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Clinical Need and Economic Factors: Influencing Orthodontic Care in a Sample of Patients in Ireland

Thesis presented by

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for the degree of

Doctor of Philosophy

University College Cork

The College of Medicine & Health, School of Dentistry

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DECLARATION

This is to certify that the work I am submitting is my own and has not been submitted for another degree, either at University College Cork or elsewhere. All external references and sources are clearly acknowledged and identified within the contents. I have read and understood the regulations of University College Cork concerning plagiarism and intellectual property.

Patricia McDermott

May 2023

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To everyone mentioned, and those who supported me behind the scenes, I am immensely proud of the achievement we have accomplished together. While the journey was arduous, it was undoubtedly rewarding, and I cherished every moment of growth, both personally and academically, which has made me a better educator.

ABSTRACT

AIM: The primary aim of the thesis is to investigate factors impacting on the child, adolescent, or parent in their decision to seek orthodontic care. The study has three objectives: 1) To investigate clinical and non-clinical factors influencing pre-treatment perceived need for orthodontic care by both parent and child/adolescent 2) To determine the amount a parent is willing to pay (WTP) pre and post treatment in order to obtain the benefit of straight teeth for their child, and 3) To investigate factors that influence patient compliance (in terms of hygiene) during fixed appliance treatment. The investigation is important in the current economic environment as orthodontic services tend to be an extremely expensive intervention and can be publicly funded. The research is influenced by studies highlighting that perceptions of need for care are multi-factorial and often influenced by non-clinical elements. Recent studies have highlighted the necessity for essential behavioural propensity assessment. RATIONALE: As orthodontic services are an expensive healthcare intervention, it is important to continue to examine the factors that may affect demand and outcomes in publicly funded and privately funded healthcare systems. There are very few studies on WTP in mainstream orthodontics. **METHOD**: It is a prospective longitudinal study using convenience sampling. The sample was stratified by age and gender, and consists of 177 subjects from the Republic of Ireland (RoI) and 177 from Northern Ireland (NI). The treatment modality was fixed appliance orthodontic treatment. The patients, aged 12 to 18 years (mean = 13.5), were studied in three different healthcare funding systems, from recruitment in 2004 until the completion of follow-up questionnaires in 2008. Instruments used to collect data included a patient administered interview at both pre- and post-treatment, two parent self-administered instruments, and a compliance instrument administered by the orthodontist. The pre- and post-treatment models were scored using Peer Assessment Rating (PAR), and the Index of Orthodontic Need (IOTN). The Dental Health Component (DHC) and the Aesthetic Component (AC) were scored by orthodontists. The orthodontists administering the treatment judged compliance and questionnaires were completed three months from the start of treatment and at the time the braces were removed. The data was analysed descriptively and empirically. The empirical analysis was undertaken using bivariate and multivariate regression analysis. **RESULTS:** The results indicate a misalignment between professionally assessed IOTNAC, and the child's perceived need. Perceived need for orthodontic treatments was more pronounced in children treated in privately

funded healthcare systems and was influenced by peer groups in both public and private funding systems. Parental factors influencing perceived need were the appearance of their children's teeth and gender differences. Parents from both NI and RoI had high perception of need levels with no significant difference between parents who are publicly funded or those who pay fees privately. Willingness to pay at the pre-treatment was associated with higher parental income and WTP did not change pre- and post-treatment. Parents from the RoI were willing to pay more than their NI counterparts, and this was true, whether or not, they were paying full societal or subsidized fees. Parental WTP pre-treatment and at completion is closely related to the societal market values for the jurisdiction and was related to ability to pay in both funding systems. There was no difference in the level oral hygiene compliance by those treated in either funding system. Compliance during treatment was better in females and children/adolescents from higher income households. More highly compliant children/adolescents had better treatment outcomes and lower PAR scores. **CONCLUSIONS:** The misalignment between perceived need and normative need may be due to lack of education in terms of what is a socially acceptable level of dento-facial appearance. The expectations of publicly funded patients/parents and their misalignment between perceived need and the value they place on treatment may not always be grounded, in practical realities but rather in external influences. Means testing would help public systems identify those who cannot afford treatment, but have a definite need for treatment. Practitioners and policy makers should consider whether the criteria for qualification for orthodontic treatment in healthcare systems should include an assessment of oral hygiene levels and cooperation. This thesis contributes by highlighting the importance of patient and parental perception and societal expectations on the demand for orthodontic care. In terms of behavioural propensity, the study provides an insight into the qualification for treatment based on potential behavior during treatment. The study has developed a practical tool for use by practitioners to gain an insight into the possible compliance of a child, depending on what is motivating them to seek treatment.

ABBREVIATIONS

CBA=Cost Benefit Analysis

Compliance(OH)=Patient compliance based on oral hygiene level

CV=contingent valuation

GLM=Univariate General Linear Model

HI=Household Income

HS=Healthcare System

HSE=Health Service Executive

IOTN AC= Aesthetic component of the index

IOTN=Index of Orthodontic Treatment Need

IOTN DHC= Dental health component of the index

NHS=National Health Service

NI= Northern Ireland

NSPRFS=Non-Subsidized Private Funding System

OE=Open-ended

PAR=Peer Assessment Rating index

ParPN=Parent Perceived Need

PN=Perceived Need

PPN=Patient Perceived Need

PRFS=Private Funding System

PSU=Primary sampling unit

PUFS=Public Funding System

RoI=Republic of Ireland

SBDC=Single Bounded Dichotomous Choice

SES=Socio-Economic Status

SPRFS=Subsidized Private Funding System

SSU=Secondary sampling unit

VAS=Visual Analogue Scale

WTP=Willingness to Pay

PREFACE TO THE THESIS

The author's contribution to the overall collaborative study of which this thesis forms a sub-study using the data collected for the overall collaborative study.

It is important to note that the sample size and sampling methodology was determined prior to the authors' involvement in the collaborative study. The author of this thesis became involved after the sample design, and at the composition of the patient and parent structured questionnaires.

Background for the overall collaborative study

A research proposal was submitted to the Higher Education Authority (HEA), North South Research Programmes, in August 2003 to obtain funding for a collaborative study between NI and RoI on Orthodontic services (Appendix A). The Island of Ireland includes Northern Ireland (NI), which is part of the United Kingdom (UK) and the Republic of Ireland (RoI). The title of the project was 'A longitudinal study of the benefit, outcome and cost of orthodontic treatment'. This thesis was part of the joint collaborative longitudinal study and used selected data to investigate Economic Factors of orthodontic healthcare services, including Perceived Need, Willingness to Pay and Compliance.

The research team for the overall collaborative study

The research team for NI, all from Queens University Belfast, included Professor Burden, Head of the Dental School, a consultant orthodontist Dr Christopher Johnston, a Health Economist Dr Ciaran O'Neill, a psychologist Dr Orlagh Hunt, and a post-graduate research assistant. The research team for the RoI included Professor Kinirons Head of Oral Health and Development, professor of orthodontics Professor Declan Millett, a consultant orthodontist Dr Denis Field, a specialist orthodontist (the author), and a postgraduate research assistant. The team met on a regular basis to plan the enactment of the approved protocol.

The following summarizes the contributions made by the author.

1. The author became a member of the research team the project in September 2003. At that time, the author was involved in the interview process for the RoI postgraduate research assistant.
2. In December 2003, the author attended the first meeting of the research team from NI and RoI. The protocol was presented to the research team and the specific outcomes of the meeting that effected the author included:
   (i) Recruitment of orthodontists RoI (n=7)
   (ii) Design of patient and parent questionnaires.
   (iii) Recruitment of patients (n=130 including patients for the piloting of questionnaires and those that were not suitable for the study)
3. Between January 2004 and April 2004 orthodontists were recruited (task (i)), meetings were held with the orthodontists, the project protocol was explained, training for the orthodontist and their associated staff was completed.

4. In addition, task (ii) was completed, the author provided mentoring and advice to the postgraduate research assistant on the patient and parent questionnaires. The author assisted with the composition of the patient and parent structured questionnaires. The author also recruited twenty patients whom were already in treatment in CUDSH, to pilot the questions for the patient questionnaire during the design period January to April 2004. The completed questionnaires were reviewed by the author who trained the postgraduate research assistant in understanding orthodontic terminology and the ways of explaining the terminology in the questionnaire to young patients.

5. Recruitment of 80 patients for the study in authors' clinic in university dental hospital, task (iii) (see Methodology recruitment of patients) which began in April 2004 and was complete by February 2005. This involves consultation, clinical assessments, and commencement of fixed appliance orthodontic treatment.
6. Treatment of author's patients participating in the study from 2004 to 2008. Normally a specialist orthodontist (academic) would have a half-day clinic once a week on average from September to July during academic year. For the study, this increased to five clinical sessions per week and these were held for 11 months of the year over the four-year period.
7. The author was responsible for all data analysis. Dr Michael Cronin statistician gave advice and guidance.

CHAPTER 1

INTRODUCTION

1.1. Introduction

This thesis will investigate the main factors influencing or motivating the child, adolescent and parent in their decision to seek orthodontic care. The present study will also investigate the parent's Willingness to Pay (WTP) for orthodontic care, which is essentially a proxy measure of the perceived benefit of orthodontic care for their child. Furthermore, the present study aims to clarify factors that influence patient oral hygiene compliance, during orthodontic treatment.

The thesis has three main objectives:

1. To determine the factors that influence perceived need (a factor of demand) for orthodontic treatment based on the perceived need of the child, adolescent, or parent, from the perspective of their pre-treatment appearance (child), and their pre-treatment awareness of the importance of straight teeth (parent).
2. To assess the parent's willingness to pay (WTP) for orthodontic care at both pre-treatment and the end of treatment. WTP for orthodontic care represents the amount the parent is willing to pay to obtain the benefit of straight teeth for their children.
3. To determine the demographic, socioeconomic and behavioural factors that influence patient compliance during active orthodontic treatment. Compliance is defined as the extent to which the patient's behaviour coincides with medical or health advice.

1.2. Rationale

Whilst the rationale for normative need has been investigated extensively, there is a dearth in research into factors influencing perceived need (a factor influencing demand), especially in longitudinal studies. This study, seeks to redress this deficiency. The identification of the significant perceived need factors influencing orthodontic care provision is highly noteworthy, in the current depressed economic environment, as there is severe competition for resources for funding of health services. Budget holders are

now requiring greater transparency with public sector spending and taxpayers are insisting on greater value for money. This investigation is unique in that the sampling frame includes children and adolescents with differing resultant effects of assessment. There are those that fell within the net of professionally determined normative need, and those that did not. There were those whose assessments led to qualifying for free treatment, while others were advised that they would have to fund their perceived orthodontic needs. The investigation into these factors is important in the current economic environment as orthodontic services tend to be an extremely expensive healthcare intervention and are largely publically funded. In a modern society improved dento-facial appearance, impacts on both societal acceptance and perceived intelligence, and may have a net benefit to society as a whole. The research is influenced by recent studies emphasizing the necessity for essential behavioural propensity assessment and highlighting that perceptions of need for orthodontic care are multi-factorial and are often influenced by non-clinical elements. The literature indicates that the perceived need of the child or adolescent is principally influenced by parental perception and societal expectations. However societal expectations may also inflate the perceived need for care increasing further the burden on public sector providers. In the Republic of Ireland public sector provision of orthodontic services is largely controlled by normative need as determined by the clinicians.

1.3. Data and Methods

It is a prospective longitudinal study using convenience sampling. The sample will be stratified by age and gender, and comprised of 210 subjects from the Republic of Ireland and 177 from Northern Ireland, (n = 387). The treatment modality is fixed appliance orthodontic treatment. The patients, aged 12 to 21 (mean = 13.5), are studied in four different health systems, from recruitment in 2004 until the completion of follow-up questionnaires in 2008. Of the 387 patients, 129 were aged between 10 and 12, 196 were aged between 12 and 15, and 62 were aged between 16 and 21. Instruments used to collect data include a patient administered interview at both pre- and post-treatment, two parent self-administered instruments, and a compliance instrument administered by the orthodontist. The pre- and post-treatment models will be scored using the Peer Assessment Rating (PAR) and the Index of Orthodontic Need (IOTN), and the dental health component and the aesthetic component (AC) will be scored by orthodontists. Compliance will be judged by the orthodontists administering the treatment and

questionnaires were completed three months from the start of treatment and at the time the braces were removed. The data will be analysed and presented descriptively and empirically. It is proposed that both bivariate and multivariate regression analysis will be used in the empirical analysis.

1.4. Structure of the Thesis

In Chapter 2, a review of orthodontic literature is undertaken to locate the study in terms of the existing research on factors related to perceived and normative need for orthodontic care. The examination of the literature identifies the theoretical framework, the statistical methods previously employed, and the factors investigated in previous studies. The review provides an appreciation of the type of results to expect, also a benchmark for the findings of this research and a framework of the problem to be investigated. In Chapter 3 the aims and hypotheses are outlined.

In Chapter 4, the materials and methods are presented and discussed. The role of the research team is outlined. The data collection methodology is explained. The rationale for patient selection and the criteria for inclusion and exclusion are clarified. Chapter 5, 6 and 7 outline the main descriptive and empirical results of the present study in relation to perceived need for orthodontic treatment, willingness to pay and child compliance, respectively. The rationale for the study is identified and the summary statistics of the main variables to be used in the empirical analysis are described in each chapter. The results of the investigation are presented, and the significant factors discussed in detail for each chapter. The results, in each case, are compared with the main findings from the relevant literature. In Chapter 8 an overall summary conclusion of the findings for perceived need, willingness to pay and compliance is presented.

