1.504***	0.520	-2.523, -0.485
Waiting time for the appointment	-0.548***	0.166	0.222, 0.873	0.003	0.194	-0.377, 0.382
Seeing the dentist	-4.361	3.534	-11.287, 2.566	-7.346	16.746	-40.168, 25.477
Number of responses	1894					
Sample size	237					
AIC	1811.29					
BIC	1888.94					
***(at 1% significance level), **(at 5% significance level), *(at 10% significance level)						

Table 4-20. Patient MXL in WTP space - ROI participants (N=116)

Dental check-up attributes – ROI	**WTP mean**	**SE**	**95% CI**	**σ**	**SE**	**95% CI**
Out of pocket Ccost	-0.041***	0.009	(-0.057, 0.024)	-0.034***	0.008	(-0.049, -0.018)
Travel time to reach the practice	-0.626***	0.166	(0.300, 0.952)	0.520**	0.221	(0.087, 0.952)
Dietary advice	-0.071	0.382	(-0.820, 0.677)	1.046	0.869	(-0.657, 2.749)
Hygiene advice	-1.080***	0.402	(-1.867, -0.293)	-0.675	0.728	(-2.101, 0.752)
Preventive treatment	-2.625***	0.847	(-4.284, -0.965)	1.823**	0.804	(0.247, 3.399)
Waiting time for the appointment	-1.263***	0.376	(0.527, 1.999)	0.806	0.793	(-0.747, 2.360)
Seeing the dentist	-7.461*	4.334	(-15.955, 1.033)	24.064***	6.833	(10.672, 37.457)
Number of responses	927					
Sample size	116					
AIC	1096.01					
BIC	1163.65					
***(at 1% significance level), **(at 5% significance level), *(at 10% significance level)						

Concerning the research question about differences in preferences for preventive care between the UK and ROI samples, it appeared that ROI participants had a stronger preference for preventive treatment but a weaker preference for dietary advice compared to their UK counterparts. Similar preferences for oral hygiene advice were revealed for individuals in both samples. Participants in ROI tended to avert longer travel time to the practice and longer waiting time for the appointment to a higher extent compared to UK individuals. The ROI group also had a lower sensitivity to out of pocket costs for a dental check-up appointment compared to the UK group. Both groups tended to have a similar low preference for seeing the dentist for preventive care.

4.4.5 LC

An LC model was used to explore unobserved preference heterogeneity by identifying groups of patients with distinct preferences for a dental check-up appointment. A three class solution was determined to be optimal according to AIC, which was 2567 (Table 4-21, page 193). The main LC was estimated in preference space to provide more policy relevant results given that the out of pocket cost coefficient was positive in the two smaller classes. (For robustness, the findings of the same LC estimated in WTP space are provided in Appendix 44, page 392) Among sociodemographic characteristics and behaviours of patients, gender, age, education, frequency of dental visits, purpose of last dental visit, sugar consumption, employment status, perceived oral health, insurance status, and living in the UK were used in the class membership function. These variables were identified in the literature review on patients' preferences.

Class 1 accounted for most respondents, comprising of 71% of the sample. Members of this class were less likely to prefer higher out of pocket costs and longer travel or waiting time for dietary and hygiene advice as well as for preventive treatment. They were more likely to receive dietary advice, oral hygiene advice and preventive treatment. Although individuals of this class preferred seeing the dentist for preventive care, the relevant coefficient was not significant at 5% level. In class 1, the average individual was interested in prevention and avoiding higher direct and indirect costs. Visiting the dentist more frequently, last dental visit being emergency and not planned treatment, consuming less sugar, being older or female, living in the UK, not having private insurance, being educated at a university level, being unemployed and perceiving oral health to be at an average or poor level were associated with a higher chance of belonging to this class. As for the findings on statistical significance, the probability of belonging in this class was significantly higher for those consuming less sugar or being older.

Class 2 consisted of 7% of the sample participants. Members of this class had a preference for higher out of pocket costs, shorter travel and waiting time. They were less likely to receive dietary advice but more likely to obtain oral hygiene advice and preventive treatment. Individuals of this class had a significant tendency to see the dentist for preventive care. Prevention wise, this group involved individuals more interested in oral hygiene advice and preventive treatment but less encouraged by dietary advice. Participants may have considered out of pocket cost of a dental check-up as a quality indicator justifying a higher preference for these costs. Visiting the dentist more frequently, last dental visit being emergency and not planned treatment, consuming less sugar, being older or female, not living in the UK, not having private insurance, being educated at a university level, being unemployed and not perceiving oral health to be at an average or poor level were associated with a higher chance

of belonging to this class. As for the findings on statistical significance, the probability of belonging in this class was significantly higher for those consuming less sugar or being older.

Class 3 involved individuals with lower sensitivities to out of pocket costs, travel time and waiting time. This group also demonstrated lower preferences for preventive care overall and a tendency of seeing another dental professional instead of the dentist. Class 3 constituted 22% of the sample. This group was regarded as the most indifferent in relation to preventive care and direct or indirect costs related to prevention. Visiting the dentist less frequently, last dental visit being about planned and not emergency treatment, consuming more sugar, being younger or male, having a private insurance, not being educated at a university level and being employed were associated with a higher chance of belonging to this class.

Results of LC in preference space agreed with findings of the base model in WTP space, with most individuals being willing to receive dietary advice, including 92% of sample individuals, oral hygiene advice, i.e., 78% and preventive treatment, i.e. 100%. In addition most respondents disliked higher out of pocket costs, comprising of 71% of sample individuals, longer travel time to the dental practice (78%) and all respondents disliked longer waiting times for a dental check-up appointment, in line with a positive WTP to avoid longer travel and waiting time in the base model. As of preferences for dental professional, most respondents preferred seeing the dentist for preventive care, confirming a positive WTP in the base model for seeing the dentist. Comparing LC findings in WTP space shown in Appendix 44, page 392 with base model results verified greater preference heterogeneity for out of pocket costs, travel time to reach the practice, preventive treatment and seeing the dentist for preventive care confirming significance of base model standard deviation coefficients. Furthermore, the LC findings confirmed the results of subgroup analysis, with individuals living in the UK being more likely to receive dietary advice and have a less strong preference for preventive treatment in comparison to participants in the ROI. Furthermore, the LC found that UK individuals tended to have a less strong aversion to travel time and waiting time as compared with their ROI counterparts, validating the subgroup analysis results.

Table 4-21. Results of LC with socio-demographic variables defining class membership

	Class 1	Robust SE	Class 2	Robust SE	Class 3	Robust SE
Cost	-0.069***	0.005	0.081**	0.040	0.004	0.004
Travel time to reach the practice	-0.039***	0.005	-0.080	0.050	0.005	0.005
Dietary advice	0.036***	0.012	-0.034	0.055	0.006	0.010
Hygiene advice	0.078***	0.012	0.073	0.048	-0.001	0.010
Preventive treatment	0.082***	0.017	0.398*	0.211	0.006	0.021
Waiting time for the appointment	-0.042***	0.009	-0.101	0.072	-0.003	0.009
Seeing the dentist	0.075	0.086	3.440***	1.211	-0.078	0.117
Intercept	-3.059***	0.856	-13.703***	2.364	0	-
Gender (Female)	0.386	0.395	0.641	0.749	0	-
Frequency of dental visits (every six months)	0.564	0.397	0.086	0.693	0	-
Last visit for planned treatment	-0.613	0.510	-0.191	0.982	0	-
Last visit for emergency treatment	0.121	0.524	0.862	0.959	0	-
Sugar consumption (1-2 sugar beverages per week)	1.189***	0.415	7.712***	2.143	0	-
Live in the UK	0.264	0.407	-0.405	0.630	0	-
Age (continuous)	0.059***	0.015	0.109***	0.028	0	-
Private insurance (Private insurance scheme or partially covered by a private insurance scheme)	-0.641	0.543	-1.355	0.905	0	-
Education (university)	0.248	0.383	1.587***	0.606	0	-

Perceived oral health (average or poor or none left)	0.612	0.428	-0.343	0.721	0	-
Status of employment (unemployed)	0.735	0.451	0.239	0.753	0	-
Class size	71%		7%		22%	
Number of responses	2589					
Sample size	324					
AIC	2567					
BIC	2830.65					

In relation to the research question about how the general public's preferences for preventive care vary according to their sociodemographic information, the following observations were made. Visiting the dentist more frequently, last dental visit being about emergency and not planned treatment, consuming less sugar, being older or female, living in the UK, not having private insurance, being educated at a university level, being unemployed and perceiving oral health to be at an average or poor level were associated with a higher chance of having positive preferences for dietary advice, oral hygiene advice, preventive treatment and seeing the dentist, but negative preferences for travel time, waiting time and out of pocket cost. An individual of a similar sociodemographic profile except for country of living, i.e., UK or ROI, and perceived oral health was likely to belong to class 2 which was comprised of individuals with positive preferences for oral hygiene advice, preventive treatment, seeing the dentist and out of pocket costs, but negative preferences for dietary advice, travel time and waiting time. Participants in this group were less likely to live in the UK, and tended to perceive their oral health as good or excellent. Visiting the dentist less frequently, last dental visit being about planned and not emergency treatment, consuming more sugar, being younger or male, having private insurance, not being educated at a university level and being employed were associated with a higher chance of belonging to class 3, characterised as being indifferent towards preventive care.

5. Discussion

This section discusses first the qualitative findings, followed by the quantitative results from each of the dentist and patient DCEs in turn. Understanding the factors which affect preferences of dentists and patients in caries prevention could inform policy recommendations concerning intrinsic and extrinsic motives which would facilitate the transition towards a more prevention oriented oral health care system in the UK and ROI, in accordance with the aims of the ADVOCATE project within which this study was implemented, see 1.1, page 15. Furthermore, identifying certain groups of respondents with common preferences for prevention based on sociodemographic information could direct policy measures targeted at increasing prevention in relation to educational programmes and information campaigns to groups of dentists and patients which would benefit the most from such initiatives, i.e., those with lower preferences for prevention.

5.1 Qualitative findings of dentist study

The development of the dentist DCE survey demonstrated that a mix of qualitative techniques was required to develop choice scenarios which were realistic, understandable by respondents and of appropriate cognitive burden (Coast et al., 2012). A multistage iterative approach was required during which different types of qualitative work were implemented and alternative questionnaire versions emerged until data were mature enough and a final version arose. This sort of mix methods qualitative analysis was considered critical, especially with research questions which have not yet been addressed using DCE methodology, such as the examination of dentists' preferences.

A mixed method approach was utilised for survey development. A review based on a systematic search of the literature reported in chapter 2, was initially used to generate raw data for the dentist DCE survey, leading to a list of factors impacting the decision making of dentists in delivering mix of preventive and restorative care. The attributes identified by the literature search were classified into groups, encompassing process, patient related and payment attributes, see Table 4-1, page 113. The literature review was followed by different rounds of qualitative methods including experts groups, cognitive interviews, focus groups and rating exercises.

Experience showed that cognitive interviews with individuals with specialised knowledge, including the dentist population, were more productive in the initial stages of development for the dentist DCE survey. Interviews may have slowed down the process of information gathering (Kløjgaard et al., 2012), as they were conducted in one to one sessions and feedback analysis from multiple respondents took longer compared to focus groups where the views of multiple participants were elicited in a single session. However, interviews allowed the elicitation of detailed information about professional practices and behaviours. Such information was useful when exploring a novel research

topic involving the design of a DCE survey on dental preferences. The fact that a realistic choice context was not clear in advance in the dentist DCE study, rendered interviews the proper tool to investigate practices and behaviours of dentists in relation to delivery of dental care. Interviews suggested that asking dentists to choose between alternative treatment plan scenarios for hypothetical patient vignettes was an acceptable choice context in measuring their preferences about dental care.

On the other hand, focus groups normally required a shorter time to be organised and coordinated. However, due to the fact that dentists had busy schedules, it was generally more difficult or time consuming to schedule focus group sessions in convenient times for a groups of dentists. It was also noticed that some dentists cancelled scheduled appointments because of unexpected workload commitments. Hence, organising focus group sessions with an audience of professional dentists imposed time and cost restrictions which were moderated by the use of interviews at the initial stages of survey development. In addition, the interviews here consisted a useful tool allowing dentists to unfold their thoughts independent of peers' influences, revealing in a more detailed and personalised style flawed assumptions about dental decision making.

Focus group sessions with dentists proved to work better at later stages of questionnaire development, after the choice context was established. With earlier versions of the dentist DCE survey, it was found that face to face interviews were the most appropriate and convenient approach to produce a realistic choice context within which eliciting dental preferences was feasible.

Confidence ratings were utilised to judge the survey on four dimensions in relation to understanding of choices and attributes, realism of scenarios and sufficiency of information, while experts groups either followed after literature reviews or mediated between interviews or focus groups to implement the changes needed to develop the next questionnaire versions, functioning as a "bridge" technique. Focus groups participants also completed the survey individually, offering pilot choice data which were analysed descriptively to assess whether participants made trade-offs between the attributes, to explore which attributes had a dominant effect on preferences, as well as to verify that all attributes were relevant to choices.

Instead of specialist qualitative software, a specific model proposed by research (Rothgeb et al., 2007) was used to organise the collected data from qualitative methods and framework analysis was applied in the data. Framework analysis was critical to classify the problems raised during one to one interviews and focus groups. Retrieval from memory and response selection issues comprised the large majority of problems. Retrieval from memory issues were mostly associated with attribute descriptions and the patient attributes forming patient vignettes, while response selection items mostly concerned unrealistic levels of treatment attributes. The results of framework analysis led to

revisions of attribute levels, incorporation of new attributes, data reductions in terms of removing insignificant attributes and adjustments to the wording of instructions and attributes. Hence, this specific model for categorisation of issues which resulted from data on interviews and focus groups into themes emerged as a promising tool to be applied in future qualitative research in DCEs with dental and potentially medical professionals.

5.2 Quantitative findings of dentist study

The quantitative findings of the dental DCE study are discussed below.

5.2.1 Prevention

Preventive advice in the context of this study consisted of hygiene advice in the form of demonstrating how to properly brush teeth, and dietary advice in the form of a personalised diet plan to help maintain good oral health. Dentists in this study were more likely to provide preventive advice when dealing with the baseline patient vignette, as expected since that referred to the most challenging patient. The baseline vignette referred to a 75 year old patient at high risk of developing caries and a serious caries condition. Dentists tended to deliver more preventive advice to younger patients but less advice to patients of a lower caries risk compared to the baseline patient. Caries severity did not influence preferences of dentists for preventive advice.

Preventive treatment in the survey was described as the application of fluoride varnish and fissure sealants to the entire mouth, and not only the existing condition represented by the caries photographs. It also involved prescribing and explaining the usefulness of high concentration fluoride toothpastes and rinses whenever such a prescription was judged necessary. Preventive treatment was related to enhancing professionally delivered prevention for the entire mouth and not just the caries condition which required immediate treatment. Dentists were more likely to provide preventive treatment to the most vulnerable patients, i.e. the baseline case according to the expectations since this patient was more in need of prevention. Moreover, individuals were more willing to offer preventive treatment to a patient with a moderate caries risk. On the other hand, individuals were less prone for preventive treatment to a patient with a mild caries condition as compared to the baseline patient. Patient's age and a low risk of caries did not affect dentists' preferences for preventive treatment.

Overall, dentists were more likely to provide preventive treatment to the most challenging patient and someone with moderate caries risk. Participants were less likely to offer preventive treatment to a patient with mild caries condition. They were more likely to deliver preventive advice to the most challenging patient and younger patients. They were less likely to offer advice to individuals with lower risk of caries. These findings agreed with prior expectations of higher prevention with the most challenging patient who was generally at the highest need for treatment. Delivery of more advice with younger patients was likely associated with a higher perceived conformity of these individuals with dental advice. Furthermore, dentists, might have expected that individuals with a lower risk of caries were less in need of preventive advice since they were healthier and this is why they delivered less advice to these patients. In addition dentists, were less likely to offer preventive treatment to someone with mild caries condition in connection to expectations of lower care for those with better

oral health. Hence internal validity of findings in dentists' preferences for prevention could be confirmed by the signs of relevant coefficients validating expectations on preference directions for such treatment.

The literature review findings presented in chapter 2 demonstrated that dentists were more likely to deliver preventive treatment to patients of lower caries risk and reduced caries severity (Gomez et al., 2014; Gordan et al., 2010; Gordan et al., 2009a; Javidi et al., 2015; Kakudate et al., 2012; O'Donnell et al., 2013; Riley III et al., 2011). These findings were in line with the results of this study on preventive treatment, which illustrated that dentists were significantly more likely to provide such care to a patient with a lower risk of caries compared to the baseline patient. Another finding was that dentists did not account for low caries risk in their preferences for preventive treatment. It may have been the case that individuals did not consider low caries risk to be an important determinant for prevention, as these patients may be less in need of such treatment. However, contrary to literature findings, participants were less likely to deliver preventive treatment to patients with a mild caries condition compared to the baseline patient, though the result was not significant at 5%.

No studies were found in the literature which specifically explored preferences of dentists for preventive advice. In particular, there were only two studies which included an answer option for instructions in plaque removal but these answers were pooled together with options for preventive treatment in final analysis (Gordan et al., 2009b; Riley III et al., 2011). Here it was revealed that dentists were more likely to deliver advice to the most challenging and younger patients while they were less prone for advice to patients of lower caries risk. These findings were regarded as new research evidence in the field of dentists' preferences for preventive care.

Overall, the magnitude of the model coefficients suggested that preventive advice was regarded as the most appropriate preventive measure to be applied, surpassing preferences for preventive treatment. Studies focusing on dentists' preventive dentistry practices found that the majority of respondents usually provided their patients with advice about oral hygiene and diet modifications rather than delivering in office fluoride treatments and fissure sealants (Saeed et al., 2016). This pattern was also observed in this experiment, with respondents preferring preventive advice over treatment.

5.2.2 Restorative treatment

In terms of preferences for restorative treatment, dentists were significantly more likely to apply such care to the baseline patient according to the expectations, since it referred to the patient of most critical condition. They were significantly less prone to intervene with a moderate caries risk patient and someone with mild caries, but tended to deliver more restorative treatment to younger patients

compared to the baseline case. Offering such care to the youngest patient of this study, i.e. 24 years of age was also significant at 5% level as opposed to a 55 years old. These findings were in agreement with prior expectations for higher restorative care to the most challenging patient but lower care for patients with lower risk of caries, based on the assumption that dentists aligned care to patient needs. A higher preference for restorative care with younger individuals was also a useful finding which could be justified by the fact that dentists perceived younger patients as more in need of immediate restoration to alleviate an existing caries condition as these patients were less likely to have more oral health complications. In addition, dentists were less likely to apply restorative treatment to a patient with a less severe caries condition in accordance with expectation for lower restoration required for a milder caries condition. Therefore internal validity of findings in dentists' preference for restorative care could be confirmed by the signs of relevant coefficients validating expectations on preference directions for such treatment.

Literature review results reported in chapter 2 demonstrated that dentists were less likely to apply restorative treatment to a patient with a less severe caries condition in agreement with findings of this study (Gomez et al., 2014; Gordan et al., 2010; Gordan et al., 2009a; Gordan et al., 2009b; Javidi et al., 2015; Kakudate et al., 2012; Mejàre et al., 1999; O'Donnell et al., 2013; Traebert et al., 2005). This finding was reasonable since this patient was less in need of restorative care due to a milder caries condition. These results were in agreement with prior assumptions as patients with a milder caries condition could be in less need for restorative treatment. As for caries risk, literature demonstrated that dentists were less likely to provide restorative care to patients at a lower risk of caries as was shown in this study with a moderate caries risk patient compared to the most challenging patient (Gomez et al., 2014; Gordan et al., 2010; Gordan et al., 2009a; Riley III et al., 2011). With regards to patient's age there was evidence in literature review that dentists were more likely to offer restorative care to younger patients confirming results of this study (Gordan et al., 2012; Kateeb, E. et al., 2016; Kateeb, E.T. et al., 2014).

5.2.3 Income

With respect to income, the model showed that dentists significantly preferred higher treatment plan payments confirming prior expectations that dentists would prefer a higher income. This effect was moderated when treating a patient with a mild caries condition but the impact was not significant on preferences at 5%. No other patient characteristics influenced preferences for income. Hence internal validity of dentists' preferences for income was confirmed by a positive and significant coefficient.

5.2.4 Quantitative tests to check for underlying assumptions of DCE

Running a MXL after removing straight liners or those always picking up the alternative option of lower income provided similar findings with the base model. Four participants were identified to have followed these behaviours. This showed that most respondents answered the choice tasks in a logical manner.

To test for attribute dominance in decision making, the participants who always chose an alternative option based on the value of each treatment attribute, were identified. This way it was explored whether there was any attribute which led to dominant preferences. A higher share of participants, including 15% of the sample, always chose the alternative offering a longer preventive advice session. Around 6% of individuals always selected the option providing a higher income. These findings confirmed stronger preferences of dentists for preventive advice which were verified by the main model results. The shares of respondents who always chose the option which was better in each attribute are reported in Appendix 41, page 389.

No attribute nonattendance tests were implemented on the dentists' dataset given the interaction parameters used in the specification of the main model, for more information on the specification used look at Equation 3-4, page 93. Applying ANA models in this case would potentially capture preference heterogeneity by identifying individuals who more likely cared less about certain interaction attributes rather than ignored them.

5.2.5 LC

A LC was fitted on the choice data ignoring interactions with patient attributes to explore the impact of dentists' characteristics in treatment preferences. An algorithm based on minimisation of AIC led to a solution of three classes. Female dentists, those working in a smaller public or mixed public and private practice, more frequently applying fluoride varnish and fissure sealants to adult patients, more frequently delivering dietary advice, with more years since graduation, working part time or seeing a higher share of exempt from payment patients were more likely to belong to class 1 which consisted 45% of the sample. Class 1 participants were more likely to provide preventive treatment, preventive advice and restorative care while they disliked a higher income. It seemed that participants of this class were mainly motivated by delivering preventive care and less by income. Participants in second class which comprised of 46% of sample participants were less likely to offer preventive treatment, had a reduced tendency for preventive advice compared to class 1 and a higher preference for income. Membership in class 2 was predicted by applying fluoride varnish more frequently, delivering less frequently dietary advice or fissure sealants, working in a private or larger practice, being female, having more years since graduation, working part time and seeing a higher share of exempt from payment patients. Dentists in class 3 who constituted a smaller proportion of the sample, i.e. around 8%, had an aversion to preventive treatment and advice as well as restorative care. They seemed to be mainly influenced by a higher income in their treatment decisions.

The literature review findings presented in chapter 2 revealed some evidence that female dentists and those offering more frequently fluoride varnish, fissure sealants and preventive advice were more likely to provide preventive and restorative treatment in line with the LC findings of this study (da Silva Tagliaferro et al., 2020; Kakudate et al., 2012).

Literature findings on the impact of practice size or mix, i.e. public versus private, on dentists' treatment preferences were mixed. A few studies showed that dentists working in a small group private practice were more prone to offer restorative care (Gordan et al., 2010; Gordan et al., 2009a; Gordan et al., 2012). One article revealed that dentists working in a public or large private practice were more likely to offer preventive treatment (Gordan et al., 2012). Another study illustrated that dentists in small practices were more likely to provide restorative care (Grembowski et al., 1997). There was also evidence that private dentists tended to offer more preventive treatment compared to public dentists (da Silva Tagliaferro et al., 2020). It was shown here that dentists working in small, public or mixed public and private practices were more likely to deliver preventive treatment and advice. Working in a private practice was associated with a lower chance of delivering preventive treatment. This effect may have been due to the fact that dentists in smaller, public or mixed public and private practices were more interested in building long lasting relationships with their patients,

focusing more on the long term oral health outcomes of their patients. In addition, dentists working in such practices may have been more motivated by providing suitable care rather than receiving a higher income.

More years since graduation were linked to higher preferences for preventive advice and restorative care in this study. In relation to preventive treatment, literature findings were mixed with more years being associated with both higher and lower preference for such care. Literature evidence pointed to a positive relationship between restorative care and years since graduation or older age of the dentist (Chana et al., 2019; Gordan et al., 2012; Kateeb, E. et al., 2016) but a negative link between preventive treatment and years since graduation (da Silva Tagliaferro et al., 2020; Gordan et al., 2012), with no study looking at the effect of years in practice on preventive advice. This study showed that individuals with more years since graduation were more likely to provide preventive advice and restorative care while findings for preventive treatment were split between higher and lower preference for such care.

Dentists working under a part time regimen were more likely to offer preventive and restorative care compared to those working under full-time or overtime regimens. Considering part-time employment as a proxy for busyness levels, lower levels of busyness were associated with higher restorative care in the literature in agreement with findings here (Gordan et al., 2009a). No study looked at the impact of busyness levels on decisions for preventive care. This study revealed a reverse relationship between levels of busyness and provision of preventive care. Furthermore, dentists seeing a higher share of exempt from payment patients were more likely to deliver restorative and preventive care. This finding confirmed literature evidence on a reverse relationship between percentage of self-paying patients and amount of restorative care (Gordan et al., 2010). The effect of share of exempt from payment patients on preventive care was not yet researched, so this study offered some new insights on this relationship.

The LC findings also provided some evidence on the robustness of base model's results. These included confirming the strong preferences of dentists for preventive advice. Adding up the shares of participants belonging to class 1 and 2, who illustrated a positive preference for preventive advice led to the finding that 91% of dentists were more likely to deliver preventive advice consistent with the findings of the main model which depicted a strong preference for such care. Furthermore, the LC found that preferences for preventive treatment were more diverse, with only 45% of participants being more likely to provide this type of treatment as was confirmed by more diverse in sign coefficients of the main model. For preferences about restorative treatment the LC displayed that most dentists, i.e., 91% were inclined to provide this type of care, in line with positive preferences for such care in the main model. In addition, most participants in LC, consisting of 54% of the sample, had

a tendency for higher income as was shown by positive preferences for income in the main model. Hence, the LC specification not only offered new evidence on the impact of dentists' characteristics and practices on treatment decisions but also confirmed overall treatment preferences of the main model.

5.3 Qualitative findings of patient study

Two broad categories of qualitative techniques were suggested in the literature for developing a DCE survey, namely focus groups (Hiligsmann et al., 2013) and one to one interviews. Although a large number of relevant studies favoured personal interviews over focus groups for pilot testing (Kun et al., 2013; Janssen et al., 2016), this study used focus groups to review most of patient DCE questionnaire versions. This occurred as it was thought that oral disease prevention was not a sensitive topic, and collaboration among a group of participants in a brainstorming format could reveal intriguing findings which would not have been captured in one to one interviews. The choice between interviews and focus groups for pilot testing was often determined by practical considerations. In the current study, the benefits of collaboration between focus group members was one of the main reasons that was used more frequently over one to one interviews.

Furthermore, focus groups appeared to be more useful in developing a questionnaire with members of general public or patients (Kjær et al., 2006; Helter and Boehler, 2016) . This was possible due to the fact that variations in knowledge about attributes of dental attendance among general public individuals was higher compared to dentists' knowledge about factors relating to preventive care. The knowledge of the general publics about oral disease prevention was mainly shaped by intuition and personal experiences of visiting the dentist. Such knowledge limitations required participants to sit in groups and discuss in order to reach a common consensus about the most important determinants impacting dental attendance. Although forcing individuals to come to a consensus could be regarded as a drawback of focus groups, when participants exchanged opinions and shared views on a topic in a discussion format, they tended to be more effective in approving or rejecting new ideas and validating existing arguments. For example, it was noticed that individuals agreed on the inclusion of some attributes only after another participant brought these attributes up in discussion, since participants had potentially not considered them in advance. Due to the relatively low level of specialised knowledge of the general public about preventive care features, focus groups offered an opportunity for participants to exchange opinions and explore all the relevant features of a dental check-up appointment which would make a difference to them, even if they had not considered some of these features individually.

Confidence ratings were also used to offer ratings on various dimensions of the questionnaire specifically participants' understanding of choice questions and attributes, the realism of hypothetical scenarios and the sufficiency of presented information. These indicators showed how changes in the choice sets, attribute levels and instructions of the survey between different DCE questionnaire versions affected responses in these four dimensions. Choice response data were analysed descriptively, as participants of interviews and focus groups were also asked to complete the survey

individually. This provided an opportunity to assess whether participants traded attributes and check whether specific attributes were dominating choices. Analysis of choice data indicated the need for revisions to the attributes' levels to avoid dominance effects, and remove some attributes which did not influence respondents' choices. Expert groups either followed after literature reviews or mediated between interviews or focus groups to implement the changes needed and develop the next questionnaire versions, functioning as a "bridge" technique.

In summary, the most frequent method with respect to the patient DCE questionnaire development process was focus groups. Interviews were also used as a complementary method. Data from both methods were analysed using framework analysis which has been previously used in a DCE context (Grindrod et al., 2010; Lloyd et al., 2011). Instead of specialist qualitative software though, a specific model found in the literature (Rothgeb et al., 2007) was applied by the researcher. Framework analysis was critical to classify the problems raised during one to one interviews and focus groups. This analysis revealed that the majority of the issues derived from the response selection group in relation to attributes of dental attendance and their levels. The results of framework analysis resulted to revisions of attribute levels, inclusion of new attributes, removal of insignificant attributes and adjustments to the wording of instructions and attributes. Hence, this specific model for classification of issues deriving from data on interviews and focus groups into themes emerged as a promising tool to be applied in future qualitative research in DCEs with general public or patients in the dental and broader medical field.

5.4 Quantitative findings of patient study

The quantitative findings of the patient DCE study are discussed in the following paragraphs.

The internal validity of patient DCE findings was assessed by reviewing the signs of WTP estimates. Most individuals were willing to pay for more preventive treatment, oral hygiene advice and dietary advice. As expected, general public valued the delivery of prevention, tending to have longer preventive care. Individuals had an aversion for longer travel time and waiting time, as well as higher out of pocket costs for a dental check-up appointment. As travel time and waiting time were considered indirect costs of receiving preventive care, and consistent with expectations, most respondents were willing to pay to avoid longer travel time to the dental practice or spare an additional day of waiting time to attend the dental check-up appointment. Pertaining to preferences for type of dental professional who delivered preventive care, participants were willing to pay to see the dentist in comparison to a dental hygienist, therapist or nurse in agreement with prior expectations for stronger preference for a dentist provider, potentially considered as an authority figure in the dental field.

5.4.1 Seeing the dentist for preventive care delivery

Participants were willing to pay an additional amount of £5.22 to see the dentist. Only one study was found in the literature review presented in chapter 2 which looked at preferences for the provision of oral hygiene advice by different types of dental professionals. The study revealed that individuals were willing to pay £24 for having oral hygiene advice delivered by the dentist as compared with £15 for having the same care by a dental hygienist (Boyers et al., 2021). In line with these findings this study reported a higher willingness pay of individuals to see the dentist for preventive care. This effect occurred despite the context of the choice experiment which informed participants that in addition to the varying attribute levels between the dental check-up appointments, everyone would be seen by the dentist for a scale and polish treatment in the beginning of the dental visit. The scale and polish session lasted for 15 minutes. Hence individuals valued the presence of dentist for preventive care even though they would also see the dentist for a different type of treatment within the same visit. However, it should be noted that variation in valuation for seeing the dentist exceeded valuation variations of the other attributes, indicating that participants had extreme preferences for this option, with some being willing to pay as much as £32 for having preventive care delivered by the dentist, while others were prepared to pay £22 for having the same care provided by a different type of dental professional such as a dental hygienist, therapist or nurse.

5.4.2 Preventive treatment

Preventive treatment was defined in the description section of P-DCE-F, as the "average time spent on preventive treatment, e.g. for fluoride varnish delivery which helps prevent tooth decay". It was apparent that participants valued preventive treatment being willing to pay between £6.57 and £13.14 for a 4 to 8 minutes session. Such findings were in agreement with evidence of the literature review in chapter 2. The review provided a range of WTP estimates between £23 and £28 for preventive treatment using fluoride varnish in the UK (Walshaw et al., 2019). Although it seemed that individuals in this study were willing to pay somewhat less for the same type of care, the results were confirmatory of positive preferences for preventive treatment. Individuals were willing to pay an extra £1.64 for each additional minute of preventive treatment, indicating that on average, they valued this type of treatment higher than the other preventive services, i.e. dietary and hygiene advice. Another point worth considering was that variation in preventive treatment valuations was higher than for hygiene or dietary advice valuations, entailing that participants had more extreme preferences for preventive treatment compared to advice.

5.4.3 Oral hygiene

Individuals were willing to pay between £5.77 and £11.55 for an oral hygiene session lasting from 6 to 12 minutes. Hygiene advice in this experiment was described as demonstrating proper tooth-brushing techniques. Literature review evidence of chapter 2 provided a wide range of WTP estimates for oral hygiene advice between £15 and £78 irrespective of the country where the study was conducted (Boyers et al., 2021; Re et al., 2015; Vermaire et al., 2012). In the UK the amount varied between £15 and £24, meaning that participants tended to demand more oral hygiene advice (Boyers et al., 2021). However, the content of the advice differed across studies and hence results were less comparable. In this study, individuals were willing to pay an extra £0.96 for each additional minute of oral hygiene advice.

5.4.4 Dietary advice

Individuals were willing to pay between £1.65 and £3.31 for a 5 to 10 minutes session of dietary advice, which was described as the explanation of a personalised diet plan delivered as a handout at the end of the appointment. There was no evidence in the literature review of chapter 2 on patients' preferences for dietary advice. Dietary advice in a dental setting could positively impact healthy eating behaviours, including lower sugar consumption, less frequent sugar intake, and avoidance of sugar intake at both meal and snack times, and could prevent dental caries (Chomitz et al., 2019; Harris et al., 2012). In this study, individuals were willing to pay an extra £0.33 for each additional minute of dietary advice. However the WTP estimate was not significant at 5% level. It was argued that some patients may perceive diet diaries as tests, carrying a potential for harassment and blame which

generated defensiveness towards dietary advice (Arheiam et al., 2018). Individuals' values, priorities and circumstances have also been found to influence the level of commitment to completing a diet diary (Arheiam et al., 2018). Moreover, other studies confirmed a low level of patient compliance to dietary advice or a lack of commitment to completing diet diaries which may signify a low preference for such advice (Arheiam, A et al., 2016; Arheiam, Arheiam et al., 2016). Another reason for the limited impact of dietary advice on patients' preferences could be that more recent technological interventions in the field of self-monitoring of health related data, including smartphone applications, have to some extent superseded traditional paper based dietary plans (Underwood et al., 2015; Schüz and Ferguson, 2015). Such findings were verified by a few patients' claims in the qualitative study part that dietary advice was not regarded as necessary due to their ability to seek themselves diet related information online.

5.4.5 Dental check-up appointment

Summing up the WTP effects of two extreme dental check-up scenarios varying only on type of dental professional and preventive care attributes while keeping travel time and waiting time equal across scenarios, a range of valuations for a dental check-up in this study was inferred. This provided evidence on valuation for a dental check-up which was compared with literature review findings of chapter 2. A dental check-up visit with preventive care attributes set to their lowest level excluding zeros, resulted in 5 minutes of dietary advice, 6 minutes of oral hygiene advice and 4 minutes of preventive treatment. Care in this scenario was provided by a non-dentist dental professional. Individuals were willing to pay £14 on average for such an appointment. The second scenario offered 10 minutes of dietary advice, 12 minutes of oral hygiene advice and 8 minutes of preventive treatment. Care in the second scenario was delivered by the dentist. Participants were willing to pay £33 on average for a similar appointment. These results were in line with literature review findings showing a diverse range of WTP estimates for a dental check-up appointment between £3 in Bulgaria to £59 in Denmark (Bech et al., 2011; Pavlova* et al., 2004; Tuominen, 2008; Vermaire et al., 2012). Therefore, results on valuation of a dental check-up appointment in this study were within the range of literature findings.

5.4.6 Indirect costs

Patients were willing to pay £0.46 to avoid spending an extra minute of travel time to the dental office. One article was identified in the literature review of chapter 2 which used an attribute of travel time to the dental office for non-acute dental care in Finland (Kiiskinen et al., 2010). It was reported that individuals were willing to pay £0.43 to avoid an additional minute of travel time to the dental office.

As for waiting time to get a dental check-up appointment, individuals were willing to pay £0.73 to spare an additional day of waiting time. Two studies were found in the literature review which included an attribute of waiting time either in weeks for non-acute dental care in Finland or in days for restorative care in China (Kiiskinen et al., 2010; Zhu et al., 2019). When the WTP estimate of weekly waiting time was converted to WTP in days by simply dividing by 7 days, it was shown that individuals were willing to pay £1.41 for each additional day they saved. In the second study, participants' payments to avoid each additional day of waiting time varied between £0.60 and £0.73. Hence findings of WTP for travel and waiting time in this study were similar to results provided by literature evidence.

5.4.7 Quantitative tests to check for underlying assumptions of DCE

A MXL was run in WTP space after excluding straight liners, and those who always chose the option of longer travel time, longer waiting time and higher out of pocket costs. These respondents were considered to have provided inconsistent responses. The findings of the reduced data model were similar to the main model. This meant that accounting for inconsistent responses did not affect the results and hence there was no reason to remove these participants from the full sample in line with literature suggestions (Lancsar and Louviere, 2006).

To test for attribute nonattendance, seven two class LCs were estimated where coefficients for each of the main model attributes was constrained to zero in second class while the remaining coefficients were restricted to be equal across classes so that preferences across individuals could only differ in the information processing rule they used. Results showed that participants seemed more likely to have ignored the type of dental professional who offered preventive care, travel time to the dental office and preventive treatment. Findings on out of pocket cost non-attendance were similar to the dental literature exploring such an effect. Around 44% of individuals appeared to have ignored the out of pocket cost attribute. In another article which was identified in the literature review on dental DCE studies, 49% of respondents did not take the cost into consideration when making choices about endodontic treatment (Sever, Ivan et al., 2019c; Sever, Ivan et al., 2019b). A growing literature investigated the impact of ignoring the cost attribute in WTP estimates showing that such a behaviour could lead to biased estimates (Lagarde, 2013; Scarpa et al., 2009; Sever, Ivan et al., 2019c).

However, findings of such analysis should be interpreted cautiously. Research demonstrated that if instead of non-attendance for a given attribute, there was strong residual heterogeneity, i.e. both low and high sensitivities, estimating a model with only two values for each coefficient, with one of them being fixed to zero, then the presence of continuous heterogeneity in the data was likely to influence both the estimate of the non-zero class and the probability of zero class (Hess et al., 2013). In the context of a model with a random coefficient for each attribute, the presence of respondents with very low sensitivities would simply be captured in a downwards pull of the mean parameter and a potential increased estimated variance (Hess et al., 2013). If, however two classes were used for each coefficient, with one value being constrained to zero, then their behaviour could also be captured by this latter class. The main point is that participants captured in the non-attendance class may not necessarily have had zero sensitivities (Hess et al., 2013). The main analysis here revealed significant standard deviation coefficients for out of pocket costs, travel time, type of dental professional and preventive treatment. These coefficients were also found to be more likely to have been ignored by respondents in the ANA model. Hence, this unobserved heterogeneity of these coefficients may have been captured by the ANA model specification which assigned it as attribute non-attendance. Hence,

despite that findings of ANA analysis showed that general public participants were less likely to attend certain attributes, it may have been that the models captured preference heterogeneity and not purely the effect of attribute non-attendance.

To test for attribute dominance in decision making, the participants who always chose an alternative option based on the value of any given treatment attribute, were identified. This way it was explored whether there was any attribute which led to dominant preferences. A considerable share of respondents including 29% of individuals always selected the option providing a lower out of pocket cost. Fewer participants always chose the option showing a shorter travel time (21%) or longer preventive treatment (17%). These findings confirmed the main model results, which revealed lower preferences for out of pocket costs and travel time and greater preference for preventive treatment. The standard deviation coefficients for all these parameters were also statistically significant indicating preference variation for these attributes among respondents.

5.4.8 LC

The LC demonstrated that more frequent dental visits, purpose of last dental visit being for emergency and not planned treatment, less sugar consumption, being older or female, living in the UK, not having private insurance, being educated at a university level, being unemployed and perceiving oral health to be at an average or poor level were associated with a higher chance of belonging to this class 1 consisting of 71% of sample participants. This class included individuals with higher preferences for preventive care and an aversion for higher out of pocket costs and longer travel or waiting time. Age and sugar consumption were also found to be significant predictors of this class membership. The same profile of patients except for living country and perceived oral health were more likely to fall into class 2 which constituted 7% of the sample. This class involved individuals with lower preference for dietary advice, similar preferences for oral hygiene advice and higher tendency for preventive treatment and seeing the dentist provider compared to class 1. Individuals of this class also had a stronger aversion towards indirect costs of travel and waiting time for a dental check-up appointment compared to class 1. However, they preferred higher out of pocket costs for the dental appointment. Age, sugar consumption and being educated at a university level were significant predictors of class 2 membership. It may have been the case that individuals of this class perceived higher out of pocket costs to be associated with a higher quality of dental care. Such positive preferences for higher dental out of pocket costs were reported in the literature review of chapter 2, exploring preferences for periodontal treatment (Vennedey et al., 2018). Class 3 involved individuals with lower preferences for out of pocket costs, travel time and waiting time compared to the other classes. This group also demonstrated lower preferences for preventive care overall and a tendency of seeing another dental professional instead of the dentist. Class 3 constituted 22% of the sample. This group was regarded as

the most indifferent with respect to preventive care and direct or indirect costs related to prevention. It mainly represented participants adding more noise in actual preferences for prevention. Visiting the dentist less frequently, last dental visit being for planned and not emergency treatment, consuming more sugar, being younger or male, having a private insurance, not being educated at a university level and being employed were associated with a higher chance of belonging to this class. It could be argued that such a profile of participants were less interested in receiving preventive care.

The literature review of chapter 2 displayed either similar or mixed findings. There existed mixed findings on the effect of age on preferences for prevention. Older adults had a higher preference for oral health advice in the UK (Harris et al., 2020). However two articles looking at preference of parents for dental sealants for their children in Thailand reported that younger individuals were willing to pay more for this service (Tianviwat et al., 2008a; Tianviwat et al., 2008b). It should be noticed though that dental sealants were not part of preventive treatment's description in this study.

Two studies found that female individuals had stronger preferences for oral hygiene advice and higher WTP for fluoride varnish treatment in line with findings in this study (Boyers et al., 2021; Walshaw et al., 2019).

Furthermore, a few studies reported that experience with dental treatment, higher frequency of dental attendance and having used dental care in the last year were associated with stronger preferences for oral hygiene advice and non-acute dental care as well as with higher WTP for dental check-up visits and fluoride varnish treatment (Boyers et al., 2021; Kiiskinen et al., 2010; Pavlova* et al., 2004; Walshaw et al., 2019). Hence findings in this study in relation to stronger preferences for prevention of those with more frequent dental visits was confirmed by the literature.

Another important finding of this study was that individuals with recent experience of emergency treatment were more likely to receive preventive care compared to those with experience of planned treatment, such as fillings. One study found that parents inexperienced with fillings were more willing to pay for dental sealants treatment to their children in Thailand (Tianviwat et al., 2008b). A recent history of dental pain for parents and their children was linked to higher WTP of parents for preventive treatment concerning themselves and their children in another study conducted in the UK and Brazil confirming the evidence here (Walshaw et al., 2019). Overall, it seemed that individuals having been in need of emergency treatment were more likely to receive preventive care compared to those having needed planned treatment. It may have been that a recent painful dental experience led individuals to demand more prevention to avoid being placed in a similar situation in the future.

No evidence was found in the literature about the impact of employment status on preferences for preventive care. Unemployment status could be regarded as an indicator of socioeconomic condition as no questions on income were included in the survey which was thought to be an insensitive topic. This variable could also include a proxy of time availability to visit a dental practice for a dental check-up appointment because of higher time availability of unemployed individuals. The literature findings were in favour of a positive relationship between income or socio-economic status and preventive care. Most studies revealed that higher income and socioeconomic status were related to stronger preferences for oral hygiene advice and non-acute dental care as well as higher WTP for fissure sealants, dental check-up visits and preventive treatment (Boyers et al., 2021; Harris et al., 2020; Kiiskinen et al., 2010; Pavlova* et al., 2004; Saadatfar and Jadidfard, 2021; Tianviwat et al., 2008a; Tianviwat et al., 2008b; Walshaw et al., 2019). On the other hand, one study showed that a lower socioeconomic status as expressed by living in a rented flat as compared with owning a house was associated with a higher WTP for preventive care (Oscarson et al., 2007). It could be argued that unemployment was an indicator of individuals' income level or socioeconomic status in this study. It was found that unemployed individuals were more likely to demand preventive care. These individuals also had an aversion towards higher out of pocket and indirect costs as could be expected by a lower socioeconomic condition. This could suggest that unemployed individuals were more likely to demand preventive care to avoid higher future costs of planned dental treatment or that they possessed more available time to visit the dental office for a dental check-up appointment compared to employed participants.

Participants with a higher education were more likely to receive preventive care, in particular oral hygiene advice and preventive treatment in agreement with literature findings (Kiiskinen et al., 2010; Pavlova* et al., 2004; Tianviwat et al., 2008b). However, there was evidence that these individuals were less prone for dietary advice. Patients who perceived their oral health to be in a poorer state were more likely to demand preventive care in line with literature evidence (Harris et al., 2020; Oscarson et al., 2007; Walshaw et al., 2019). Just one study showed an opposite effect with individuals who perceived having a better health being more willing to pay for a dental check-up appointment (Pavlova* et al., 2004). Respondents with a poorer perceived oral health may consider they are in higher need of preventive care to improve their oral health state and avoid future oral health deterioration.

Limited or no evidence was detected in the literature on the influence of practice location and sugar consumption on preferences about prevention (Harris et al., 2020). Here it was revealed that living in the UK compared to ROI was associated with lower preferences for preventive treatment, whereas people in ROI were more likely to avoid dietary advice. This finding confirmed subgroup analysis

results which demonstrated that individuals in the UK were less willing to pay for preventive treatment but more willing to pay for dietary advice in comparison to ROI people, see Table 4-19, page 188 and Table 4-20, page189. Consuming less sugar was linked to higher preferences for preventive care. However, there was also an indication of lower preference for dietary advice for those consuming less sugar. This could mean that people with healthier diet habits were more likely to avoid dietary advice potentially thinking they were not in high need of such type of care.

Most individuals, including 71% of the sample belonged to class 1. These participants were more likely to receive preventive care and less likely to accept higher direct and indirect costs. Around 7% of participants comprising class 2 were more likely to pursue a higher out of pocket cost for a check-up appointment. This might have been since participants perceived a higher out of pocket cost to indicate a better quality of care. Class 3 consisting of 22% of sample participants represented individuals who were less sensitive towards prevention according to the LC. WTP estimates of this class were not statically significant, see Appendix 44, page 392. The distributions of estimates in the main model demonstrated that a small share of participants ranging between 5%-15% had unexpected WTP estimates in terms of positive preferences for indirect costs or negative preferences for preventive care. Such variation of WTP estimates in the main model could be justified by the fact that a small share of individuals belonging to class 2, i.e., 7% of the sample, had a tendency for higher out of pocket costs. This outcome in conjunction with some random noise in preferences deriving from class 3 yielded to the small share of WTP estimates with reverse signs in the main model. Another finding of the main model which was validated by the LC was the significant variation in relation to seeing the dentist for preventive care, as depicted by the large range of WTP values in LC, see Appendix 44, page 392. Hence applying the LC increased the robustness of the main model findings by validating preference heterogeneity.

5.4.9 Preferences of UK and ROI participants about attributes of dental attendance

Some preference differences emerged between individuals in the UK and the ROI. People in the ROI had higher WTP for preventive treatment compared to those in the UK, and were also willing to pay more to avoid an extra minute of transport and waiting time. Furthermore, individuals in the ROI were less willing to pay for dietary advice compared to their counterparts in the UK.

The higher WTP measures estimated for the ROI sample may have been due to a lower dental attendance rate for people living in the ROI. A sociodemographic analysis showed that people in the UK visited the dentist more frequently than those in the ROI. For example, 72% of participants in the UK visited the dentist within the last year, compared to 51% of those in the ROI, and a check-up, examination or cleaning was the reason for the last dental visit for 76% of the UK sample, as opposed

to 54% of the ROI sample. In addition, 58% of the UK sample reported visiting the dentist every six months compared to only 29% of the ROI sample. Twice the proportion of participants in the UK reported visiting the dentist every six months (58%) compared to those in the ROI (29%), implying that the majority of UK individuals conducted two visits to the dentist yearly in comparison to people in ROI. This fact could partially explain why ROI respondents were willing to pay more for preventive treatment, provided the majority would spend this amount less frequently than their UK counterparts. In contrast, approximately 60 % of UK respondents payed the cost of a dental visit twice a year, making them more sensitive to the out of pocket costs of preventive services at a given individual dental appointment. It may have been on the same grounds that ROI participants were willing to pay more to avoid longer transport and waiting times for a dental appointment, since a larger share of the ROI sample bore these indirect costs just once, compared to twice annually for the UK sample.

5.5 Limitations

A limitation of using an out of pocket costs attribute as the payment vehicle in patient DCE study, was the extent to which the WTP estimates of the main model truly reflected the maximum amount individuals were willing to pay for prevention services as opposed to what they believed as fair to pay in a subsidised system of dental services such as those in the UK and ROI. The literature review of chapter 2 revealed a few studies which used alternative forms of payment vehicles in dentistry including dental insurance premiums, private dental insurance coverage as one-time payment and additional taxes through government coverage in the United States and Canada (Birch, Stephen et al., 2004; Matthews et al., 1999; Srivastava, A et al., 2020; Srivastava, Akanksha et al., 2014). Findings of these studies suggested that more individuals were willing to pay for dental services through out of pocket payments or private insurance coverage compared to public funded programs. It was argued that such an effect could be a result of negative perceptions towards higher tax payments or a lack of confidence in the effectiveness of a public program (Birch, Stephen et al., 2004). Furthermore, this may also have derived from participants' attitudes about what governmental programs could provide as compared with private insurance programs, as well as their perceptions of the uncertainty about getting the disease (Srivastava, A et al., 2020).

However, despite the use of an out of pocket payment vehicle to elicit WTP of patients about preventive services had limitations, there was evidence that its use in a tax-based funded system was a common practice which has been reported in past dental studies. The literature review of chapter 2 identified four articles looking at preferences of general public or patients for dental preventive services using out of pocket payments in a mixed public and private setting in the UK and England (Boyers et al., 2021; Harris et al., 2020; Vernazza, C.R. et al., 2015; Walshaw et al., 2019). In addition, a few other studies used a similar approach to evaluate preferences on prevention in public settings outside the UK (Oscarson et al., 2007; Pavlova* et al., 2004; Saadatfar and Jadidfard, 2021; Tianviwat et al., 2008a; Tianviwat et al., 2008b; Tuominen, 2008). Furthermore, a few other dental DCE studies applied out of pocket payments in the investigation of patients' preferences about dental treatment not related to prevention in mixed public and private settings in Croatia and China (Sever, I. et al., 2018; Sever, Ivan et al., 2019c; Sever, Ivan et al., 2019b; Zhu et al., 2019). Hence, it could be argued that despite its limitations, the use of out of pocket payments to investigate preferences for dental services was a common practice in the dental literature.

It was likely that individuals would be more willing to pay for dental preventive services using different payment vehicles including private insurance premiums or private payments assuming no subsidization. However, it would be more challenging for respondents to accept different payment vehicles and make decisions based on them as they were not used to such payment mechanisms in

the UK or ROI. The studies identified in the literature using these alternative forms of payment vehicles were conducted outside the UK and perhaps participants were more familiar with them. Another argument to support the use of out of pocket payments in a subsidized system was that participants did not seem to consider the effect of subsidies when making decisions during the interviews and focus group sessions in the qualitative phase of this study and they appeared to engage well with the concept of out-of-pocket payments. It was left to future research to compare preferences for dental preventive services using different payment vehicles such as out of pocket payments and private insurance premiums in a subsidized dental system.

Future research could also use other non-monetary vehicles including time or risk sacrifices to shed more light on the value of preventive services. Such attempts were identified in the literature review of chapter 2 for non-preventive dental services where the methods of TTO or SG were applied to measure preferences for different tooth states, prosthetic treatment options, third molar surgery and other treatments (Cohen, M.E. et al., 1990; Fyffe et al., 1999; Fyffe and Kay, 1992; Ismail et al., 2004; Sendi, P et al., 2018). The payment vehicles used in these studies were in the form of either lifetime sacrifice for achieving a better oral health state, or TTOs for remaining in a painful oral health state or risk trade-offs in relation to immediate tooth loss through extraction. One other study asked participants about the shortest interval between dental check-ups they would be willing to accept for a given improvement in oral health (Fukai et al., 2012). These payment vehicles could be used as alternative options in measuring preferences for preventive dental services.

From a policy perspective though, monetary vehicles may seem more relevant. Expressing preferences for preventive services in monetary terms could offer useful inputs to cost-benefit analysis through elicitation of WTP measures for individual characteristics of prevention. One study identified in the literature review presented in chapter 2, applied DCE WTP estimates to compare preferences about different preventive treatment packages for periodontitis varying on both outcomes and services (Boyers et al., 2021). Cost benefit analysis permitted decision making to account for a wider range of evidence beyond narrowly defined services, which were insensitive to the processes of care that were valued by dental service users (Kastenbom et al., 2019). For example, this study evaluated preferences not only for process attributes in relation to preventive care for dental caries but also for travelling time to the dental practice and waiting time for a check-up appointment. Such attributes were less sensitive to alternative non-monetary payment vehicles such as time and risk, as general public would be less willing to trade lifetime or time at a painful oral health state or risk of tooth loss to gain an improvement in travel and waiting time. This study found that general public cared both about prevention related services and indirect costs such as travel time and waiting time. It was hence

important, that service providers and decision makers would account for both preventive treatment services as well as a broader range of non-care services when making resource allocation decisions.

Other limitations of the current study was reliance on hypothetical choices and the absence of clinical data. Hypothetical bias referred to the ability of testing for external validity of WTP estimates. There was limited evidence pertaining to external validity of WTP estimates in health care because of the challenges in designing external validity tests in this context (Ryan and Watson, 2009). Due to the design of payment system for dental services in both countries, individuals did not pay at the point of consumption separately for each type of care but provided an out of pocket payment covering multiple preventive services at the same time. Hence it was impossible to assess the external validity of WTP estimates for different types of preventive services, i.e. the amount of hypothetical bias. This consisted an important consideration for future studies.

Moreover, there were several difficulties in accessing and collecting clinical data about preventive treatment and advice through electronic dental records. Restrictions included the absence of specific codes describing certain preventive procedures as well as the inability to quantify some types of preventive care such as advice. In this study, advice was measured in minutes, with longer sessions implying a higher amount of preventive advice. However, this assumption needed to be tested in future research, as dentists might have perceived what longer preventive advice entailed in practice in different ways. Other assumptions were that longer preventive and restorative treatments were linked to higher amount of prevention and restoration. Again, even though dentists seemed to agree with this as they preferred more time for preventive and restorative treatment when they had to deal with a challenging patient case, further research was needed to validate this effect.

Another limitation was social desirability bias deriving from participants in the qualitative phase of both studies. Dentists and patients could be tempted to demonstrate a prevention-oriented behaviour which was perceived as more socially acceptable, by expressing opinions in favour of prevention or choosing scenarios containing more preventive care contrary to their true attitudes and preferences. However, the combination of focus groups with personal cognitive interviews was aimed at restricting the effect of such bias. A series of different methods with separate individuals was also purposed to eliminate social desirability effects by diversifying the samples in terms of respondents. There remained though the chance that some participants wanted to demonstrate a proclivity towards prevention. A study found a significantly higher WTP in the telephone and paper surveys compared to an internet survey which was attributed to social desirability bias, even though the findings were not conclusive (Poder and He, 2016). It could be argued that quantitative findings were less susceptible to such bias given the online completion of both surveys.

Another study restriction consisted the ambiguity in the dentist DCE choice scenario regarding the setting in which the decision took place. It was likely that participants would make different choices under a public and private setting. The literature review presented in chapter 2, provided limited evidence on the impact of type of setting on treatment decision making. A few studies reported the existence of such an effect. In particular, one study revealed that private practice dentists were more likely to deliver preventive treatment (da Silva Tagliaferro et al., 2020). Other studies depicted that dentists working in small group private practices were more likely to offer restorative care (Gordan et al., 2010; Gordan et al., 2009a; Gordan et al., 2012), while those practicing in public health or large private practices were more likely to deliver preventive treatment (Gordan et al., 2012). The LC specification accounted for the effect of working in a private practice in the dentists' decision making see Table 4-8, page . The findings demonstrated that dentists working privately were more likely to provide preventive advice but less prone for preventive treatment. They were also motivated by a higher income. Contrary to this result dentists working in a public or mixed public-private practices had stronger preference for preventive advice, were more likely to provide preventive treatment and were less motivated by higher income. Hence, it was possible that the type of setting would affect preferences of dentists for treatment of dental caries. It was left to future research to verify the effect and explore the drivers of these differences. It would be useful for future research to investigate the reasons for the potential differences in dentists' treatment preferences under different settings.

Moreover, the qualitative methods of the dentist study used a smaller number of participants for interviews and focus groups in comparison to the patient study. This occurred as a natural consequence of the limited time that dentists could commit to a research project due to their very demanding workload. Although a satisfying level of data saturation was achieved even with fewer participants, it should be suggested that future research consider such an issue, devoting more time and organisation efforts in recruiting more dentists to get involved in the qualitative work of a DCE study.

A further limitation included the generalisability of the findings on preferences of dentists and patients in the prevention of dental caries. It was likely that the sample of dentists was not representative of the true dentist population in the UK and the ROI as a snowball recruitment method was used. Major dental networks were contacted to recruit dentists in both countries, but possibly due to an excessive workload of dental professionals, many of those reached did not return the questionnaire. Future DCE research exploring the decision making in the prevention of caries, should be focused on targeting a more representative sample of dentists.

In addition, general public individuals were either part of a research panel (N=314) or completed the online questionnaire through Facebook (N=39). This entailed that they may have not consisted of a representative sample to the true population of patients. Research panel participants were paid a standard fee in exchange for completing the questionnaire and hence they may have behaved in a different way in comparison to the true population. This could include responding to the questions assigning less attention to the tasks or representing only certain groups of the population such as those with lower income. Individuals who decided to participate in the survey through Facebook may represent a part of population more interested in oral health matters.

5.6 Suggestions for future research

The use of snowball technique in recruitment of dentists did not allow the calculation of those reached to estimate the response rate to the DCE questionnaire, even though it was ensured that primary contacts of main dental organisations in both countries were sent the questionnaire and requested to forward it to their dentist members. It was also likely that dentists who completed the questionnaire were more diversified from the true population in relation to their interest in care. Recruiting hard to reach populations such as dentists, due to their limited availability for survey participation and the high costs associated with using online panels of dentists restricted this study to apply a snowball technique in recruitment. The limitation of this approach was a sample of participants which was less representative of the true population of dentists. Hence it was advised that a mix of methods should be used in recruitment of hard to reach populations such as dentists in future preference research. A combination of snowball technique and reaching participants in the dental office would be a useful mix even though it would require a significant increase in resources.

Recruitment of patients or general public individuals occurred through an online panels company and a snowball method through Facebook. A low cost of recruiting general public individuals using online panels permitted their use as the main source of recruitment which provided 314 participants. Another 39 were recruited through Facebook. Online panels' participants were compensated with a fixed fee for completing the questionnaire and this may diversify them from the true population. Being part of online panels could also be associated with higher time availability and need for additional income. Facebook individuals may also represent a part of the population with a higher interest in dental prevention. It would be recommended for future preference research with patients or general public individuals to use a mix of recruitment methods such as reaching participants at the dental office or using registries to increase representativeness. However it should be noted that such methods would also raise the resources required in recruitment.

Other suggestions for future research referred to the use of alternative payment vehicles in estimation of WTP measures in a subsidized dental system. It was shown in the literature that the main alternative monetary vehicles comprised of private payments and private insurance premiums. It would be useful for future research to use these vehicles and potentially compare the findings on WTP for dental prevention with WTP using out of pocket payments to test whether out of pocket payments reflected the true amount patients were willing to pay for these services. Research should also focus on potential differences in dentist' treatment preferences under public or private settings. It was revealed here that dentists operating within a private setting were less likely to offer preventive care compared to public dentists. The validation of these differences and exploration of reasons behind these would lead to distinct policy measures for increasing prevention in each setting accounting for the different groups of preferences. Another challenge which resulted from this study was testing the external validity of WTP measures in the patient DCE study due to special features of payment system designs for dental services in both countries. It would be useful if future research could design external validity tests to verify the accuracy of WTP for preventive services of dental caries.

It would be useful for future DCE studies using vignettes to account for these in the design estimation process. In the dentist DCE survey of this study patient vignettes were randomly generated and allocated across the choice tasks of the design. The estimated model worked well as shown by the internal validity of results but accounting for patient interactions in the design phase would be suggested for future studies to further control the design estimation process.

Attribute non-attendance in the patient DCE study was explored by estimating seven consecutive two class LCs where respondents were either assumed to have attended to all attributes (class 1) or to have ignored one attribute (class 2). Coefficients were assumed to be fixed and an MNL model was applied in both classes. However, literature suggested that if instead of non-attendance for a given attribute, there was strong residual heterogeneity, i.e. both low and high sensitivities, estimating a model with only two values for each coefficient, with one of them being fixed to zero, then the presence of continuous heterogeneity in the data was likely to affect both the estimate of the non-zero class and the probability of zero class (Hess et al., 2013). The main point is that participants captured in the non-attendance class may not necessarily have had zero sensitivities (Hess et al., 2013). Research suggested alternative specifications to overcome this issue by using combined LC-MXL models to ensure that for any given class in the new model, random heterogeneity was allowed for those coefficients not fixed to zero (Hess et al., 2013). The advantage of this approach was that it would allow some of the random heterogeneity to be captured in the randomly distributed non-zero parameters. This enhanced flexibility should decrease the risk of a class where an attribute was not used, i.e., its coefficient was fixed to zero, simply capturing heterogeneity including low sensitivity

instead of genuine attribute non-attendance. However, some risk of confounding still remained even after application of such models (Hess et al., 2013). Future studies could implement more advanced specifications such as combined LC-MXL models to further improve findings on attribute non-attendance.

5.7 Generalisability of research methods in the dental and medical field

Application of the two DCE surveys had positive implications for future preference research in the dental and medical field. The literature provided some examples of DCE studies with patients or general public individuals in the dental field covering a wide range of dental treatments and services (Bech et al., 2011; Boyers et al., 2021; Ryan and Miguel, 2003; Sever, I. et al., 2018; Sever, Ivan et al., 2019c; Sever, Ivan et al., 2019b; Vennedey et al., 2018; Zhu et al., 2019). This study also provided a useful example in conducting a DCE to explore patients' preferences in receiving preventive care for dental caries.

1. No other DCE study in the literature looked at patients' preferences for prevention of dental caries. Therefore, this study provided a unique example that DCEs could be applied in a new area of dentistry offering useful findings for preference research.

As for the dentist DCE study, the literature also offered some examples of CA using descriptions of patients in the form of vignettes and asking dentists for treatment choices for the different patients (Bakhurji et al., 2019; Kateeb, E. et al., 2016; Kateeb, E.T. et al., 2014).

2. No study in the dental field combined patient vignettes with treatment options until this study was conducted. This included an innovation of this study which could guide future DCE research with dental professionals in the dental and more broadly medical areas. There was some earlier research which combined patient vignettes with treatment options in medical field outside dentistry (Webb et al., 2019).

Similar survey designs could be used more frequently in investigating the decision-making of dental and medical professionals given familiarity of professionals with the choice context of such experiments which replicate more closely the decision making in a real medical setting. Such designs also offer useful findings in relation to how patients' characteristics affect treatment decisions of dental and medical professionals.

3. The application of a mix of qualitative methods in an iterative process and thematic analysis of qualitative data deriving from focus groups and interviews using a specific classification framework could be used in future DCE surveys in the dental and medical field.

Such an approach benefited from a diverse set of advantages of multiple qualitative methods. It also assisted in dealing with comprehension issues related to the DCE surveys arising from focus group and interview sessions in a targeted manner to improve face validity and functionality of the DCE instrument.

6. Conclusions

This chapter summarizes the key features of both studies and underlined the novel findings which were drawn from both qualitative and quantitative analysis of the preferences of dentists and patients for preventive care of dental caries. Policy suggestions for increasing preventive care from a dentist, patient, and a dentist-patient relationship perspectives are provided. Recommendations concerning future research are also covered in this part. A summary of these recommendations, which are further described in this section, is presented below.