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction

The basic economic considerations for the provision of orthodontic care in a healthcare service depend on the normative treatment need of the patient, the perceived need or demand by the patient, and the healthcare system's supply of orthodontic care to meet both the need and the demand (Woods, MA (Health Economics) Figure 1). The normative treatment need of the patient is professionally determined and is therefore objective. The perceived need of the patient is based on self-perception and is subjective.

There have been a number of reports in the orthodontic literature assessing the association between objective and subjective orthodontic treatment need (Livas and Delli, 2012). Professionally-judged objective need is measured using occlusal indices in order to categorise features of a patient's malocclusion. Subjective need can be measured using patient-based questionnaires or the Index of Orthodontic Treatment Need Aesthetic Component to grade appearance from the patient's perspective. Orthodontic treatment is an extremely expensive healthcare intervention and healthcare systems aim to provide treatment to those most in need and those who would benefit the most.

The outcome of treatment is important from an economical point of view, and it is not only dependent on the skill of the provider, but also on the patient's level of co-operation (Fox et al., 2000). For young patients, the level of co-operation may depend on the parent's degree of interest, motivation, and the value which they place on the outcome of treatment. The present study examines value placed on outcomes by the parent using parental Willingness to Pay (WTP). Thus, this study aims to assess if the factors that influence perceived need, and those that influence the parental value placed on treatment, also influence the patient's co-operation.

Internationally, a large volume of research has been conducted into the range of factors which influence the planning, delivery, receipt and outcome of orthodontic care. The research presented in this thesis explores some of the most important areas of orthodontic care provision: perceived need (parent and child), the value placed on orthodontic care by patients and their parents (WTP) and compliance. The literature review that follows will focus primarily on the previous research in these three areas, taking into account both the results and methodology of the most relevant studies.

Therefore, the purpose of this literature review is to locate the present study, in terms of the existing research, on factors identified as having an influence on the perceived need of the parent and child for orthodontic care. The examination of the literature identifies the theoretical framework, the statistical methods previously employed, and the factor variables used in previous studies. Furthermore, the review provides an appreciation of the type of results to expect. This creates a benchmark for the findings of this research. The orthodontic literature based on parental WTP for orthodontic care reports very few studies to date. There is a paucity of previous studies which report a model for clinical compliance based on oral hygiene compliance levels, that compares hygiene levels longitudinally between publicly and privately funded healthcare funding systems, and none using an Irish sample.

2.2. Patient perceived need

2.2.1. Definition of perceived need

Perceived need is simply the perception that as an individual, group, or society, a good or service is needed, without evidence as to how much or how many are needed. A perceived need for orthodontic care is the perception that an individual, group, or society, requires orthodontic care without being clinically assessed or without evidence as to whether care is required or the extent to which care is needed. Perceived need is one facet of the overall health services system of orthodontic care and one facet of demand, as is demonstrated in the Figure 1 below where perceived need is included under the umbrella of 'Demand' in Health Economics.

1 = Normative Need (the patient has a professionally assessed need orthodontic treatment need).

2 = Perceived need (the patient and expresses a need for treatment). This may contribute to a demand for orthodontic treatment on health service.

3 = Service available to supply both normative need and perceived need (5, 6, 7). There may be a supply for normative need or perceived need. Orthodontic treatment is supplied to those patients' who express a need, either by means of normative need or perceived need.

4=Unmet need (no treatment is provided).

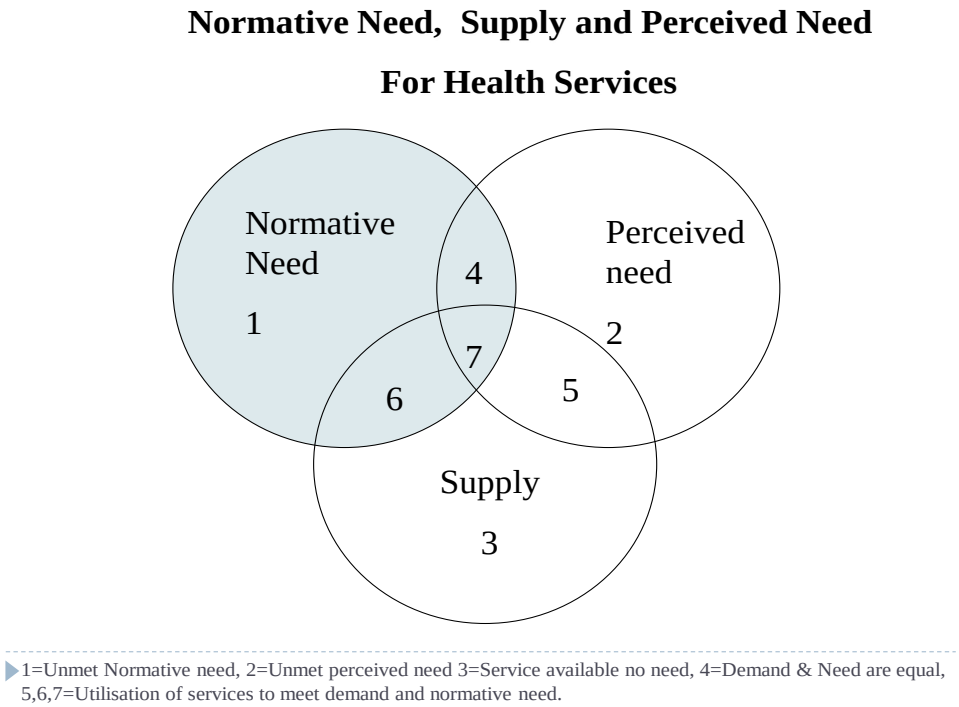


Figure 1. The interaction of Normative Need, Supply and Perceived Need in Healthcare Economics

In terms of the literature, certain guidelines have been laid out by the World Health Organisation (WHO) for oral health surveys conducted across populations. Many, studies on perceived need for orthodontic treatment have attained these standards and the methodology used has evolved as the guidelines have changed. Despite the complete lack of any previous orthodontic study in Ireland on patient perceived need, there is an abundance of international literature. In line with the purpose of this study, the literature reviewed in this section, is based on the perceived need analyses that were questionnaire based, including the use of visual analogue scales within the questionnaires. This criterion was used to select many studies for this review from the orthodontic literature.

2.2.2. Measurement of patient perceived need using questionnaires

The studies highlighted in Table 1 investigated and measured perceived need using patient questionnaires, either self-administered or as part of a face-to-face interview process. Before assessing the results on perceived need, it is worth noting that the method of questioning and responses were not uniform across the studies, and this could be

responsible for differing results. Based on the studies presented, it is possible to identify the development and emerging trends with regard to the relationship between perceived need and normative need. However, the review of the literature overall shows differing results without conclusive evidence.

Table 1. Perceived need studies that included questionnaires either self-administered or part of a face-to-face interview, the age range of the sample, the questions asked that measured patient perceived need for orthodontic treatment and possible responses.

Study	Age in years	Perceived need question	Possible responses
Shaw (1981) * Holmes (1992)*	12.54±0.27	Do you think your teeth need straightening?	Definitely no Probably no Don't know Probably yes Definitely yes
Birkeland et al. (1996) * Stenvik et al. (1997)*	10.6 12-20.7	Do you want to have your teeth straightened?	Yes very much Yes probably No probably not No not at all
Tickle et al. (1999)*	14	Do your teeth need straightening?	Yes, no, I don't know
Chew and Aw (2002) [1] Dias and Gleiser (2010)[1]	12±2.4 9-12	Do you think you need braces?	No definitely not No I don't think so Yes I think so Yes definitely yes
Kerosuo et al. (2004)*	15.3±1.08	Do you think that you are in need of orthodontic treatment?	Yes, no, I don't know
Ngom et al. (2007)[1]	12-13	Do you feel your teeth need to be straightened?	Yes, no, I don't know
Christopherson et al. (2009)*	9.37±0.96	Do you want braces for your teeth?	Yes, No

** Indicates studies inclusive of face-to-face interviews; [1] Indicates studies inclusive of self-administered questions.*

Shaw (1981), in a landmark historical paper, assessed perceived need of the patient within a healthcare system that provided orthodontic treatment in response to a perceived need of the child and/or parent. At that time in the United Kingdom (UK), a perceived need for orthodontic treatment resulted in the guaranteed receipt of public health service care. No professionally assessed normative measure of need was in place, and there was limited knowledge regarding factors that may influence patient perceived need. However, the study showed a positive correlation between professionally judged tooth irregularities and perceived need for orthodontic treatment. Also, perceived need being based solely on dental appearance was disputed because 48% of the children with professionally judged moderate to severe tooth irregularities, were satisfied with the appearance of their teeth. Within a decade of this investigation, Brook and Shaw (1989), developed the Index of Orthodontic Treatment Need. This would eventually be used in UK healthcare systems to prioritise children with the greatest professionally assessed normative need.

From 1st April 2006, the use of the Index of Treatment Need (IOTN) was compulsory in government (NHS) funded Orthodontics in England and Wales. It was introduced in the NHS for Scotland on October 1st, 2011, and into the NHS for Northern Ireland on April 1st, 2014 [The collaborative study protocol Appendix A for this sample was the investigation into the introduction of the IOTN to discern qualification for orthodontic treatment in NI]. If the patients' malocclusion is assessed as IOTN DHC grade 3, then there is a further allocation of grade to somewhere between 3.1 and 3.10 by application of the Aesthetic Component (IOTN AC 1-10). To be eligible for free NHS treatment, the overall score must be 3.6 or higher (IOTN DHC 3, IOTN AC 6) or be assessed as IOTN DHC 4 or 5.

Following the development of the IOTN index (Brook and Shaw, 1989) any future orthodontic studies concentrated on the relationship of perceived need to professionally assessed normative need. Holmes (1992) produced one of the first studies to test the hypothesis that the perceived need of the child was not related to normative need based on the Index of Orthodontic Treatment Need (IOTN). The Holmes (1992) study clearly showed that children assessed as having the greatest normative need using both the IOTN DHC and IOTN AC, had a definite perceived need for treatment. The study comprised of 955 adolescents and 66% categorised as in definite need of treatment (IOTN DHC grades 4-5), had a perceived need for treatment. Interestingly in the 'little or no' and 'borderline' need for treatment categories (IOTN DHC grades 1-3), 31% still reported a

perceived need. Likewise, aesthetically 44% perceived a need although professionally assessed as being in low to moderate need (IOTN AC 1-7). Adolescents judged professionally to be in definite need of treatment, by their dental appearance, IOTN AC grades (8-10), had reduced percentages of perceived need (26.5%) compared with the IOTN DHC (4-5) of 66%.

Thus, a trend was emerging in the UK where less children with moderate to severe dental irregularities, expressed satisfaction with their appearance, a change from 48% reported by Shaw (1981) to 42.5% by Holmes (1992). This change appeared to affect demand, 55.8% of adolescents in the more attractive categories of IOTN AC (1-3) had a perceived need for treatment (Holmes 1992). This continued to increase seven years later, Tickle et al. 1999 reported a level of 58.5% perceived need for 'little or no' and 'borderline' need categories (IOTN DHC 1-3) compared to 22% (Holmes 1992) for the same categories of normative need.

Using the Holmes (1992) study as a basis for comparison, the relevant studies that followed, also used IOTN dental health component (IOTN DHC) and the IOTN aesthetic component (IOTN AC) to assess normative need in most studies. All studies compared the percentage of the sample with a definite normative need IOTN DHC (grades 4-5) and IOTN AC (grades 8-10) to the percentage of the sample with a perceived need. The studies carried out in this area highlight the disparity that exists between the assessed normative need and perceived need for orthodontic treatment in healthcare systems. In Table 2 below the recorded percentages of patient perceived need within samples of the studies listed in Table 1, that report both patient perceived need for each category of professional normative need using IOTN DHC and/or where possible IOTN AC are given.

Table 2. Patient perceived need percentages for each of the categories IOTN DHC (1-3) and (4-5) and IOTN AC (1-3) and (8-10)

	Patient Perceived Need percentages			
	IOTN DHC (1- 3)	**IOTN DHC (4- 5)**	**IOTN AC (1-3)**	**IOTN AC (8-10)**
Holmes (1992)	44	66	55.8	44.2
Birkeland et al. (1996)	65	35		
Tickle et al. (1999)	58.5	41.5		
Chew and Aw (2002)	22	78		
Kerosuo et al. (2004)	56.5	43.5	48	52
Dias and Gleiser (2010)	42.3	57.7	62.2	37.8

The results can be listed as follows:

1. Perceived need was reported for patients categorised with definite normative need IOTN DHC (4-5) and IOTN AC (8-10) by (Birkeland et al., 1996; Holmes,1992; Stenvik et al., 1997; Tickle et al., 1999; Chew and Aw, 2002; Kerosuo et al., 2004; Christopherson et al., 2009; Dias and Gleiser, 2010).

2. Perceived need was also reported for patients with low to borderline or moderate need IOTN DHC (1-3) and IOTN AC (1-7) by (Birkeland et al., 1996; Holmes, 1992; Stenvik et al., 1997; Tickle et al., 1999; Chew and Aw, 2002; Kerosuo et al., 2004; Christopherson et al., 2009; Dias and Gleiser, 2010).