Study recommendations:

1. The use of a mix of qualitative methods is proposed in the design of dental DCE surveys. In addition, the application of an analytical framework is suggested to structure and deal with data collected through interviews and focus group sessions in the qualitative phase of a DCE to improve understanding of a DCE survey.
2. Policies should be targeted at a more appropriate remuneration of dentists for delivering preventive treatment.
3. Specific guidelines should be designed prioritising the need of preventive treatment for all groups of patients
4. Preventive treatment could be assigned to a different dental professional including a dental hygienist, therapist or nurse as the welfare of patients was not worsened off to a great extent in case a non-dentist professional deliver preventive care.
5. Dental professionals should be trained to provide more information on the benefits of dietary advice as patients were less likely to receive such advice.
6. Educational initiatives and targeted information campaigns for enhancing prevention should be focused on certain segments of the population instead of everyone. Such a measure would permit a more efficient allocation of public policy resources for increasing delivery of preventive care.

6.1 Qualitative research in healthcare/dental DCEs

The main issues with qualitative research in the context of healthcare DCEs was the absence of information in the benefits of qualitative research methods. Detailed guidelines about qualitative research methods for DCEs generally addressed only the area of attributes development and levels identification, without emphasising their useful applications in survey development and improving face validity. It was demonstrated here that qualitative research methods dealt effectively with a variety of aspects regarding DCEs apart from attributes and levels development. These included the formation of an acceptable choice context, improvement in understanding of the choice tasks, detection of incompatible choice situations, development of an appropriate survey layout, exploration of interpretation issues in relation to choice tasks, and confirmation of trading behaviour between attributes using descriptive analysis of choice answers.

Another important suggestion of this study was the use of a mix of qualitative research methods in an iterative process of multiple phases to develop two DCE questionnaires in dentistry. A few other studies used a mix of qualitative research methods to design dental DCE surveys (Barber, Sophy et al., 2019; Boyers et al., 2021). What this study added for future research was the application of an analytical framework in qualitative data from interviews and focus groups which were used in the development of two DCE questionnaires. This framework was useful in classifying issues into broader themes and setting priorities for next changes leading to newer versions of the DCE questionnaire in an evolutionary process leading up to the final version when data saturation was reached, and no new themes emerged. Expert groups then engaged in transforming priorities into actual changes through updating the choice context, removing inappropriate attributes, incorporating new attributes, revising attribute levels and checking the wording and terminology of attributes/instructions. The application of an analytical framework to structure and deal with data collected through interviews and focus group sessions in the qualitative phase to improve face validity of a DCE survey was the new avenue that this study opened up for future DCE research in dentistry and medicine in general.

6.2 Dentist DCE study

Dentists were significantly more likely to deliver preventive advice to the most challenging patient and a younger patient at 5%. They were significantly less likely to offer preventive advice to a low caries risk patient. In addition, they were significantly more likely to provide preventive treatment to a moderate caries risk patient. As for restorative care, dentists were significantly more likely to restore the caries condition of a challenging patient and a 24 years old patient. On the other hand, they were significantly less likely to offer restorative care to a moderate caries risk patient and someone with mild caries condition. Individuals were significantly more likely to prefer a higher income for treatment. Future research was needed to verify these findings as this was the first study to explore preferences of dentists in the delivery of the mix of preventive and restorative care for dental caries using a DCE survey with patient interactions.

These results were useful from a policy perspective for resource allocation purposes. It was shown that dentists were more willing to offer preventive advice but less prone for preventive treatment. Research on dentists' attitudes on prevention found that there was a profile of dentists who although believed in the value of prevention as a worthwhile venture, financial and time constrains prevented them from applying preventive care (Witton and Moles, 2015). It could be inferred that dentists should be more properly remunerated in order to offer more preventive treatment as they were willing to do so only for a moderate caries risk patient at a 5% level. To increase supply of preventive treatment, policies should target at remunerating dentists more properly for this type of care so that they could be motivated to offer more prevention. Studies provided mixed results in benefits between a fee for service remuneration system and a capitation based system for increasing prevention (Clarkson et al., 2008; Johansson et al., 2007). Payment systems in the UK and ROI remunerated preventive care as whole without distinguishing between preventive advice and treatment. Dentists though seemed to have different preferences for these types of care, tending to offer more preventive advice over treatment. Therefore, adjusting the design of dental payment systems to remunerate dentists for preventive treatment and advice separately and remunerating dentists more properly for preventive treatment could be an effective policy measure to improve rates of preventive treatment. Educational initiatives could also be implemented providing dentists with more knowledge on the importance of preventive treatment. Furthermore, specific guidelines could be designed prioritising the need of preventive treatment for all groups of patients. Research illustrated that a certain group of dentists applied selectively recommendations on prevention to patients they perceived as motivated (Witton and Moles, 2015). Therefore, guidelines should stress out that preventive treatment could benefit all patients irrespective of their motivation in receiving such care.

On the other hand, preference for preventive advice was significantly high so dentists would provide such care irrespective of additional funding provided. Policies to raise preventive advice could include educational initiatives such as training courses on preventive advice as it seemed that there were no financial constraints which limited dentists for delivering such care. Previous research on dentists' attitudes on prevention revealed that a certain profile of dentists valued the benefit of prevention for all patients, but they sought additional professional and patient support to fully implement guidelines on prevention (Witton and Moles, 2015). Overall, it seemed that funding priority should be given at enhancing preventive treatment rather than advice from a supply perspective. As for restorative care, dentists appeared to comply with patient needs, providing more care to challenging and the youngest patients, while less care to those of a lower caries risk and a milder caries condition.

LC findings illustrated three distinct groups of dentists' preferences. Most dentists, i.e., 46% had high preferences for advice and restorative care, were less likely to offer preventive treatment and had a tendency for higher income. Members of this group were more likely to work in a larger, private practice, apply fluoride varnish more frequently, deliver fissure sealants and dietary advice less frequently, be female individuals, have more years since graduation, work part time and see more exempt from payment patients. A large share of dentists, i.e. 45%, had stronger preference for preventive care compared to the first group, high preference for restorative care and lower preferences for higher income. Working in a smaller, public or mixed public-private practice, applying more frequently fluoride varnish and fissure sealants to adult population, delivering more frequently dietary advice, being female, having more years since graduation, working part time and seeing a higher share of exempt from payment patients was associated with a higher likelihood of belonging to this group. It was encouraging that only a small proportion of dentists were less likely to offer care and more motivated by income consisting of 8% of the sample. Dentists of this last group were more likely to apply fluoride varnish less frequently, be male, have fewer years since graduation, work full time or overtime and see fewer exempt from payment patients. Future research was needed to verify these findings and explore the reasons underlying differences in treatment preferences among the distinct profiles of dentists.

Hence, measures targeted on increasing the supply of preventive care including educational interventions and targeted information campaigns on the benefits of prevention would be more effective with dentists working in larger or private practices, male dentists, providers with fewer years in practice, full time or overtime dentists and those dealing with a lower share of exempt from payment patients, as these individuals were less likely to deliver preventive care.

6.3 Patient DCE study

Quantitative analysis demonstrated that patients were willing to pay £0.33 (p< 1%) for each additional minute of dietary advice, £0.96 (p< 1%) for each additional minute of hygiene advice, £1.64 (p< 1%) for each extra minute of preventive treatment and £5.23 (p< 1%) for seeing the dentist over a different dental profession for delivery of preventive care. Moreover, they were willing to pay £0.46 (p< 1%) to avoid an additional minute of transport time and £0.73 (p< 1%) to save an extra day of waiting time to attend the dental check-up appointment. Variation in preferences was significantly higher for preventive treatment, seeing a dentist provider for preventive care, travel time to the dental practice and out of pocket costs. Future research was needed to verify these findings as this was the first study to explore preferences of patients in receiving preventive care for dental caries using a DCE survey.

Subgroup analysis revealed similar findings in terms of the direction of preferences when the overall patient sample was divided into two parts to compare preferences about prevention between participants in the UK and those in the ROI. People in the ROI were willing to pay more for each additional minute of preventive treatment, i.e., £2.62, but less for each additional minute for dietary advice, i.e. £0.07 compared to their UK counterparts with corresponding amounts of £1.40 and £0.49. Individuals in both countries had a similar WTP for each addition minute of oral hygiene advice, between £1.06 and £1.08. People in ROI were also more willing to pay to spare an additional minute of travel time, i.e., £0.63 and an additional day of waiting time, i.e. £1.26 compared to £0.49 and £0.55 respectively for UK participants. Individuals in both countries were not significantly willing to pay to see the dentist provider for preventive care at a 5% significance level. This meant that the type of dental provider for prevention did not seem to significantly affect their preferences. Among UK participants, preference variation was significantly higher for preventive treatment and out of pocket costs. Among ROI individuals, preference variation was significantly higher for preventive treatment, seeing a dentist provider, travel time and out of pocket costs.

The higher WTP measures elicited for the ROI sample might have derived from a lower dental attendance rate of people living in the ROI compared to those in the UK. A sociodemographic analysis gave evidence that the dental attendance frequency was higher in the UK than in the ROI. The fact that people in the ROI visited the dentist less frequently than those in the UK could explain the higher WTP for preventive treatment. In addition, a lower frequency of dental visits could explain why they were prepared to pay more to avoid longer transport and waiting times for a dental check-up appointment. As for dietary advice, only UK participants were willing to pay to receive such advice. It could be argued that people in UK valued more this type of care compared to ROI individuals because of attitudinal differences in relation to the benefits of dietary advice. As there was no evidence in the literature comparing preferences on dental prevention between these countries, more research was

needed to verify the differences and explore the underlying reasons of such discrepancies. Training dental professional to provide more information on the benefits of dietary advice in oral health may be useful in encouraging people in ROI to pursue such care. Further research was demanded to confirm the differences in preferences for preventive care between individuals in the UK and ROI since this study included the first attempt of such a comparison.

With respect to variations in preferences for dental prevention as explained by sociodemographic characteristics and behaviours of the full sample participants, a LC findings revealed three distinct groups of patients' preferences. Group 1 included 71% of total sample participants. Visiting the dentist more frequently, last dental visit being for emergency and not planned treatment, consuming less sugar, being older or female, living in the UK, not having private insurance, being educated at a university level, being unemployed and perceiving oral health to be at an average or poor level was associated with a higher chance of belonging to this group. These individuals were more likely to receive preventive care and avoid higher out of pocket costs, as well as longer travel and waiting times. Seeing a dentist provider for preventive care did not seem to affect preferences of participants in this group. Group 2 represented 7% of the sample. Participants of the same sociodemographic profile as in group 1, except for living status and perceived oral health were more likely to belong in this group. People in ROI and those perceiving their oral health to be at a good or excellent oral health state were also more likely to fall into this group. Members of group 2 preferred more preventive treatment and oral hygiene advice. They were less likely to receive dietary advice and accept longer travel or waiting times. They were more prone for higher out of pocket costs and had a strong inclination for seeing a dentist provider for preventive care. A positive preference for out of pocket cost entailed that these participants might have interpreted costs as an indicator of dental care quality. Group 3 constituted 22% of the sample. This group involved individuals with lower sensitivities to out of pocket costs, travel time and waiting time. Its members also demonstrated lower preferences for preventive care overall. Hence they were regarded as the most indifferent towards preventive care and direct or indirect costs related to prevention. Visiting the dentist less frequently, last dental visit being for planned and not emergency treatment, consuming more sugar, being younger or male, having a private insurance, not being educated at a university level and being employed were associated with a higher chance of belonging to group 3. Future research was needed to verify these findings and explore the reasons underlying differences in preferences for preventive care among these distinct groups of patients.

Measures for increasing prevention from a demand side should include educational interventions and targeted information campaigns which would inform general public and dental patients about the benefits of preventive care in terms of future oral health outcomes. Such initiatives should be tailored to those less interested in preventive care. According to the LC analysis of this study this group

consisted of those individuals visiting the dentist less frequently, having received planned treatment recently, consuming more sugar, having a private insurance or a lower level of education and being a male younger or employed individual. As these members of the general public were less interested in prevention, targeting them with information of its benefits through educational initiatives and campaigns would encourage them to follow a more prevention-oriented behaviour. In addition focusing these initiatives on certain segments of the population instead of everyone could permit a more efficient allocation of public policy resources for increasing delivery of preventive care.

6.4 Dentist-patient relationship

The finding of the two preference studies revealed that dentists were more likely to deliver preventive advice while patients were more likely to receive preventive treatment. This gap in preferences was a novel finding of this study which could guide policy measures to the direction of increasing preventive care from both supply and demand sides. One such measure could be the proper remuneration of dentists for delivering preventive treatment. Dentists overall showed a higher but insignificant preference for preventive treatment except for a patient with moderate risk of caries. They also tended to prefer a higher income for treatment delivery. Patients were significantly willing to pay £1.64 on average for each additional minute of preventive treatment. Hence, resources for more properly remunerating dentists for delivery of preventive treatment could derive from out of pocket payments by patients since they highly valued this type of care. A different measure could focus on the type of dental professionals who deliver preventive treatment. Patients were significantly willing to pay a small amount for seeing the dentist for preventive care instead of an alternative dental professional, equalling to £5.23 on average. This meant that their welfare would not be significantly affected by not having the dentist deliver preventive treatment. A significant reminder at this point was that the choice context described initial involvement of the dentist for a scale and polish session of 15 minutes in all choice situations. Patients may have felt that after seeing the dentist at the beginning of the appointment, were less willing to have preventive care delivered by the dentist as they already had some time spent consulting an authority figure. The implication of such finding was that preventive treatment could be assigned to a different dental professional including a dental hygienist, therapist or nurse without worsening off to a great extent the welfare of patients and given that dentist were less willing to offer preventive treatment. This way dentists could concentrate on delivering treatments they preferred more including preventive advice or those requiring a higher level of expertise such as restorative care. Further research was required to confirm this finding and assess the effectiveness of the proposed measures in increasing the delivery of preventive care.

Dentists were more likely to provide preventive advice and preferred a higher income for such treatment delivery. These findings indicated that they were willing to sacrifice a share of income for delivering more preventive advice. In addition, patients were willing to pay to receive oral hygiene advice. The implications of these results would be that savings could derive from income sacrifices of dentists and out of pocket payments offered by patients in the provision of oral hygiene advice. Such savings could be used to fund other services in the dental public system promoting a more efficient allocation of resources. Further research was needed to confirm this finding and investigate methods of allocating potential saved resources from the delivery of oral hygiene advice to alternative uses in the public dental system.

Furthermore patients were on average less willing to pay for dietary advice. Dental teams should be encouraged to commit more time with patients on dietary advice and incorporate this type of treatment as a distinct part of a dental check-up appointment given its high impact in the prevention of dental caries (Sheiham, Aubrey and James, 2015). Dental should also provide more information on the benefits of dietary advice emphasizing to patients its importance on caries prevention and motivate them to pursue such care. Although patients were less willing to pay for a diet plan delivered as a handout at the end of a check-up appointment, encouraging dentists to provide such materials and inform patients on the benefits of following a customised diet plan on their oral health could enhance patients' interest in such care. Further research could be used to reveal the reasons underlying lower preferences of patients for dietary advice.

7. Appendices

Appendix 1. Search strategies to identify literature on dentists' preferences in delivering dental care

Database(s): **Embase Classic+Embase** 1947 to 2022 March 11
Search Strategy:

#	Searches	Results
1	Decision Making/ and Dentists/	558
2	(dentist* adj3 decision*).tw.	335
3	(dentist* adj3 choice*).tw.	194
4	(dentist* adj3 preference*).tw.	144
5	1 or 2 or 3 or 4	1127
6	dental procedure/	29385
7	exp Dental Caries/	61651
8	periodontitis/	29692
9	endodontic procedure/	2640
10	prosthetic replacement/	468
11	periodontal disease/	51927
12	preventive dentistry/	10027
13	tooth implant/	16124
14	conservative treatment/	98903
15	dental caries.tw.	22069
16	((tooth or teeth) adj4 decay).tw.	2242
17	dental lesion*.tw.	356
18	6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17	277122
19	health economics/	38969
20	exp economic evaluation/	331251
21	exp health care cost/	317438
22	pharmacoeconomics/ or "drug cost"/ or drug utilization/ or "utilization review"/	172966
23	socioeconomics/ and economics/	16139
24	*socioeconomics/	23944
25	Economic model/	2699
26	*fee/	6687
27	*"cost"/	14675
28	cost*.ti.	181088

29	(cost* adj2 (effective* or utilit* or benefit* or minimi* or evaluat* or analy* or study or studies or consequenc* or compar* or efficienc* or variable* or unit or estimate*)).ab.	294015
30	(price or prices or pricing).tw.	64815
31	(economic* or pharmacoeconomic* or pharmaco-economic*).tw.	414128
32	budget*.tw.	43870
33	(value adj1 (money or monetary)).tw.	1000
34	(financ* adj2 (cost* or data or "health care")).tw.	12451
35	financ*.tw. and economics/	16063
36	(expenditure* not energy).tw.	46773
37	health utilit*.tw.	4010
38	(hui1 or hui2 or hui3).tw.	598
39	disutil*.tw.	1078
40	standard gamble*.tw.	1152
41	(time trade off or time tradeoff).tw.	2173
42	Decision Trees/	16163
43	Visual Analog Scale/	104554
44	willingness to pay.tw.	10874
45	(rating or ranking).tw.	200759
46	Q-methodology.tw.	614
47	discrete choice experiment.tw.	2803
48	best-worst.tw.	676
49	conjoint analysis.tw.	1118
50	perceived demand.tw.	51
51	perceived need.tw.	3119
52	supplier induced demand.tw.	90
53	contingent valuation.tw.	1009
54	19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53	1583727
55	5 and 18 and 54	58

Database(s): **Ovid MEDLINE(R) ALL** 1946 to March 11, 2022
Search Strategy:

#	Searches	Results
1	Decision Making/ and Dentists/	256
2	(dentist* adj3 decision*).tw.	319
3	(dentist* adj3 choice*).tw.	172
4	(dentist* adj3 preference*).tw.	122
5	*Practice Patterns, Dentists'/	1712
6	1 or 2 or 3 or 4 or 5	2407
7	exp Dental Caries/	48682
8	periodontitis/	19599
9	periodontal disease/	26883
10	preventive dentistry/	3280
11	conservative treatment/	4519
12	dental caries.tw.	19991
13	((tooth or teeth) adj4 decay).tw.	1844
14	dental lesion*.tw.	257
15	7 or 8 or 9 or 10 or 11 or 12 or 13 or 14	102549
16	Economics/	27433
17	exp Economics, Dental/	4072
18	exp Economics, Nursing/	4013
19	exp Economics, Medical/	14330
20	exp Economics, pharmaceutical/	3056
21	exp Economics, Hospital/	25518
22	exp "Costs and Cost Analysis"/	255922
23	exp "Fees and Charges"/	31076
24	exp budgets/	13978
25	exp "Value of Life"/ec [Economics]	253
26	budget*.tw.	32704
27	cost*.ti.	133337
28	(cost* adj2 (effective* or utilit* or benefit* or minimi* or evaluat* or analy* or study or studies or consequenc* or compar* or efficienc* or variable or unit or estimate*)).ab.	208731
29	(economic* or pharmacoeconomic* or pharmaco-economic*).tw.	320562
30	(price or prices or pricing).tw.	45311
31	(financ* adj2 (cost* or data or "health care")).tw.	9190

32	(fee or fees).tw.	19848
33	(value adj1 (money or monetary)).tw.	764
34	exp models, economic/	16082
35	markov chains/	15631
36	"Global Burden of Disease"/ [new 2017]	1362
37	(hui1 or hui2 or hui3).tw.	412
38	disutil*.tw.	545
39	standard gamble*.tw.	888
40	(time trade off or time tradeoff).tw.	1530
41	Decision Trees/	11904
42	Visual Analog Scale/	4010
43	willingness to pay.tw.	7141
44	(rating or ranking).tw.	142278
45	Q-methodology.tw.	544
46	discrete choice experiment.tw.	1902
47	best-worst.tw.	494
48	conjoint analysis.tw.	842
49	perceived demand.tw.	46
50	perceived need.tw.	2475
51	supplier induced demand.tw.	79
52	contingent valuation.tw.	825
53	16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52	983229
54	6 and 15 and 53	36

Appendix 2. Table of relevant literature on dentists' preferences in delivering a mix of preventive and restorative care for dental caries (Part 1)

Author	Aim	Country	Setting	Method of data collection	Study design	Population
(Kateeb, E. et al., 2016)	To investigate the relative impact of patients' characteristics to use ART to restore posterior primary teeth.	US	Mixed public and private	Survey questionnaire	Conjoint experiment	Paediatric dentists
(Kateeb, E.T. et al., 2014)	To focus on the importance of patients' characteristics on willingness of paediatric dentists to perform ART restorations.	US	Mixed public and private	Survey questionnaire	Conjoint experiment	Paediatric dentists
(Bakhurji et al., 2019)	To determine what most affects the paediatric dentists' decision-making process when choosing amalgam use versus other restorative materials	US	Mixed public and private	Survey questionnaire	Conjoint experiment	Paediatric dentists

Appendix 3. Table of relevant literature on dentists' preferences in delivering a mix of preventive and restorative care for dental caries (Part 2)

Author	Intervention	Comparison	Dentists' factors	Patients' factors	Higher utility for restorative care by patients' factors	Higher utility for restorative care by dentists' factors
(Kateeb, E. et al., 2016)	ART	-	Age, practice type, practice location, business of the practice; whether considering ART to be definitive or interim treatment and why; factors influencing the decision regarding the therapeutic goals of ART	Patient caries risk; patient age; patient insurance type	Younger, less cooperative, uninsured or privately insured children	Age of paediatric dentists; practice busyness
(Kateeb, E.T. et al., 2014)	ART	-	Gender; age; wherther considering ART to be definitive or interim treatment and why; knowledge about ART; self-reported factors influencing the decision regarding the therapeutic goals of ART	Patient's age; patient's level of cooperation ;patient's insurance type	Younger, less cooperative, uninsured or privately insured children	-
(Bakhurji et al., 2019)	Amalgam	Composite, stainless steel crown (SSC), or other materials	Gender; age; race; degree of graduate training; Board certification status; Type of employment; Practice location; Years of practice; environmental impact of amalgam waste; reported amalgam use in clinic	Caries risk; dental insurance; percentage of Medicaid patients percentage of Non-White	Uninsured children; high caries risk	-

Appendix 4. Word search strategy to identify literature on patients' preferences in receiving dental care

Database(s): **Embase Classic+Embase** 1947 to 2022 March 11
Search Strategy:

#	Searches	Results
1	patient* prefer*.tw.	26602
2	Patient preference/	22746
3	Choice behavior/	232592
4	(decision making adj4 patient*).tw.	24148
5	(choice adj4 patient*).tw.	31396
6	Patient decision making/	11079
7	1 or 2 or 3 or 4 or 5 or 6	319441
8	dental care/	69034
9	(tooth or teeth).tw.	191949
10	oral health.tw.	31245
11	(prevention adj4 (dental or oral disease or caries)).tw.	6081
12	Dental procedure/	29385
13	8 or 9 or 10 or 11 or 12	276499
14	health economics/	38969
15	exp economic evaluation/	331251
16	exp health care cost/	317438
17	pharmacoeconomics/ or "drug cost"/ or drug utilization/ or "utilization review"/	172966
18	socioeconomics/ and economics/	16139
19	*socioeconomics/	23944
20	Economic model/	2699
21	*fee/	6687
22	*"cost"/	14675
23	cost*.ti.	181088
24	(cost* adj2 (effective* or utilit* or benefit* or minimi* or evaluat* or analy* or study or studies or consequenc* or compar* or efficienc* or variable* or unit or estimate*)).ab.	294015
25	(price or prices or pricing).tw.	64815
26	(economic* or pharmacoeconomic* or pharmaco-economic*).tw.	414128
27	budget*.tw.	43870
28	(value adj1 (money or monetary)).tw.	1000
29	(financ* adj2 (cost* or data or "health care")).tw.	12451

30	financ*.tw. and economics/	16063
31	(expenditure* not energy).tw.	46773
32	quality adjusted life year/	31009
33	(eq-5d* or eq5d* or euroquol* or euroqol* or euroqual* or euro-quol* or euro-qol* or euroqual*).tw.	25882
34	quality adjusted life.tw.	23176
35	(qaly or qalys or qald or qale or qtime).tw.	23373
36	disability adjusted life.tw.	5113
37	disability-adjusted life year/	3081
38	(daly or dalys).tw.	4859
39	(SF6D or sf 6d or short form 6d or shortform6d).tw.	1687
40	health* year* equivalent*.tw.	41
41	(hye or hyes).tw.	149
42	health utilit*.tw.	4010
43	(hui1 or hui2 or hui3).tw.	598
44	disutil*.tw.	1078
45	standard gamble*.tw.	1152
46	(time trade off or time tradeoff).tw.	2173
47	(hqol or h qol or hr qol or hrqol).tw.	33666
48	(pqol or qls).tw.	697
49	Decision Trees/	16163
50	Visual Analog Scale/	104554
51	willingness to pay.tw.	10874
52	(rating or ranking).tw.	200759
53	Q-methodology.tw.	614
54	discrete choice experiment.tw.	2803
55	best-worst.tw.	676
56	conjoint analysis.tw.	1118
57	perceived demand.tw.	51
58	perceived need.tw.	3119
59	supplier induced demand.tw.	90
60	contingent valuation.tw.	1009

61	14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59 or 60	1627984
62	7 and 13 and 61	357

Database(s): **Ovid MEDLINE(R) ALL** 1946 to March 11, 2022
Search Strategy:

#	Searches	Results
1	patient* prefer*.tw.	16741
2	Patient preference/	10173
3	Choice behavior/	34341
4	(decision making adj4 patient*).tw.	15497
5	(choice adj4 patient*).tw.	19410
6	1 or 2 or 3 or 4 or 5	88440
7	dental care/	22266
8	(tooth or teeth).tw.	177586
9	oral health.tw.	29778
10	(prevention adj4 (dental or oral disease or caries)).tw.	5708
11	7 or 8 or 9 or 10	218734
12	Economics/	27433
13	exp Economics, Dental/	4072
14	exp Economics, Nursing/	4013
15	exp Economics, Medical/	14330
16	exp Economics, pharmaceutical/	3056
17	exp Economics, Hospital/	25518
18	exp "Costs and Cost Analysis"/	255922
19	exp "Fees and Charges"/	31076
20	exp budgets/	13978
21	exp "Value of Life"/ec [Economics]	253
22	budget*.tw.	32704
23	cost*.ti.	133337
24	(cost* adj2 (effective* or utilit* or benefit* or minimi* or evaluat* or analy* or study or studies or consequenc* or compar* or efficienc* or variable or unit or estimate*)).ab.	208731
25	(economic* or pharmacoeconomic* or pharmaco-economic*).tw.	320562
26	(price or prices or pricing).tw.	45311
27	(financ* adj2 (cost* or data or "health care")).tw.	9190
28	(fee or fees).tw.	19848
29	(value adj1 (money or monetary)).tw.	764
30	quality-adjusted life years/	14474

31	(eq-5d* or eq5d* or euroquol* or euroqol* or euroqual* or euro-quol* or euro-qol* or euroqual*).tw.	14125
32	exp models, economic/	16082
33	markov chains/	15631
34	quality adjusted life.tw.	15249
35	(qaly or qalys or qald or qale or qtime).tw.	12539
36	disability adjusted life.tw.	4268
37	(daly or dalys).tw.	3714
38	"Global Burden of Disease"/ [new 2017]	1362
39	health* year* equivalent*.tw.	40
40	(hye or hyes).tw.	75
41	(hui1 or hui2 or hui3).tw.	412
42	disutil*.tw.	545
43	standard gamble*.tw.	888
44	(time trade off or time tradeoff).tw.	1530
45	(hqol or h qol or hrqol or hr qol).tw.	20674
46	(pqol or qls).tw.	424
47	(sf6d or sf 6d or short form 6d or shortform 6d or sf sixd or sf six d).tw.	929
48	Decision Trees/	11904
49	Visual Analog Scale/	4010
50	willingness to pay.tw.	7141
51	(rating or ranking).tw.	142278
52	Q-methodology.tw.	544
53	discrete choice experiment.tw.	1902
54	best-worst.tw.	494
55	conjoint analysis.tw.	842
56	perceived demand.tw.	46
57	perceived need.tw.	2475
58	supplier induced demand.tw.	79
59	contingent valuation.tw.	825
60	12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59	1011816
61	6 and 11 and 60	120

Appendix 5. Table of relevant literature on patient preferences in receiving preventive care for dental caries (Part 1)

Author	Aim	Country	Setting	Method of data collection	Study design
(Boyers et al., 2021)	To elicit UK general population preferences for SP (scale and polish) and OHA (personalized oral hygiene) services and relevant dental health and aesthetic outcomes	UK	Mixed public and private	Survey questionnaire	DCE
(Tianviwat et al., 2008a)	To measure individuals' WTP for services provided at a regional hospital and for the same services provided by a mobile clinic.	Thailand	Public	Interviews	Self-report WTP
(Tianviwat et al., 2008b)	To measure and compare the WTP of parents for two services; sealants and fillings.	Thailand	Public	Interviews	Self-report WTP
(Tuominen, 2008)	To evaluate three commonly used methods for preference measurement in dental programs by comparing the outcomes of WTP, VAS (visual analogue scale) and RO (rank order), and measure the relative values of the selected programs	Finland	Public	Survey questionnaire	VAS and Self-report WTP

(Pavlova* et al., 2004)	To investigate the willingness and ability of Bulgarian consumers to pay for public health dental care services	Bulgaria	Public	Interviews	Self-report WTP
(Vermaire et al., 2012)	To investigate the parental willingness to invest in the oral health of their child in terms of money and time and to relate this to oral health related knowledge and behavioural aspects	Netherlands	-	Oral health examination and survey questionnaire	Self-report WTP
(Vernazza, C.R. et al., 2015)	To elicit values for a dental preventive intervention and to analyse the factors affecting these	UK and Germany	Mixed public and private	Survey questionnaire and treatment	Self-report WTP
(Walshaw et al., 2019)	To determine the WTP for fluoride varnish in a sample of Brazilian adults as well as parents in the UK.	UK and Brazil	Mixed public and private	Survey questionnaire	Self-report WTP
(Re et al., 2015)	To compare the plaque removing efficacy of two different toothbrushes in a population unfamiliar with sonic toothbrushes and to collect and analyse data regarding oral hygiene habits	Italy	-	Oral examination and survey questionnaire	Single-cohort, crossover clinical trial and self-report WTP

(Kiiskinen et al., 2010)	To explore preferences about non-acute dental care	Finland	Mixed public and private	Survey questionnaire	DCE
(Ryan and Miguel, 2003)	To test the completeness axiom in preferences for dentist consultation	Scotland	-	Survey questionnaire	DCE
(Bech et al., 2011)	To investigate the impact of the number of choice sets presented to each respondent, on response behaviour and mean WTP estimates for dental care	Denmark	Private	Survey questionnaire	DCE
(Harris et al., 2020)	To compare how dental patients' value and respond to information on risk in three ways: usual verbal advice (V); V supported by information on their TL (traffic light) rating; and V supported by a QLF (quantitative light fluorescence) photograph.	England	Public	Survey questionnaire and follow up contact by phone or email	Multi-centre, parallel-group, patient randomised control trial and self-report WTP

(Oscarson et al., 2007)	To undertake a cost-benefit analysis of a preventive dental programme for adolescents by measuring their WTP and the programme cost	Sweden	Public	Interviews	Self-report WTP
(Saadatfar and Jadidfard, 2021)	To elicit and compare parents' WTP for health services such as fissure sealant and composite filling	Iran	Public	Interviews	Self-report WTP

Appendix 6. Table of relevant literature on patients' preferences in receiving preventive care for dental caries (Part 2)

Authors	Population	Intervention	Comparator	Patient factors
(Boyers et al., 2021)	General public	Preventive care plan for periodontitis	-	Gender; age; residence; smoking status; income; smoking status; education; employment; self-reported dental health; self-reported general health; registered with a dental practice status; payment status for dental care; ever visited a dental hygienist; frequency of scale and polish; frequency of dental attendance
(Tianviwat et al., 2008a)	Parents	Dental sealant in permanent teeth at hospital setting and mobile setting	Filling in permanent teeth at hospital setting and mobile setting	Age; income; gender; employment and educational status; perceived child's oral health; experiences with dental care for child at the mobile school-based dental clinic; experiences with dental care for child at the community hospital
(Tianviwat et al., 2008b)	Parents	Dental sealant	Filling	Age; income; gender; occupation; education; perceived child's oral health; child's experience with fissure sealants; child's experience with fillings
(Tuominen, 2008)	Students	Dental check-up program for 7-year-old children for one year	-	Age; gender; whether studying medicine or dentistry; wealth (value of monetary assets and personal property);
(Pavlova* et al., 2004)	General public	Visit for a dental check-up		Age; gender; education; perceived health; place of residence; family size; family budgets; number of chronically sick family members; past year utilised services; past year paid services and paid amounts per service

(Vermaire et al., 2012)	Parents and children	Oral hygiene consultancy visit within a check-up appointment	-	Education of mother; education of father; dental hygiene knowledge; perceived dental hygiene knowledge; oral hygiene index; decayed, missing and filled surfaces (DMFS); child's gender; child's ethnicity; only child or not; single parent family or not; importance of child's general health; importance of child's oral health; perceived child's oral health by parent; oral health habits for child; fluoride-use; usual toothpaste type; dietary habits for child
(Vernazza, C.R. et al., 2015)	Dental patients	Coating (Prevora) applied topically to teeth to reduce the risk of caries	-	Gender; age; income; frequency of dental visits; number of restorations in the last two years; perceived risk of needing a restoration in next 12 months
(Walshaw et al., 2019)	Dental patients and parents	Fluoride varnish	-	Gender; age; income; frequency of dental visits; number of restorations in the last two years; perceived likelihood of restoration in the next year; number of natural teeth remaining; dental pain experience; previous fluoride varnish experience; child's gender; age; cooperation of child to tooth brushing; frequency of dental visits; number of restorations in the last two years; perceived likelihood of restoration in the next year; number of decayed teeth; dental pain experience; high sugar diet; previous fluoride varnish experience

(Re et al., 2015)	Dental patients	Sonic toothbrush	Manual toothbrush	Gender; age; use of mouthwash; use of floss; current toothbrush type; shopping toothbrush method; frequency of dental check-up; frequency of in-office oral hygiene; assessed pre- and post-brushing plaque scores in two appointments
(Kiiskinen et al., 2010)	General public	Non acute dental care		Income; employment status; education; difficulty to choose; use of dental care in the last 12months; experience of tooth ache in the last 12 months; age; number of teeth; Perceived need for care; fear of dental care
(Ryan and Miguel, 2003)	General public	Dental check-up	-	Age; gender; year of study; degree for which they were studying; whether first language was English
(Bech et al., 2011)	General public	Dental check-up plus cleaning	-	Gender; age; income; education; Familiarity with digital X-ray; Familiarity with painless anaesthesia
(Harris et al., 2020)	Non-emergency dental patients	Traffic light (TL); QLF (quantitative light fluorescence) photograph	Verbal advice (V)	Self-perceived oral health; tooth-brushing frequency; duration of tooth-brushing; frequency of eating/drinking cakes or biscuits; puddings or pastries; chocolate or other sweets; fruit juice (not squash); fizzy drinks; soft drinks like squash; frequency of sugar in hot drinks; smoking status; literacy in Medicine; periodontal status; gender; age; income; education; socioeconomic status; number of natural teeth; frequency of dental attendance

(Oscarson et al., 2007)	Dental patients	Preventive dental care plan	-	Gender, school status; employment status, type of living area; type of household; parental occupation(s); actual caries risk; perceived caries risk within next 2 years; Oral Health Related Quality of Life (OHRQOL); global rating of oral well-being; treatment cost; travel cost; time cost; out-of-pocket cost
(Saadatfar and Jadidfard, 2021)	Parents	Fissure sealant	Filling	Parental gender; parental age; child's age; child's gender; parental gender; parental education; household size; monthly income; house ownership; parental occupation; child's dental experience; parental experience of toothache; parental satisfaction from previous dental treatments; health insurance status; complementary health insurance status; perceived child's oral health status by parent; parental supervision on child's brushing; reason for their presence in the paediatric office on the interview day; Child's experience of dentistry

Appendix 7. Table of relevant literature on patients' preferences in receiving preventive care for dental caries (Part 3)

Author	**Mean WTP[10] (or Median where mean was not reported) for preventive care**	**Higher WTP for preventive intervention by patient factors**	**Higher utility for preventive intervention by patient factors**
(Boyers et al., 2021)	Personalized oral hygiene advice from dentist compared to none: £24; Personalized oral hygiene advice from hygienist compared to none: £15	-	Experience with scale and polish; experience with the hygienist; females; higher income
(Tianviwat et al., 2008a)	-	Younger; higher income	-
(Tianviwat et al., 2008b)	Sealant: £4 (baht 225); se: £3 (baht 188)	Higher income; younger; better educated; unexperienced with fillings	-
(Tuominen, 2008)	Dental check-up: £11 (€14)	-	-
(Pavlova* et al., 2004)	Visit for a dental check-up: £3 (BGL 3); SD: £3 (BGL 3)	Higher education; better perceived health; higher income; higher frequency of past year dental check-up service	-
(Vermaire et al., 2012)	Check-up/oral hygiene consultancy visit: £27 (€31); SD: £27 (€31)	Willingness to invest longer time in brushing; willingness to invest more time in visits to dentist	-
(Vernazza, C.R. et al., 2015)	Prevora coating (caries preventive coating): £96 (SD: £61)	Not answering question about perceived risk of caries	-

[10] Purchasing power parity at the time of study publication was used to convert WTP expressed in a different currency into £ so that amounts were comparable across studies .

(Walshaw et al., 2019)	Fluoride varnish (Brazil only patients): £24 (SD: £17); Fluoride varnish (UK parents own use): £28(SD: £21); Fluoride varnish (UK parents for use in child): £28 (SD: £23)	Higher frequency of attendance; higher self-perceived need for treatment; a recent history of dental pain; having a child with recent restorations; female; higher income; parental self-perceived high need for treatment; parents having recent dental pain; higher income	-
(Re et al., 2015)	Professional oral hygiene session: £78 (€78), SD: £25 (€25); Manual toothbrush: £5 (€5), SD: £4 (€4); Sonic toothbrush: £55 (€55), SD: £36 (€36)	-	-
(Kiiskinen et al., 2010)	Non-acute dental care by private dentist (compared to no care): £200 (€251); Non acute dental care by public dental service (compared to no care): £192 (€243)	-	Higher income; higher education level; used dental care in the last 12 months
(Ryan and Miguel, 2003)	-	-	-
(Bech et al., 2011)	Routine check-up involving cleaning: £59 (DKK621)	-	-
(Harris et al., 2020)	Oral health advice (verbal information): £30 (SD: £39); Oral health advice (traffic light information): £21 (SD: £29); Oral health advice (QLF information): £26 (SD: £31)	Practice location; traffic light information; having fewer than 20 teeth; higher socioeconomic status measured by IMD (index of Multiple Deprivation); higher medicine literacy score	Older adults; practice location
(Oscarson et al., 2007)	-	High caries risk; living in rented flat as compared with own house	-

(Saadatfar and Jadidfard, 2021)	Fissure sealant: £60 (Tomans 269724), SD: £160 (Tomans 715475)	Higher income	-

Appendix 8. Search strategies to identify literature on Patient-Dentist Relationship in the mix of preventive and restorative care for dental caries

Database(s): **Embase Classic+Embase** 1947 to 2022 March 11
Search Strategy:

#	Searches	Results
1	caries.tw.	49561
2	exp Dental Caries/	61651
3	((tooth or teeth) adj4 decay*).tw.	5640
4	dental lesion*.tw.	356
5	1 or 2 or 3 or 4	73114
6	((dental or dentist*) adj2 (office or practice or surgery)).tw.	17693
7	general practice, dental/	1767
8	dental facility/	3962
9	private practice/	18709
10	6 or 7 or 8 or 9	39491
11	Practice Patterns, Dentists'/	1880
12	Dentists/ and Decision Making/	558
13	"Attitude of Health Personnel"/	76163
14	(dentist* adj3 decision*).tw.	335
15	practice pattern*.tw.	15174
16	11 or 12 or 13 or 14 or 15	93683
17	5 and 10 and 16	245

Database(s): **Ovid MEDLINE(R) ALL** 1946 to March 11, 2022
Search Strategy:

#	Searches	Results
1	caries.tw.	46027
2	exp Dental Caries/	48682
3	((tooth or teeth) adj4 decay*).tw.	5091
4	dental lesion*.tw.	257
5	1 or 2 or 3 or 4	64681
6	((dental or dentist*) adj2 (office or practice or surgery)).tw.	17302
7	general practice, dental/	4833
8	dental facility/	259
9	private practice/	8414
10	6 or 7 or 8 or 9	29135
11	Practice Patterns, Dentists'/	2480
12	Dentists/ and Decision Making/	256
13	"Attitude of Health Personnel"/	129100
14	(dentist* adj3 decision*).tw.	319
15	practice pattern*.tw.	9575
16	11 or 12 or 13 or 14 or 15	140379
17	5 and 10 and 16	221

Appendix 9. Table of relevant literature on Patient-Dentist Relationship in the mix of preventive and restorative care for dental caries (Part 1)

Author	**Aim**	**Place**	**Method of data collection**	**Population**	**Public/Private Setting**
(Chana et al., 2019)	Investigate restorative intervention threshold decisions for occlusal and proximal carious lesions.	England	Survey questionnaire	Dentists	Mixed public and private
(da Silva Tagliaferro et al., 2020)	Quantify procedures used for caries prevention for adult patients among dentists.	Brazil	Survey questionnaire	Dentists	Mixed public and private
(Gordan et al., 2009a)	Investigate restorative intervention threshold decisions for proximal carious lesions and identify characteristics that are associated with restorative intervention in proximal lesions that have penetrated only the enamel.	US, Sweden, Denmark, Norway	Survey questionnaire	Dentists	Mixed public and private

(Gordan et al., 2009b)	To identify and quantify the types of treatment that dentists in general dental practice use to manage defective dental restorations and identify characteristics that are associated with these dentists' decisions to replace existing restorations.	US, Sweden, Denmark, Norway	Survey questionnaire	Dentists	Mixed public and private
(Gordan et al., 2012)	To determine whether dentists are more likely to repair rather than replace a restoration that they diagnose as defective, quantify the specific reasons for repairing or replacing restorations and explore whether certain dentist-, patient- and restoration-related variables are associated with the decision to repair or to replace restorations.	US, Sweden, Denmark, Norway	Survey questionnaire and patient log form for recording information about eligible restorations	Dentists	Mixed public and private
(Javidi et al., 2015)	To investigate the impact of repair vs replacement of failed restorations on patient related outcome measures, and to explore the clinical factors that influence this decision.	England	Recording in a patient form	Dentists	Mixed public
(Grembowski et al., 1997)	To assess the association of restorative care with the patient's clinical or perceived needs, patient's personal characteristics and dentist factors.	US	Oral examination, claims data and survey questionnaire	Dentists and patients	Not specified

(Gomez et al., 2014)	To investigate treatment decision and recall intervals based on caries threshold, patient caries risk and types of lesions and explore the influence of dentist's characteristics in the practitioner's treatment decisions.	Colombia	Survey questionnaire	Dentists	Mixed public and private
(Traebert et al., 2005)	To investigate restorative thresholds and explore whether treatment decision is associated with the number of years since qualification and attendance of postgraduate courses.	Brazil	Interview	Dentists	Not specified
(Gordan et al., 2010)	To quantify the carious lesion depths at which dentists intervene surgically for cases of varying caries penetration and caries risk and to identify characteristics that are associated with surgical intervention.	US, Sweden, Denmark, Norway	Survey questionnaire	Dentists	Mixed public and private
(Kakudate et al., 2012)	To examine differences in treatment thresholds for interproximal primary caries and identify characteristics among dentists associated with the decision to intervene surgically in proximal lesions that were still within the enamel.	Japan	Survey questionnaire	Dentists	Not specified
(Mejàre et al., 1999)	To investigate variability in caries diagnoses and restorative treatment strategies among dentists and to assess the choice of restorative dental material for different caries diagnoses and different surfaces.	Sweden	Survey questionnaire	Dentists	Mixed public and private

(Riley III et al., 2011)	To quantify dentist's opinions of the importance of specific caries risk factors, quantify the percentage of dentists who report using CRA (caries risk assessment) on adult patients and to test the hypothesis that certain practice, dentist, and patient characteristics are associated with use of CRA.	US, Sweden, Denmark, Norway	Survey questionnaire	Dentists	Mixed public and private
(Fiset and Grembowski, 1997)	To determine use of adult pit-and-fissure sealants, chlorhexidine rinses and fluoride varnishes by dentists for control of caries	US	Survey questionnaire	Dentists	Private
(O'Donnell et al., 2013)	To identify the behaviours and thought processes of practicing dentists when making treatment decisions regarding sealing of noncavitated carious lesions.	US	Interview	Dentists	Private setting

Appendix 10. Table of relevant literature on Patient-Dentist Relationship in the mix of preventive and restorative care for dental caries (Part 2)

Author	Study design	Problem	Intervention	Comparison	Caries factors	Patient factors
(Chana et al., 2019)	Cross sectional patient vignette study	Patients with proximal and occlusal carious lesions of different progression stages	Restorative treatment	-	Caries depth (enamel or dentine caries); caries tooth surface	-
(da Silva Tagliaferro et al., 2020)	Cross sectional study.	Prevention for dental caries	Preventive treatment	-	-	Age; interest in a caries prevention regimen
(Gordan et al., 2009a)	Cross sectional vignette study	Patients with proximal carious lesions of different progression stages	Restorative treatment	Preventive treatment	Caries depth; caries risk	Dental insurance coverage, percentage of patients who self-pay; age; ethnicity; caries risk

(Gordan et al., 2009b)	Cross sectional vignette study.	Patients with defective restorations with carious lesions of different progression stages	Replacement	Repair treatment; preventive treatment	Caries depth	Dental insurance coverage; number of patients who self-pay (pay out of their own resources); age distribution; ethnicity distribution
(Gordan et al., 2012)	Cross-sectional study with a consecutive patient and restoration recruitment design	Patients with defective restorations	Repair	Replacement	-	Gender; age; ethnicity; number of restorations; dental insurance or any third-party coverage; waiting time for new-patient examination appointment; waiting time for a treatment procedure appointment
(Javidi et al., 2015)	Cross-sectional study with a consecutive patient recruitment design.	Patients with defective restorations with carious lesions of different progression stages	Repair	Replacement	Caries depth	Dental anxiety; self-reported pain experience during the procedure instantly after the procedure; self-reported pain experience during the procedure the day after the procedure
(Grembowski et al., 1997)	Cross-sectional prospective follow-up study	Restorative undertreatment or overtreatment for dental patients	Replacement and restorative treatment	-		Age; gender; ethnicity; household size; education; family income; perceived oral health status; number of decayed surfaces and number of filled teeth at baseline; oral self-care behaviour, insurance; satisfaction with dental care

(Gomez et al., 2014)	Cross-sectional vignette study	Patients with proximal and occlusal carious lesions of different progression stages	Restorative treatment	Preventive treatment	Caries depth; caries risk; caries tooth surface	-
(Traebert et al., 2005)	Cross-sectional vignette study	Patients with proximal carious lesions of different progression stages	Restorative treatment	-	Caries depth	-
(Gordan et al., 2010)	cross-sectional vignette study	Patients with occlusal carious lesions of different progression stages	Restorative treatment	Preventive treatment	Caries depth; caries risk	Dental insurance coverage; age; whether or not dentists recommended restorative treatment
(Kakudate et al., 2012)	Cross-sectional vignette study	Patients with proximal carious lesions of different progression stages	Restorative treatment	Preventive treatment	Caries depth; caries risk	Dental insurance coverage; self-paying status; age; ethnicity
(Mejàre et al., 1999)	Cross-sectional vignette study	Patients with proximal and occlusal carious lesions of different progression stages	Restorative treatment	-	Caries depth; caries tooth surface	-

(Riley III et al., 2011)	Cross-sectional vignette study	Patients with proximal and occlusal carious lesions of different progression stages	Restorative treatment	Preventive treatment	Caries depth; caries risk; caries tooth surface	Age; payment source; patient wating time for examination appointment
(Fiset and Grembowski, 1997)	Cross-sectional study	Prevention of dental caries	Fluoride varnish; fissure sealants; light cured composite resins; chlorhexidine rinse; salivary functioning tests	-	Caries risk;	Interest in fluoride varnish and fissure sealants; insurance coverage
(O'Donnell et al., 2013)	Cross-sectional vignette study	Patients with a demineralized lesion without evidence of cavitation, also sometimes referred to as an early lesion, an incipient lesion, or a white-spot lesion	Restorative treatment	Preventive treatment	Caries depth; caries tooth surface	-

Appendix 11. Table of relevant literature on Patient-Dentist Relationship in the mix of preventive and restorative care for dental caries (Part 3)

Author	Dentist factors	Share of dentists choosing restorative or replacement treatment by caries factors (lesion progression and caries risk)	Share of dentists choosing preventive or repair treatment by caries factors (lesion progression and caries risk)	Higher probability of restorative or replacement treatment by dentist and patient factors	Higher probability of preventive or repair treatment by dentist and patient factors
(Chana et al., 2019)	Age, gender, job role, years post-qualification, importance of restoring; whether attended any courses in the discipline of cariology/caries management during the past 5 years; preparation method for a proximal lesion; preparation method for occlusal lesion; restorative material for a proximal lesion; restorative material for occlusal lesion	-	-	More years post qualification; placing importance on restoring carious teeth	-
(da Silva Tagliaferro et al., 2020)	Age; gender; type of practice; years since dental school graduation; type of dental school; specialization; degree; frequency of dental explorer use to diagnose an occlusal caries lesion; whether uses caries risk assessment; whether uses a special form for caries risk assessment	-	-	-	Female dentists; private practice dentists; type of dental school; less years since dental school graduation; higher dental sealants treatment; higher non-prescription fluoride treatment; higher in-office fluoride treatment; higher chlorhexidine rinse treatment; higher prescription of fluoride; higher sugarless-xylitol

					gum prescription; older patients; higher patient interest in caries prevention
(Gordan et al., 2009a)	Year since graduation from dental school; race/ethnicity; gender; practice busyness; waiting time for a restorative dentistry appointment; practice region; type of practice; % of patient contact spent each day doing restorative procedures, % of patient contact time spent each day doing aesthetic procedures, % of patient contact time spent each day doing extractions; whether or not caries risk is done as a routine part of treatment planning	Low risk patient: lesion at enamel: 41%; lesion at dentin: 59%. High risk patient: lesion at enamel: 75%; lesion at the dentine: 25%	Low risk patient: lesion at enamel: 59%. High risk patient: lesion at enamel: 25%.	Dentists practicing in small group private practices; male dentists; lower level of business	
(Gordan et al., 2009b)	Year of graduation from dental school, ethnicity, gender; whether assessment of caries risk is applied; practice busyness, waiting time for a restorative dentistry appointment; practice region; type of practice; % of patient contact spent each day doing restorative work, % of patient contact time spent each day doing esthetic work, % of patient contact time spent each day doing extractions	Scenario 1 (defective composite with dentine margins): 87%. Scenario 2 (defective composite with enamel margins): 84%. Scenario 3 (defective amalgam restoration): 44%.	Scenario 1: 4%. Scenario 2: 6%. Scenario 3: 4%.	-	-

(Gordan et al., 2012)	Gender; type of work (full time); number of dental chairs per office; practice type; percentage of revenue derived from dental insurance; percentage of time spent on nonimplant restorative care; dentist placing the original restoration; practice type; percentage of time spent performing nonimplant restorative dentistry; years since Dental School Graduation; type of tooth surface involved in repair or replacement; number of tooth surfaces involved in repair or replacement; material used in original restoration; reason for repair or replacement of restoration	Secondary or recurrent caries: 70%	Secondary or recurrent caries: 30%	More years since dental school graduation; practicing in a small group private practice; not having been the dentist who placed the original restoration; younger patients	Fewer years since dental school graduation; practicing in a public health or large practice; having been the dentist who placed the original restoration; older patients
(Javidi et al., 2015)	Whether a local anaesthetic was used; overal time to complete the procedure of repair or replacement; type of dental material used to treat the failed dental restoration	White spot caries: 10%; enamel caries: 54%; dentine caries: 36%	White spot caries: 44%; enamel caries: 38%; dentine caries: 19%	-	-
(Grembowski et al., 1997)	Practice size/scale; restorative fees; practice busyness; dentist experience; practice beliefs; dentist education; diagnostic criteria for the placement or replacement of filling	-	-	Higher number of non-decayed teeth with satisfactory fillings; higher number of missing surfaces; existence of any decay elsewhere in the mouth; higher number of	-

				decayed surfaces; poorer perceived oral health; higher income; dentists in smaller practices	
(Gomez et al., 2014)	Practice city; graduation year; university; gender; type of practice; mix of practice (public/ private)	Low risk patient: Scenario 1 (lesion at inner half enamel): 29% Scenario 2 (lesion at inner half enamel):34% Scenario 3 (lesion at inner half enamel): 80% Scenario 4 (lesion at enamel- outer third dentine junction): 57% Scenario 5 (lesion at outer third dentine): 91% High risk patient: Scenario 1: 44%; Scenario 2: 45%. Scenario 3: 82%. Scenario 4: 72%; Scenario 5: 95%.	Low risk patient: Scenario 1: 71%. Scenario 2: 66%. Scenario 3: 20%. Scenario 4: 43% Scenario 5: 9%. High risk patient: Scenario 1: 56%; Scenario 2: 55%. Scenario 3: 18%. Scenario 4: 28%; Scenario 5: 6%.	-	-
(Traebert et al., 2005)	Gender; age; year of qualification; attendance on postgraduate courses	Scenario 1 (lesions at external half of enamel): 32%. Scenario 2 (lesion at internal half of the enamel): 55% Scenario 3 (lesion at enamel-dentine junction): 79%, Scenario 4 (lesion at dentine but not deep): 97%, Scenario 5 (dentine deep): 100%		-	-

(Gordan et al., 2010)	Gender, ethnicity, years since graduation from dental school, region of practice, type of practice, practice charges by payment source for patients; time devoted to restorative dentistry, time devoted to aesthetic dentistry, time devoted to extractions, practice busyness; assessment of patients' caries risk;	Low risk patient: Scenario 1 (lesion at outer half enamel): 14%. Scenario 2 (lesion at inner half enamel): 63%;Scenario 3 (lesion at outer third dentin): 90%. High risk patient: Scenario 1 (lesion at outer enamel): 25%.; Scenario 2 (lesion at inner enamel): 77%; Scenario 3 (lesion at dentin): 94%.	Low risk patient: Scenario 1 (lesion at outer enamel): 17%. Scenario 2 (lesion at inner enamel): 13%;Scenario 3 (lesion at dentin): 3%. High risk patient: Scenario 1 (lesion at outer enamel): 35%. Scenario 2 (lesion at inner enamel): 13%;Scenario 3 (lesion at dentin): 3%.	Dentists in small group private practices; practices with lower percentage of self-paying patients	-
(Kakudate et al., 2012)	Years since graduation from dental school; ethnicity; gender; type of practice; practice busyness; patient waiting time for restorative dentistry; city population; patient contact time spent each day on restorative procedures, patient contact time spent each day on aesthetic procedures; patient contact time spent each day on extractions; whether or not caries risk is assessed as a routine part of treatment planning; examination by dental explorer for primary occlusal caries diagnosis; diet counselling	Low risk patient: Enamel lesion: 46%. Dentine lesion: 54%. High risk patient : Enamel lesion: 74%. Dentine lesion: 26%	Low risk patient: Enamel lesion: 54%. High risk patient : Enamel lesion: 26%	Female dentists; practice at a city with larger population; being employed by another dentist as compared with self-employed; caries risk assessment is used; more frequent diet counselling; dental explorer more frequently used for a	-

				primary occlusal caries diagnosis	
(Mejàre et al., 1999)	Age; practicing region; mix of practice (public vs private)	Enamel lesion: 1%. Dentine lesion: 99%.		-	-
(Riley III et al., 2011)	Gender; practicing region; practice mix (private/public); graduation year; patient contact time spent on restorative procedures; whether caries risk assessment is used; percentage of patients receiving individualized caries prevention; caries risk factors; dentist belief in prediction of new caries development	Low risk patient: Occlusal lesion at the enamel: 10%; Occlusal lesion at the dentine: 90%. Proximal lesion at the enamel: 41%. Proximal lesion at the dentine: 69%. High risk patient: Occlusal lesion at the enamel: 24%; Occlusal lesion at the dentine: 76%. Proximal lesion at the enamel: 74%. Proximal lesion at the dentine: 26%.	Low risk patient: Occlusal lesion at the enamel: 90%; Proximal lesion at the enamel: 59%. High risk patient: Occlusal lesion at the enamel: 76%. Proximal lesion at the enamel: 26%.	-	Belief in predicting new caries; use of caries risk assessment
(Fiset and Grembowski, 1997)	Gender; ethnicity; dental school; type of practice (solo); weekly reported hours of seeing patients; years of practice; years of graduation; location of dental office	-	-	-	-
(O'Donnell et al., 2013)	Type of practice; gender; age; American Dental Association membership; Year of Graduation; choice of treatment; caries	Scenario 1 (noncavitated pit-and-fissure lesion at tooth no. 3: 50%. Scenario 2 (noncavitated	Scenario 1 (noncavitated pit-and-fissure lesion at tooth no. 3: 50%.	-	-

	Diagnosis; solutions helping with implementation of fissure sealants	pit and fssure lesion at tooth no. 12: 59%. Scenario 3 (white, opaque noncavitated lesion at tooth no. 17): 36%. Scenario 4 (small, noncavitated occlusal lesion at tooth no. 14): 32%.	Scenario 2 (noncavitated pit and fssure lesion at tooth no. 12: 41%. Scenario 3 (white, opaque noncavitated lesion at tooth no. 17): 64%. Scenario 4 (small, noncavitated occlusal lesion at tooth no. 14): 68%.		

Appendix 12. Table of Dental DCE-CA Review (Part 1)

Authors/ Date	Country	Setting	Methods	Variables used	how it related/helped this study
(Vennedey et al., 2018)	Germany	Mixed public and private	DCE	Gender; age; education; time since diagnosis; smoking status; treatment experience; health insurance status	• LC • Subgroup analyses • Distributional assumptions for variables in MXL • Decision of best model-fit based on AIC
(Boyers et al., 2021)	UK	Mixed public and private	DCE	Gender; age; residence; smoking status; income; smoking status; education; employment; self-reported dental health; self-reported general health; registered with a dental practice status; payment status for dental care; ever visited a dental hygienist; frequency of scale and polish	• Distributional assumptions for variables in ECL • Subgroup analyses • Thematic analysis of focus group data • General population preferred services to be delivered by the dentist rather than hygienist
(Barber, Sophy et al., 2019)	UK	Public	DCE	-	• Attribute development in an iterative process of applying multiple qualitative methods • Use of blocking to increase the number of tasks included • Use of opt-out created concern it may lead to high levels of non-response where the trade-off was judged to be difficult

(Bech et al., 2011)	Denmark	Private	DCE	Gender; age; income; education; familiarity with digital X-ray; familiarity with painless anaesthesia	-
(Kiiskinen et al., 2010)	Finland	Mixed public and private	DCE	Income; employment status; education; use of dental care in the last 12months; experience of tooth ache in the last 12 months; age; number of teeth; perceived need for care; fear of dental care	-
(Sever, I. et al., 2018)	Croatia	Mixed public and private	DCE	Age; gender; education; income; primary motive for having a dental care at the school clinic; prior experience with dental care at the school clinic; prior experience with dental care in private dental practice; perceived service quality at the dental school clinic; perceived service quality at the dental school clinic relative to the private dental practices	• Distributional assumptions for variables in MXL • Bayesian Information Criterion (BIC) as decisional rule for optimal number of classes in LC
(Sever, Ivan et al., 2019b)	Croatia	Mixed public and private	DCE/ Contingent Valuation/ BWS	Age; gender; education; income; primary motive for having a dental care at the school clinic; prior experience with dental care at the school clinic	• Attribute non-attendance model specification • Considerable share of respondents (49%) not considering cost when making choices

(Sever, Ivan et al., 2019c)	Croatia	Mixed public and private	DCE / Contingent Valuation	Age; gender; education; income; primary motive for having a dental care at the school clinic; prior experience with dental care at the school clinic; prior experience with dental care in private dental practice; perceived service quality at the dental school clinic; perceived service quality at the dental school clinic relative to the private dental practices	• WTP space model specification • Distributional assumptions for WTP variables
(Zhu et al., 2019)	China	Mixed public and private	DCE	Gender; age; education; income; medical insurance type; residence status; previous hospital experience	• Distributional assumptions for variables in MXL • LC • BIC as decisional rule for optimal number of classes in the LC
(Ryan and Miguel, 2003)	Scotland	-	DCE	Age; gender; year of study; degree for which they were studying; whether first language was English	• No greater proportions of respondents showed imprecise preferences or failed the tests of completeness for the health care interventions than for the commonly used good (the supermarket). This suggested that unfamiliar goods did not conform less well than commonly used goods to the axiom of completeness.