3. Perceived need was greater in lower categories of normative need IOTN DHC (Shaw, 1981; Birkeland et al., 1996; Tickle et al., 1999; Kerosuo et al., 2004).

4. Perceived need was greater in lower categories of normative need IOTN AC (Shaw, 1981; Holmes, 1992; Dias and Gleiser, 2010). Shaw (1981) measured dental irregularities because the study was performed before the IOTN index existed.

Based on a comparison of these results, there appears to be a shift over time in relation to perceived and normative need. Holmes (1992) reported greater perceived need in the presence of great normative need. However, Tickle et al. (1999) later found perceived

need even in the absence of normative need and greater perceived need in 'little or no' to 'borderline' normative need (IOTN DHC 1-3). This finding was later supported by Kerosuo et al. (2004) in Kuwait. In addition, where percentages were not reported the author did report a similar trend (Christopherson et al., 2009) in the USA.

2.2.3. Validity of perceived need measures using questionnaires

Table 3 gives an overview of methodologies used for the studies examined, including information about the geographic location, sample size, gender, the number of recruitment sites, and details regarding the interview process. The sampling designs of the listed studies will be compared with the WHO guidelines for oral health surveys.

Table 3. The methodology used in the studies listed in Table 1. The country of origin, sample numbers, gender, number of sites sample was recruited from interview face-to-face=yes and self-administered=no.

Study	Origin of the study	Sample size	Gender M/F	Sites	Interview
Shaw (1981)	UK	200	100/100	1	Yes
Holmes (1992)	UK	955	452/503	22	Yes
Birkeland et al. (1996)	Norway	359	183/176	8	No
Stenvik et al. (1997)	Norway	306	No data	8	Yes
Tickle et al. (1999)	UK	5918	No data	27	Yes
Chew and Aw (2002)	Singapore	257	137/120	1	No
Kerosuo et al. (2004)	Kuwait	139	70/69	2	No
Ngom et al. (2007).	Senegal	665	338/327	16	Yes
Christopherson et al. (2009)	USA	1566	825/741	29	Yes
Dias and Gleiser (2010)	Brazil	407	216/191	13	Yes

As described in (section 2.2) the literature shows varied results for the relationship between normative and perceived need. This may be due to the different methodologies used in the studies. The two studies performed in the UK which highlight this trend, Holmes (1992) and Tickle et al. (1999), are comparable in methodology and the

population investigated was quite uniform. The studies were both performed in the North of England, involved numerous schools and the samples age allows correct assessment of the developing dentition using IOTN DHC. With regards to power calculations, more recent studies use epidemiological knowledge of the prevalence of normative need in the general population to calculate the size of the sample needed for a comparative study of perceived need. That data was not available at the time of the Holmes (1992) study, but the sample numbers are very high in both UK studies, and it is reasonable to assume they were representative of the general population.

The Tickle et al. (1999) study revealed a perceived need that was higher than the actual number of children who qualified for orthodontic care and had emerged in the years following the Holmes (1992) study. This trend was reinforced by two more recent studies, Christopherson et al. (2009) in the USA and Kerosuo et al. (2004) in Kuwait, although some flaws in these studies must be recognized. The Christopherson et al. (2009) study found perceived need was much higher than the normative need, supporting the societal trend evident in the UK, and was adequately powered in terms of sample size and sites tested. It also reported different ethnicities within the sample and was inclusive of more deprived children. However, the sample was very young (8-11 years) and in some cases a valid IOTN DHC could not be recorded. The trend was also apparent in the Kerosuo et al. (2004) study. However, this study used a sub-sample of a larger study, only a few sampling sites and a much smaller sample size. The use of a subsample meant this study was under powered compared to the WHO guidelines for oral health surveys.

On the contrary, Ngom et al. (2007) used a survey that closely followed the WHO guidelines for oral health surveys and reported the opposite findings for perceived need i.e., definite need IOTN DHC (4-5) occurred in 42.6% of the sample but only 23.8% reported a perceived need for orthodontic treatment. However, despite following the WHO guidelines, when the researchers tested the knowledge base of the sample population about braces, they found this to be limited (10.8% of the sample). This clearly makes it difficult to accurately assess children for perceived need when they do not know what orthodontic treatment actually entails. Thus, the Ngom et al. (2007) study was difficult to legitimately compare to other study results that were obtained from a sample with a greater knowledge of orthodontic care.

In the remaining studies, the method of calculating the final figure for the level of perceived need may also render the studies unsuitable for direct comparisons (Stenvik et

al., 1997; Birkeland et al., 1996; Chew and Aw, 2002). In these studies, the responses to two questions were combined: one for actual perceived need and the other regarding appearance. The validity of the calculated dichotomous variable is questionable as a direct measure of perceived need, and therefore the results of the studies using this method of assessing perceived need should be interpreted with care, and only compared to studies with similar methodology.

2.2.4. Patient Perceived Need determined using the Index of Orthodontic Treatment Need Aesthetic Component for self-assessment

This methodology was employed to assess patient perceived need based on the evidence that the major factors determining a patient's perceived need for orthodontic treatment may be broadly described as aesthetic (Shaw, 1981; Tickle 1999; Josefsson et al., 2005). The majority of studies that used the IOTN AC, measured the patient's perception of their own dental aesthetics. The patient's judgement once established was then compared to both the professional assessment of the child's dental appearance using the IOTN AC and the professional assessment of the patient's malocclusion using the IOTN DHC. The review of the literature in this section aims to analyse the patient's judgement in relation to the professional assessment of their appearance and the normative need measured by IOTN DHC. The working hypothesis for reviewing the papers is that no relationship exists between patient perceived need IOTN AC and the professional assessment of treatment need IOTN AC and IOTN DHC Table 4. The results of the studies using IOTN AC methodology are summarised in Table 5.

Table 4. Studies of patient perceived need using the IOTN AC to measure perceived need from the patient's perspective and the hypotheses being tested for each individual study

Study	Area	Data	Methodology	Hypothesis
Holmes 1992	UK	955 12yrs	Cross sectional Photographs of own teeth	The child's assessment of malocclusion using photographs is not associated with normative need
Grzywacz 2003	Poland	84 12yrs	Cross sectional IOTN AC child	The IOTN AC is not a reliable self-measure of perceived need in children
Hamdan 2004	Jordan	103 15.3yrs	Cross sectional Normative need Perceived need IOTN AC	No relationship exists between patient and professional assessment of normative need
Flores-Mir and Major 2004	Peru	329 University students	Cross sectional IOTN AC/questionnaires Visual analogue scale Normative need	No relationship exists between perceived need measures using IOTN AC, visual analogue scale or questionnaires
Mandall et al. 2005	UK	525 11-12yrs	Cross sectional IOTN AC child Normative need	The IOTN AC cannot be used to predict the uptake of orthodontic treatment

Study	Area	Data	Methodology	Hypothesis
Bernabe and Flores-Mir 2006	Peru	281 1st yr university	Cross sectional IOTN AC Professional assessment using IOTNDHC	No relationship exists between patient perceived appearance and professional assessment of malocclusion
Hassan 2007	Saudi Arabia	743 17-24yrs Private or Public Clinic	Cross sectional IOTN AC Normative need DHC	No relationship exists between patient perceived appearance and professional assessment of malocclusion
Ngom et al. 2007	Senegal	665 12-13yrs 16 schools	Cross sectional IOTN AC child Normative need	No relationship exists between patient perceived need for orthodontic treatment and professional assessment
Dias and Geiser 2010	Brazil	407 9-12yrs 10 schools	Cross sectional IOTN AC self-assessment IOTN AC professional assessment	No relationship exists between patient perceived need for orthodontic treatment and professional assessment
Trivedi et al. 2011	India	100 18-20yrs	Cross sectional IOTN AC self-assessment And questionnaire	No relationship exists between patient perceived need for orthodontic treatment and professional assessment

Study	Area	Data	Methodology	Hypothesis
Aikins et al. 2012	Nigeria	621 13-17yrs 6 schools	Cross sectional IOTN AC self-assessment IOTN AC professional assessment	No relationship exists between patient perceived need for orthodontic treatment and professional assessment
Singh et al. 2014	Nepal	252 17-19yrs	Cross sectional IOTN AC self-assessment IOTN AC professional assessment	No relationship exists between patient perceived need for orthodontic treatment and professional assessment

Table 5. The percentage of children recorded in IOTN AC or IOTN DHC categories either self or the result of a professional assessment

Study	Year	IOTN AC (1-4) Patient recorded in percentages	IOTN AC (8-10) Patient recorded in percentages	IOTN AC (1-4) Professionally recorded in percentages	IOTN AC (8-10) Professionally recorded in percentages	IOTNDHC (4-5) Professionally recorded in percentages
Holmes	1982	17.6	4.1	13.9	4.9	66
Grzywacz	2003	94		85.7		
Hamdan	2004	73.3	16.17	48	21	71
Flores-Mir et al.	2004	87.5				
Mandall et al.	2005	72		12	86	73
Bernabe and Flores-Mir	2006	87.2	1.8		1.8	29.9
Hassan	2007	72.7	17	60.6	16.1	71.6
Ngom et al.	2007	86.2	3.2		8.7	42.6
Dias and Geiser	2010	84.3	5	62.2	11.3	34.2
Trivedi et al.	2011	93		78		
Aikins et al.	2012	82.5		64.9		
Singh et al.	2014	85.3		68		

The results of this review can be summarized as follows:

1. Perceived need based on IOTN AC percentages recorded lower levels of perceived need compared to the professional normative need (IOTN AC and IOTN DHC).

2. Increased percentages of patients placed themselves in the 'little or no need' (IOTN AC 1-4) category compared to the professional.

For the majority of studies, the IOTN AC (8-10) did not relate to the IOTN DHC (4-5). The IOTN AC (8-10) related to the patient IOTN AC (8-10) in four studies only. Over 90% of the studies reported that the majority of children rated themselves in IOTN AC (1-4) and bore no relation to their normative aesthetic need judged professionally. Certainly in 100% of the studies the professional rated less patients in IOTN AC (1-4) grade than did the patients themselves. This means that the IOTN AC is unable to differentiate the samples in terms of acceptable or unacceptable appearance when used by the patients. Over 70% of each sample in 90% of the studies report a good acceptability of their appearance. Obviously, this is not the case when compared to the professional grading of IOTN AC. Patients are unable to use the IOTN AC in any reliable manner. The patient is unable to understand the IOTN AC due to inadequate dental knowledge and lack of training and consistently underscores their orthodontic treatment need in 100% of the studies in comparison to the scores awarded by professionals. The IOTN AC should be used only by the trained professional to identify the impact of the visual malocclusion traits on the resultant dental appearance of the patient. The use of the IOTN DHC and IOTN AC together is essential because high percentages of patients if scored only on the basis of their IOTN AC score, would be deemed ineligible for treatment due to a professionally judged satisfactory appearance.

Using the IOTN AC only as a measure of patient perceived need without asking relevant questions directly to the patient about their perceived need, could mask the trend highlighted in section 2.2 because most children usually judge their appearance to be acceptable (IOTN AC). Therefore, without also clarifying perceived need using questionnaires, it is difficult to understand the demand for orthodontic treatment in the health services because patient assessed IOTN AC would tend to suggest a trend towards low resultant demand.

2.2.5. Factors associated with patient perceived need for orthodontic treatment

It is apparent from the literature reviewed thus far that there is a disparity between patient perceived need and professional judged normative need for orthodontic treatment. If the patient expresses satisfaction with their dental appearance and yet desires orthodontic treatment Holmes (1992) other influential factors must be present. Possible explanatory factors are those derived from the reviewed studies that measured perceived need using the methodologies described in sections 2.1 and 2.2 (structured patient questionnaires or patient self-assessed IOTN AC) and are listed in Table 5.

A historical study by Albino (1981) consisted of 11–16-year-olds used a methodology that may be comparable to the more recent Q-methodology described by Prabakaran et al. (2012). Albino used discriminate analysis narrowing down the factors in patient perceived need to four main categories occlusal, perceptual, attitudinal, and psychosocial. With resultant factors, showing concern about occlusion, desire for treatment, positive perceptions of treatment, and relative values of treatment. The Q-methodology combined common factors in the form of themes that may influence the patient. It is possible that Q-methodology and the derivation of themes may be compared to the discriminate analysis performed by Albino. Certainly, the results are similar in relation to concerns for occlusion, desire and perception of treatment. No other study after Albino has assessed the relative value a patient places on orthodontic treatment.

Table 6 presents perceived need studies that investigated factors that may influence patient perceived need for orthodontic treatment. There has been no study performed in Ireland that has investigated factors that may explain patient perceived need in an Irish sample. Therefore, it is important to replicate the most investigated factors from the literature to use in an Irish study to allow for comparisons with the studies listed. The most common factors are appearance, age, gender, socio-economic status, funding system, normative need, peers, and teasing. Questionnaires can be structured to elicit information on these factors. Following the Albino et al. (1981) study it would be important to include the value parents place on orthodontic treatment using WTP.

Table 6. Studies that have tested patient perceived need with two different methodologies against independent factors that may affect the measurement and resultant factors that are significant

Study	Dependent factor	Independent factors	Resultant factors
Shaw 1981 Shaw et al. 1991	Perceived need Photographs Questionnaire	Gender, age, decision, appearance, teased, appliance type, treatment time	Females, dental appearance, decision parent, teased, age attendance pattern
Albino et al. 1981	Perceived need Questionnaire	Demographics, psycho-social, appearance, severity of malocclusion	Severity of malocclusion, dental-facial appearance, gender
Gosney 1986	Perceived need Questionnaire	Severity of malocclusion, dental appearance, teasing, decision	Dental appearance, decision
Burden 1995	Uptake of treatment	Social class, gender, influence of peers	Peers>social class or gender
O'Brien et al. 1996	Accepted for treatment	Gender, funding system, IOTNDHC, social class	Normative need, gender
Ng'ang'a et al. 1997	Perceived need Questionnaire	Gender, normative need	Gender girls more dissatisfied with appearance
Tickle et al. 1999	Perceived need Questionnaire	Normative need, socio-economic status	Socio-economic status
Kerosuo 2002	Perceived need Questionnaire	Funding system, age, gender, ethnicity, socioeconomic status	Funding system, gender, socioeconomic status
Josefsson et al. 2005	Perceived need Questionnaire	Demographics, Dental appearance, Behaviour pattern, Ethnicity	Gender and ethnicity Females higher perceived need
Mandall et al. 2005	Uptake of treatment	Socio-economic, normative need, patient perceived need IOTN AC	Patient perceived need IOTN AC
Josefsson et al. 2009	Perceived need Questionnaire	Gender, peers, severity of malocclusion, ethnicity	Normative need IOTNDHC and peers

Study	Dependent factor	Independent factors	Resultant factors
Marques et al. 2009	Perceived need Questionnaire	Normative need, gender, age, socio-economic status, decision	Normative need and parent perceived need
Christophers on et al. 2009	Perceived need Questionnaire	Age, dental appearance, ethnicity, socio-economic, normative need	Normative need, decision and dental appearance
Prabakaran et al. 2012	Perceived need Questionnaire	Decision, dental appearance, teasing, appliance type, treatment time	Dental appearance
Grzywacz 2003	Perceived need IOTN AC	Age, gender, aesthetics, decision	Aesthetics, Decision (self, dentist, parent)
Flores-Mir et al. 2004	Perceived need IOTN AC	VAS, OASIS, age, gender, aesthetics, teasing, peers, previous orthodontics	Method of assessment of aesthetics
Hamdan 2004	Perceived need IOTN AC	Age, gender, decision, social class, dental appearance, normative need	Decision, normative need
Bernabe et al. 2006	Perceived need IOTN AC	Age, gender, socioeconomic status	Adult not significant No significant factors
Dias and Gleiser 2010	Perceived need IOTN AC	Age, gender, socio-economic, normative need	Gender, normative need, decision
Trivedi et al. 2011	Perceived need IOTN AC	Age, gender, normative need, dental appearance, function, demand	Normative need IOTN AC, dental appearance
Aikins et al. 2012	Perceived need IOTN AC	Age, gender, normative need	Age is not significant but 16-18yrs shows increased IOTN AC
Singh et al. 2014	Perceived need IOTN AC	Age, gender, area of living, education, IOTN AC, demand	Normative need IOTN AC, demand

2.2.6. Patient perceived need and gender

Fifteen reported studies tested gender (Table 6) but only five found gender to have an influence on the level of the patient's perceived need for orthodontic treatment. There were five papers that reported females as desiring treatment to a greater extent than males due to dissatisfaction with their dental appearance, usually the irregularity of their anterior teeth (Albino, 1981; Shaw, 1981; Ng'ang'et al., 1997; Josefsson et al., 2005; Dias and Gleiser, 2010). O'Brien et al. (1996) viewed gender in terms of an association with the uptake of orthodontic treatment in patients with normative need and reported that this was three times more frequent in females than males in the UK with similar findings in Kuwait (Kerosuo et al., 2002).

2.2.7. Patient perceived need and normative need

Recorded levels of patient perceived need (Table 2) for orthodontic treatment differ from patient normative need measured professionally using the dental health and aesthetic component of the IOTN. The IOTN index records need on the basis of the dental health risk of certain occlusal features in conjunction with the aesthetic impact of the dental appearance. Occlusal features which are recorded as needing orthodontic correction such as deep traumatic overbite, severe posterior crossbite or impacted teeth may not have any aesthetic implications. Thus, if the patient is judging their own appearance these anomalies may not be apparent to them. This is reflected in lower patient scores when using the IOTN AC and even in lower professional IOTN AC scores compared to IOTN DHC scores. The lowest treatment need has been recorded by the patient and then the professional when judging dental appearance. The professional is trained to recognise anomalies such as deep bite, crossbite and impacted teeth, the patient is untrained and therefore cannot use the IOTN AC index accurately. Consequently, professional normative need assessments of dental appearance can only agree with the patient's interpretation of their teeth, if the anomaly affecting the dental appearance is immediately obvious to the patient. Thus, the type of occlusal feature present in each individual within a sample of patients could certainly affect the resultant perceived need. This introduces bias and reduces the reliability of the study and it has been shown previously that patients perceive a need with certain malocclusion traits (Gosney, 1986). A representative sample of any given population will have a random spread of malocclusions and the discernment of perceived need should not rely on the presence or absence of visual anomalies. On this basis normative need measured using the IOTN DHC is more reliable in scientific studies

and should be used in conjunction with structured questionnaires that establish patient perceived need. Professional IOTN AC should also be measured to establish if there is a perceived need in the 'little or no need' categories of normative need based on dental appearance.

2.2.8. Patient perceived need and dental appearance

The occlusal anomalies that have a greater impact on dental appearance are degree of crowding, severity of overjet, depth of overbite and the presence of crossbites. The appearance of crowding proved significant to overall dental appearance by (Shaw,1981; Gosney,1986; Marques et al.,2009), whereas Josefsson et al. (2009) noted that anterior crossbite was the most significant feature. The following studies report dental appearance as being significant (Albino,1981; Shaw,1981; Shaw et al.,1991; Gosney,1986; Mandall et al.,2005; Christopherson et al.,2009; Gryzwacz,2003; Trivedi et al.,2011; Prabakaran et al.,2012) in relation to patient perceived need. Albino 1981) proved that patients believe that dental appearance is also important for dento-facial appearance and confirmed by (Gryzwacz, 2003; Flores-Mir and Major, 2004; Christopherson et al., 2009; Trivedi et al., 2011). A study performed in Brazil, Marques et al. (2009) reported dental-facial appearance as being the main reason for orthodontic treatment demand. Prabakaran et al. (2012) used Q-methodology and factor analysis to cover a wide range of questions administered to the patient about malocclusion traits. The factors were narrowed down into overall themes using complex statistical factor analysis and mapping. This very recent study using more advanced statistical techniques, reported that the patient perceived need analysis produced 3 main factors and they were all related to appearance for example "I want a better smile".

2.2.9. Patient perceived need and decision to seek orthodontic treatment

The decision to undergo orthodontic treatment could be initiated by the patient, parent or professional. Gosney (1986) reported that only 22% of children initiated a referral to the orthodontist, 42% were parents and 36% general dentists. Gryzwacz (2003) found that a significant number of children would undergo treatment if a parent or dentist suggested it. Although, in contrast to both these studies Prabakaran et al. (2012) reported that the patient's dentist suggesting they need braces did not rate highly as a motivating factor. Hamdan (2004) claimed that the patient initiated the visit to the orthodontist, although the sample of their parents in the study reported a higher perceived need for treatment.

Studies reporting the very important influence of parents on a child's decision to seek orthodontic treatment, did so on the basis that the parent's had a very high measure of perceived need (Marques et al., 2009; Dias and Geiser, 2010). An explanation for the high perceived need scores for parents found by Hamdan (2004) thought that parent perceived need scores may be biased. The parent is conscious of their child's need to be treated in a public service and do not want to be guilty of not being able to provide adequate care for their child.

2.2.10. Patient perceived need and socio-economic status

Tickle et al. (1999) showed that when a patient's malocclusion was severe there was no influence of social class on treatment uptake, it was only in the mild to moderate categories that higher social class showed an increased uptake. From their results regarding children with a low normative need, 19% of middle-class children went on to receive treatment compared to 6% in low social groups. Marques et al. (2009) in a study in Brazil agreed and highlighted the fact that the low wages of the parents in their study could be a reason for not receiving treatment. Marques et al. (2009) used the 'Brazilian Economic Classification Criterion' based on household possessions to determine socioeconomic status. Marques et al. (2009) also recorded the income of the family and whether the sample qualified for free treatment based on income levels. The socioeconomic status of the patient was associated with uptake of treatment because only parents with the ability to pay could access orthodontic treatment.

Social class was determined by area of living Burden (1995) used postal codes and O'Brien et al. (1996) accessed the 1991 census data or wage. Burden (1995) used a sample with a cross section of socioeconomic status. The socioeconomic status was determined using the postal code of the patient and applying the ACORN data, 'A Classification of Residential Neighbourhoods'. In this classification ranked divisions were employed to allocate each individual into socioeconomic groups of above average, average, and below average circumstances. The results showed that the uptake of treatment did not differ between the three social groups. O'Brien et al. (1996) used the Townsend score to for socio economic status. This is a composite measure of social deprivation derived from relevant variables that were collected during the 1991 census (Townsend, 1985). There was no effect of social deprivation on treatment uptake.

These two studies results report different findings to those of Kenealy et al. (1989) in a longitudinal study of school children found that it was only when a child's malocclusion was severe that there was association between social class and uptake of treatment. However, when the malocclusion was mild to moderate there was a significant social class effect: more middles class children received treatment.

2.2.11. Patient perceived need and peers

Three studies (Shaw et al., 1991; Burden, 1995; Josefsson et al., 2009) mention the influence of peers in relation to orthodontic treatment and each describe a different interpretation of the context in which a child receiving orthodontic treatment may be affected by peer input. Shaw et al. (1991) felt that the effect of the peer response would depend on the familiarity of the child with orthodontic appliances on others, either in school or in their neighbourhood. Burden (1995) reported that the uptake of orthodontic treatment by friends and acquaintances has a greater influence on the child's decision to embark on orthodontic treatment then either social class or gender. Josefsson et al. (2009) concluded that the perceived need for orthodontic treatment was associated with 'how the child felt about the appearance of their teeth compared to their peers', and if they felt they looked worse this would effectively increase perceived need.

2.2.12. Patient perceived need and teasing

Bullying among school children has been defined as 'a specific form of aggressive behaviour and can be described as a situation when a student is exposed repeatedly and over time, to negative actions on the part of one or more students' (Olweus, 1994). Teasing is considered to be a milder form of aggression than bullying, though if it causes harm or distress, it should be considered bullying (Pearce, 1991). The frequency of teasing related to dental features has been reported to be 7% among school children aged 9 to 13 years (Shaw et al., 1980) and teeth were the fourth most common feature that children were teased about (Shaw et al., 1980). Certain occlusal traits have been associated with teasing, though background facial attractiveness appears to play a more influential role than the individual's dental condition (Shaw et al., 1980). Two studies from the UK Shaw (1981) and Gosney (1986) investigated teasing prior to treatment and found it was related to dental appearance particularly in children with overjet greater than 10mm.

2.2.13. Summary of methods for measuring perceived need

According to Birkeland et al. (1996), it is difficult to validate questionnaires used to investigate perceived need because differences in question wording and response options affect the results. Thus, direct comparison between studies reported in the literature using questionnaires is difficult because of the differentiation in selected assessment methods. It can be anticipated that diverse scales and starting points in the response options may have a certain impact on the participant replies. In order to eliminate wastage through incorrectly completed or defaced forms, several investigators preferred to use face-to-face interviews in their studies (Holmes, 1992; Espeland et al., 1993; Stenvik et al., 1997; Hamdan, 2004; Bernabe and Flores-Mir, 2006; Christopherson et al., 2009; Chu et al., 2009; Dias and Gleiser, 2010). Nevertheless, the face-to-face interviews risk the introduction of bias. The respondents may distort their answers in order to make a more favourable impression on the interviewer, giving the most socially acceptable response to questions rather than giving a genuine answer. The competence of non-specialists to perform interviews or address possible queries may also raise an issue about the study protocol (Christopherson et al., 2009; Josefsson et al., 2009).

2.2.14. Perceived need measured using measures of appearance

Another method that can be used to measure perceived need is a visual analogue scale (VAS). A VAS is a measurement instrument that attempts to measure a characteristic that ranges across a continuum of values and cannot easily be directly measured (Crichton, 2001). The VAS is a straight horizontal line of fixed length, usually 100 mm. The ends are defined as the extreme limits of the parameter to be measured orientated from the left (worst) to the right (best) (Petersen and Dahlstrom, 1998). The participant marks a point on the line that they feel represents their perception of their current state; the VAS score is determined by measuring in millimetres from the left hand end of the line to the point that the patient marks. The VAS is widely used due to its simplicity and adaptability to a broad range of populations and settings. Hunt et al. (2001) used a VAS to assess the level of importance attached to proposed orthodontic benefits by general dental practitioners (GDPs) and orthodontists. Improved self-esteem, improved physical attractiveness and improved self-confidence were the three highest ranked benefits by both GDPs and orthodontists, while at the opposite end of the spectrum, they found that a reduction in temporomandibular dysfunction (TMD) problems was the lowest ranked

item. There is a paucity of studies that use the VAS scale to measure how a patient feels about the attractiveness of their face or teeth or smile.

To cover both methodologies, it is possible to elicit perceived need by using a perceived need question and a VAS score within the same structured questionnaire, in a face-to-face interview.