(Kateeb, E. et al., 2016)	US	Mixed public and private	Conjoint experiment	Whether considering ART to be definitive or interim treatment and why; age, practice type, practice location, business of the practice; factors influencing the decision regarding the therapeutic goals of ART;	• Use of patient vignettes in measuring dentists' preferences
(Kateeb, E.T. et al., 2014)	US	Mixed public and private	Conjoint experiment	Whether considering ART to be definitive or interim treatment and why; age, practice type, practice location, business of the practice; factors influencing the decision regarding the therapeutic goals of ART;	• Use of patient vignettes in measuring dentists' preferences
(Bakhurji et al., 2019)	US	Mixed public and private	Conjoint experiment	Gender; age; race; degree of graduate training; Board certification status; Type of employment; practice location; years of practice; percentage of Medicaid patients percentage of non-white; choice of restoration material; environmental impact of amalgam waste; reported amalgam use in clinic	• Use of patient vignettes in measuring dentists' preferences • Subgroup analysis

Appendix 13. Table of Dental DCE-CA Review (Part 2)

Authors/ Date	objective/study question	labelled vs. unlabelled designs	framing of DCE question	Number of choice alternatives
(Vennedey et al., 2018)	To estimate the relative importance of attributes characterizing periodontitis and its treatment	Unlabelled	"Without treatment you will loose 3 teeth within the next 10 years. With treatment you can reach one of the following situations. Which situation do you prefer?"	2
(Boyers et al., 2021)	To elicit UK general population preferences for SP (scale and polish) and personalized OHA (oral health advice) services and relevant dental health and aesthetic outcomes	Unlabelled	"Please compare the dental packages offered, and tick which package, if any, you would choose"	3
(Barber, Sophy et al., 2019)	To elicit preferences for hypodontia care from adolescents and adolescent–parent dyads through a DCE	Unlabelled	"Which hypodontia treatment do you like best? / would you pick this treatment or no treatment?"	2+1 opt-out alternative

(Bech et al., 2011)	To investigate the impact of the number of choice sets presented to each respondent, on response behaviour and mean WTP estimates.	Unlabelled	Choice of dentist	3
(Kiiskinen et al., 2010)	To explore the alternative ways of modelling non-demanders of non-acute dental care.	Labelled	"Which scenario would you choose in a dental setting of non-acute care"	3
(Sever, I. et al., 2018)	To explore the relative importance and WTP for selected attributes of dental care delivery at the school clinic and investigate heterogeneity in preferences by patient characteristics	Labelled	"Please choose your preferred option among different dental care alternatives on offer."	2+1 private dental care as a follow-up option

(Sever, Ivan et al., 2019b)	To estimate the marginal WTP values for different attributes of dental care	Labelled	"Please choose your preferred option among different dental care alternatives on offer."	2+1 private dental care as a follow-up option
(Sever, Ivan et al., 2019c)	To examine the extent of attribute non-attendance (ANA) in a DCE, with a specific focus on the cost attribute	Labelled	"Please choose your preferred option among different dental care alternatives on offer."	2+1 private dental care as a follow-up option
(Zhu et al., 2019)	To explore the general public's preferences for dental care in China and the heterogeneity in preferences by patient characteristics	Labelled	"When you have a cavity, which hospital would you choose?"	4

(Ryan and Miguel, 2003)	To test the completeness axiom in preferences for dental care	Unlabelled	-	2
(Kateeb, E. et al., 2016)	To investigate the relative impact of patients' characteristics, on pediatric dentists' willingness to use ART to restore posterior primary teeth	Patient vignettes	"How willing are you to use ART for carious lesion deep into the dentin but with no pulpal involvement evident clinically or radiographically in a lower posterior primary tooth?"	1
(Kateeb, E.T. et al., 2014)	To explore the importance of patients' characteristics on willingness of pediatric dentists to perform ART restorations	Patient vignettes	"How willing are you to use ART for carious lesion deep into the dentin but with no pulpal involvement evident clinically or radiographically in upper anterior primary tooth"	1

(Bakhurji et al., 2019)	To determine the importance of patients' characteristics on paediatric dentists' decision-making process when choosing amalgam use versus other restorative materials	Patient vignettes	"Assume a 5-yold boy with a carious lesion on the lower left primary molar that requires an occlusal restoration. The lesion is characterized as 2 mm deep but not wider than one-third of the intercuspal distance. Which dental material would you choose for this restoration? "	1

Appendix 14. Table of Dental DCE-CA Review (Part 3)

Authors/ Date	Attributes investigated	Properties of experimental design	Statistical DCE model specification
(Vennedey et al., 2018)	Tooth loss within next 10 years (No tooth loss (reference), 1 tooth lost, 2 teeth lost); own costs for treatment follow-up care and re-treatment (0€ per year, €100 per year, €300 per year, €500 per year); complaints and symptoms (No complaints, occasional gum bleeding, "Long teeth" due to gum recession, sensitive tooth nec); frequency of periodontist visits (None necessary, 2 times per year, 4 times per year)	Main effects D-efficient (non-zero priors)-level balanced	MXL/ LC
(Boyers et al., 2021)	Oral hygiene advice (No detailed and personalized advice, Detailed and personalized advice by dentist, Detailed and personalized advice by hygienist), Scale and polish (None, 1per year by dentist, 1per year by hygienist, 2per year by dentist, 2per year by hygienist), Bleeding (Never, Hardly ever, Occasionally, Fairly often, Very often), Aesthetics (Very unclean, Unclean, Moderately clean, Clean, Very clean), Cost (£10per year, £20per year, £50per year, £100per year, £200per year)	Main effects D-optimal / pivoted and segmented design	Error Components Logit Model
(Barber, Sophy et al., 2019)	Discomfort (No/mild discomfort, Moderate discomfort, severe discomfort); Appointment schedule (every 2 weeks for 2 months, Every 2m for 3 years, Every 2m for 5 years); Waiting time (3 months, 1 year, 3 years); Problems during treatment (Mild/ no problems, Moderate problems, Severe problems); Function (improved, compromised); Appearance	Main effects D-efficient-level balanced	CL

	(improved, compromised); Future cost (No extra cost per year, £50 a year, £250 a year)		
(Bech et al., 2011)	Business hours (8–18, 9–15); Distance to dentist (1, 3, 7, 15 km); Whether the dentist is part of a dental centre includinga dental hygienist and specialists (Yes, No); Whether the dentist has a digital X-ray machine (Yes, No); Whether the dentist has painless anaesthesia (Yes, No) Price of routine check-up plus cleaning (200, 270, 360, DKK500)	Main effects D-efficient	CL / Heteroskedastic Logit Model
(Kiiskinen et al., 2010)	Out-of-pocket cost (30, 40, 50, 60, 120–70, 120–60, 120–50, 120–40 euros); Direct National Health Insurance refund (Not applicable for Public dental service, Yes, No); waiting time (1, 2, 3, 4 weeks); Travel time (one-way) (10, 20, 30, 40 min); number of visits (1, 2, 3 visits); Recall check-up visit (Yes, No); Type of provider (Public dental service, Private dentist)	Orthogonal fractional factorial design plus random pairing-unbalanced	Nested Logit Model / Probit Model
(Sever, I. et al., 2018)	Out-of-pocket cost (HRK 0, 75, 150, 300, 375 and 450); Explanation of dental treatment (Detailed, none); Dental staff behavior (Warm and friendly, formal and inattentive); Waiting time in the office (5, 20, 45 min); dental care provider (Faculty dental care provided by a student (supervised by faculty member, Faculty dental care provided by a faculty member, Private dental care provided by a DMD)	D-efficient	MXL / LC
(Sever, Ivan et al., 2019b)	Out-of-pocket cost (HRK 0, 75, 150, 300, 375 and 450); Explanation of dental treatment (Detailed, none); Dental staff behaviour (Warm and friendly, formal and inattentive); Waiting time in the office (5, 20, 45 min); dental care provider (Faculty dental care provided by a student (supervised by faculty member,	D-efficient plus correlation matrix	CL/ EAA/ BWS model

	Faculty dental care provided by a faculty member, Private dental care provided by a DMD)		
(Sever, Ivan et al., 2019c)	Out-of-pocket cost (HRK0, 75, 150, 300, 375 and 450); Explanation of dental treatment (Detailed, none); Dental staff behavior (Warm and friendly, formal and inattentive); Waiting time in the office (5, 20, 45 min); dental care provider (Faculty dental care provided by a student (supervised by faculty member, Faculty dental care provided by a faculty member, Private dental care provided by a DMD)	D-efficient	MXL estimated in WTP space/ EEA/ CL
(Zhu et al., 2019)	Waiting environment (quiet, clean and tidy, not quiet and dirty); waiting time (no more than 0.5 hours, no more than 1hour, no more than 2hours); choice of doctor (choice, no choice); distance (20 minutes, 40 minutes, 60 minutes); cost (¥200, ¥400, ¥600); hospital type (Class A tertiary hospital Community hospital, High-level private hospital, Small private clinic)	D-efficient	MXL/LC
(Ryan and Miguel, 2003)	Waiting time for appointment (7 days, 14 days, 28 days); waiting room time (10, 20, 30 min); cost of check-up (£5, £10, £15); travel distance to the dental practice (0.5, 1.5, 3 miles).	-	-
(Kateeb, E. et al., 2016)	Child's age (3 years, 5 years, 8 years); level of cooperation (uncooperative child, showing moderate cooperation, cooperative); insurance type (public insurance, private insurance, no insurance)	Orthogonal fractional factorial design	Multinomial Regression Model
(Kateeb, E.T. et al., 2014)	Child's age (2 years, 4 years, 6 years); level of cooperation (uncooperative child, showing moderate cooperation, cooperative); insurance type (public insurance, private insurance, no insurance)	Orthogonal fractional factorial design-correlation across attributes	Multinomial Regression Model

(Bakhurji et al., 2019)	Type of dental insurance (private, public, and no insurance); caries risk assessment (high, moderate, and low)	Full factorial design	CL

Appendix 15. Table of Dental DCE-CA Review (Part 4)

Authors/ Date	marginal WTP estimates of the main DCE model[11]	Quantitative tests of DCE model specification	Overall summary comments of the main contribution to your aims
(Vennedey et al., 2018)	Not reported or possible to calculate	Dominance choice task	Not focused on prevention of dental caries
(Boyers et al., 2021)	Personalized advice from none: -£12.84; Personalized advice from dentist: £11.05; Personalized advice from hygienist: £1.79; scale and polish from none: -£68.20; scale and polish every 12 months from dentist: £17.25; scale and polish every 12 months from hygienist: -£5.87; scale and polish every 6 months from dentist: £30.05; scale and polish every 6 months from hygienist: £26.77; never bleeding gums: £37.25; Hardly ever bleeding gums: £28.41; Occasionally bleeding gums: -£3.08; Fairly often bleeding gums: -£8.54; Very often bleeding gums: -£54.04; Very unclean teeth: -£86.09; Unclean teeth: -£39.25; Moderately clean teeth: £13.98; clean teeth: £50.56; Very clean teeth: £60.82; package versus no package: £44.72	Straight liners / Repeated choice task	Focused on prevention of periodontal disease but not dental caries

[11] Mean WTP estimates if not reported in the article, were estimated based on CL or nested logit model coefficients by taking the ratio of the respective attribute coefficient to the cost coefficient. Purchasing power parities at the time of study publication were used to convert WTP expressed in a different currency into £ so that amounts were comparable across studies.

(Barber, Sophy et al., 2019)	Not reported or possible to calculate	Not reported	Not focused on prevention of dental caries
(Bech et al., 2011)	Opening hours 8am–6pm (compared to 9am-3pm): £6.34 (DKK67); distance: -£0.85 (DKK9); dentist is part of centre (compared to not): £3.12 (DKK33); digital X-ray (compared to not): £6.81 (DKK72); painless anaesthesia (compared to not having such procedure): £9.65 (DKK102); no routine check-up: -£58.72 (-DKK621)	Straight liners/ Always preference for the best level of one attribute	Not focused on prevention of dental caries
(Kiiskinen et al., 2010)	Private dentist (compared to none): £199.67 (€250.98); Public dental service: £192.49 (€242.92); waiting time -£9.84 (-€12.42); travel time: -£0.43 (-€0.55); number of visits: -£10.71 (-€13.52); recall-check-up visit: £9.71 (€12.25); direct National Health Insurance refund: £6.02 (€7.60)	Straight liners	Not focused on prevention of dental caries
(Sever, I. et al., 2018)	Faculty member as care provider (compared to private dental care): -£2.45(-HRK11.9); student as care provider: -£35.72 (-HRK173.4) ; Detailed explanation of treatment (compared to none): £69.04 (HRK 335.1); warm and friendly behaviour (compared to formal and inattentive): £42.87 (HRK208.1); 5-min waiting time (compared to 20	Not reported	Not focused on prevention of dental caries

	min): £7.83 (HRK38.0); 45 min waiting time: -£23.63(-HRK114.7)		
(Sever, Ivan et al., 2019b)	Faculty member as care provider (compared to private dental care): -£1.22(-HRK5.888); student as care provider: -£33.76 (-HRK162.953) ; Detailed explanation of treatment (compared to none): £73.95 (HRK 357); warm and friendly behaviour (compared to formal and inattentive): £43.71 (HRK211); 5-min waiting time (compared to 20 min): £7.87 (HRK38); 45 min waiting time: -£21.75(-HRK105)	EAA	Not focused on prevention of dental caries
(Sever, Ivan et al., 2019c)	Faculty member as care provider (compared to private dental care): -£1.22(-HRK5.888); student as care provider: -£33.76 (-HRK162.953) ; Detailed explanation of treatment (compared to none): £73.95 (HRK 357); warm and friendly behaviour (compared to formal and inattentive): £43.71 (HRK211); 5-min waiting time (compared to 20 min): £7.87 (HRK38); 45 min waiting time: -£21.75(-HRK105)	Always preference for the best level of one attribute/ EAA	Not focused on prevention of dental caries
(Zhu et al., 2019)	not quiet and dirty waiting environment (compared to quiet, clean and tidy): -£20.37 (¥ RMB 125.32); no more than 1 hour waiting time (compared with no more than 0.5hours): -£16.5 (¥101.52); No more than 2 hours: - £28.78 (¥177.06); no choice of doctor (compared with choice of doctor): -£19.18 (¥117.97); 40 minutes distance (compared with 20 minutes distance): -£14.67 (¥ 90.26); 60 minutes distance: -£23.93 (¥147.19); Community hospital (compared with Class A tertiary hospital): -£35.08 (¥215.80); High-level private hospital: -£25.08 (¥154.32); Small private clinic: -£77.9 (¥479.22)	Straight liners - Dominance choice task	Not focused on prevention of dental caries

(Ryan and Miguel, 2003)	Not reported or possible to calculate	Repeated tasks	Not focused on prevention of dental caries
(Kateeb, E. et al., 2016)	Not reported or possible to calculate	Straight liners	Not focused on dentists' preferences in delivering a mix of preventive and restorative care
(Kateeb, E.T. et al., 2014)	Not reported or possible to calculate	Straight liners	Not focused on dentists' preferences in delivering a mix of preventive and restorative care
(Bakhurji et al., 2019)	Not reported or possible to calculate	Not reported	Not focused on dentists' preferences in delivering a mix of preventive and restorative care

Appendix 16. DES

A. Below are a list of factors which may be important to you when deciding which dental practice to work with. Please read through each factor and imagine that you are in the process of finding a new dental practice to work with. Rate each factor in accordance to its importance to your decision (where 15 is the most important factor and 1 the least important factor). For example if "Time in the dental chair showing brushing/flossing" is of highest importance in your decision, rate this factor with 15 whereas if it is of lowest significance place 1.

- Time in the dental chair showing brushing/flossing ☐
- Time in the dental chair to deliver preventive advice ☐
- Time in the dental chair to apply clinical prevention (fluoride varnish/fissure sealants etc.) ☐
- Time in the dental chair to deliver scale and polish (restorative treatment) ☐
- Time in the dental chair to deliver filling and drilling (restorative treatment) ☐
- Expected annual income ☐
- Dental provider (only for showing brushing/flossing and clinical prevention) ☐
- Minutes spent on administration work per appointment (e.g. typing notes into the system) ☐
- Payment method only for preventive services (demonstration of brushing/flossing, advice on diet, smoking, alcohol and sugar free medication and delivery of fluoride varnish and fissure sealants), assuming no change in your annual income (payment methods include capitation, fee per service and monthly salary) ☐
- A practice which involves a robust system of recording and measuring preventive services ☐

B. Rank the following factors based on their importance in your decision to deliver preventive care either in form of advice such as showing brushing and flossing or clinical prevention e.g. using fluoride varnish/fissure sealants (Where 5 is the most important factor and 1 is the least important factor)

Patients' age ☐

Patients' income ☐

Patients' type of dental insurance ☐

Patients' educational background ☐

Patients' first language ☐

Patients' medical history (i.e. diabetes, cardiovascular disease etc.) ☐

Patients' dental history ☐

Patients' risk of developing caries ☐

Patients' caries depth ☐

C. For each of the following factors below could you assign two numerical levels to describe the factor? For example for "Time in the dental chair showing brushing/flossing in minutes" what would be the minimum and maximum number of minutes you would be willing to commit to the process on average?

Factors	What would be the minimum value for this factor?	What would be the maximum value for this factor?
Time in the dental chair showing brushing/flossing in minutes		
Time in the dental chair delivering fluoride varnish/ fissure sealants in minutes		
Time in the dental chair to deliver diet, smoking, alcohol and sugar free medication advice in minutes		
Time in the dental chair for scale and polish in minutes		
Time in the dental chair applying drilling and filling in minutes		
Time spent on administration work per appointment in minutes (e.g. typing notes into the system)		
Expected annual income in £		

Appendix 17. D-DCE1

We are conducting a survey to explore dentists' preferences in relation to preventive treatment. Prior to the design of the final questionnaires we have come up with this pilot questionnaire intended to test the feasibility of treatment plans' choices and gather any additional information about treatment plans' characteristics and their associated values. The final aim of this is to identify all the important factors/characteristics affecting preventive treatment delivery.

In this occasion we would like you to imagine you are encountering with two assumed patient scenarios. Supposing you had two different options or choices of dental treatment plans with distinct values in the following characteristics, which one would you choose for each assumed patient scenario? Please select either treatment plan 1 or treatment plan 2 for each scenario presented below.

Scenario A

We would like you to imagine you are treating a patient aged between 18-35 years old with enamel caries at an occlusal surface and moderate risk of developing carries. Which of the following treatment plans would you choose if you had 1.5 hours available to undertake the treatment?

Characteristics	**Treatment plan 1**	**Treatment plan 2**
Preventive treatment e.g. fluoride varnish	5 minutes	7.5 minutes
Preventive advice e.g. oral hygiene and dietary advice	3 minutes	12 minutes
Restorative treatment e.g. drilling and filling	25 minutes	15 minutes
Preventive advice e.g. oral hygiene and dietary advice provided by	Dental nurse	Dental therapist
Preventive treatment e.g. fluoride varnish applied by	Dental hygienist	Dentist
Payment received by treatment plan	150 £	220 £
Which treatment plan would you choose? (place an **X** in the corresponding box)		

Scenario B

We would like you now to imagine you are treating a patient aged 55+ years old with dentine caries at an occlusal surface and a high risk of developing carries. Which of the following treatment plans would you choose if you had 2 hours available to undertake the treatment?

Characteristics	**Treatment plan 1**	**Treatment plan 2**
Preventive treatment e.g. fluoride varnish	7.5 minutes	3 minutes
Preventive advice e.g. oral hygiene and dietary advice	8 minutes	12 minutes
Restorative treatment e.g. drilling and filling	35 minutes	25 minutes
Preventive treatment e.g. fluoride varnish applied by	Dental therapist	Dental nurse
Preventive advice e.g. e.g. oral hygiene and dietary advice provided by	Dentist	Dental therapist
Payment received by treatment plan	150 £	75 £
Which treatment plan would you choose? (place an **X** in the corresponding box)		

Appendix 18. D-DCE2

We are conducting a survey to explore dentists' preferences in relation to the balance of preventive-restorative treatment. Prior to the design of the final questionnaires we have come up with this pilot questionnaire intended to test the feasibility of treatment plans' choices within a dental appointment. The final aim of this is to identify all the important factors/characteristics affecting the balance of preventive-restorative treatment delivery.

> On this occasion we would like you to imagine you are seeing two potential patient scenarios in a dental appointment. Supposing you had two different options or choices of dental treatment plans with distinct values in the following characteristics, which one would you choose for each potential patient scenario? Please select either **Option A** or **Option B** for each scenario presented below.

Scenario A

Imagine you are treating a 25 years old patient with moderate risk of developing caries in a dental appointment. You have decided there is caries which requires treatment in the occlusal surface (see picture below). Which of the following treatment plans would you choose if you had 60 minutes available to undertake the treatment during this dental appointment?

Characteristics	**Treatment plan A**	**Treatment plan B**
Time for preventive treatment e.g. fluoride varnish	3 minutes	5 minutes
Time for preventive advice e.g. oral hygiene and dietary advice	8 minutes	0 minutes
Time for restorative treatment e.g., drilling and filling	15 minutes	35 minutes
Preventive treatment and advice delivered by	Dental therapist	Dentist
Payment	£55	£70
Which treatment plan would you choose?		

Scenario B

Imagine you are treating a 50 years old patient with high risk of developing caries in a dental appointment. You have decided there is caries which requires treatment in the occlusal surface (see picture below). Which of the following treatment plans would you choose if you had 50 minutes available to undertake the treatment during this dental appointment?

Characteristics	**Treatment plan A**	**Treatment plan B**
Time for preventive treatment e.g. fluoride varnish	5 minutes	0 minutes
Time for preventive advice e.g. oral hygiene and dietary advice	8 minutes	3 minutes
Time for restorative treatment e.g., drilling and filling	15 minutes	25 minutes
Preventive treatment and advice delivered by	Dental nurse	Dental therapist
Payment	£55	£85
Which treatment plan would you choose?		

Appendix 19. Design of D-DCE3

D error	0.002511								
A error	0.005955								
Design									
Choice situation	alt1.payment	alt1.treat	alt1.adv	alt1.restor	alt2.payment	alt2.treat	alt2.adv	alt2.restor	Block
1	55	3	8	15	70	0	0	35	1
2	55	5	8	15	85	0	3	25	1
3	30	5	3	0	55	0	12	35	1
4	85	7.5	3	35	55	3	0	35	1
5	85	3	8	15	55	7.5	12	25	1
6	70	0	12	15	70	7.5	8	25	1
7	55	7.5	3	15	85	5	0	15	1
8	30	3	12	0	55	5	0	25	1
9	85	7.5	8	35	30	0	8	0	2
10	55	5	12	35	70	5	12	15	2
11	55	3	0	25	70	3	3	35	2
12	55	0	3	15	55	0	8	25	2
13	55	5	8	35	30	7.5	0	0	2
14	85	3	12	25	70	7.5	0	15	2
15	55	3	3	15	85	0	0	15	2
16	70	5	3	25	55	7.5	12	15	2

We are preparing to do a survey looking at what sort of treatment plans dentists choose for patients. Before doing our survey, we want to test out a few questions. That's why we'd like your opinions on how understandable and meaningful they are. Please read through and answer the following questions. There are no right or wrong answers. We are interested in your own honest, personal opinions. **In each of the questions below, we will describe a patient attending a dental appointment. We will tell you the patients' age and the risk of developing carries. We will also show you a picture and a radiograph corresponding to the surface you have to treat.**

We will then describe the features of two possible treatment plans. Based on these features, you should say which of the two plans you would choose for the patient. Imagine you have to choose between the two plans shown. Assume both plans are identical apart from the features described.

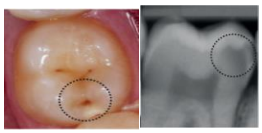
Descriptions of dental practice features

Time for preventive treatment	Time spent on preventive treatment, e.g. fluoride varnish
Time for preventive advice	Time spent on dental related dietary and hygiene advice, e.g. a personalised diet plan to help maintain good oral health and help with proper teeth brushing technique.
Time for restorative treatment	Time spent on restorative treatment, e.g. drilling and filling
Payment	The amount of money you receive for the appointment

Question 1

Which treatment plan would you choose in this case?

Imagine you are a dentist treating a 55+ years old patient with low risk of developing caries in a dental appointment. You have decided there is caries which requires treatment in the occlusal surface (see picture and radiograph below).

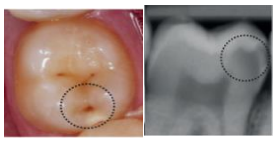


Characteristics	Treatment plan A	Treatment plan B
Time for preventive treatment	3 minutes	0 minutes
Time for preventive advice	8 minutes	0 minutes
Time for restorative treatment	15 minutes	35 minutes
Payment	€55	€70
Which treatment plan would you choose?		

Question 2

Which treatment plan would you choose in this case?

Imagine you are a dentist treating a 55+ years old patient with moderate risk of developing caries in a dental appointment. You have decided there is caries which requires treatment in the distal occlusal surface (see picture and radiograph below).



Characteristics	Treatment plan A	Treatment plan B
Time for preventive treatment	5 minutes	0 minutes
Time for preventive advice	8 minutes	3 minutes
Time for restorative treatment	15 minutes	25 minutes
Payment	€55	€85
Which treatment plan would you choose?		

Question 3

Which treatment plan would you choose in this case?

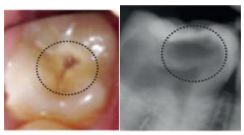
Imagine you are a dentist treating an 18-35 years old patient with moderate risk of developing caries in a dental appointment. You have decided there is caries which requires treatment in the distal occlusal surface (see picture and radiograph below).

Characteristics	Treatment plan A	Treatment plan B
Time for preventive treatment	5 minutes	0 minutes
Time for preventive advice	3 minutes	12 minutes
Time for restorative treatment	0 minutes	35 minutes
Payment	€30	€55
Which treatment plan would you choose?		

Question 4

Which treatment plan would you choose in this case?

Imagine you are a dentist treating a 55+ years old patient with low risk of developing caries in a dental appointment. You have decided there is caries which requires treatment in the distal occlusal surface (see picture and radiograph below).



Characteristics	Treatment plan A	Treatment plan B
Time for preventive treatment	7.5 minutes	3 minutes
Time for preventive advice	3 minutes	0 minutes
Time for restorative treatment	35 minutes	35 minutes
Payment	€85	€55
Which treatment plan would you choose?		

Question 5

Which treatment plan would you choose in this case?

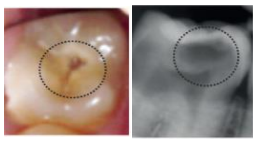
Imagine you are a dentist treating an 18-35 years old patient with high risk of developing caries in a dental appointment. You have decided there is caries which requires treatment in the occlusal surface (see picture and radiograph below).

Characteristics	Treatment plan A	Treatment plan B
Time for preventive treatment	3 minutes	7.5 minutes
Time for preventive advice	8 minutes	12 minutes
Time for restorative treatment	15 minutes	25 minutes
Payment	€85	€55
Which treatment plan would you choose?		

Question 6

Which treatment plan would you choose in this case?

Imagine you are a dentist treating an 18-35 years old patient with low risk of developing caries in a dental appointment. You have decided there is caries which requires treatment in the distal occlusal surface (see picture and radiograph below).

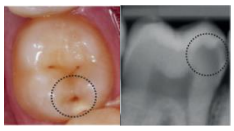


Characteristics	Treatment plan A	Treatment plan B
Time for preventive treatment	0 minutes	7.5 minutes
Time for preventive advice	12 minutes	8 minutes
Time for restorative treatment	15 minutes	25 minutes
Payment	€70	€70
Which treatment plan would you choose?		

Question 7

Which treatment plan would you choose in this case?

Imagine you are a dentist treating a 35-55 years old patient with moderate risk of developing caries in a dental appointment. You have decided there is caries which requires treatment in the distal occlusal surface (see picture and radiograph below).

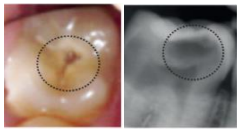


Characteristics	Treatment plan A	Treatment plan B
Time for preventive treatment	7.5 minutes	5 minutes
Time for preventive advice	3 minutes	0 minutes
Time for restorative treatment	15 minutes	15 minutes
Payment	€55	€85
Which treatment plan would you choose?		

Question 8

Which treatment plan would you choose in this case?

Imagine you are a dentist treating a 35-55 years old patient with high risk of developing caries in a dental appointment. You have decided there is caries which requires treatment in the distal occlusal surface (see picture and radiograph below).



Characteristics	Treatment plan A	Treatment plan B
Time for preventive treatment	3 minutes	5 minutes
Time for preventive advice	12 minutes	0 minutes
Time for restorative treatment	0 minutes	25 minutes
Payment	€30	€55
Which treatment plan would you choose?		

Question 9

Consider the questions we asked above. On a scale from 1 to 7 indicate how much you agree with the following statements (7=strongly agree, 1=strongly disagree)

a) I understood the questions

q 1	q 2	q 3	q 4	q 5	q 6	q 7

b) I understood the features of each treatment plan

q 1	q 2	q 3	q 4	q 5	q 6	q 7

c) The hypothetical patient cases were realistic

q 1	q 2	q 3	q 4	q 5	q 6	q 7

d) All the important information I needed was there

q 1	q 2	q 3	q 4	q 5	q 6	q 7

Question 10

Was there anything you found difficult to understand? q Yes q No

If yes, what was it?

Was any information missing which would be vital for your decision? q Yes q No

If yes, what was it?

Are there any other features that would strongly influence your decision about what dental treatment plan to choose? q Yes q No

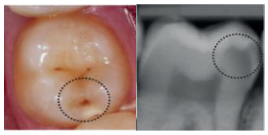
If yes, what?

Do you have any other comments?

Question 1

Which treatment plan would you choose in this case?

Imagine you are a dentist treating an 18-35 years old patient with low risk of developing caries in a dental appointment. You have decided there is caries which requires treatment in the occlusal surface (see picture and radiograph below).

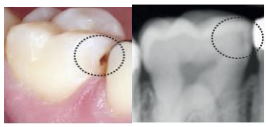


Characteristics	Treatment plan A	Treatment plan B
Time for preventive treatment	7.5 minutes	0 minutes
Time for preventive advice	8 minutes	8 minutes
Time for restorative treatment	35 minutes	0 minutes
Payment	€85	€30
Which treatment plan would you choose?		

Question 2

Which treatment plan would you choose in this case?

Imagine you are a dentist treating a 55+ years old patient with high risk of developing caries in a dental appointment. You have decided there is caries which requires treatment in the distal occlusal surface (see picture and radiograph below).

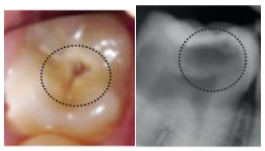


Characteristics	Treatment plan A	Treatment plan B
Time for preventive treatment	5 minutes	5 minutes
Time for preventive advice	12 minutes	12 minutes
Time for restorative treatment	35 minutes	15 minutes
Payment	€55	€70
Which treatment plan would you choose?		

Question 3

Which treatment plan would you choose in this case?

Imagine you are a dentist treating a 55+ years old patient with moderate risk of developing caries in a dental appointment. You have decided there is caries which requires treatment in the distal occlusal surface (see picture and radiograph below).

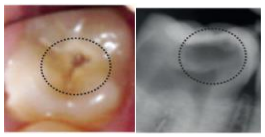


Characteristics	Treatment plan A	Treatment plan B
Time for preventive treatment	3 minutes	3 minutes
Time for preventive advice	0 minutes	3 minutes
Time for restorative treatment	25 minutes	35 minutes
Payment	€55	€70
Which treatment plan would you choose?		

Question 4

Which treatment plan would you choose in this case?

Imagine you are a dentist treating an 18-35 years old patient with moderate risk of developing caries in a dental appointment. You have decided there is caries which requires treatment in the distal occlusal surface (see picture and radiograph below).

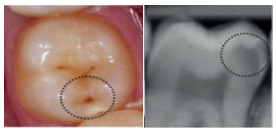


Characteristics	Treatment plan A	Treatment plan B
Time for preventive treatment	0 minutes	0 minutes
Time for preventive advice	3 minutes	8 minutes
Time for restorative treatment	15 minutes	25 minutes
Payment	€55	€55
Which treatment plan would you choose?		

Question 5

Which treatment plan would you choose in this case?

Imagine you are a dentist treating an 18-35 years old patient with high risk of developing caries in a dental appointment. You have decided there is caries which requires treatment in the occlusal surface (see picture and radiograph below).

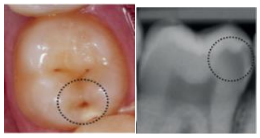


Characteristics	Treatment plan A	Treatment plan B
Time for preventive treatment	5 minutes	7.5 minutes
Time for preventive advice	8 minutes	0 minutes
Time for restorative treatment	35 minutes	0 minutes
Payment	€55	€30
Which treatment plan would you choose?		

Question 6

Which treatment plan would you choose in this case?

Imagine you are a dentist treating a 35-55 years old patient with high risk of developing caries in a dental appointment. You have decided there is caries which requires treatment in the distal occlusal surface (see picture and radiograph below).

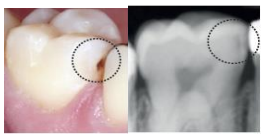


Characteristics	Treatment plan A	Treatment plan B
Time for preventive treatment	3 minutes	7.5 minutes
Time for preventive advice	12 minutes	0 minutes
Time for restorative treatment	25 minutes	15 minutes
Payment	€85	€70
Which treatment plan would you choose?		

Question 7

Which treatment plan would you choose in this case?

Imagine you are a dentist treating a 35-55 years old patient with moderate risk of developing caries in a dental appointment. You have decided there is caries which requires treatment in the distal occlusal surface (see picture and radiograph below).



Characteristics	Treatment plan A	Treatment plan B
Time for preventive treatment	3 minutes	0 minutes
Time for preventive advice	3 minutes	0 minutes
Time for restorative treatment	15 minutes	15 minutes
Payment	€55	€85
Which treatment plan would you choose?		

Question 8

Which treatment plan would you choose in this case?

Imagine you are a dentist treating a 35-55 years old patient with low risk of developing caries in a dental appointment. You have decided there is caries which requires treatment in the distal occlusal surface (see picture and radiograph below).

Characteristics	Treatment plan A	Treatment plan B
Time for preventive treatment	5 minutes	7.5 minutes
Time for preventive advice	3 minutes	12 minutes
Time for restorative treatment	25 minutes	15 minutes
Payment	€70	€55
Which treatment plan would you choose?		

Appendix 22. Syntax of D-DCE-Final design

```
Design
;alts = alt1*, alt2*
;rows = 72
;block = 9
;eff = (mnl,d)
;rep = 500
;rdraws = halton(250)

;cond:
if (alt1.restor=0, alt1.payment=20),
if (alt2.restor=0, alt2.payment=20),
if (alt1.restor>0, alt1.payment>20),
if (alt2.restor>0, alt2.payment>20)

;model:
U(alt1) = b_payment[0]*payment[20,40,60] + b_treat[0]*treat[0,4,8] +
b_adv[0]*adv[0,6,12] + b_restor[0]*restor[0,15,20]/
U(alt2) =  b_payment*payment + b_treat*treat + b_adv*adv + b_restor*restor
$
```

Appendix 23. Design of D-DCE-Final

D error	0.000478								
A error	0.000757								
Design									
Choice situation	alt1.payment	alt1.treat	alt1.adv	alt1.restor	alt2.payment	alt2.treat	alt2.adv	alt2.restor	Block
7	60	8	12	20	20	0	6	0	1
26	40	0	12	15	40	8	0	20	1
44	40	4	6	20	60	4	6	15	1
47	40	8	0	15	60	0	12	15	1
52	60	4	12	20	20	8	0	0	1
55	20	8	6	0	60	0	6	20	1
57	60	8	0	20	20	0	12	0	1
63	40	0	6	20	60	8	6	15	1
1	20	8	12	0	40	0	0	15	2
13	60	0	6	15	40	8	6	20	2
19	40	8	0	15	60	0	12	20	2
21	40	8	0	15	40	4	12	15	2
29	60	8	12	20	40	0	0	15	2
30	40	8	12	15	40	0	0	15	2
35	60	0	0	15	40	8	12	15	2
66	40	4	12	15	40	4	0	15	2
4	40	0	0	20	60	8	6	15	3
6	40	0	6	15	20	8	6	0	3
18	60	0	12	15	40	8	0	20	3
28	20	0	6	0	60	8	0	20	3
41	20	4	0	0	60	0	12	20	3
43	60	8	12	15	40	0	0	20	3
62	60	0	6	15	40	8	12	20	3
67	20	0	0	0	60	8	6	20	3
2	60	4	6	15	40	0	6	20	4
16	40	0	0	15	60	8	12	15	4
56	60	4	12	15	40	0	0	20	4
64	40	4	12	20	40	4	0	15	4
68	60	4	6	20	20	4	0	0	4
69	20	4	12	0	60	4	6	20	4
70	40	8	0	15	40	0	12	15	4
71	20	4	0	0	60	4	12	20	4
9	40	8	6	20	60	4	6	15	5
11	40	4	0	20	60	4	12	15	5
31	20	4	6	0	60	4	12	20	5
34	60	8	6	15	40	0	6	15	5
39	60	8	6	20	20	0	6	0	5
49	40	4	12	20	60	8	0	15	5
53	60	4	0	20	20	4	12	0	5

60	60	8	6	15	40	0	12	20	5
3	60	0	6	20	20	4	6	0	6
17	60	0	12	20	20	8	0	0	6
25	40	0	0	20	20	8	12	0	6
27	60	0	0	20	40	8	12	15	6
36	40	4	6	15	60	4	6	15	6
37	40	0	12	15	60	8	0	15	6
50	40	0	6	15	40	8	6	15	6
65	20	4	12	0	60	4	0	15	6
5	60	0	0	15	40	8	6	20	7
12	40	0	12	20	60	8	0	15	7
20	20	4	12	0	60	8	6	20	7
22	60	4	0	15	40	4	12	20	7
32	40	4	12	20	20	4	0	0	7
40	40	8	0	15	40	0	12	20	7
45	60	0	0	20	20	4	12	0	7
48	40	8	0	15	40	0	6	15	7
14	60	4	0	15	40	4	12	15	8
33	20	4	6	0	60	4	6	20	8
38	60	0	6	15	40	4	6	20	8
46	20	0	6	0	60	4	6	20	8
51	40	4	0	20	60	0	12	15	8
58	40	8	6	20	40	0	6	15	8
61	20	8	12	0	60	4	0	20	8
72	60	0	6	20	20	8	12	0	8
8	20	8	12	0	60	0	0	20	9
10	60	8	6	15	40	4	6	20	9
15	40	8	12	20	60	0	0	15	9
23	60	0	6	15	40	8	0	20	9
24	20	4	0	0	60	8	12	20	9
42	40	8	0	20	20	0	12	0	9
54	60	8	12	20	20	0	0	0	9
59	60	4	12	20	40	4	0	15	9

Appendix 24. Correlation between attributes in the D-DCE-Final design

	alt1.payment	alt1.prev.treat	alt1.prev.adv	alt1.restor.treat	alt2.payment	alt2.prev.treat	alt2.prev.adv	alt2.restor.treat
alt1.payment	1.00	-0.09	-0.02	0.77	-0.67	0.00	0.02	-0.38
alt1.prev.treat	-0.09	1.00	0.08	-0.03	0.00	-0.83	0.00	0.01
alt1.prev.adv	-0.02	0.08	1.00	-0.05	-0.02	0.00	-0.85	0.00
alt1.restor.treat	0.77	-0.03	-0.05	1	-0.55	0.00	0.01	-0.53
alt2.payment	-0.67	0.00	-0.02	-0.55	1.00	0.07	0.00	0.77
alt2.prev.treat	0.00	-0.83	0.00	0.00	0.07	1.00	-0.06	0.01
alt2.prev.adv	0.02	0.00	-0.85	0.01	0.00	-0.06	1.00	-0.02
alt2.restor.treat	-0.38	0.01	0.00	-0.53	0.77	0.01	-0.02	1.00

Appendix 25. D-DCE-Final-Block 1

Dental preferences of oral disease prevention

Introduction

This survey is assessing what features dentists prefer when providing dental treatment. Please read through and answer the following questions. There are no right or wrong answers. We are interested in your own honest, personal opinions.

This questionnaire is organised into two parts.

The first part asks you to provide some demographic information about you and your practice within the dental profession.

The second part presents you with eight scenarios. You will then be asked in each scenario to select out of two possible treatment plans which one you would provide to this patient. For each scenario we would like you to imagine you are seeing a patient of a specific age, having an either low, moderate or high risk of developing new caries and the clinical condition shown in the photograph and radiograph provided. You will be given two treatment plan options for that patient and required to choose which plan you would like to provide based on the options presented.

Demographics Part A

What is your gender?

- Male
- Female
- Other/Prefer not to say

How old are you?

Which country did you undertake your dentistry undergraduate qualification?

Which of these most accurately describes your NHS/Health service working arrangements at the moment?

- Principal/Providing-Performer
- Associate
- Partner
- Provider only
- Other

If you selected other, please specify:

On average, how was your time spent between NHS/Health Service and private work in 2018?

- Mainly private (0-25% - NHS share) Mixed
- (>25% and <75% - NHS share) Mainly NHS
- (75-100% - NHS share) 100%
- NHS
- 100% Private

What is your working status?

- I work full time (35 hours per week)
- I work part time (<35 hours per week) I
- work more than 35 hours per week

On average, what percentage of your patients are under 18 years of age?

- 1 - 24%
- 25 - 49%
- 50 - 74%
- 75% or more

On average, what percentage of your patients are exempt from payment?

- 1 - 24%
- 25 - 49%
- 50 - 74%
- 75% or more

When did you officially graduate/qualify as a dentist?

How many full time dentists are working with you in the same practice?

How many full time dental hygienists are working with you in the same practice?

How many full time dental therapists are working with you in the same practice?

How many full time dental nurses are working with you in the same practice?

Where is the practice you are currently working with?

- England
- Scotland
- Ireland
- Wales

Demographics Part B

How often do you give tooth brushing advice to your adult patients?

- Never
- Sometimes
- Usually
- Always

How often do you demonstrate tooth brushing to your adult patients?

- Never
- Sometimes
- Usually
- Always

How often do you give dietary advice to your adult patients?

- Never
- Sometimes
- Usually
- Always

How often do you apply fluoride varnish to your adult patients?

- Never
- Sometimes
- Usually
- Always

How often do you place preventive fissure sealants to your adult patients?

- Never
- Sometimes
- Usually
- Always

How often do you check existing fissure sealants at each recall visit for your adult patients?

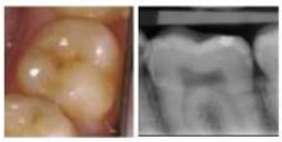
- Never
- Sometimes
- Usually
- Always

For each scenario we would like you to imagine you are seeing a patient of a specific **age**, having an either low, moderate or high **risk of developing new caries** and the clinical condition shown in the **photograph** and **radiograph** provided. You will be given two **treatment plan** options for that patient and **required to choose** which plan you would like to provide **based on the options presented**. Here follows a description of patient and treatment level options you will see in each scenario. Please read through the table before answering the questions. This first scenario below serves just as an example to show you how to complete the rest of the choices in the following pages.

Options	Descriptions
Patient level	
Patient's age	Age of the patient you are seeing.
Risk of developing new caries	The overall risk of developing caries for the entire mouth of the patient as assessed by a number of criteria including: **frequent or prolonged consumption of sugary foods and drinks between meal exposures per day**, **3 or more carious lesions or restorations in last 36 months**, **teeth missing due to caries in the past 36 months**, **severe dry mouth (xerostomia)**. **High risk of developing caries** corresponds to a patient who satisfies at least one of the above criteria. A **moderate risk of developing caries** describes a patient with at least one of the following features: **no fluoride exposure**, **no previous established dental record consisting of regular dental care in the dental office**, **special health care needs impeding taking care of her own oral health**, **eating disorders**, **medications that reduce salivary flow**, **drug / alchohol abuse**, **1 or 2 new carious lesions or restorations in last 36 months** and **visible plaque**. Patients with no such conditions belonging to the two categories above are grouped into the **low risk of developing caries** class. Risk assessment of developing caries **does not** include the case showing up in the corresponding photograph and radiograph.
Photograph and radiograph	Photograph and radiograph of the surface you are called to consider for treatment.
Treatment level	
Time for preventive treatment	Time spent on preventive treatment for the entire mouth, e.g. application of fluoride varnish and fissure sealants and provision of information to the patient relating to its significance. In addition, time spent on prescribing and explaining the importance of high concentration fluoride toothpastes and fluoride rinses in whichever case such prescriptions are judged necessary.
Time for preventive advice	Time spent on dental related dietary and hygiene advice, e.g design and explanation of a personalised plan to the patient to help maintain good oral health and help with proper teeth brushing and flossing techniques.
Time for restorative treatment	Time spent on restorative treatment in relation to the photograph and radiograph, e.g. filling and drilling.
Payment	The amount of money you receive for delivering the relevant treatment plan, i.e. income including pensionable earnings.

Example choice

You are seeing a **55** year old patient, with a **low** risk of developing new caries in their mouth.
You are seeing this patient in a **dental check-up appointment.**
Imagine you have undertaken clinical and radiographic examination before you choose a treament plan.
The photo and radiograph below show the condition of the one tooth which might require treatment.



Which treatment plan would you choose?
You have to choose only between the two plans shown.

	Treatment plan A	Treatment plan B
Time for preventive treatment	8 minutes	0 minutes
Time for preventive advice	12 minutes	6 minutes
Time for restorative treatment	20 minutes	0 minutes
Payment	£60	£20

If you prefer Treatment Plan B, then choose that option below as shown. Please now continue with answering the scenario questions in the following pages.

- ○ Treatment plan A
- ◉ Treatment plan B

Choice 1

You are seeing a **55** year old patient, with a **low** risk of developing new caries in their mouth.
You are seeing this patient in a **dental check-up appointment.**
Imagine you have undertaken clinical and radiographic examination before you choose a treament plan.
The photo and radiograph below show the condition of the one tooth which might require treatment.

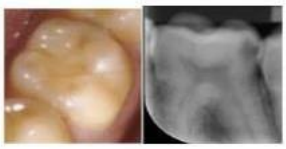
Which treatment plan would you choose?
You have to choose only between the two plans shown.

	Treatment plan A	Treatment plan B
Time for preventive treatment	8 minutes	0 minutes
Time for preventive advice	12 minutes	6 minutes
Time for restorative treatment	20 minutes	0 minutes
Payment	£60	£20

- Treatment plan A
- Treatment plan B

Choice 2

You are seeing a **55** year old patient, with a **high** risk of developing new caries in their mouth.
You are seeing this patient in a **dental check-up appointment.**
Imagine you have undertaken clinical and radiographic examination before you choose a treament plan.
The photo and radiograph below show the condition of the one tooth which might require treatment.



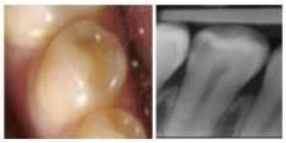
Which treatment plan would you choose?
You have to choose only between the two plans shown.

	Treatment plan A	Treatment plan B
Time for preventive treatment	0 minutes	8 minutes
Time for preventive advice	12 minutes	0 minutes
Time for restorative treatment	15 minutes	20 minutes
Payment	£40	£40

- Treatment plan A
- Treatment plan B

Choice 3

You are seeing a **24** year old patient, with a **moderate** risk of developing new caries in their mouth.
You are seeing this patient in a **dental check-up appointment.**
Imagine you have undertaken clinical and radiographic examination before you choose a treament plan.
The photo and radiograph below show the condition of the one tooth which might require treatment.



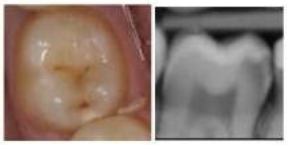
Which treatment plan would you choose?
You have to choose only between the two plans shown.

	Treatment plan A	Treatment plan B
Time for preventive treatment	4 minutes	4 minutes
Time for preventive advice	6 minutes	6 minutes
Time for restorative treatment	20 minutes	15 minutes
Payment	£40	£60

- Treatment plan A
- Treatment plan B

Choice 4

You are seeing a **55** year old patient, with a **moderate** risk of developing new caries in their mouth.
You are seeing this patient in a **dental check-up appointment.**
Imagine you have undertaken clinical and radiographic examination before you choose a treament plan.
The photo and radiograph below show the condition of the one tooth which might require treatment.



Which treatment plan would you choose?
You have to choose only between the two plans shown.

	Treatment plan A	Treatment plan B
Time for preventive treatment	8 minutes	0 minutes
Time for preventive advice	0 minutes	12 minutes
Time for restorative treatment	15 minutes	15 minutes
Payment	£40	£60

- Treatment plan A
- Treatment plan B

Choice 5

You are seeing a **55** year old patient, with a **low** risk of developing new caries in their mouth.
You are seeing this patient in a **dental check-up appointment.**
Imagine you have undertaken clinical and radiographic examination before you choose a treament plan.
The photo and radiograph below show the condition of the one tooth which might require treatment.

Which treatment plan would you choose?
You have to choose only between the two plans shown.

	Treatment plan A	Treatment plan B
Time for preventive treatment	4 minutes	8 minutes
Time for preventive advice	12 minutes	0 minutes
Time for restorative treatment	20 minutes	0 minutes
Payment	£60	£20

- Treatment plan A
- Treatment plan B

Choice 6

You are seeing a **75** year old patient, with a **high** risk of developing new caries in their mouth.
You are seeing this patient in a **dental check-up appointment.**
Imagine you have undertaken clinical and radiographic examination before you choose a treament plan.
The photo and radiograph below show the condition of the one tooth which might require treatment.

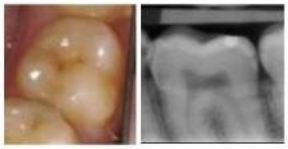
Which treatment plan would you choose?
You have to choose only between the two plans shown.

	Treatment plan A	Treatment plan B
Time for preventive treatment	8 minutes	0 minutes
Time for preventive advice	6 minutes	6 minutes
Time for restorative treatment	0 minutes	20 minutes
Payment	£20	£60

- Treatment plan A
- Treatment plan B

Choice 7

You are seeing a **24** year old patient, with a **high** risk of developing new caries in their mouth.
You are seeing this patient in a **dental check-up appointment.**
Imagine you have undertaken clinical and radiographic examination before you choose a treament plan.
The photo and radiograph below show the condition of the one tooth which might require treatment.



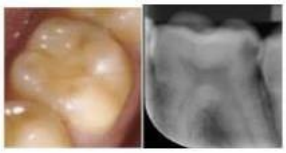
Which treatment plan would you choose?
You have to choose only between the two plans shown.

	Treatment plan A	Treatment plan B
Time for preventive treatment	8 minutes	0 minutes
Time for preventive advice	0 minutes	12 minutes
Time for restorative treatment	20 minutes	0 minutes
Payment	£60	£20

- Treatment plan A
- Treatment plan B

Choice 8

You are seeing a **24** year old patient, with a **low** risk of developing new caries in their mouth.
You are seeing this patient in a **dental check-up appointment.**
Imagine you have undertaken clinical and radiographic examination before you choose a treament plan.
The photo and radiograph below show the condition of the one tooth which might require treatment.



Which treatment plan would you choose?
You have to choose only between the two plans shown.

	Treatment plan A	Treatment plan B
Time for preventive treatment	0 minutes	8 minutes
Time for preventive advice	6 minutes	6 minutes
Time for restorative treatment	20 minutes	15 minutes
Payment	£40	£60

- Treatment plan A
- Treatment plan B

Feedback

Consider the questions we asked above. On a scale from 1 to 7 indicate how much you agree with the following statements (1=strongly disagree, 7=strongly agree).

I understood the questions.

I understood the options of each scenario.

The hypothetical treatment plans were realistic.

All the important information I needed was there.

Was there anything you found difficult to understand?

- Yes
- No

If yes, what was it?

Was any information missing which would be **vital** for your decision?

- Yes
- No

If yes, what was it?

Please provide any additional comment you might have here.

Please provide your email address if you would like feedback on this survey.

Please contract Evangelos Zormpas with any questions or queries: **dnez@leeds.ac.uk**

Thank you a lot for participating in our survey!

Appendix 26. R Code of main model with patient interactions in the dentist DCE study

```
library(apollo)

################################################################## #

#### LOAD LIBRARY AND DEFINE CORE SETTINGS
####

# ################################################################
#

setwd("")

### Clear memory

rm(list = ls())


### Initialise code

apollo_initialise()


### Set core controls

apollo_control = list(

  modelName ="MAIN MIXED LOGIT MODEL",

  modelDescr ="MAIN MIXED LOGIT MODEL",

  indivID ="ID",

  mixing = TRUE,

  nCores = 4,

  analyticGrad = TRUE


)

# ################################################################
#

#### LOAD DATA AND APPLY ANY TRANSFORMATIONS
####

# ################################################################
#

database<-readRDS(file ="database.Rds")

# ################################################################
#
```

```
#### DEFINE MODEL PARAMETERS
####

# ##################################################################
#

### Vector of parameters, including any that are kept fixed in
estimation

apollo_beta=c(


  b_prev_constant_mu=0,

  b_prev_moderate_caries_risk_mu=0,

  b_prev_low_caries_risk_mu=0,

  b_prev_55_years_old_mu=0,

  b_prev_24_ years_old_mu=0,

  b_prev_pics_group_B_mu=0,


  sigma_prev_constant =0,

  sigma_prev_moderate_caries_risk =0,

  sigma_prev_low_caries_risk =0,

  sigma_prev_55_years_old =0,

  sigma_prev_24_ years_old =0,

  sigma_prev_pics_group_B =0,


  b_prev_a_constant_mu=0,

  b_prev_a_moderate_caries_risk_mu=0,

  b_prev_a_low_caries_risk_mu=0,

  b_prev_a_55_years_old_mu=0,

  b_prev_a_24_ years_old_mu=0,

  b_prev_a_pics_group_B_mu=0,


  sigma_prev_a_constant =0,

  sigma_prev_a_moderate_caries_risk =0,

  sigma_prev_a_low_caries_risk =0,

  sigma_prev_a_55_years_old =0,
```

```
sigma_prev_a_24_ years_old =0,
sigma_prev_a_pics_group_B =0,

 b_rest_constant_mu=0,
 b_rest_moderate_caries_risk_mu=0,
 b_rest_low_caries_risk_mu=0,
 b_rest_55_years_old_mu=0,
 b_rest_24_ years_old_mu=0,
 b_rest_pics_group_B_mu=0,

 sigma_rest_constant =0,
 sigma_rest_moderate_caries_risk =0,
 sigma_rest_low_caries_risk =0,
 sigma_rest_55_years_old =0,
 sigma_rest_24_ years_old =0,
 sigma_rest_pics_group_B =0,

 b_inc_constant_mu=0,
 b_inc_moderate_caries_risk_mu=0,
 b_inc_low_caries_risk_mu=0,
 b_inc_55_years_old_mu=0,
 b_inc_24_ years_old_mu=0,
 b_inc_pics_group_B_mu=0,

 sigma_inc_constant =0,
 sigma_inc_moderate_caries_risk =0,
 sigma_inc_low_caries_risk =0,
 sigma_inc_55_years_old =0,
 sigma_inc_24_ years_old =0,
 sigma_inc_pics_group_B =0
 )
```

```
### Vector with names (in quotes) of parameters to be kept fixed at
their starting value in apollo_beta, use apollo_beta_fixed = c() if
none

apollo_fixed = c()

# ##################################################################
#

#### DEFINE RANDOM COMPONENTS
####

# ##################################################################
#

### Set parameters for generating draws

apollo_draws = list(

  interDrawsType = "mlhs",

  interNDraws    = 100,

  interUnifDraws = c(),

  interNormDraws =
c("draws_prev","draws_prev_a","draws_rest","draws_inc")

)


### Create random parameters

apollo_randCoeff = function(apollo_beta, apollo_inputs){

randcoeff = list()


randcoeff[["b_prev_con"]] = (b_prev_constant_mu

                      + sigma_prev_constant * draws_prev)


randcoeff[["b_prev_moderate_caries_risk"]] =

                           (b_prev_moderate_caries_risk_mu

                    + sigma_prev_moderate_caries_risk * draws_prev)


  randcoeff[["b_prev_low_caries_risk"]] =

                           (b_prev_low_caries_risk_mu

                    + sigma_prev_low_caries_risk * draws_prev)


randcoeff[["b_prev_55_years_old"]] = (b_prev_55_years_old_mu
```

```
                    + sigma_prev_55_years_old * draws_prev)

randcoeff[["b_prev_24_years_old"]] = (b_prev_24_years_old_mu
                   + sigma_prev_24_years_old * draws_prev)



  randcoeff[["b_prev_pics_group_B"]] = (b_prev_pics_group_B_mu
                   + sigma_prev_pics_group_B * draws_prev)



  randcoeff[["b_prev_a_con"]] = (b_prev_a_constant_mu
                     + sigma_prev_a_constant * draws_prev_a)

  randcoeff[["b_prev_a_moderate_caries_risk"]] =
                    (b_prev_a_moderate_caries_risk_mu
                   + sigma_prev_a_moderate_caries_risk *
                                                draws_prev_a)

  randcoeff[["b_prev_a_low_caries_risk"]] =
                    (b_prev_a_low_caries_risk_mu
                   + sigma_prev_a_low_caries_risk * draws_prev_a)

  randcoeff[["b_prev_a_55_years_old"]] = (b_prev_a_55_years_old_mu
                    + sigma_prev_a_55_years_old * draws_prev_a)

  randcoeff[["b_prev_a_24_years_old"]] = (b_prev_a_24_years_old_mu
                   + sigma_prev_a_24_years_old * draws_prev_a)

  randcoeff[["b_prev_a_pics_group_B"]] = (b_prev_a_pics_group_B_mu
                   + sigma_prev_a_pics_group_B * draws_prev_a)
```

```
randcoeff[["b_rest_con"]] = (b_rest_constant_mu
                     + sigma_rest_constant * draws_rest)

randcoeff[["b_rest_moderate_caries_risk"]] =
                    (b_rest_moderate_caries_risk_mu
                    + sigma_rest_moderate_caries_risk *
                                                draws_rest)

randcoeff[["b_rest_low_caries_risk"]] =
                    (b_ rest_low_caries_risk_mu
                   + sigma_rest_low_caries_risk * draws_rest)

randcoeff[["b_rest_55_years_old"]] = (b_rest_55_years_old_mu
                    + sigma_rest_55_years_old * draws_rest)

randcoeff[["b_rest_24_years_old"]] = (b_rest_24_years_old_mu
                   + sigma_rest_24_years_old * draws_rest)

randcoeff[["b_rest_pics_group_B"]] = (b_rest_pics_group_B_mu
                   + sigma_rest_pics_group_B * draws_rest)

randcoeff[["b_inc_con"]] = (b_inc_constant_mu
                     + sigma_inc_constant * draws_inc)

randcoeff[["b_inc_moderate_caries_risk"]] =
                    (b_inc_moderate_caries_risk_mu
                    + sigma_inc_moderate_caries_risk *
                                                draws_inc)
randcoeff[["b_inc_low_caries_risk"]] =
                    (b_ inc_low_caries_risk_mu
                   + sigma_inc_low_caries_risk * draws_inc)
```

```
  randcoeff[["b_inc_55_years_old"]] = (b_inc_55_years_old_mu
                      + sigma_inc_55_years_old * draws_inc)

  randcoeff[["b_inc_24_years_old"]] = (b_inc_24_years_old_mu
                     + sigma_inc_24_years_old * draws_inc)

  randcoeff[["b_inc_pics_group_B"]] = (b_inc_pics_group_B_mu
                     + sigma_inc_pics_group_B * draws_inc)

return(randcoeff)
}

# ################################################################
#
#### GROUP AND VALIDATE INPUTS
####
# ################################################################
#

apollo_inputs = apollo_validateInputs()

# ################################################################
#

#### DEFINE MODEL AND LIKELIHOOD FUNCTION
####
# ################################################################
#

apollo_probabilities=function(apollo_beta, apollo_inputs,
functionality="estimate"){

  ### Attach inputs and detach after function exit
  apollo_attach(apollo_beta, apollo_inputs)
  on.exit(apollo_detach(apollo_beta, apollo_inputs))
```

```
  ### Create list of probabilities P
  P = list()

b_prev_caries_risk = b_prev_low_caries_risk *risk.A +
                                  b_prev_moderate_caries_risk *risk.B

b_prev_age = b_prev_24_years_old *age.A + b_prev_55_years_old *age.B

b_prev_pics =b_prev_pics_group_B * pic.Group.B

b_prev= b_prev_con + b_prev_caries_risk +b_prev_age + b_prev_pics
#####################################################################
b_prev_a_caries_risk = b_prev_a_low_caries_risk *risk.A +
                            b_prev_a_moderate_caries_risk *risk.B

b_prev_a_age = b_prev_a_24_years_old *age.A + b_prev_a_55_years_old
                                                              *age.B

b_prev_a_pics =b_prev_a_pics_group_B * pic.Group.B

b_prev_a= b_prev_a_con + b_prev_a_caries_risk +b_prev_a_age +
                                                        b_prev_a_pics
#####################################################################
b_rest_caries_risk = b_rest_low_caries_risk *risk.A +
                            b_rest_moderate_caries_risk *risk.B

b_rest_age = b_rest_24_years_old *age.A + b_rest_55_years_old *age.B

b_rest_pics =b_rest_pics_group_B * pic.Group.B

b_rest= b_rest_con + b_rest_caries_risk +b_rest_age + b_rest_pics
```

```
#################################################################
b_inc_caries_risk = b_inc_low_caries_risk *risk.A +
                            b_inc_moderate_caries_risk *risk.B

b_inc_age = b_inc_24_years_old *age.A + b_inc_55_years_old *age.B

b_inc_pics =b_inc_pics_group_B * pic.Group.B

b_inc= b_inc_con + b_inc_caries_risk +b_inc_age + b_inc_pics

  ### List of utilities: these must use the same names as in
mnl_settings, order is irrelevant
  V = list()

V[['treat_A']]=b_prev * prev1 + b_prev_a * prev.a1+ b_rest * rest1+
b_inc * inc1
V[['treat_B']]=b_prev * prev2 + b_prev_a * prev.a2+ b_rest * rest2+
b_inc * inc2

### Define settings for MNL model component
  mnl_settings = list(
    alternatives  = c(treat_A=1,treat_B=2),
    avail         = list(treat_A=1,treat_B=1),
    choiceVar     = choices,
    V             = V
  )

  ### Compute probabilities using MNL model
  P[['model']] = apollo_mnl(mnl_settings, functionality)

  ### Take product across observation for same individual
  P = apollo_panelProd(P, apollo_inputs, functionality)
```

```
### Average across inter-individual draws
  P = apollo_avgInterDraws(P, apollo_inputs, functionality)


  ### Prepare and return outputs of function
  P = apollo_prepareProb(P, apollo_inputs, functionality)
  return(P)
}


# ##################################################################
#
#### MODEL ESTIMATION
####
# ##################################################################
#


model = apollo_estimate(apollo_beta, apollo_fixed,
apollo_probabilities, apollo_inputs)


# ##################################################################
#
#### MODEL OUTPUTS
####
# ##################################################################
#


# ----------------------------------------------------------------
#
#---- FORMATTED OUTPUT (TO SCREEN)                               ---
-
# ----------------------------------------------------------------
#


modelOutput_settings<-list(
  printPVal=2
)
apollo_modelOutput(model,
```

```
                    modelOutput_settings)


# ------------------------------------------------------------------
#
#---- FORMATTED OUTPUT (TO FILE, using model name)                ---
-
# ------------------------------------------------------------------
#


saveOutput_settings<-list(
  printPVal=2
)


apollo_saveOutput(model,saveOutput_settings)
```

Appendix 27. PES

1. *This table shows some factors which might be important to you to increase prevention when visiting the dentist, in order to maintain a healthy mouth. Please have a quick read through the table as a discussion will follow on how significant you perceive each of these factors to be in your decision to visit the dentist for prevention and what levels you would propose for each one of them.*	**Description**	**Levels**
Out of pocket expenses	Extra cost for paying for the dental visit	Currently a dental check-up visit with NHS costs approximately £20
Co-payment option	What proportion of a dental check-up cost would you prefer to be reimbursed from the public insurance system, i.e. the NHS?	
Committed time in preventive care	What would be the ideal duration of a dental check-up appointment?	
Waiting time for the appointment	What would be a proper waiting time for attending a dental check-up appointment since the booking time?	One day/ One week/ One month
Dentist's communication skills	How would you describe your dentist's communication skills?	Good/ Average/ Poor
Frequency of dental check-up visits within a year time	How many dental check-up visits per year would you feel would enhance your oral disease prevention?	One/ Two/ Three
Dental provider	Who else apart from your dentist would you trust to deliver prevention during your dental check-up appointment?	Dental hygienist/ therapist/ nurse
Transportation -travel time	Have you experienced any transportation issues in visiting the dentist?	Time/ money/ distance

Preventive treatment	Would either the type and/or amount of preventive treatment affect your dental attendance in relation to prevention?	Not at all/ a little/ moderately/ a lot
Preventive advice	How would you describe the advice on prevention you received in your last dental check-up visit?	Little/ some/ good or tailored and detailed advice on prevention
2. *Would there be any additional factors you regard important to increase prevention when visiting the dentist, please report them here alongside their suitable levels.*		

Appendix 28. Ranking exercise

A. Below are a list of factors which may be important to you when deciding which dental practice to register with. Please read through each factor and imagine that you are trying to find a new practice to register with. Rank each factor in order of which would be the most important to you. Please use each number once only.

Please pick one number on the 1-8 scale. 1 is the least important factor and 8 is the most important. You can only use each number once. NOTE: 'Out of pocket expenses' refers to the cost of the dental visit. 'Family appointment' refers to the availability of appointments for the whole family in one visit. 'Transportation-travel time' refers to getting to the dentist. 'Communication skills' refers to the communication skills of the dentist (e.g. how they speak to you and inform you of your needs). 'Minutes of dietary advice' refers to the amount of time spent giving you dietary advice. 'Minutes of hygiene advice' refers to the amount of time spent giving you hygiene advice. 'The person who provides the prevention' refers to whether the prevention is provided by the dentist or by a dental hygienist. 'Waiting time for an appointment' refers to the amount of time you have to wait between making the appointment and having the appointment.

Out of pocket expenses ☐

Family appointment ☐

Transportation-travel time ☐

Communication skills ☐

Minutes of dietary advice ☐

Minutes of hygiene advice ☐

The person who provides the prevention ☐

Waiting time for an appointment ☐

B. For each factor below please can you give three levels to describe the factor? For example, for 'out of pocket expenses' what would be the average cost you would be willing to pay, what would be the highest cost you would be willing to pay and what would be the lowest cost you would be willing to pay? For 'minutes of dietary advice' what would be the average amount of time you would expect to be spent on dietary advice in the consultation? What would be the maximum amount of time acceptable to you to be spent on dietary advice, and what would be the minimum amount of time you would find acceptable to be spent on dietary advice?

Factors	**What would be the lowest value for this factor?**	**What would be the average value for this factor?**	**What would be the highest value for this factor?**
Out of pocket expenses- Cost in £			
Transportation- Minutes			
Minutes of dietary advice- Minutes			
Minutes of hygiene advice- Minutes			
Waiting time for an appointment- Days or weeks			

C. For each factor below please can you describe a description of a best and worst scenario? For example for family appointments the best might be 'children can come to any appointment with an adult' and worst might be 'children cannot attend an adult's appointment'.

Factors	**Please describe the worst outcome for this factor**	**Please describe the best outcome for this factor**
Communication skills of dentist		
The person who provides the prevention		
Family appointments		

Appendix 29. P-DCE1

We are preparing to do a survey looking at what features people prefer when signing up to a new dental practice. Before doing our survey, we want to test out a few questions. That's why we'd like your opinions on how understandable and meaningful they are. Please read through and answer the following questions. There are no right or wrong answers. We are interested in your own honest, personal opinions.

In each of the questions below, imagine you are going to register with a dental practice. You will be shown the features of a typical check-up appointment for two hypothetical dental practices. Based on these features, you should choose which you would register with. Imagine there are no options available apart from the two practices shown. Assume the practices are identical apart from the described features.