2.2.15. A summary of relevant findings from the patient perceived need studies reported in the orthodontic literature

1. In a 'structured interview methodology with a direct question about perceived need' the studies more discerning of a patient's desire for treatment in the presence of 'little or no' normative need and moderate need (IOTN DHC 1-3). A study that used IOTN DHC (1-2) for 'little or no need' assessment reported that 28% of patients still perceived a need, while another included IOTN DHC (1-3) thus 'little or no need' to 'moderate' need and reported 22% of patients perceived a need. How the patient determined their perceived need in the absence of definite normative need for these studies was not reported.

2. In studies that measured normative need solely by dental anomalies (IOTN DHC) and compared it to patient perceived need, a societal trend was identified. Such that the 'little or need' category of IOTN DHC (1-2) does not accurately reflect patient perceived need. Studies from 1992, 1996 and 2004 drew similar conclusions, 20.9%, 19.7% and 28% of patients perceived a treatment need although their normative need assessment represented 'little or no need'.

3. Three conclusions can be drawn from the studies that were inclusive of the IOTN AC. One, that appearance of the teeth (IOTN AC) and normative need (IOTN DHC) cannot be compared due to occlusal anomalies detected by (IOTN DHC) that cannot be seen and judged in the appearance by (IOTN AC). Two, that the (IOTN AC) cannot be used successfully by the patient, the patient measures are consistently below professional judgement. Three, the patient consistently places their appearance in the 'little or no need' category and thus any perceived need and demand for orthodontic treatment, for these patients, must be based on factors that are independent of dental appearance.
4. A longitudinal study that investigated the change in perceived need in relation to age of the patient found good agreement between perceived need and normative need in

the older subjects. Older patients were more accurate in their perception of treatment need.

5. Several studies used IOTN AC patient self-assessment and combined this with questionnaires to obtain a measure of perceived need. A disparity was found between the perceived need derived from the questions and the perceived need from their self-judgement of appearance. In a study of 955 school children 81.1% of them placed themselves in the 'little or no need' for treatment based on their appearance but when asked if they felt their teeth needed straightening 40.7% said 'yes' and 'probably yes'. Thus, patients' have been shown to judge their appearance favourably and still perceive a need for treatment.

6. In studies that measured normative need professionally using the (IOTN AC) index and compared this to the patients' perceived need derived from questionnaires, there was a clear perceived need in the absence of normative need. In studies from 1992 and 2004 the results were the same. In the 1992 study 72.6% of the sample were IOTN AC (1-4) yet 38.1% answered 'yes' or 'probably yes' to the needs for braces. However, the 2004 study reported 76% of the sample as IOTN AC (1-4) of whom 22% perceived a need for treatment. Patients' have had their appearance judged professionally as being favourable and still perceived a need for treatment.

7. Studies that use questionnaires to identify patients in the 'little or no need' category who desire treatment provide a more realistic perspective of the actual demand and potential demand on the health care services

8. In scenarios where the patient is satisfied with their dental appearance and perceives a need for braces other factors must be considered. External influences that possibly effect the levels of perceived need and resultant demand are gender, dental appearance, who makes the decision to seek treatment, socioeconomic (e.g. income), healthcare system, normative need and the parents' perceived need.

9. There is a paucity of studies that use questionnaires only to determine perceived need compared to perceived need derived using IOTN AC judged by the patient. There was only one study that reported a detailed comparison of the answers to the perceived need questions, for each category of IOTN DHC and IOTN AC.

10. There are more studies that relate patient perceived need to IOTN DHC but because IOTN DHC and IOTN AC show disparity, to fully understand perceived need both components of IOTN must be incorporated into research investigating perceived need in relation to normative need.

11. Questions are more accurate than the normative need IOTN AC and IOTN DHC for discerning perceived need in 'little or no need' categories of normative need due to a lack of positive correlation between the two measures. The greater the normative need the more accurately the agreement with perceived need. That is why this method was chosen for the present study.

12. There is a paucity of studies that record the answer to perceived need questions on a visual analogue scale.

2.3. Parent perceived need

2.3.1. Introduction

The belief that parents influence their children regarding orthodontic treatment (Lewitt and Virolainen, 1968), has led to the inclusion of the parent in perceived need investigations of the child. The influence on the child maybe multi-directional and not always to the benefit of the child and not be in sync with the child's or professional assessment of their orthodontic treatment needs. The research studies in this area are quite diverse, although investigators agree the perception of parents' is important for the initiation, the partaking in orthodontic treatment and the attainment of successful outcomes for their child. Overall, in the orthodontic literature, parent perceived need has been measured as an adjunct to the measurement of patient perceived need, by using questionnaires or parental judgement of the child's dental appearance. In the first methodology, the sample of parents accompanying or responsible for the child completed an interview-based questionnaire. For school-based samples the parental questionnaires were sent home or mailed. Although the questionnaires contained a range of questions that were sometimes quite complex, covering a variety of factors, they still contained questions in common. Thus, based on these similar questions examples of which are listed in Table 7, a certain degree of comparison between the investigations can take place. For the studies listed in tables 7 and 8, the aims and age range of the samples are

quite different, but where similar aims exist, comparisons can be made for the purpose of drawing very basic conclusions. Table 8 lists the demographics of the sample.

1. Is parent perceived need the same as patient perceived need?
2. Is parent perceived need the same as normative need?

Table 7. The measurement of parent perceived need using questionnaires in the studies listed, the age of the sample, questions and the possible responses

Study	Age yrs	Questions	Response
Pietila and Pietila (1994)	7-8	Do you have anxiety about the alignment of your child's front teeth?	Yes/No
Pratelli et al. (1998)	9	Do you think your child will need braces?	Yes/No
Tung and Kiyak (1998)	10.85	Does your child need braces?	Yes/No
Chew (2002)	12	Does your child need to wear braces?	Yes/No
Hamdan (2004)	15.3	Does your child need treatment?	Yes/No
Chestnut et al. (2006)	12,15	Does your child need treatment?	Yes/No
Daniels et al. (2009)	13	Would you like braces for your child?	Yes/No
Marques et al. (2009)	14-18	Perception of dental aesthetics Need for orthodontic treatment	Satisfactory Yes/No
Wedrychowska and Syrynska (2010)	7-18	What is the reason you came to see an orthodontist?	Appearance

Table 8. The study, origin of the study, sample numbers of parents, basic aims of the study and overall method used for the distribution of questionnaires

Study	Origin	Sample size	Aims	Method
Pietila and Pietila (1994)	Finland	261	Parent's concerns compared to professional concerns	Public health survey
Pratelli et al. (1998)	UK	437	Parent's concerns in relation to their own orthodontic experience	School based survey
Tung and Kiyak (1998)	USA	75	Factors that may influence the timing of treatment	School based survey
Chew (2002)	Singapore	257	Parent's desire for treatment for their child	Public dental centre
Hamdan (2004)	Jordan	103	Compare parent, child and clinician perceived need	University hospital
Chestnut et al. (2006)	UK	4737	Report on orthodontic condition of 12- and 15-year-olds	Public health survey
Daniels et al. (2009)	USA	227	Assessment of treatment motivation of child and parent	University hospital
Marques et al. (2009)	Brazil	403	To determine factors that influence desire for treatment	School based survey
Wedrychowska and Syrynska (2010)	Poland	674	To examine parent's motivation for treatment for their child	Public health survey

To compare parent perceived need to patient perceived need it is necessary to determine accurately from the literature the recorded values for these measures. The recorded values were presented in only a small number of studies and were reported statistically in other studies without the raw data being presented. Hamdan (2004) used a visual analogue scale to measure perceived need of the parent and child, the average level of perceived need for the parent was 66% and the child 61%. The percentage of the sample in IOTN

DHC (4-5) was 71% and the IOTN AC (8-10) was 21%. The parent perceived a greater need than the child and underestimates need in comparison to the clinician. The range of percentages of parents in the selected literature that perceive a need for treatment varies from 20% to 90%. This is affected by the percentage of patients in the total sample deemed as being in definite need of treatment. For example, in Chew and Aw (2002) the percentage of parent's perceiving a need for treatment was 90% but the sample consisted of 73% of IOTN DHC (grades 4 and 5), the parents again perceived a need in 17% of the sample that did not have a normative need. Similarly, Birkeland et al. (1996) had a sample in which 83% of parent's perceived a need for orthodontic treatment, when only 53.2% of patient's had a very great need. Chestnut et al. (2006) presented normative need information and linked the perceived need of the parent to both normative need and the age of the patient. For patients aged 12 years 42% of the parents perceived a need for treatment for patients in definite need that means 58% of parents did not recognize a need for braces. For patients aged 15 years only 20% of parents perceived a need for treatment in patients that also had a definite need.

Age appears to be a significant factor affecting the degree of influence a parent has over their child, the younger the child the greater the influence (Lewit and Virolainen, 1968; Wedrychowska and Syrynska, 2010). Therefore, in terms of results, in order to draw more meaningful and valid conclusions, age matching would be the preferred methodology. In study samples age 7-9 years, where limited orthodontic intervention is possible, the results indicated that a parents' level of anxiety about their child's malocclusion and their own attitude towards orthodontic treatment, were significant factors affecting their perceived need. The studies (Chew and Aw, 2002; Hamdan, 2004; Chestnut et al., 2006; Daniels et al., 2009) may be grouped, the age ranges are consistent with the normal age range for orthodontic treatment. The studies (Chew and Aw, 2002; Hamdan, 2004; Daniels et al. 2009) all found parents perceived a greater need for braces than their children. Marques et al. (2009), in an older sample, reported good agreement between parent and patient perceived need.

Conversely, the study by Wedrychowska and Syrynska (2010) with a wide age range from 7-18 years, found no significant association with patient perceived need but found a significant association between professional recommendations and parent perceived need. In studies with samples of young adolescents, age range from 7-10.85 years, parent

perceived need was found to be much greater than normative need (Pietila and Pietila, 1994; Tung and Kiyak, 1998).

2.3.2. Parents perception of their child's need based on appearance

Thus far, this literature review has summarised the findings of parent perceived need measured using questionnaires. However, this section concentrates on the ability of the parent to assess the appearance of their child's teeth compared to professionally designed indices. The literature investigates whether the following hypotheses are valid:

1. There is no difference between the parent and patient perceived need based on appearance of the patient's anterior teeth (IOTN AC).

2. There is no difference between parent perceived need and professionally assessed normative need (IOTN AC and IOTN DHC).

The comparisons of child and parent perceived need rely on the parent and child looking at the arrangement of the anterior teeth of the IOTN AC index, photographs of the child's own malocclusion or general malocclusions (Table 9).

Table 9. Studies investigating parent perceived need using indices based on appearance of the child's dental appearance, the origin, data, variables, methodology and hypotheses

Study	Year	Area	Data Parent	Dependant Variables	Independent Variables	Methodology	Hypothesis
Dogan et al.	2010	Turkey	208	IOTN AC parent	IOTNDHC Social-demographics	Cross sectional Prospective	No difference in need assessment
Spalj et al.	2009	Croatia	3196	SCAN parent	DAI(clinician) SCAN(chid)	Cross sectional Prospective	No difference in need assessment
Hamdan et al.	2007	Jordan	100	IOTN AC parent	IOTN AC (child, clinician)	Cross sectional Prospective	No difference in need assessment
Hamdan	2004	Jordan	103	IOTN AC parent	IOTNDHC IOTN AC (child, clinician)	Cross sectional Prospective	No difference in need assessment
Stenvik et al.	1997	Norway	126	IOTN AC parent	IOTN AC (child, adult)	Cross Sectional Prospective	No difference in need assessment
Shaw	1981	UK	50	Photographs child's teeth	Rating/orthodontist	Cross sectional Prospective	No difference in rating severity of malocclusion
Prahl-Andersen	1978	NL	Not listed	Photographs of general population	Rating dentist /orthodontist	Cross sectional	No difference in rating severity of malocclusion

Two studies that reported good agreement between the child and parent perceived need were Spalj et al. (2009) and Hamdan et al. (2007). Conversely, Hamdan (2004) and Stenvik et al. (1997) reported higher perceived need for the parent using the IOTN AC index for the parent and child. It must be noted that Hamdan presented two studies with opposite findings but explained the differences by suggesting an underlying bias of the parents in the 2004 sample, in which parents had a desire to have their child treated in the public healthcare clinic, thus scored their child's malocclusion more highly. The IOTN AC was also configured differently in the two studies. Hamdan et al. (2007) used the IOTN AC in a ranked manner dividing the index into three groups and this may have led to more accuracy, as shown by Burden (1995) who reported that ranking IOTN AC helped to improve the ability of professionals to use the IOTN AC index more effectively and accurately.

A comparison between parent perceived need and professionally assessed normative need has also led to conflicting results from previous studies in this area. Before the creation of the IOTN indices, Prahl-Andersen (1978) tested the parent's ability to recognize malocclusions that needed treatment, from general photographs (the parents were not asked to link their child's malocclusion to the depicted malocclusions) and he reported good agreement between the professional and parental assessment of treatment need. However, a recent study by Dogan et al. (2010) compared normative need of the child based on the IOTN DHC index, with the parent's judgement of their child's malocclusion using the IOTN AC index and reported the parent to be less critical than the clinician. Conversely, when both the clinician and the parent's used the IOTN AC for their assessment of treatment need, as was done in the study by Hamdan (2004), the parent was found to be more critical than the clinician.