Descriptions of dental practice features

Out-of-pocket cost	Average out-of-pocket-cost per check-up visit
Travel time	Length of time it takes to get to the practice
Time for dietary advice	Average amount of time in each check-up spent on dental related dietary advice, **e.g. a personalised diet plan to help maintain good oral health**
Time for dental hygiene advice	Average amount of time in each check-up spent on dental/oral hygiene advice**, e.g. help with proper teeth brushing technique.**
Time for preventive treatment	Average time spent on preventive treatment, **e.g. fluoride varnish treatment which helps prevent tooth decay**
Waiting time for an appointment	Typical time you wait for an appointment after trying to book one
Text/email reminders	Whether practice sends you text/email reminders before a check-up appointment

Question 1

Characteristics	Dental practice 1	Dental practice 2
Out-of-pocket cost	**£50**	**£20**
Travel time	**15 minutes**	**45 minutes**
Time for dietary advice	**3 minutes**	**9 minutes**
Time for dental hygiene advice	**12 minutes**	**3 minutes**
Time for preventive treatment	**7.5 minutes**	**0 minutes**
Waiting time for an appointment	**10 days**	**15 days**
Text/email reminders	**Dental hygienist**	**Dentist**
I choose	Practice 1	Practice 2

Question 2

Characteristics	Dental practice 1	Dental practice 2
Out-of-pocket cost	**£100**	**£20**
Travel time	**30 minutes**	**15 minutes**
Time for dietary advice	**0 minutes**	**3 minutes**
Time for dental hygiene advice	**6 minutes**	**12 minutes**
Time for preventive treatment	**3 minutes**	**5 minutes**
Waiting time for an appointment	**1 day**	**15 days**
Text/email reminders	**Dental therapist**	**Dental hygienist**
I choose	Practice 1	Practice 2

Question 3

Consider the questions we asked above. On a scale from 1 to 7 indicate how much you agree with the following statements (7=strongly agree, 1=strongly disagree)

e) I understood the questions

q 1	q 2	q 3	q 4	q 5	q 6	q 7

f) I understood the features of each practice

q 1	q 2	q 3	q 4	q 5	q 6	q 7

g) The hypothetical dental practices were realistic

q 1	q 2	q 3	q 4	q 5	q 6	q 7

h) All the important information I needed was there

q 1	q 2	q 3	q 4	q 5	q 6	q 7

Question 4

Was there anything you found difficult to understand? q Yes q No

If yes, what was it?

Was any information missing which would be vital for your decision? q Yes q No

If yes, what was it?

Are there any other features that would strongly influence your decision about what dental practice to choose? q Yes q No

If yes, what?

Do you have any other comments?

Appendix 30. P-DCE2

We are preparing to do a survey looking at what features people prefer when signing up to a new dental practice. Before doing our survey, we want to test out a few questions. That's why we'd like your opinions on how understandable and meaningful they are. Please read through and answer the following questions. There are no right or wrong answers. We are interested in your own honest, personal opinions.

In each of the questions below, imagine you are going to register with a dental practice. You will be shown the features of a typical check-up appointment for two hypothetical dental practices. Based on these features, you should choose which you would register with. Imagine there are no options available apart from the two practices shown. Assume the practices are identical apart from the described features.

Descriptions of dental practice features

Out-of-pocket cost	Average out-of-pocket-cost per check-up visit
Travel time	Length of time it takes to get to the practice
Time for dietary advice	Average amount of time in each check-up spent on dental related dietary advice, **e.g. a personalised diet plan to help maintain good oral health**
Time for dental hygiene advice	Average amount of time in each check-up spent on dental/oral hygiene advice**, e.g. help with proper teeth brushing technique.**
Time for preventive treatment	Average time spent on preventive treatment, **e.g. fluoride varnish treatment which helps prevent tooth decay**
Waiting time for an appointment	Typical time you wait for an appointment after trying to book one
Text/email reminders	Whether practice sends you text/email reminders before a check-up appointment

Descriptions of responsibilities of dental professionals

Dentists: Registered dental professionals who can carry out all of the treatments.

Dental therapists: Registered dental professionals who carry out certain items of dental treatment direct to patients or under prescription from a dentist.

Dental hygienists: Registered dental professionals who help patients maintain their oral health by promoting good oral health practice.

Dental nurses: Registered dental professionals who provide clinical and other support to patients.

Question 1

Which dental practice would you choose?

Characteristics	Dental practice 1	Dental practice 2
Out-of-pocket cost	**£50**	**£20**
Travel time	**45 minutes**	**15 minutes**
Time for dietary advice	**3 minutes with the dental hygienist**	**9 minutes with the dentist**
Time for dental hygiene advice	**12 minutes with the dental hygienist**	**3 minutes with the dentist**
Time for preventive treatment	**7.5 minutes with the dental hygienist**	**0 minutes**
Waiting time for an appointment	**10 days**	**15 days**
Text/email reminders	**Yes**	**No**
I choose	q Practice 1	q Practice 2

Question 2

Which dental practice would you choose?

Characteristics	Dental practice 1	Dental practice 2
Out-of-pocket cost	**£100**	**£20**
Travel time	**30 minutes**	**15 minutes**
Time for dietary advice	**3 minutes with the dental nurse**	**0 minutes**
Time for dental hygiene advice	**12 minutes with the dental nurse**	**6 minutes with the dental hygienist**
Time for preventive treatment	**3 minutes with the dental nurse**	**5 minutes with the dental hygienist**
Waiting time for an appointment	**1 day**	**15 days**
Text/email reminders	**Yes**	**No**
I choose	q Practice 1	q Practice 2

Question 3

Consider the questions we asked above. On a scale from 1 to 7 indicate how much you agree with the following statements (7=strongly agree, 1=strongly disagree)

i) I understood the questions

q	q	q	q	q	q	q
1	2	3	4	5	6	7

j) I understood the features of each practice

q	q	q	q	q	q	q
1	2	3	4	5	6	7

k) The hypothetical dental practices were realistic

q	q	q	q	q	q	q
1	2	3	4	5	6	7

l) All the important information I needed was there

q	q	q	q	q	q	q
1	2	3	4	5	6	7

Question 4

Was there anything you found difficult to understand? q Yes q No

If yes, what was it?

Was any information missing which would be vital for your decision? q Yes q No

If yes, what was it?

Are there any other features that would strongly influence your decision about what dental practice to choose? q Yes q No

If yes, what?

Do you have any other comments?

Appendix 31. Design of P-DCE3

MNL efficiency measures																		
D error	0.011252																	
A error	0.143229																	
Design																		
Choice situation	alt1.cost	alt1.travel	alt1.diet	alt1.hyge	alt1.fluo	alt1.wait	alt1.email	alt1.online	alt2.cost	alt2.travel	alt2.diet	alt2.hyge	alt2.fluo	alt2.wait	alt2.email	alt2.online	Block
1	100	15	6	12	3	1	1	0	50	30	3	0	3	0	0	1	1
2	75	45	6	12	7.5	1	0	1	100	45	9	6	3	0	1	1	1
3	50	45	6	3	5	1	1	0	75	30	9	0	0	1	1	1	1
4	75	15	0	3	3	15	1	1	50	30	3	12	0	15	1	0	1
5	75	15	3	0	5	10	0	0	50	45	3	6	5	15	1	1	1
6	75	30	9	6	7.5	10	0	0	100	30	0	3	5	0	0	0	1
7	100	45	9	12	0	10	0	1	50	15	0	6	7.5	15	0	1	1
8	75	15	6	6	0	0	1	0	100	45	0	0	7.5	10	1	0	1
9	50	15	6	3	0	10	0	1	100	45	3	3	0	15	0	0	2
10	50	45	0	0	3	1	0	0	100	15	9	6	5	1	0	1	2
11	50	15	9	0	5	0	0	0	75	15	3	3	7.5	1	1	1	2
12	75	45	6	0	5	15	1	1	100	30	0	6	0	1	1	0	2
13	100	30	6	0	7.5	15	0	1	50	30	0	12	5	10	1	1	2
14	100	15	3	12	7.5	0	1	1	75	30	9	12	3	15	0	0	2
15	75	45	0	12	0	0	0	1	50	45	9	3	7.5	0	1	0	2
16	100	30	6	3	3	10	1	1	75	45	3	6	3	10	0	0	2

Appendix 32. P-DCE3-Block 1

We are preparing to do a survey looking at what features people prefer when signing up to a new dental practice. Before doing our survey, we want to test out a few questions. That's why we'd like your opinions on how understandable and meaningful they are. Please read through and answer the following questions. There are no right or wrong answers. We are interested in your own honest, personal opinions.

In each of the questions below, imagine you are going to register with a dental practice. You will be shown the features of a typical check-up appointment for two hypothetical dental practices. Based on these features, you should choose which you would register with. Imagine there are no options available apart from the two practices shown. Assume the practices are identical apart from the described features.

Descriptions of dental practice features

Cost	Average cost per check-up visit
Travel time	Length of time it takes to get to the practice
Time for dietary advice	Average amount of time in each check-up spent on dental related dietary advice, **e.g. a personalised diet plan to help maintain good oral health**
Time for dental hygiene advice	Average amount of time in each check-up spent on dental/oral hygiene advice**, e.g. help with proper teeth brushing technique.**
Time for preventive treatment	Average time spent on preventive treatment, **e.g. fluoride varnish treatment which helps prevent tooth decay**
Waiting time for an appointment	Typical time you wait for an appointment after trying to book one
Text/email reminders	Whether practice sends you text/email reminders before a check-up appointment
Online booking	Whether there is an option of booking your appointment online instead by phone call.

Descriptions of responsibilities of dental professionals

Dentists: Registered dental professionals who can carry out all of the treatments.

Dental therapists: Registered dental professionals who carry out certain items of dental treatment direct to patients or under prescription from a dentist.

Dental hygienists: Registered dental professionals who help patients maintain their oral health by promoting good oral health practice.

Dental nurses: Registered dental professionals who provide clinical and other support to patients.

Question 1

Which dental practice would you choose?

Characteristics	**Dental practice 1**	**Dental practice 2**
Cost	**€100**	**€50**
Travel time	**15 minutes**	**30 minutes**
Time for dietary advice	**6 minutes with the dental hygienist**	**3 minutes with the dental nurse**
Time for dental hygiene advice	**12 minutes with the dental hygienist**	**0 minutes**
Time for preventive treatment	**3 minutes with the dental hygienist**	**3 minutes with the dental nurse**
Waiting time for an appointment	**1 day**	**0 days**
Text/email reminders	**Yes**	**No**
Online booking	**No**	**Yes**
I choose	q Practice 1	q Practice 2

Question 2

Which dental practice would you choose?

Characteristics	**Dental practice 1**	**Dental practice 2**
Cost	**€75**	**€100**
Travel time	**45 minutes**	**45 minutes**
Time for dietary advice	**6 minutes with the dental nurse**	**9 minutes with the dentist**
Time for dental hygiene advice	**12 minutes with the dental nurse**	**6 minutes with the dentist**
Time for preventive treatment	**7.5 minutes with the dental nurse**	**3 minutes with the dentist**
Waiting time for an appointment	**1 days**	**0 days**
Text/email reminders	**No**	**Yes**
Online booking	**Yes**	**Yes**
I choose	q Practice 1	q Practice 2

Question 3

Which dental practice would you choose?

Characteristics	**Dental practice 1**	**Dental practice 2**
Cost	**€50**	**€75**
Travel time	**45 minutes**	**30 minutes**
Time for dietary advice	**6 minutes with the dental therapist**	**9 minutes with the dental hygienist**
Time for dental hygiene advice	**3 minutes with the dental therapist**	**0 minutes**
Time for preventive treatment	**5 minutes with the dental therapist**	**0 minutes**
Waiting time for an appointment	**1 day**	**1 days**
Text/email reminders	**Yes**	**Yes**
Online booking	**No**	**Yes**
I choose	q Practice 1	q Practice 2

Question 4

Which dental practice would you choose?

Characteristics	**Dental practice 1**	**Dental practice 2**
Cost	**€75**	**€50**
Travel time	**15 minutes**	**30 minutes**
Time for dietary advice	**0 minutes**	**3 minutes with the dentist**
Time for dental hygiene advice	**3 minutes with the dental therapist**	**12 minutes with the dentist**
Time for preventive treatment	**3 minutes with the dental therapist**	**0 minutes**
Waiting time for an appointment	**15 days**	**15 days**
Text/email reminders	**Yes**	**Yes**
Online booking	**Yes**	**No**
I choose	q Practice 1	q Practice 2

Question 5

Which dental practice would you choose?

Characteristics	**Dental practice 1**	**Dental practice 2**
Cost	**€75**	**€50**
Travel time	**15 minutes**	**45 minutes**
Time for dietary advice	**3 minutes with the dental hygienist**	**3 minutes with the dental hygienist**
Time for dental hygiene advice	**0 minutes**	**6 minutes with the dental hygienist**
Time for preventive treatment	**5 minutes with the dental hygienist**	**5 minutes with the dental hygienist**
Waiting time for an appointment	**10 days**	**15 days**
Text/email reminders	**No**	**Yes**
Online booking	**No**	**Yes**
I choose	q Practice 1	q Practice 2

Question 6

Which dental practice would you choose?

Characteristics	**Dental practice 1**	**Dental practice 2**
Cost	**€75**	**€100**
Travel time	**30 minutes**	**30 minutes**
Time for dietary advice	**9 minutes with the dentist**	**0 minutes**
Time for dental hygiene advice	**6 minutes with the dentist**	**3 minutes with the dentist**
Time for preventive treatment	**7.5 minutes with the dentist**	**5 minutes with the dentist**
Waiting time for an appointment	**10 days**	**0 days**
Text/email reminders	**No**	**No**
Online booking	**No**	**No**
I choose	q Practice 1	q Practice 2

Question 7

Which dental practice would you choose?

Characteristics	**Dental practice 1**	**Dental practice 2**
Cost	**€100**	**€50**
Travel time	**45 minutes**	**15 minutes**
Time for dietary advice	**9 minutes with the dental therapist**	**0 minutes**
Time for dental hygiene advice	**12 minutes with the dental therapist**	**6 minutes with the dental hygienist**
Time for preventive treatment	**0 minutes**	**7.5 minutes with the dental hygienist**
Waiting time for an appointment	**10 days**	**15 days**
Text/email reminders	**No**	**No**
Online booking	**Yes**	**Yes**
I choose	q Practice 1	q Practice 2

Question 8

Which dental practice would you choose?

Characteristics	**Dental practice 1**	**Dental practice 2**
Cost	**€75**	**€100**
Travel time	**15 minutes**	**45 minutes**
Time for dietary advice	**6 minutes with the dental nurse**	**0 minutes**
Time for dental hygiene advice	**6 minutes with the dental nurse**	**0 minutes**
Time for preventive treatment	**0 minutes**	**7.5 minutes with the dental nurse**
Waiting time for an appointment	**0 days**	**10 days**
Text/email reminders	**Yes**	**Yes**
Online booking	**No**	**No**
I choose	q Practice 1	q Practice 2

Question 9

Consider the questions we asked above. On a scale from 1 to 7 indicate how much you agree with the following statements (7=strongly agree, 1=strongly disagree)

a) I understood the questions

q 1	q 2	q 3	q 4	q 5	q 6	q 7

b) I understood the features of each practice

q 1	q 2	q 3	q 4	q 5	q 6	q 7

c) The hypothetical dental practices were realistic

q 1	q 2	q 3	q 4	q 5	q 6	q 7

d) All the important information I needed was there

q 1	q 2	q 3	q 4	q 5	q 6	q 7

Question 10

Was there anything you found difficult to understand? q Yes q No

If yes, what was it?

Was any information missing which would be vital for your decision? q Yes q No

If yes, what was it?

Are there any other features that would strongly influence your decision about what dental practice to choose? q Yes q No

If yes, what?

Do you have any other comments?

Question 1

Which dental practice would you choose?

Characteristics	Dental practice 1	Dental practice 2
Cost	**€50**	**€100**
Travel time	**15 minutes**	**45 minutes**
Time for dietary advice	**6 minutes with the dentist**	**3 minutes with the dental nurse**
Time for dental hygiene advice	**3 minutes with the dentist**	**3 minutes with the dental nurse**
Time for preventive treatment	**0 minutes**	**0 minutes**
Waiting time for an appointment	**10 days**	**15 days**
Text/email reminders	**No**	**No**
Online booking	**Yes**	**No**
I choose	q Practice 1	q Practice 2

Question 2

Which dental practice would you choose?

Characteristics	Dental practice 1	Dental practice 2
Cost	**€50**	**€100**
Travel time	**45 minutes**	**15 minutes**
Time for dietary advice	**0 minutes**	**9 minutes with the dental nurse**
Time for dental hygiene advice	**0 minutes**	**6 minutes with the dental nurse**
Time for preventive treatment	**3 minutes with the dentist**	**5 minutes with the dental nurse**
Waiting time for an appointment	**1 day**	**1 day**
Text/email reminders	**No**	**No**
Online booking	**No**	**Yes**
I choose	q Practice 1	q Practice 2

Question 3

Which dental practice would you choose?

Characteristics	**Dental practice 1**	**Dental practice 2**
Cost	**€50**	**€75**
Travel time	**15 minutes**	**15 minutes**
Time for dietary advice	**9 minutes with the dental therapist**	**3 minutes with the dentist**
Time for dental hygiene advice	**0 minutes**	**3 minutes with the dentist**
Time for preventive treatment	**5 minutes with the dental therapist**	**7.5 minutes with the dentist**
Waiting time for an appointment	**0 days**	**1 day**
Text/email reminders	**No**	**Yes**
Online booking	**No**	**Yes**
I choose	q Practice 1	q Practice 2

Question 4

Which dental practice would you choose?

Characteristics	**Dental practice 1**	**Dental practice 2**
Cost	**€75**	**€100**
Travel time	**45 minutes**	**30 minutes**
Time for dietary advice	**6 minutes with the dentist**	**0 minutes**
Time for dental hygiene advice	**0 minutes**	**6 minutes with the dental therapist**
Time for preventive treatment	**5 minutes with the dentist**	**0 minutes**
Waiting time for an appointment	**15 days**	**1 day**
Text/email reminders	**Yes**	**Yes**
Online booking	**Yes**	**No**
I choose	q Practice 1	q Practice 2

Question 5

Which dental practice would you choose?

Characteristics	**Dental practice 1**	**Dental practice 2**
Cost	**€100**	**€50**
Travel time	**30 minutes**	**30 minutes**
Time for dietary advice	**6 minutes with the dental therapist**	**0 minutes**
Time for dental hygiene advice	**0 minutes**	**12 minutes with the dental nurse**
Time for preventive treatment	**7.5 minutes with the dental therapist**	**5 minutes with the dental nurse**
Waiting time for an appointment	**15 days**	**10 days**
Text/email reminders	**No**	**Yes**
Online booking	**Yes**	**Yes**
I choose	q Practice 1	q Practice 2

Question 6

Which dental practice would you choose?

Characteristics	**Dental practice 1**	**Dental practice 2**
Cost	**€100**	**€75**
Travel time	**15 minutes**	**30 minutes**
Time for dietary advice	**3 minutes with the dental therapist**	**9 minutes with the dental nurse**
Time for dental hygiene advice	**12 minutes with the dental therapist**	**12 minutes with the dental nurse**
Time for preventive treatment	**7.5 minutes with the dental therapist**	**3 minutes with the dental nurse**
Waiting time for an appointment	**0 days**	**15 days**
Text/email reminders	**Yes**	**No**
Online booking	**Yes**	**No**
I choose	q Practice 1	q Practice 2

Question 7

Which dental practice would you choose?

Characteristics	**Dental practice 1**	**Dental practice 2**
Cost	**€75**	**€50**
Travel time	**45 minutes**	**45 minutes**
Time for dietary advice	**0 minutes**	**9 minutes with the dental hygienist**
Time for dental hygiene advice	**12 minutes with the dental hygienist**	**3 minutes with the dental hygienist**
Time for preventive treatment	**0 minutes**	**7.5 minutes with the dental hygienist**
Waiting time for an appointment	**0 days**	**0 days**
Text/email reminders	**No**	**Yes**
Online booking	**Yes**	**No**
I choose	q Practice 1	q Practice 2

Question 8

Which dental practice would you choose?

Characteristics	**Dental practice 1**	**Dental practice 2**
Cost	**€100**	**€75**
Travel time	**30 minutes**	**45 minutes**
Time for dietary advice	**6 minutes with the dental hygienist**	**3 minutes with the dental therapist**
Time for dental hygiene advice	**3 minutes with the dental hygienist**	**6 minutes with the dental therapist**
Time for preventive treatment	**3 minutes with the dental hygienist**	**3 minutes with the dental therapist**
Waiting time for an appointment	**10 days**	**10 days**
Text/email reminders	**Yes**	**No**
Online booking	**Yes**	**No**
I choose	q Practice 1	q Practice 2

Appendix 34. Syntax of P-DCE-Final design

```
Design
;alts = alt1*, alt2*
;rows = 72
;block = 9
;eff = (mnl,d)
;rep = 500
;rdraws = halton(250)
;model:
U(alt1) = b_cost[0]*cost[20,35,50] + b_travel[0]*travel[15,30,45] +
b_dietary[0]*dietary[0,5,10] + b_hygiene[0]*hygiene[0,6,12] +
b_fluoride[0]*fluoride[0,4,8] + b_waiting[0]*waiting[1,10,15] +
b_provider.dummy[0]*provider[0,1]
/
U(alt2) = b_cost*cost + b_travel*travel + b_dietary*dietary +
b_hygiene*hygiene + b_fluoride*fluoride + b_waiting*waiting +
b_provider.dummy*provider
$
```

Appendix 35. Design of P-DCE-Final

D error	0.000741														
A error	0.008619														
Design															
Choice situation	alt1.cost	alt1.travel	alt1.dietary	alt1.hygene	alt1.fluoride	alt1.waiting	alt1.provider	alt2.cost	alt2.travel	alt2.dietary	alt2.hygene	alt2.fluoride	alt2.waiting	alt2.provider	Block
9	50	45	10	6	8	1	0	20	15	0	6	0	15	1	1
11	50	30	5	6	0	10	1	20	30	5	6	8	10	0	1
17	20	45	0	0	8	1	1	50	15	10	12	0	15	0	1
19	35	45	0	12	4	1	0	35	15	10	0	4	15	1	1
20	50	45	5	0	4	15	0	20	15	5	12	4	1	0	1
23	20	15	5	0	0	1	0	50	45	5	12	8	15	1	1
50	50	30	5	0	4	15	0	20	30	5	12	8	1	1	1
71	20	30	10	12	4	10	0	50	30	0	0	4	10	1	1
4	20	15	0	0	8	10	0	50	45	10	12	0	10	1	2
12	50	15	0	12	4	10	0	20	45	10	0	4	10	1	2
21	20	15	10	12	4	1	0	50	45	0	0	4	15	1	2
28	50	45	5	6	4	15	0	20	15	5	6	4	1	1	2
44	20	30	0	12	8	10	1	50	30	10	0	0	10	0	2
45	20	30	5	6	8	15	0	50	30	5	6	0	1	1	2
61	35	30	10	0	8	15	1	35	30	0	12	0	1	0	2
65	50	30	5	6	4	10	1	20	30	5	6	4	10	0	2
1	35	15	0	6	8	1	1	35	45	10	6	0	15	0	3
8	35	45	10	6	4	10	0	35	15	0	6	4	10	1	3
10	20	15	10	0	4	1	0	50	45	0	12	4	15	1	3
25	20	30	5	12	4	15	0	50	30	5	0	4	1	1	3
35	50	15	10	0	8	15	1	20	45	0	12	0	1	0	3
40	20	15	0	0	0	1	1	50	45	10	12	8	15	0	3

52	35	30	10	12	0	10	1	35	30	0	0	8	10	0	3
58	35	45	5	6	8	15	1	35	15	5	6	0	1	0	3
3	20	15	5	0	0	15	1	50	45	5	12	8	1	0	4
26	35	45	0	6	0	15	0	35	15	10	6	8	1	1	4
30	50	30	10	12	4	1	1	20	30	0	0	4	15	0	4
31	50	45	0	6	4	1	0	20	15	10	6	4	15	1	4
41	35	30	5	0	0	10	1	35	30	5	12	8	10	0	4
55	50	45	0	12	4	10	1	20	15	10	0	0	10	0	4
60	35	15	0	0	0	15	1	35	45	10	12	8	1	0	4
68	35	45	10	6	0	10	1	35	15	0	6	8	10	1	4
2	50	15	5	12	4	1	1	20	45	5	0	0	15	0	5
15	35	15	5	6	0	1	1	35	45	5	6	8	15	0	5
29	20	30	5	12	0	1	0	50	30	5	0	8	15	1	5
39	35	45	0	12	0	10	1	35	15	10	0	8	10	0	5
46	20	30	5	12	8	1	1	50	30	5	0	0	15	0	5
53	35	15	5	6	8	15	1	35	45	5	6	0	1	0	5
57	35	30	10	12	8	15	0	35	30	0	0	0	1	1	5
72	20	30	10	12	0	15	1	50	30	0	0	8	1	0	5
13	50	15	10	6	0	10	1	20	45	0	6	8	10	0	6
18	35	15	0	12	4	1	0	35	45	10	0	4	15	1	6
22	50	30	10	0	4	1	1	20	30	0	12	4	15	0	6
27	50	30	0	6	0	15	0	20	30	10	6	8	1	1	6
34	50	15	10	6	4	1	0	20	45	0	6	4	15	1	6
37	50	15	5	6	0	15	0	20	45	5	6	8	1	1	6
38	20	45	0	0	0	10	0	50	15	10	12	8	10	1	6
48	35	45	10	12	4	10	0	35	15	0	0	4	10	1	6
6	20	45	10	12	0	10	1	50	15	0	0	8	10	0	7
47	50	45	10	0	4	1	0	20	15	0	12	4	15	1	7
51	50	30	0	6	0	1	1	20	30	10	6	8	15	0	7
54	20	45	0	12	0	15	1	50	15	10	0	8	1	0	7

59	20	30	0	0	0	15	1	50	30	10	12	4	1	0	7
63	20	45	10	0	8	1	0	50	15	0	12	0	15	1	7
66	20	30	5	0	8	1	0	50	30	5	12	0	15	1	7
67	50	45	10	6	4	15	0	20	15	0	6	4	1	1	7
5	50	45	0	0	8	1	1	20	15	10	12	0	15	0	8
7	50	15	5	6	4	10	0	20	45	5	6	4	10	1	8
14	35	15	0	12	8	10	0	35	45	10	0	0	10	1	8
24	50	15	0	12	8	15	0	20	45	10	0	0	1	1	8
32	35	30	5	6	0	10	1	35	30	5	6	8	10	0	8
49	35	15	5	0	4	15	0	35	45	5	12	4	1	1	8
56	20	30	10	6	8	15	1	50	30	0	6	0	1	0	8
70	35	30	0	12	4	10	1	35	30	10	0	4	10	0	8
16	35	15	10	6	4	1	1	35	45	0	6	4	15	0	9
33	20	30	10	0	8	15	1	50	30	0	12	0	1	0	9
36	20	45	5	12	8	10	1	50	15	5	0	0	10	0	9
42	35	15	10	12	0	10	0	35	45	0	0	8	10	1	9
43	50	45	5	0	8	10	1	20	15	5	12	0	10	0	9
62	35	15	0	6	8	15	0	35	45	10	6	0	1	1	9
64	20	45	0	0	4	10	0	50	15	10	12	4	10	1	9
69	35	45	5	0	0	1	0	35	15	5	12	8	15	1	9

Appendix 36. Correlations between attribute levels of P-DCE-Final design

	alt1.cost	alt1.travel	alt1.dietary	alt1.hygene	alt1.fluoride	alt1.waiting	alt1.provider	alt2.cost	alt2.travel	alt2.dietary	alt2.hygene	alt2.fluoride	alt2.waiting	alt2.provider
alt1.cost	1.00	0.00	0.02	0.00	-0.02	0.00	-0.03	-1.00	0.00	-0.02	0.00	0.02	0.00	0.00
alt1.travel	0.00	1.00	0.00	-0.02	0.02	0.02	0.00	0.00	-1.00	0.00	0.02	-0.02	0.02	0.00
alt1.dietary	0.02	0.00	1.00	0.00	0.04	-0.03	0.00	-0.02	0.00	-1.00	0.00	0.00	0.01	0.03
alt1.hygene	0.00	-0.02	0.00	1.00	-0.04	0.02	0.00	0.00	0.02	0.00	-1.00	0.00	0.06	0.03
alt1.fluoride	-0.02	0.02	0.04	-0.04	1.00	-0.01	-0.07	0.02	-0.02	-0.04	0.04	-0.96	-0.05	0.03
alt1.waiting	0.00	0.02	-0.03	0.02	-0.01	1.00	0.02	0.00	-0.02	0.03	-0.02	0.02	-0.95	-0.04
alt1.provider	-0.03	0.00	0.00	0.00	-0.07	0.02	1.00	0.03	0.00	0.00	0.00	0.00	0.02	-0.94
alt2.cost	-1.00	0.00	-0.02	0.00	0.02	0.00	0.03	1.00	0.00	0.02	0.00	-0.02	0.00	0.00
alt2.travel	0.00	-1.00	0.00	0.02	-0.02	-0.02	0.00	0.00	1.00	0.00	-0.02	0.02	-0.02	0.00
alt2.dietary	-0.02	0.00	-1.00	0.00	-0.04	0.03	0.00	0.02	0.00	1.00	0.00	0.00	-0.01	-0.03
alt2.hygene	0.00	0.02	0.00	-1.00	0.04	-0.02	0.00	0.00	-0.02	0.00	1.00	0.00	-0.06	-0.03
alt2.fluoride	0.02	-0.02	0.00	0.00	-0.96	0.02	0.00	-0.02	0.02	0.00	0.00	1.00	0.02	0.03
alt2.waiting	0.00	0.02	0.01	0.06	-0.05	-0.95	0.02	0.00	-0.02	-0.01	-0.06	0.02	1.00	0.02
alt2.provider	0.00	0.00	0.03	0.03	0.03	-0.04	-0.94	0.00	0.00	-0.03	-0.03	0.03	0.02	1.00

Appendix 37. P-DCE-Final-Block 1

Preferences of oral health prevention

Introduction

This survey is assessing what features people prefer when signing up to a **new** dental practice. Please read through and answer the following questions. There are no right or wrong answers. We are interested in your own honest, personal opinions.

This questionnaire is organised into **two parts**. The **First part** asks you to provide some information about you, your perceived oral health and some behaviours related to that.

The **second part** presents you with eight scenarios. You will then be asked in each scenario to select which dental practice you would like to register at for a **dental check-up appointment**. For each scenario we would like you to imagine you are going to register with a **new** dental practice for a first time. You will be given options of a **typical check-up appointment** for two **hypothetical** dental practices and **you will be required to choose** which you would like to register with **based on the options presented**.

Demographics

Gender

- Female
- Male
- Other/Prefer not to say

Age

What is your smoking status?

- I have never smoked
- I am a former smoker
- I am a currentsmoker

When did you last visit a dentist about your teeth, dentures or gums?

- Less than 1 year ago
- 1 to less than 2 years ago
- 2 or more years ago
- I have never attended
- I can’t remember

What was the reason for your last visit to the dentist?

- Check-up, examination or cleaning
- Planned treatment (e.g. routine filling or extraction)
- Emergency treatment
- I do not know
- Other

If you selected Other, please specify:

What is your average alcohol consumption weekly?

- 0-1 drinks/week
- 1-4 drinks/week
- 5-14 drinks/week
- 15 drink or more/week

What is your average daily consumption of sugared beverages? Note: Sugared beverages include fruit juice, soft drink, cordial, energy drinks or flavored milk?

- 0-1 per day
- 2-3 times per day
- 4 or more times per day

What is your working status?

- Full time work (35 hours per week)
- Part time work (less than 35 hours per week)
- More than 35 hours per week
- Unemployed

How often do you go to the dentist?

- Every 6 months
- Every 1 year
- Every 2 years
- Less often
- Only in pain/emergency

What is your ethnicity?

- White
- Mixed/ Multiple ethnic groups
- Asian/ Asian British
- Black / African / Caribbean / Black British
- Other

If you selected other, please specify:

Given the categories below, where do you think your profession belongs most suitably to?

- Service class: professionals, administrators and managers; higher grade technicians; supervisors of non-manual workers
- Routine non-manual workers: routine non-manual employees in administration and commerce; sales personnel
- Small properties and artisans and so on, with and without employees
- Farmers and smallholders and other self-employed workers in primary production
- Non-skilled workers: semi- and unskilled manual workers (not in agriculture etc.)
- Agricultural labourers: agricultural and other workers in primary production
- Never worked or long term unemployed

How healthy do you think your teeth are?