Thus, comparative analyses using the appearance of the child's anterior teeth (IOTN AC), rather than occlusal features, would appear to affect the relationship between normative need and parental perceived need scores. Burden (1995) reported that professionals found the AC component of IOTN difficult to master. If this is the case, untrained parents' cannot adequately assess their child's malocclusion based on this index therefore this method for measuring parent perceived need is not reliable.

2.3.3. Factors associated with the parents' perception of their child's need for orthodontic treatment

It is appropriate to include parents in the assessment of perceived need because parents may have different concerns compared to their children and may be influenced by different factors in their decision to seek treatment for their child. There appears to be a definite gap in the orthodontic literature, relatively few studies look at parental factors that may affect parent perceived need for orthodontic care for their child. Most investigations have concentrated to a greater extent on child factors, with less emphasis being placed on parental factors. Certain studies had parental factors more central to the aims of the research and were more specifically designed to investigate a wider range of parental factors (Pietila and Pietila, 1994; Pratelli et al,. 1998; Marques et al., 2009; Dogan et al., 2010;Wedrychowska and Srynska, 2010). The appearance of the child has formed the basis for obtaining parent perceived need levels, although other child factors may also influence these levels (Pietila and Pietila, 1994; Birkeland et al., 1996; Tung and Kiyak, 1998; Spalj et al., 2009; Daniels et al., 2009; Wedrychowska and Syrynska, 2010). While child factors are important, studies that report detailed parental factors may be more insightful in terms of demand on healthcare services. Certainly, parents that have experienced the benefits of orthodontic treatment appeared to be more motivated to seek treatment for their child (Pratelli et al., 1998; Tung and Kiyak, 1998) and the majority of parents believed that orthodontic treatment produces good outcomes (Birkeland et al., 1996). Maybe that is why parents may pressurize their children to seek orthodontic treatment or it may be to avoid possible claims in the future by the child that the parent had neglected their condition (Wedrychowska and Syrynska, 2010).

Table 10. Possible explanatory factors (independent and resultant) that explain parent perceived need

Study	Dependent variable	Independent factors	Resultant factors
Shaw 1981	Parent perceived need photographs	Age, Gender, the ability to describe and recognize in photograph their child's teeth	1/3 of the sample of parents could not recognize their child's teeth in photograph
Pietila and Pietila 1994	Parent perceived need questionnaire	Child factors (function, appearance, best age for treatment), history orthodontic treatment in the family, parent's own appearance, anxiety about child's dental alignment	20% cases parents initiated treatment, parents accept concept early treatment, own appearance not significant
Stenvik et al. 1997	Parent perceived need IOTN AC	Age, gender	No significant findings
Birkeland et al. 1996	Parent perceived need IOTN AC	Age, gender, Child factors (appearance, importance straight teeth), parental view on orthodontic outcomes	No difference for gender 93% of parents believe orthodontic outcomes are good
Pratelli et al. 1998	Parent perceived need questionnaire	Parent's attitude towards orthodontic treatment, history of orthodontic treatment	Perceived need three times greater for parent's with history of orthodontic treatment
Tung and Kiyak 1998	Parent perceived need questionnaire	Child factors (appearance, body image), history of orthodontic treatment	63% of parents had orthodontic treatment, child appearance significant
Chew 2002	Parent perceived need questionnaire	Age, gender	No significant findings
Hamdan 2004	Parent perceived need questionnaire	Age, gender	No significant findings

Study	Dependent variable	Independent factors	Resultant factors
Chestnut et al. 2006	Parent perceived need questionnaires	Socioeconomic (deprived schools, non-deprived schools)	Greater unmet treatment need in deprived schools
Daniels et al. 2009	Parent perceived need questionnaire	Age, gender, child factors (ethnicity, year in school, dental/orthodontic history, treatment stage	Female parents more motivated, higher perceived need for child in treatment
Marques et al. 2009	Parent perceived need questionnaire	Age, gender, income, cost of treatment, educational level of parents	Income, cost of treatment, educational levels, age and gender not significant
Spalj et al. 2009	Parent perceived need IOTN AC	Age, gender, child factors (satisfaction with appearance, importance of straight teeth, speech, laughing, socially)	Low predictive value with child factors
Dogan et al. 2010	Parent perceived need IOTN AC	Age, gender Educational level of parents Social Insurance benefits Income of family Knowledge of orthodontics Reason for treatment demand	Gender Father's education level
Wedrychowska and Syrynska 2010	Parent perceived need questionnaire	Child factors (irregular teeth, appearance), referral from professional, teasing, neglect, speech, eating, pain in TMJ, get better job)	Parents pressurized children to seek orthodontic treatment to avoid possible future claims of neglect, seek treatment due to referral

Depending on the country of origin (tables 7 and 8) of the studies listed in table 9, the sample may differ widely in terms of socioeconomic data. The overriding influence for parents that must be considered when embarking on assessing parental factors should be the orthodontic public healthcare provision that was in place in the country of origin. Studies undertaken in Finland, UK, Norway, Singapore, Jordan and Turkey, where publicly funded orthodontic treatment was provided, recruited parents for whom cost was not a factor. However, studies based in the USA, used parental samples from both private and public healthcare systems, thus certain parents were experiencing costs. Similar to the studies performed in the USA, a study in Brazil by Marques et al. (2009) selected children from public and private schools, thus from families with different income bases determined from the parental questionnaire which contained socioeconomic questions. They concluded that income was related only to the ability of the parent to pay for private orthodontic treatment. The Dogan et al. (2010) study which originated in Turkey was the only study to report means testing of the family income before treatment was provided in the state-run dental hospital. Treatment was provided free for children of parents who qualified for social health insurance benefits based on no income or low income. Unlike other studies based in public healthcare systems the Dogan et al. (2010) study contained no children from high income families and therefore was not representative of the general population. Dogan et al. (2010) reported that income, social insurance status, knowledge of orthodontics and the reason for application (functional and aesthetic) had no significant effect on parent perceived need. Education levels of the parents were recorded in both studies (Marques et al., 2009; Dogan et al., 2010) that included family income and were significant in both. This would make sense because parents with high levels of education tend to have increased incomes due to better jobs and vice versa.

In the Chestnutt study based in UK schools it was the free milk provided to deprived children that was used to determine the deprivation status of the school. Unmet need in the Chestnutt et al. (2006) study in which the sample was derived from deprived and non-deprived schools, reported only 4% difference in the numbers of children with unmet orthodontic treatment need at 15 years of age compared to the numbers of children with a normative need at 12 years of age, both age groups are entitled to treatment in the public healthcare system. Thus, factors other than deprivation or non-deprivation and the cost of treatment were responsible for the failure of parents to seek treatment for their children. In Brazil (Marques et al., 2009) unmet need was due to the cost of orthodontic treatment by orthodontists in the private sector and the lack of ability of the parents to meet the

costs due to low incomes. The cost of orthodontic treatment per month would amount to more than the family income.

Also, for the studies reviewed (Table 10) age and gender of the child most studies had no significant impact on the level of parent perceived need. Unfortunately, two excellent studies one based in Croatia (Spalj et al., 2009) and the other in Poland (Wedrychowska and Syrynska, 2010) contained no healthcare system or socioeconomic information.

2.3.4. A summary of the relevant findings from the parent perceived need studies reported in the orthodontic literature

1. Many studies in this area are mainly about the patient, with the parental investigation acting as an adjunct to the main aims.

2. Based on the inconsistent availability of information across relevant parental studies it is difficult to draw conclusions from the literature.

3. This has limited the possible conclusions drawn from the studies that investigate parent perceived need and its relationship to normative need.

4. Parent perceived need is higher than normative need levels in three out of four studies that contained information on normative need.

5. A wide range of parent perceived need percentages have been reported and the level appears to relate to the number of patients with a definite need for orthodontic treatment within the sample.

6. Only one study which originated in the UK reported lower levels of perceived need for the parent compared to the level of normative need. There may be a cultural difference in this study compared to other studies in terms of the level of acceptance of occlusal irregularities or unknown factors may be lowering the parent`s perceived need.

7. Although, repeatedly used to measure parent perceived need, IOTN AC methodology is not reliable, and the results are invalid because the parent is not trained adequately in the use of IOTN AC. Only IOTN AC scores measured by a professional are valid.

8. The income level of the family may be extremely important because it can limit or aid access to public healthcare provision and likewise private healthcare provision.

9. Unmet need may be a result of the cost of private orthodontic treatment making the treatment unavailable to low-income families whose income is too high to qualify for social insurance benefits. In countries where the means are tested.

10. This study resembles most closely the Shaw et al. (1981) where parents in any socio-economic class could access orthodontic treatment for their child that was not based on qualifying dental criteria.

11. Unmet need can also occur in public healthcare systems because the parent may not be motivated to seek orthodontic treatment for their child, or the child may not be willing to partake in orthodontic treatment.

12. Socio-economic systems and type of healthcare systems reported in the literature form the basis of investigations researching the factors influencing parental perceived need. This has not been investigated in Ireland.

2.4. Economic evaluation-willingness to pay

2.4.1. Introduction

The purpose of this section is to review the literature on economic evaluation and in particular willingness-to pay (WTP). The literature is evaluated in this area as one of the principal questions of this study is to determine the amount a parent is willing to pay in order to obtain the benefit of straight teeth for their child. This appraisal will provide the theoretical background to WTP, identify the methods of measuring WTP, and locate this research in terms of previous oral health, and/or orthodontic studies, on this method of measuring the monetary benefit in a cost-benefit analysis.

2.4.2. Economic Evaluations

Economic evaluation is a technique that was developed by economists to assist decision making when choices must be made between several courses of action (Robinson, 1993). Several methods of economic evaluation have been studied, to evaluate medical interventions: cost-minimization, cost-effectiveness, cost-utility, and cost-benefit analyses. These methods basically assemble evidence on expected costs and consequences of different procedures or programmes.

Cost-benefit analysis is believed to be the most comprehensive and theoretically sound form of economic evaluation (Donaldson, 1990), (Robinson, 1993), (Zarnke et al., 1997). In any economic analysis (health services included) costs are compared with the consequences of different activities. The main objective is to determine whether the value of health benefits exceeds the costs of obtaining those benefits. Paretian welfare theory provides the conceptual foundation to cost–benefit analysis (CBA), which can be used to evaluate healthcare programmes, where both costs and utility (i.e., benefits) are measured in monetary units (O'Brien and Gafni, 1996). CBA is also based on individual preferences for the value of increased (decreased) health as a trade-off against other goods and services.

Three approaches to the monetary valuation of health outcomes exist (Johannesson, 1996; Drummond et al., 1997): 'human capital' (involving measurement of the value of health improvements as increased earning and decreased healthcare costs), 'revealed preferences' (involving observation of individuals' choices in real-market situations, i.e. actual purchases), and 'stated preferences' of willingness-to-pay (WTP; involving contingent valuation, a hypothetical investigation of individuals' expressed WTP for improved health). The contingent valuation method (CVM), developed in environmental economics (Mitchell and Carson, 1989), is a common survey-based, hypothetical, direct method that makes it possible to elicit monetary values (i.e. WTP) for welfare changes (Johannesson, 1993; Klose,1999). Willingness-to-pay (WTP) assigns monetary values to both costs and outcomes of health care to determine the net benefit.

As early as 1996, O'Brien and Gafni indicated the growth of CVM as an application in general medical health care and this methodology increased in use after 1996 in further medical studies (Lindholm et al., 1997; Zethraeus et al., 1998; Bala et al., 1998; Zillich et al., 2002). While this interest was also visible in dental care, only a few CBA studies using the CVM had been published during or prior to 2004 (Table 11). The CVM method was used to elicit individuals WTP for water fluoridation (Dixon and Shackley, 1999), for different periodontal therapy options (Matthews et al., (1999), for orthognathic treatment (Cunningham and Hunt, 2001; Smith and Cunningham, 2004), for dental check-ups (Tamaki et al., 2004), and for dentine regeneration (Birch et al., 2004). Aside from Cunningham and Hunt, (2001) that included perceived need for orthodontics, no CBA had been published prior to 2004, for fixed appliance orthodontic treatment, that analysed individuals' WTP using the CVM.

Tables 11 and 12 list dental studies and show details of methodologies used including sampling and whether the WTP was elicited in a hypothetical or real-life healthcare scenario.

Early WTP studies elicited values using an open-ended question from a self-interest perspective to obtain personal use values; e.g how much would you be willing to pay to obtain straight teeth for your child? (Smith and Richardson, 2005). These open-ended formats ask WTP values without presenting a starting point value. Respondents are simply asked to give a monetary value. However, researchers have questioned the validity of this format because responses are prone to a high number of non-response or zero values and because responses are heavily skewed towards high values, perhaps, in part due to strategic bias (Donaldson, 1990; O'Brien and Gafni, 1996). Asking for WTP monetary values using an open-ended format requires using an unbounded response scale (starts at zero but with no definite upper end)(Kahneman et al., 1999). Therefore people may be more likely to give strategic values with an unbounded scale; a respondent may believe that the treatment has a high social value and thus places a very high value not grounded in the reality of actually paying such a figure as an out-of-pocket expense (Arrow et al., 1993). Conversely a respondent may give an artificially low response in an attempt to influence the actual price eventually charged.

Table 11. Willingness to pay elicitation studies from both the medical and dental research literature to investigate the monetary value placed on healthcare interventions possibly for healthcare decisions regarding service provision and the priority of publicly funded service provision by policy makers. For each listed study the origin, the sample, the method, and the hypothesis details are given. WTP is the dependent variables and is tested by independent varaibles.