- None left
- Poor
- Average
- Good
- Excellent

How do you pay for your dental care and treatment?

- Partially (covered by the NHS or a public medical scheme)
- Partially (covered by a private insurance scheme)
- Completely by myself
- Private insurance scheme
- I do not pay
- I do not know

Do you enjoy or dread a visit to the dentist?

- Enjoy
- Dread
- Don’t mind

What is your highest level of education?

- No education
- Primary education (elementary school / left school at age 11-14)
- Secondary school (left school after age 14 without qualification)
- Pre-vocational / vocational education (GCSEs, Standard Grade, GNVQ Foundation & Intermediate, NVQ levels 1 and 2)
- Pre-vocational / vocational education (GCSE A/AS levels, Higher Grade, CSYS, GNVQ Advanced, NVQ Level 3)
- Vocational qualification (qualification in higher education)
- University (Bachelor, Master and doctoral degree)
- Prefer not to say

Where do you live?

- England
- Wales
- Scotland
- Ireland

Which is the region you are currently living (in case England is selected in the previous question)?

- North West of England
- Yorkshire and the Humber
- North East of England East
- Midlands
- London
- West Midlands
- South West of England
- East of England
- South East of England

Example choice

For each scenario below we would like you to imagine you are going to register with a new dental practice for a first time. You will be given options of a typical check-up appointment for two hypothetical dental practices and you will be required to choose which you would like to register with based on the options presented. Here follows a table describing the changing options for the dental practices. Please read through the table before answering the questions. This first scenario below serves just as an example to show you how to complete the rest of the choices in the following pages.

Options	Descriptions
Cost of a dental check up	Cost of the dental appointment you have to pay in £.
Transport time to reach the practice	Average amount of time needed to drive or move to the practice by train/bus/car.
Amount of dietary advice	Average amount of time in each check up spent on dental related dietary advice, e.g. a personalised diet plan to help maintain good oral health which is delivered as handout and thorooughly explained at the appointment.
Amount of hygiene advice	Average amount of time in each check up spent on dental/oral hygiene advice, e.g. demonstration of proper teeth brushing techniques.
Amount of preventive treatment	Average time spent on preventive treatment, e.g. fluoride varnish treatment which helps prevent tooth decay.
Waiting time for the appointment	Typical time you wait for an appointment after trying to book one.
Dietary advice, hygiene advice and preventive treatment provided by	Dietary advice, hygiene advice and preventive treatment above provided by either the dentist or a dental professional including a dental therapist or a dental hygienist.

Example Choice

In the question below, imagine you are going to register with a **new** dental practice. You will be shown the options of a typical **check-up appointment** for two **hypothetical dental practices.**
Based on these options, you should choose which practice you would register with.
Imagine there are no options available apart from the two practices shown. In both practices you will initially see the dentist for a scale and polish which will take about 15 minutes. The only variation between practices is in the options below.

Which dental practice would you choose?

	Dental Practice A	Dental Practice B
Transport time to reach the practice	45 minutes	15 minutes
Amount of dietary advice	0 minutes	10 minutes
Amount of hygiene advice	12 minutes	0 minutes
Amount of preventive treatment	0 minutes	8 minutes
Waiting time for the appointment	15 days	1 day
Dietary advice, hygiene advice and preventive treatment are provided by	dentist	dental professional
Cost of a dental check-up	£20	£50

If you prefer Dental Practice B, then choose that option below as shown.

Please now continue with answering the scenarios questions in the following pages.

○ Treatment plan A

◉ Treatment plan B

Choice 1

In the question below, imagine you are going to register with a **new** dental practice. You will be shown the options of a typical **check-up appointment** for two **hypothetical dental practices.**
Based on these options, you should choose which practice you would register with.
Imagine there are no options available apart from the two practices shown. In both practices you will initially see the dentist for a scale and polish which will take about 15 minutes. The only variation between practices is in the options below.

Which dental practice would you choose?

	Dental Practice A	Dental Practice B
Transport time to reach the practice	45 minutes	15 minutes
Amount of dietary advice	10 minutes	0 minutes
Amount of hygiene advice	6 minutes	6 minutes
Amount of preventive treatment	8 minutes	0 minutes
Waiting time for the appointment	1 day	15 days
Dietary advice, hygiene advice and preventive treatment are provided by	dentist	dental professional
Cost of a dental check-up	£50	£20

- ○ Dental Practice A
- ○ Dental Practice B

Choice 2

In the question below, imagine you are going to register with a **new** dental practice. You will be shown the options of a typical **check-up appointment** for two **hypothetical dental practices.**
Based on these options, you should choose which practice you would register with.
Imagine there are no options available apart from the two practices shown. In both practices you will initially see the dentist for a scale and polish which will take about 15 minutes. The only variation between practices is in the options below.

Which dental practice would you choose?

	Dental Practice A	Dental Practice B
Transport time to reach the practice	30 minutes	30 minutes
Amount of dietary advice	5 minutes	5 minutes
Amount of hygiene advice	6 minutes	6 minutes
Amount of preventive treatment	0 minutes	8 minutes
Waiting time for the appointment	10 days	10 days
Dietary advice, hygiene advice and preventive treatment are provided by	dental professional	dentist
Cost of a dental check-up	£50	£20

- ○ Dental Practice A
- ○ Dental Practice B

Choice 3

In the question below, imagine you are going to register with a **new** dental practice. You will be shown the options of a typical **check-up appointment** for two **hypothetical dental practices.**
Based on these options, you should choose which practice you would register with.
Imagine there are no options available apart from the two practices shown. In both practices you will initially see the dentist for a scale and polish which will take about 15 minutes. The only variation between practices is in the options below.

Which dental practice would you choose?

	Dental Practice A	Dental Practice B
Transport time to reach the practice	45 minutes	15 minutes
Amount of dietary advice	0 minutes	10 minutes
Amount of hygiene advice	0 minutes	12 minutes
Amount of preventive treatment	8 minutes	0 minutes
Waiting time for the appointment	1 day	15 days
Dietary advice, hygiene advice and preventive treatment are provided by	dental professional	dentist
Cost of a dental check-up	£20	£50

- ○ Dental Practice A
- ○ Dental Practice B

Choice 4

In the question below, imagine you are going to register with a **new** dental practice. You will be shown the options of a typical **check-up appointment** for two **hypothetical dental practices.**
Based on these options, you should choose which practice you would register with.
Imagine there are no options available apart from the two practices shown. In both practices you will initially see the dentist for a scale and polish which will take about 15 minutes. The only variation between practices is in the options below.

Which dental practice would you choose?

	Dental Practice A	Dental Practice B
Transport time to reach the practice	45 minutes	15 minutes
Amount of dietary advice	0 minutes	10 minutes
Amount of hygiene advice	12 minutes	0 minutes
Amount of preventive treatment	4 minutes	4 minutes
Waiting time for the appointment	1 day	15 days
Dietary advice, hygiene advice and preventive treatment are provided by	dentist	dental professional
Cost of a dental check-up	£35	£35

- ○ Dental Practice A
- ○ Dental Practice B

Choice 5

In the question below, imagine you are going to register with a **new** dental practice. You will be shown the options of a typical **check-up appointment** for two **hypothetical dental practices.**
Based on these options, you should choose which practice you would register with.
Imagine there are no options available apart from the two practices shown. In both practices you will initially see the dentist for a scale and polish which will take about 15 minutes. The only variation between practices is in the options below.

Which dental practice would you choose?

	Dental Practice A	Dental Practice B
Transport time to reach the practice	45 minutes	15 minutes
Amount of dietary advice	5 minutes	5 minutes
Amount of hygiene advice	0 minutes	12 minutes
Amount of preventive treatment	4 minutes	4 minutes
Waiting time for the appointment	15 days	1 day
Dietary advice, hygiene advice and preventive treatment are provided by	dentist	dentist
Cost of a dental check-up	£50	£20

- ○ Dental Practice A
- ○ Dental Practice B

Choice 6

In the question below, imagine you are going to register with a **new** dental practice. You will be shown the options of a typical **check-up appointment** for two **hypothetical dental practices.**
Based on these options, you should choose which practice you would register with.
Imagine there are no options available apart from the two practices shown. In both practices you will initially see the dentist for a scale and polish which will take about 15 minutes. The only variation between practices is in the options below.

Which dental practice would you choose?

	Dental Practice A	Dental Practice B
Transport time to reach the practice	15 minutes	45 minutes
Amount of dietary advice	5 minutes	5 minutes
Amount of hygiene advice	0 minutes	12 minutes
Amount of preventive treatment	0 minutes	8 minutes
Waiting time for the appointment	1 day	15 days
Dietary advice, hygiene advice and preventive treatment are provided by	dentist	dental professional
Cost of a dental check-up	£20	£50

- ○ Dental Practice A
- ○ Dental Practice B

Choice 7

In the question below, imagine you are going to register with a **new** dental practice. You will be shown the options of a typical **check-up appointment** for two **hypothetical dental practices.**
Based on these options, you should choose which practice you would register with.
Imagine there are no options available apart from the two practices shown. In both practices you will initially see the dentist for a scale and polish which will take about 15 minutes. The only variation between practices is in the options below.

Which dental practice would you choose?

	Dental Practice A	Dental Practice B
Transport time to reach the practice	30 minutes	30 minutes
Amount of dietary advice	5 minutes	5 minutes
Amount of hygiene advice	0 minutes	12 minutes
Amount of preventive treatment	4 minutes	8 minutes
Waiting time for the appointment	15 days	1 day
Dietary advice, hygiene advice and preventive treatment are provided by	dentist	dental professional
Cost of a dental check-up	£50	£20

- ○ Dental Practice A
- ○ Dental Practice B

Choice 8

In the question below, imagine you are going to register with a **new** dental practice. You will be shown the options of a typical **check-up appointment** for two **hypothetical dental practices.**
Based on these options, you should choose which practice you would register with.
Imagine there are no options available apart from the two practices shown. In both practices you will initially see the dentist for a scale and polish which will take about 15 minutes. The only variation between practices is in the options below.

Which dental practice would you choose?

	Dental Practice A	Dental Practice B
Transport time to reach the practice	30 minutes	30 minutes
Amount of dietary advice	10 minutes	0 minutes
Amount of hygiene advice	12 minutes	0 minutes
Amount of preventive treatment	4 minutes	4 minutes
Waiting time for the appointment	10 days	10 days
Dietary advice, hygiene advice and preventive treatment are provided by	dentist	dental professional
Cost of a dental check-up	£20	£50

- ○ Dental Practice A
- ○ Dental Practice B

Feedback

Consider the questions we asked above. On a scale from 1 to 7 indicate how much you agree with the following statements (1=strongly disagree, 7=strongly agree).

I understood the questions.

I understood the options of each scenario.

The hypothetical dental practices were realistic.

All the important information I needed was there.

Was there anything you found difficult to understand?

- Yes
- No

If yes, what was it?

Was any information missing which would be **vital** for your decision?

- Yes
- No

If yes, what was it?

Please provide any additional comment you might have here.

Please contract Evangelos Zormpas with any questions or queries: **dnez@leeds.ac.uk**

Thank you very much for participating in our survey!

Appendix 38. Dentist DCE Study- MNL with all 24 parameters of the main model specification

Treatment level attributes	Patient attributes	Parameter mean	Robust SE	CI-95%
Preventive treatment	Constant	0.044	0.029	-0.013, 0.101
	Moderate caries risk	0.046	0.029	-0.011, 0.103
	Low caries risk	-0.039	0.027	-0.092, 0.014
	55 years of age	-0.015	0.031	-0.076, 0.046
	24 years of age	-0.015	0.028	-0.070, 0.040
	Mild caries condition	-0.035	0.025	-0.084, 0.014
Preventive advice	Constant	0.12***	0.023	0.075, 0.165
	Moderate caries risk	-0.005	0.027	-0.058, 0.048
	Low caries risk	-0.086***	0.022	-0.129, -0.043
	55 years of age	0.03	0.022	-0.013, 0.073
	24 years of age	0.064**	0.026	0.013, 0.115
	Mild caries condition	-0.035*	0.019	-0.072, 0.002
Restorative treatment	Constant	0.095**	0.042	0.013, 0.177
	Moderate caries risk	-0.032	0.021	-0.073, 0.009
	Low caries risk	-0.006	0.023	-0.051, 0.039
	55 years of age	0.024	0.022	-0.019, 0.067
	24 years of age	0.03	0.022	-0.013, 0.073
	Mild caries condition	-0.108**	0.048	-0.202, -0.014
Income	Constant	0.034***	0.01	0.014, 0.054
	Moderate caries risk	-0.003	0.011	-0.025, 0.019
	Low caries risk	-0.01	0.01	-0.030, 0.010
	55 years of age	-0.006	0.009	-0.024, 0.012
	24 years of age	0.003	0.011	-0.019, 0.025
	Mild caries condition	-0.022	0.02	-0.061, 0.017
Log-likelihood	-662.3097			
Number of responses	1128			

Sample size	143
AIC	1372.62
BIC	1493.3

Appendix 39. Dentist DCE Study- MXL with all 24 parameters of the main model specification

Treatment level attributes	Patient attributes	Parameter mean	Robust SE	CI-95%		Robust SE	CI-95%
Preventive treatment	Constant	0.079	0.071	-0.060, 0.217	-0.017	0.368	-0.739, 0.705
	Moderate caries risk	-0.032	0.085	-0.200, 0.135	-0.045	0.152	-0.344, 0.253
	Low caries risk	-0.026	0.058	-0.139, 0.087	-0.099	0.182	-0.455, 0.258
	55 years of age	0.062	0.045	-0.025, 0.150	0.174	0.236	-0.289, 0.636
	24 years of age	-0.049	0.144	-0.331, 0.233	0.260	0.164	-0.062, 0.582
	Mild caries condition	-0.072	0.064	-0.198, 0.053	-0.169	0.325	-0.807, 0.468
Preventive advice	Constant	0.138***	0.041	0.059, 0.218	0.071	0.073	-0.072, 0.214
	Moderate caries risk	-0.065	0.116	-0.292, 0.163	0.047	0.067	-0.084, 0.177
	Low caries risk	-0.023	0.105	-0.228, 0.183	-0.044	0.126	-0.291, 0.202
	55 years of age	0.087	0.119	-0.146, 0.319	0.243	0.192	-0.134, 0.620
	24 years of age	0.125	0.107	-0.086, 0.335	-0.093	0.080	-0.250, 0.063
	Mild caries condition	-0.005	0.075	-0.153, 0.142	-0.022	0.064	-0.148, 0.104
Restorative treatment	Constant	0.170***	0.066	0.041, 0.299	0.159*	0.082	-0.002, 0.321
	Moderate caries risk	0.029	0.062	-0.092, 0.151	-0.034	0.038	-0.109, 0.041
	Low caries risk	0.032	0.042	-0.051, 0.116	0.058	0.160	-0.255, 0.372
	55 years of age	0.011	0.124	-0.231, 0.253	0.149	0.167	-0.179, 0.476
	24 years of age	-0.050	0.039	-0.126, 0.026	0.007	0.060	-0.111, 0.125
	Mild caries condition	-0.189**	0.080	-0.346,-0.032	-0.105	0.090	-0.282, 0.072
Income	Constant	0.050**	0.021	0.008, 0.092	-0.021	0.020	-0.060, 0.018
	Moderate caries risk	0.011	0.033	-0.055, 0.076	-0.030	0.033	-0.095, 0.036
	Low caries risk	-0.005	0.017	-0.038, 0.027	0.019	0.061	-0.101, 0.138
	55 years of age	0.011	0.042	-0.071, 0.093	-0.100	0.101	-0.297, 0.097
	24 years of age	-0.002	0.022	-0.044, 0.040	-0.037	0.032	-0.100, 0.026

	Mild caries condition	-0.031	0.045	-0.120, 0.058	0.021	0.023	-0.024, 0.065
Log-likelihood	-614.2899						
Number of responses	1128						
Sample size	143						
AIC	1324.58						
BIC	1565.93						

Appendix 40. Dentist DCE study MXL -reduced dataset after accounting for inconsistent respondents

Treatment level attributes	Patient attributes	Parameter mean	Robust SE	CI-95%		Robust SE	CI-95%
Preventive treatment	Constant	0.032	0.030	(-0.027, 0.092)	0.193***	0.051	(0.093, 0.292)
	Moderate caries risk	0.079**	0.038	(0.005, 0.153)	0.058	0.052	(-0.160, 0.044)
	Low caries risk			-	-	-	-
	54 years of age	-	-	-	-	-	-
	24 years of age	-	-	-	-	-	-
	Mild caries condition	-0.065*	0.039	(-0.142, 0.011)	0.145*	0.082	(-0.306, 0.015)
Preventive advice	Constant	0.190***	0.042	(0.108, 0.273)	0.082	0.056	(-0.192, 0.028)
	Moderate caries risk	-0.085*	0.052	(-0.186, 0.016)	0.143***	0.055	(0.036, 0.251)
	Low caries risk	-0.135***	0.040	(-0.214, -0.055)	0.050	0.056	(-0.161, 0.060)
	55 years of age	0.122**	0.053	(0.017, 0.226)	0.102	0.065	(-0.230, 0.026)
	24 years of age	0.085**	0.034	(0.018, 0.152)	0.040	0.051	(-0.139, 0.059)
	Mild caries condition	-	-	-	-	-	-
Restorative treatment	Constant	0.154***	0.050	(0.056, 0.252)	0.092	0.064	(-0.218, 0.034)
	Moderate caries risk	-0.068***	0.018	(-0.104, -0.033)	0.007	0.034	(-0.059, 0.073)
	Low caries risk	-	-	-	-	-	-
	55 years of age	0.085	0.063	(-0.038, 0.208)	0.281**	0.132	(-0.540, -0.021)
	24 years of age	0.053***	0.020	(0.014, 0.091)	0.039	0.027	(-0.013, 0.092)
	Mild caries condition	-0.131*	0.068	(-0.265, 0.003)	0.034	0.064	(-0.092, 0.159)
Income	Constant	0.046***	0.011	(0.024, 0.069)	0.042***	0.015	(0.013, 0.072)
	Moderate caries risk	-	-	-	-	-	-
	Low caries risk	-	-	-	-	-	-
	54 years of age	-	-	-	-	-	-
	24 years of age	-	-	-	-	-	-

	Mild caries condition	-0.044*	0.026	(-0.095, 0.006)	0.014	0.022	(-0.057, 0.028)
Log-likelihood	-606.64						
Number of responses	1105						
Sample size	139						
AIC	1273.28						
BIC	1423.51						
***(at 1% significance level), **(at 5% significance level), *(at 10% significance level)							

Appendix 41. Shares of respondents who always chose the option which was better in each attribute in dentist DCE study

Attribute level dominance	Number of respondents who always based their choices on	Shares of respondents who always based their choices on
Longer preventive treatment	4	3%
Longer preventive advice	22	15%
Longer restorative treatment	6	4%
Higher income	9	6%
Shorter preventive treatment	4	3%
Shorter preventive advice	0	0%
Shorter restorative treatment	4	3%
Lower income	3	2%
Full sample	143	

Appendix 42. Patient MXL in WTP space-reduced dataset after accounting for inconsistent respondents (N=327)

Dental check-up attributes	**Estimate**	**SE**	**95% CI**	**σ**	**SE**	**95% CI**
Cost	-0.067***	0.006	(-0.080, -0.055)	0.044***	0.005	(0.034, 0.054)
WTP parameters	**WTP mean**	**SE**	**95% CI**	**σ**	**SE**	**95% CI**
Travel time to reach the practice	-0.466***	0.061	(-0.584, -0.347)	0.304***	0.104	(0.100, 0.509)
Dietary advice	-0.377**	0.175	(-0.719, -0.035)	0.262	0.429	(0.579, 1.103)
Hygiene advice	-0.933***	0.168	(-1.262, -0.603)	0.558	0.348	(0.124, 1.241)
Preventive treatment	-1.476***	0.277	(-2.018, -0.934)	1.411***	0.397	(0.632, 2.189)
Waiting time for the appointment	-0.699***	0.125	(-0.943, -0.455)	0.043	0.110	(0.172, 0.259)
Seeing the dentist	-5.180***	1.832	(-8.771, -1.589)	13.906***	3.535	(6.976, 20.835)
Number of responses	2615					
Sample size	327					
AIC	2571.71					
BIC	2653.88					

Appendix 43. Shares of respondents who always chose the option which was better in each attribute in patient DCE study

Attribute level dominance	Number of respondents who always based their choices on	Shares of respondents who always based their choices on
Lower out of pocket cost	103	29%
Shorter waiting time	0	0%
Shorter travel time	73	21%
Longer preventive treatment	59	17%
Longer dietary advice	6	2%
Longer hygiene advice	19	5%
Seeing the dentist	15	4%
Higher out of pocket cost	6	2%
Longer waiting time	9	3%
Longer travel time	4	1%
Shorter preventive treatment	7	2%
Shorter dietary advice	1	0%
Shorter hygiene advice	4	1%
Seeing an alternative dental professional	2	1%
Full sample	353	

Appendix 44. Patient DCE study-LC in WTP space

	Class 1	Robust SE	Class 2	Robust SE	Class 3	Robust SE
Cost	-0.069***	0.005	0.081**	0.040	0.004	0.004
Travel time to reach the practice	-0.559***	0.070	0.990	0.347	-1.390	1.943
Dietary advice	-0.522***	0.182	-0.424	0.638	1.663	3.054
Hygiene advice	-1.134***	0.173	0.897**	0.455	-0.194	2.711
Preventive treatment	-1.179***	0.263	4.916***	0.921	1.517	5.255
Waiting time for the appointment	-0.606***	0.135	1.245**	0.569	0.727	2.456
Seeing the dentist	-1.084	1.256	42.525***	10.109	-20.448	39.774
Intercept	-3.059	0.856	-16.313	2.126	0	-
Gender (Female)	0.385	0.395	0.641	0.749	0	-
Frequency of dental visits ()	0.564	0.397	0.087	0.693	0	-
Last visit for planned treatment (restorative care)	-0.613	0.510	-0.191	0.983	0	-
Last visit for emergency treatment	0.123	0.524	0.863	0.960	0	-
Sugar consumption	1.190***	0.415	10.319***	1.906	0	-
Live in the UK	0.265	0.407	-0.405	0.630	0	-
Age	0.059***	0.015	0.109***	0.028	0	-
Private insurance	-0.642	0.543	-1.358	0.899	0	-
Education (university)	0.248	0.382	1.587***	0.606	0	-
Perceived oral health (average or poor or none left)	0.612	0.428	-0.343	0.721	0	-

Status of employment (unemployed)	0.735	0.451	0.239	0.753	0	-
Class size	71%		7%		22%	
Number of responses			2589			
Sample size			324			
AIC			2567			
BIC			2830.65			

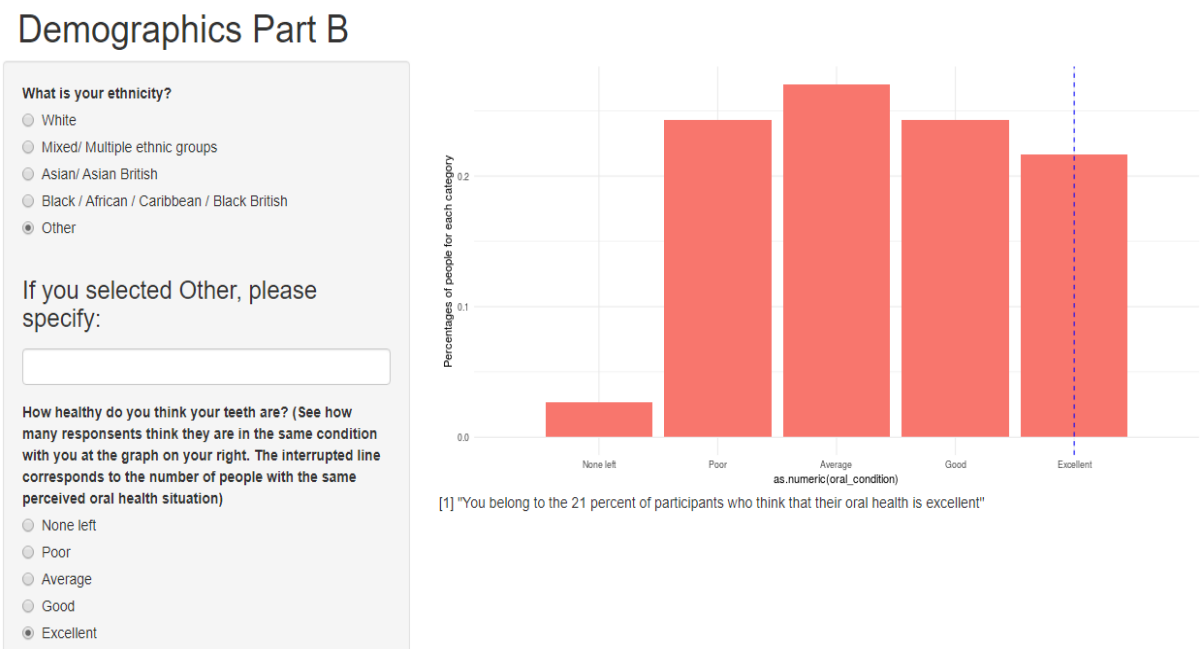
Appendix 45. R-Shiny online questionnaire application

The oral disease prevention toolkit (ODPT) display is a web page organised in twelve different pages: “Welcome”, “Demographics part A”, “Demographics part B”, eight “Choice tasks” and “Feedback”. When a user opens the application, they are directed to the “Welcome” page which contains a short description of the aim of the survey and the tasks that will be called to complete in two parts, i.e. providing sociodemographic information and making choices of a dental practice between eight pairs of hypothetical scenarios. At the end of the description section participants are informed that after submitting the survey they will receive a personally customised “Prevention Graph” which they could download and share with their Facebook friends to show how much they excel in the oral health paradigm. Finally there was the notification that their response data would be stored in a drobox file and fully anonymised before the analysis took place.

The “Demographics part A” page presents participants with a set of 9 static questions asking information about age, education level, daily consumption of sugar beverages, working status, gender, time of last visit to the dentist, frequency of dental visits and the reason for the last visit to the dentist.

"Demographics part B" page displays eight different questions in relation to respondents' ethnicity, perceived oral health, payment method for dental treatment, professional category, feelings about a dental visit, smoking status, living country and living city in the country. A bar chart based on participants' input to the question of perceived oral health is provided on the right hand side showing in real time the shares of individuals having chosen each answer category in a graphical form. An interactive message is also generated below the graph informing the individual about the exact percentage of respondents that the same answer. An interrupted blue line appears attached on the bar reflecting the chosen category, illustrating vividly the position of each individual's response. For a depiction of the interactive bar chart have a look at Graph 1.

Graph 1. Interactive bar chart of online questionnaire application measuring perceived oral health



Following the demographics pages, a series of eight choice tasks are presented to participants in eight different pages. In the upper part of first choice task page, there is a description section providing the choice context. A descriptions table also appears below this section defining the attributes used in the choice tasks. Each choice task is presented to participants in the form of a table with rows' names the names of the attributes and column names the unlabelled titles of "Dental Practice A" and "Dental Practice B" (Graph 2). The values inside the table correspond to the levels of the associate attributes as estimated by a D efficient design for nine different blocks. Participants were not allowed to proceed with answering the next choice tasks through the next button until a choice had been made to the pre-existing choice task page, prompting them to provide answers to all choice tasks.

At this point it should be noticed that a useful specification of the application was the linkage of each of the nine blocks estimated by the full D-efficient design, it with a different participant through a random number generator each time a respondent activated the application by pressing the link.

Graph 2. Choice sets presentation style of the online questionnaire application

In the question below, imagine you are going to register with a **new dental practice.** You will be shown the options of a typical **check-up appointment** for two **hypothetical** dental practices.

Based on these options, you should choose which practice you would register with.

Imagine there are no options available apart from the two practices shown. In both practices you will initially see the dentist for a scale and polish which will take about 15 minutes. The only variation between practices is in the options below.

Which dental practice would you choose?

	Dental Practice 1	Dental Practice 2
Travel time to reach the practice	15 minutes	45 minutes
Amount of dietary advice	5 minutes	5 minutes
Amount of hygiene advice	0 minutes	12 minutes
Amount of preventive treatment	0 minutes	8 minutes
Waiting time for the appointment	15 days	1 day
Dietary advice, hygiene advice and preventive treatment are provided by	dental professional	dentist
Cost of a dental check-up	£20	£50

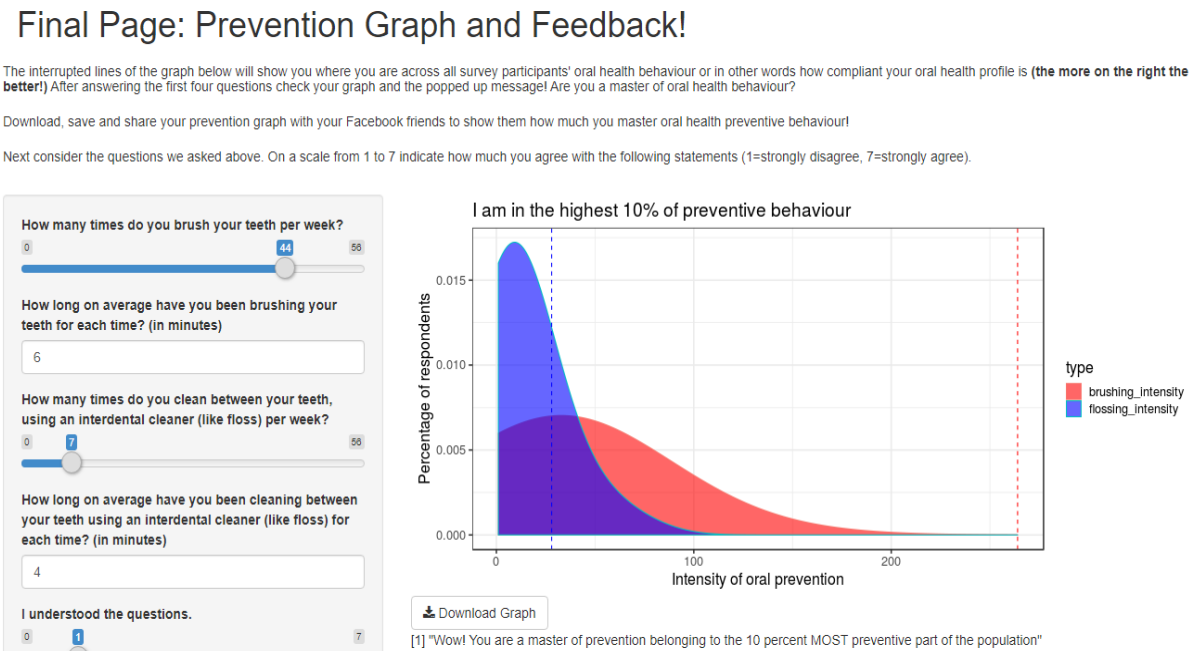
Choose One

- (•) Alternative 1
- ( ) Alternative 2

< Previous | Next >

On the final page of the application, participants were initially demonstrated with two questions asking for weekly frequency of teeth brushing and weekly frequency of cleaning using interdental floss and questions about average time in minutes for each of these behaviours. The inputs of these four answers were used by the application to calculate two separate scores one reflecting intensity of brushing process and another for intensity of interdental cleaning. Each of these scores was mapped against the overall scores provided by all participants through a colourful graph showing two distributions. One graph was coloured blue corresponding to the distribution of flossing intensity scores while the other was coloured pink reflecting the distribution of brushing intensity scores. Two interactive interrupted lines and a message were also produced in real time, to show their scores' position in the distributions and inform them about how good their score is in relation to other participants according to quantile analysis of scores. . An interactive title was also assigned to graph assigning quantile information. Message and title outputs were produced by an overall measure calculated by summing up teeth brushing and flossing intensity scores for each individual and mapping it across all respondents. A download option was available for those willing to download and share the graph. Please have a look at figure 6 as to how the distribution graph appears in Graph 3.

Graph 3. Interactive graph of online questionnaire application for distributional representation of preventive behaviour score across all participants



The oral prevention toolkit (OPT) is accessible online as a webpage (https://evangelos-zormpas-advocate-project.shinyapps.io/de…/) and a github repository (https://github.com/predecessor/Dental_survey). For users seeking to understand the code or build their own health survey application, the annotated code is available via github. The application could run in both a laptop and smartphone device and the only requirement for its use is internet connection.

The last part of questionnaire application titled “Feedback” involved a range of rating statements and open type questions similar to previous questionnaire versions.

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