Study	Area	Data	Dependent variable	Independent variable	Method	Hypothesis
Bala et al. (1998)	USA	65-70 year olds	WTP versus QALYS	Prevention of Shingles (medical paper)	Random selection WTP Bidding Double-bounded dichotomous mode	WTP and QALYS measure health preferences equally
Matthews et al. (1999)	Canada	23 patients 18 staff	WTP	Periodontal treatment modalities	Convenience sample Bidding CV Pilot study	WTP increase was not affected by treatment modalities
Dixon and Shackley, (1999)	UK	100 people	WTP WTA	Water fluoridation	Quota sampling Open ended CV	No difference between WTP and WTA
Cunningham and Hunt, (2001)	UK	40 patients	WTP versus Utility values	Perceived need for orthodontics and orthognathic surgery	Convenience sample WTP payment card Pilot study	No difference exists between WTP values and utility values
Tamaki et al. (2004)	Japan	5132 from private dental practices	WTP	Check up Gender, age, household income	Convenience sample Questionnaires mailed Self-administered Open ended CV	WTP for dental check ups is not associated with gender, age or income

Study	Area	Data	Dependent variable	Independent variable	Method	Hypothesis
Smith and Cunningham, (2004)	UK	88 patients 100 general public	WTP	Ability to pay, level of education, occupation, malocclusion	Convenience sample WTP payment card method	WTP is not associated with ability to pay, occupation, education, type malocclusion
Birch et al. (2004)	Canada	611 dentate adults	WTP	Dentine regeneration Economic Demographic Oral health	Random selection Phone interview Open ended CV with and without dental insurance	WTP for dentine regeneration is not related to demographics, economics, oral health
Cawley (2006)	USA	800 general population	WTP	Income, interest, attitudes	Random selection Phone interview Double-ended dichotomous bidding	WTP to reduce childhood obesity was not related to perception of obesity
Oscarson et al. (2007)	Sweden	82 patient Age 19 years	WTP	High and low caries risk Housing, gender, occupation	Random selection Interview process Bidding binary CV Open ended CV	WTP is the same for high and low risk caries groups
Rosvall et al. (2009)	USA	50 adults	WTP	Acceptability attractiveness value braces Income	Random selection Computer images and questionnaire Bidding CV	WTP is not associated with the appearance of orthodontic braces

Study	Area	Data	Dependent variable	Independent variable	Method	Hypothesis
Garni et al. (2012)	Saudi Arabia	100 patients	WTP	Gender, income, clinic setting	Convenience sample Bidding CV	WTP for implants is not associated with socio-demographic or patients factors
Vermaire et al. (2012)	NL	290 parents	WTP WTI	Caries rate Education Oral health habits, dietary habits	Random selection Payment card Invest time in children's oral health	WTP is not associated with a parent wanting to invest in a caries free and pain free mouth for their child
Moshkelgosha et al. (2013)	Iran	200 patients	WTP	Demographic Socio-economic factors Cost of treatment	Convenience sample Cross sectional Open-ended CV If full payment or supplemented by insurance	WTP for orthodontic treatment is not associated with the cost of treatment, demographic or socio-economic factors

Table 12: Lists the significant details of the willingness to pay elicitation research studies methodologies, including whether 1. Dental insurance is the norm in the country of origin of the study, 2. The interview means a face-to-face interview was performed, 3. The method used to elicit willingness to pay values, 4. The characteristics of the sample would determine if the willingness to pay scenario was hypothetical or real to the respondent. Were the respondents' patients or members of the public

Study	Area	Dental insurance	Interview	WTP elicitation	Hypothetical scenario	Real scenario
Bala et al. (1998)	USA	Yes	Yes	Binary bidding Closed	Yes general public	Yes general public
Matthews et al. (1999)	Canada	Yes	Yes	Binary bidding Bidding	Yes hospital staff	Yes treatment patients
Cunningham and Hunt, (1999)	UK	No Public funding	Yes	Pilot study Payment card	No to treatment patients	Yes treatment patients
Dixon and Shackley, (1999)	UK	No Public funding	Yes	Pilot study Payment card	Yes general public	No general public
Tamaki et al. (2004)	Japan	No Private payment	Mail survey	Open ended	No private practice patients	Yes treatment patients
Smith and Cunningham, (2004)	UK	No Public funding	Yes	Payment card	Yes for general public	Yes for treatment patients
Birch et al. (2004)	Canada	Yes	Telephone survey	Open-ended	Yes general public	No general public

Study	Area	Dental insurance	Interview	WTP elicitation	Hypothetical scenario	Real scenario
Cawley, (2006)	USA	No	Telephone survey	Bidding	No general public	Yes general public
Oscarson et al. (2007)	Sweden	No Public funding	Yes	Binary bidding Open ended	No treatment patients	Yes general public
Rosvall et al. (2009)	USA	Yes	Computerised answers	Bidding	Yes general public	No general public
Garni et al. (2012)	Saudi Arabia	No Private payment	Yes	Binary bidding Bidding	Yes to hospital Patients	No to hospital patients
Vermaire et al. (2012)	NL	No Public funding	Yes	Payment card	No to general public	Yes to sample parents
Moshkelgosha et al. (2013)	Iran	No Private funding	Yes	Open ended	Yes hospital patients	No hospital patients

The evidence suggests that monetary values are more difficult to elicit from the lay public if they are part of a publicly funded healthcare system, with zero costs. To overcome this obstacle, economists using cost-benefit analysis, rely on "shadow prices" (Robinson, 1993). Shadow prices reflect the value of health services even though they are not actually charged. The shadow prices are presented to the respondents in the form of a yes/no response. Shadow prices can be used as a stand-alone approach or a combined approach with open ended questions, such as willingness-to-pay.

Table 13. Highlights the literature on methods elicitation of WTP in medical and dental research

Study	Methodology	Factors tested	Results
Bala et al. (1998)	Interview face to face Randomized bid questions	Age, gender, household size, income. Knowledge of shingles personally or friend	WTP lower if respondent had experienced shingles. WTP increases with duration of pain
Matthews et al. (1999)	Bidding method	Income	Income
Cunningham and Hunt (1999)	Payment card method	Townsend deprivation scale Age, gender, malocclusion	WTP is not influenced by ability to pay
Dixon and Shackley (1999)	Payment card method	Income, age, gender, education, employment, number of dependents, for and against fluoridation	WTP= GBP 12.63/29.68 those for/against fluoridation Income and when income was standardized preference for fluoridation strengthened
Tamaki et al. (2004)	Payment card method	Age, gender, occupation, household income, attendance for regular dental check-ups	No significant findings
Smith and Cunningham (2004)	Payment card method Patients and general public	Age, gender, ethnic group, Townsend deprivation scale, incisor relationship, occupation, education, QOL	Gender or ethnic group had no significant affect. WTP= GBP 5230/7996 for public/patient values. Increased WTP with increased treatment need. Class II Div 1 significant

Birch et al. (2004)	Contingent valuation open ended question	Age, gender, dentate, dental insurance, ethnicity, education, income, dental needs, attendance patterns.	Income, dental needs, attendance at dentist more regular
Cawley (2006)	Binary bidding Double bounded CV	Income, perceptions of youth obesity, opinion of current tax levels, political affiliation	Income, perception of childhood obesity
Oscarson et al. (2007)	Binary CV and Open ended CV	Gender, housing, parent's occupation, caries risk, self-esteem, attitudes	Housing rented accomodation and high caries risk
Rosvall et al. (2009)	Payment card method	Income, type of appliance	Patients are WTP more for clear braces
Garni et al. (2012)	Bidding method	Age, gender, clinic setting, employment, education	Higher incomes showed higher WTP, patients perception of oral health and the position of the implant in the mouth
Vermaire et al. (2012)	Payment card method	Age, gender, ethnicity, education, socio-economic status, knowledge of hygiene, number of children in family	Lower education, lower socio-economic status, lower dental hygiene knowledge and Increased burden of dental hygiene
Moshkelgosha and Golkari (2013)	Open ended contingent valuation for hypothetical situation	Income, perceived need, malocclusion, had received orthodontic treatment or relative, cost of treatment, education level	Income, education level, costs helped by insurance, treatment at lower cost with general dentist

O'Brien and Gafni, (1996) highlighted that the WTP elicitation format used in studies may influence the reliability of the results. Table 13 demonstrates from the listed studies WTP contingent valuation can be carried out in a few ways, namely: (1) Open-ended format (OE), (2) Bidding game format (BG), (3) Payment card format (PC), (4) Dichotomous-choice format (DC).

Professor Ciaran O'Neill a Health Economist from the University of Ulster designed the WTP contingent valuation questions for the present study. He based his design on two studies, one of which he was directly involved in Ozolins et al., 2004 and the other Motley and Finlay, 1989, which provided the WTP template for the Ozolins et al., 2004 study. The template consisted of two methods of WTP elicitation, the dichotomous-choice (DC) and the open ended (OE) contingent valuation methods. The dichotomous-choice was a single bounded format with 'yes' or 'no' replies.

The OE method is susceptible to hypothetical bias, especially in an artificial hypothetical situation (Liljas and Blumenschein, 2000), such as the NI NHS publicly funded sample, in the present study. An experimental or trial setting in circumstances where no actual resource commitment is required by the respondent, usually trigger much higher valuations, compared to trials with fee-paying respondents (Whynes et al., 2005). By using a combination of elicitation methods, for example the dichotomous WTP CVM and the OE CVM, then a reduction in hypothetical bias associated with public healthcare systems can be achieved (Motley and Finlay, 1989; Pavlova et al., 2004).

However, the DC format is prone to "yea-saying" where respondents have a tendancy to agree to the amount presented (Yeung et al., 2006). They may respond to register a positive vote for the monetary value for treatment offered but in reality they would pay a much lower amount. A combination of both formats allows a certain degree of cross-checking between the methods for possible over-valuations, yea-saying, hypothetical and strategic bias.

Arrow et al. (1993) recommended the adoption of in-person interviews by experienced professional interviewers to motivate respondents to pay close attention to the details of the WTP scenarios. This reduces item non-response and hypothetical bias, especially if respondents are reminded about budget restraints (Arrow et al., 1993).

Advantages of the open-ended format are that it does not introduce range or starting point biases and it can be highly statistically efficient compared to discrete choice formats. The

open-ended response allows smaller sample sizes, whereas the discrete choice formats require larger sample sizes and are expensive to administer.

Whynes et al. (2005) tested the different methods of elicitaton for contingent evaluation in cost benefit analysis and concluded that the most informative elicitation method appears to be the open-ended format. When eliciting the information there was concern that the patients would "be worried about the affect their answers would have on their status, in their healthcare system", for those seeking free treatment in government-controlled clinics. Whynes et al. (2005) clarified the position of the investigators " The environment in which our experiments were conducted was one in which subjects could have had no realistic expectations that their nominated WTP valuations would be translatable into actual payments. Indeed, this divorce between reality and experiment was formalised. The committees who granted ethical approval for the studies required that our subjects be told that their elicited WTP would in no way effect zero-provision, for fear of engendering anxiety and concerns about the UK healthcare system". Careful attention must be paid to this and is an advantage of face-to-face interviews.

Previous WTP studies have reported an issue about who judges the WTP. Preferences which are given monetary values, can be obtained from a number of population sub-groups including parents (Drummond & McGuire, 2001). If it is a patient or in the present study the parent, then the stakes are higher, compared with members of the public (Zarnke et al., 1997).

Nord (1999) stated that it is more appropriate to elicit valuations from those people who are currently experiencing the health state for which values are sought. The argument being that only the people experiencing the health state can really give a true valuation. However, (Gold et al., 1996) reported that a consensus panel convened by the United States Public Health Service, recommended that the source of values should be a representative sample of the general population. The reason for this stance being that the public bears the cost associated with healthcare decisions.

Drummond et al. (2001) states that, the disitinction between the patients and the public being used to give coverage preferences, is blurred. Economists would be critical of the social perspective valuation because it is not motivated by self interest (Drummond, et al., 2001). Zarnke et al. (1997) concluded that the monetary values obtained, from an

aggregation of individual preferences, may reflect the societal value placed on the programme of interest, thus negating the need for public valuations.

2.4.3 Factors in WTP

The basic demographic factors age and gender were investigated in five out of the six studies listed in Table 14, which represent the WTP CVM methodology studies in and prior to 2004. Age was not a significant variable in 5 out of the six studies (4 dental and 1 medical). The dental studies listed had adult patients only. There was a paucity of studies investigating what parents would be willing-to-pay for adolescents prior to 2004. Gender showed no significant relationship with WTP in the dental studies published in the literature prior to or during the design of the present study (Table 14). One study found a significant relationship with treatment need and one study found no relationship with perceived need for orthodontic treatment. There was a paucity of studies investigating orthodontic treatment, orthodontic treatment need, patient perceived need and parent perceived need with WTP CVM at and prior to 2004.

A positive association between WTP and income is typically observed in contingent valuation studies pre- the present 2004 study and is true of the studies selected for this review (Matthews et al., 1999; Dixon and Shackley, 1999; Birch et al., 2004). This can bias the aggregated results in favour of the preferences of richer respondents. For example, if richer people are more likely to oppose increased taxes to control childhood obesity, then the aggregate WTP would be higher even if the numbers for and against were the same and their intensity of preferences were the same. Income can of course be standardised to test the aggregate WTP, and this was performed in one study on water fluoridation (Dixon and Shackley, 1999). The Dixon and Shackley (1999) study used WTP to measure the strength of preference for water fluoridation among the general population, of Sheffield, UK, a city with relatively low naturally occurring fluoride in its water supply. Among those individuals favouring water fluoridation, the mean willingness-to-pay, in additional taxes to support the programme was 12.63 UK pounds per year. In a multivariate analysis of variation in WTP, only income, was found to be significant, with higher income groups having higher WTP on average. This study standardised the income to test aggregate preferences. The preference was still in favour of fluoridation when the incomes were neutralized, thus the preference was not related to ability to pay, only the amount that the respondents could afford to pay was related to WTP.

Smith and Cunningham, (2004) used Townsend scores to assess social class, because they stated that even though it was better to use actual income, in order to assess ability to pay, they found this very difficult to elicit from patients. The Townsend Index was found, not to be significant in multivariate regression analysis. Smith and Cunningham, (2004) did find in the regression analysis that significant factors that affect WTP, included type of malocclusion, awareness of orthognathic treatment on referral, and quality of life aspects. A higher family budget was also associated with a higher willingness and ability to pay in a public healthcare study (Pavlova et al., 2004). Since WTP is associated with the ability to pay, some postulate that it may lead to skewed resource allocations that favour the rich rather than most of the population (Donaldson, 2001). Suggestions to circumvent this include an examination of preferences across different social classes with different household incomes in WTP studies. Different people with different incomes, will have different abilities to pay, and this may influence what they are willing-to-pay. Matthews et al. (1999), WTP values were elicited for two distinct periodontal treatment regimens, deep cleaning and periodontal surgey. There was a pattern that suggested increase of WTP with increase in income. The sample size was insufficient for multivariate analysis. Matthews et al. (2002) later studied the use of a topical anaesthetic gel in periodontal treatment and assessed the WTP of patients to use this gel during treatment in a dental hospital setting. The sample included the general public and a patient population. The resultant treatment would have meant an increase in insurance and out of pocket expense for the patient. The only factors that proved significant in multivariate analysis were dental pain and concern about needles. The two studies highlight the fact that patients are not willing to pay more, even if thay have the ability to pay more, if they do not want the treatment or cannot see a benefit to the treatment compared to the cost.

2.4.3. Healthcare funding system

In the literature it was not possible to find a cost-benefit study such as this one prior to 2004. Pietila et al. (1998) conducted a cost productivity analysis of orthodontic care in Finland. They found high costs were associated with inexperienced general dentists and would save money by devolving the work to experienced orthodontists. Richmond et al. (2004) performed a cost effectiveness study in orthodontic care. Both studies were not assessing the value respondents place on orthodontic treatment.

Post-2004 there were two studies that used WTP CVM to investigate how respondents from hypothetical and real-life payment scenarios, valued orthodontic treatment. In a

study by Srivastava et al. (2014), higher income was associated with higher WTP in a public funding scenario, but no statistically significant relationship was detected for an out-of-pocket payment scenario. Garni et al. (2012) found that the WTP amount increased with income and a higher mean WTP was found for private clinics compared to government dental clinics [(β=1.073; p=0.03)].

A cost-benefit assessment of patients or parents has not been performed in NI (publicly-funded) or in the RoI private sector (out-of-pocket payment) healthcare systems. There is a need to fill this void in the orthodontic literature because policy makers who spend public funds, need to know if the treatment and outcomes are valued by the parents who would otherwise have to pay.

2.4.4. A summary of relevant findings from the willingness to pay studies reported in the dental literature

1. There is a paucity of economic evaluation studies in the dental literature using WTP contingent valuation methodology to assess the value parents place on the benefits of orthodontic treatment for their children.

2. Open-ended contingent valuation appears to be the most informative format for WTP contingent valuation elicitation of monetary values for orthodontic treatment from respondents. It is the most favourable for statistical analysis.

3. Combining open-ended and single-bounded dichotomous format methodology reduces biases.

4. Face-to-face interviews with respondents and pre-testing of questions by professional interviewers reduces biases and increases the validity of the WTP valuations.

5. Respondents from publicly funded healthcare systems are giving hypothetical values.

6. Respondents paying actual fees give real values.

7. The factor most frequently cited in the literature that influences WTP monetary values is level of income of the respondent and ability to pay.

2.5. Patient compliance

2.5.1. Introduction

Compliance, as it relates to healthcare, is the extent to which a person's behaviour coincides with medical or health advice. In this section of the literature review, orthodontic studies are analysed for scientific evidence that assessment of patient compliance can be performed accurately, validly, and reproducibly in a clinical environment. Furthermore, the analysis of the studies attempts to address the question about factors that may control patient compliance levels and the possibility of predicting compliance.

A physician led approach to prescribing treatment came to be described as 'compliance' in the medical literature in the 1950's. Although this later became known in relation to medicine as "adherence" it remains known as the term "compliance", in orthodontics. Compliance is defined as the extent to which a person's behaviour, such as taking medication, following a diet, and/or executing lifestyle changes, corresponds with recommendations the person has agreed to with a healthcare provider. It also implies that people freely choose to undertake behavioural plans, have input into them, and have collaborative involvement in developing and adjusting their treatment strategy. The overall perspective of investigators includes an agreement that the outcome of orthodontic treatment is dependent on patient compliance. Successful orthodontic treatment requires active cooperation from the patient throughout the necessary lengthy orthodontic procedures.

This review therefore aims to assess the methodologies described in the literature to measure patient compliance and analyze the factors that influence compliance for the studies independent of the method of measurement. Also, comment on the uniformity or diversity of the findings for the influential factors, and whether or not they relate to the methodology used within the studies.

2.5.2. The measurement of compliance.

The measurement of compliance can be divided into three categories: (1) Compliance from the orthodontists' perspective, (2) Compliance from the patients' perspective and (3) Compliance from the parents' perspective. In the literature reviewed compliance levels were measured using three distinct methods: (a) Validated (b) Structured and (c)

Clinically based questionnaires. The timing of the administration of the patient questionnaires included: (i) Initial consultation, (ii) During treatment at different time intervals, and (iii) Post orthodontic treatment. The time points were selected because compliance levels can change during orthodontic therapy due to the extended length of time required for this healthcare intervention.

The studies reviewed are listed in Table 14 excluding historical papers (Ash, 1951; Allan and Hodgson, 1968; Clemmer and Hayes, 1979; Fields, 1980) which are mentioned in the text.

Table 14. Studies investigating patient compliance: the origin of the study, age profile, methodology and hypotheses tested

Study	Year	Area	Data	Methodology	Hypothesis
Rinchuse et al.	1992	USA	116 6-17yrs Male 47% Female 49%	Consecutive sample Cross sectional Demographics Academic rating Professional/self-rating of oral hygiene	The level of oral hygiene during treatment is patient dependent and cannot be changed and is independent of age, gender and academic level.
Sergl et al.	1992	Germany	94 8-14yrs Male 42 Female 41	Cross sectional Questionnaire orthodontic attitude Orthodontic patient compliance scale (OPCS)	Psychological evaluation of patients cannot predict compliance during treatment
Nanda and Kierl	1992	USA	100 9-16yrs Male 43 Female 57	Cross sectional Questionnaires, demographics, personality, desire for treatment, relationship to orthodontist	There are no well-defined characteristics of the compliant orthodontic patient
Sinah et al.	1996	USA	199 8-17yrs Male 94 Female 105	Cross sectional Questionnaires, Orthodontic behaviour, visit satisfaction scale, relationship with orthodontist and orthodontic patient compliance scale (OPCS)	The patient/orthodontist relationship has no effect on the patients behaviour during treatment or their level of satisfaction

Study	Year	Area	Data	Methodology	Hypothesis
Mehra et al.	1998	USA	1262 Orthodontists	Cross sectional Questionnaire of 118 items Derived from literature	Patient compliance cannot be predicted and improved
Richter et al.	1998	USA	144 9-17yrs Male 63 Female 81	Cross sectional Orthodontic patient compliance scale (OPCS) Clinical compliance evaluation (CCE)	Behaviour modification in orthodontics cannot be achieved using a reward system
Bos et al.	2005	NL	466 Mean age 21.2yrs Male 147 Female 319	Cross sectional Untreated/Previously treated subjects Dental Attitude Questionnaire	Males and female do not differ in their attitude towards orthodontics and previously treated patients do not have a more positive attitude
Mandall et al.	2008	UK	144 10-19yrs	Consecutive sample Utility values/OASIS scores/Social class IOTN/Oral Hygiene Appointments/Appliance care	No relationship exists between quality of life measures, health economic values, demographics, gender, age and IOTN with compliance
Daniels et al.	2009	USA	227 8-17yrs Male 114 Female 113	Cross sectional Self-administered questionnaire to determine perceived need and perceived compliance	No relationship exists between patient/parent perceived need for orthodontic treatment and perceived /actual compliance

2.5.3. Studies of measurement of patient compliance by the orthodontist

The methods used to measure patient compliance by professionals are both scientifically and clinically based. The scientific methodology utilises validated and structured questionnaires to determine the level of compliance and possible predictors of compliance. Three of the studies listed in Table 10, used the Orthodontic Patient Compliance Scale (OPCS), which is a 10-item instrument that measures patient compliance as it relates to keeping appointments, wearing and maintaining appliances, patient attitudes towards treatment, oral hygiene maintenance and parental interest in treatment (Sergl et al., 1992; Sinah et al., 1996; Richter et al., 1998). The OPCS scale was validated and found to have good internal consistency by Slakter et al. (1980). It has been used to categorize the patient into a type of complier, for example above-average or below-average compliers. In contrast to validated questionnaires, Mehra et al. (1998) designed a structured questionnaire based on evidence from the orthodontic literature. The questionnaire contained 118 items and in that study was completed by 1262 orthodontists. The aim of the study was to rank the criteria used by orthodontists to assess and possibly predict patient compliance. The third method of measuring patient compliance by professionals consisted of a clinically based incorporated clinical criteria described historically by Jarabak (1965) and Tweed (1966). It is known as the Clinical Competence Evaluation Method (CCEM) and consists of four of the most common denominators of patient compliance (oral hygiene levels, appliance wear, appliance maintenance, and appointment attendance), which are given numerical scores essential for statistical analysis. The Clinical Competence Evaluation Instrument (CCEI) was utilised in studies by (Allan and Hodgson, 1968; Richter et al., 1998; Mehra et al., 1998; Mandall et al., 2008) to quantify patient compliance.

2.5.4. Studies of measurement of patient compliance by the patient

The most straightforward clinical measure of patient compliance reported in the orthodontic literature assessed the level of oral hygiene performed by 116 patients during treatment (Rinchuse and Zullo, 1992). The oral hygiene was assessed by the orthodontist, patient, and parent on a scale of 1(very poor)-6(very good) and the three groups showed no agreement. The study showed that the patient and the parent could not recognise a problem with hygiene levels and gave high scores to poor compliance levels. This was the only study that used photographs. More frequently structured questionnaires were used for patients to assess their level of compliance. A study by Daniels et al. (2009)

administered a structured questionnaire to 83 patients prior to treatment to determine their perceived compliance and compared this to a separate group of 144 patients that assessed their own level of compliance during treatment. The questionnaires consisted of four groups of structured questions (1) demographic questions (gender, age, ethnicity, and school grade), (2) dental and orthodontic history (3) motivation for treatment, (4) treatment compliance. Under patient compliance only two compliance questions were asked of the patient amongst all the other items. Unfortunately, the same sample of 83 children for which perceived compliance was measured were not the same children tested for actual compliance. The study was able to achieve the aim of comparing the motivation for treatment with perceived compliance (83 children) and actual compliance (144 children). In the sample of 144 children there was a proven link between original treatment motivation and actual compliance, however the methodology is flawed because the motivation for treatment was measured retrospectively instead of prospectively. The researchers concluded that a longitudinal sample would have improved the results and possibly validated the correlation between motivation for treatment, perceived compliance and actual compliance.

There seems to be a deficiency in the literature with a particular paucity in longitudinal studies on the same sample, (Clemmer and Hayes, (1979); Rinchuse et al,. 1992; Sergl et al., 1992; Sinah et al., 1996; Richter et al., 1998; Mandall et al., 2008) investigated patients undergoing treatment, whereas (Mehra et al., 1998; Bos et al., 2005) both studied patients post treatment. In contrast to Nanda and Kierl, (1992) and Daniels et al. (2009) who investigated different groups of patients pre-treatment and during treatment. The age profiles of the studies were compatible except for Bos et al. (2005) who used university students. The ages ranged from 8 to 17 years approximately for the majority of studies and were consistent with the age at which orthodontic treatment would normally be administered. Age was a significant factor influencing compliance levels will be addressed in section 2.2 which explores the factors that influence compliance.

2.5.5. Factors that may influence patient coiance

A significant portion of the orthodontic literature regarding patient compliance is based on patient psychology, but the following review of the factors that influence patient compliance did not delve into reported psychology factors in depth. For completeness two examples of studies in the literature that report on the psychology of the patient which the present study is unable to investigate are as follows. Historically, Ash (1951)

suggested that there may be a psychosomatic reaction of the child to emotional disturbances which originate from the home and manifest as poor compliance to orthodontic treatment. It is difficult to pursue this line of enquiry without invading the privacy of the family which would be protected under current law and be deemed more medical than dental. Likewise, Allan and Hodgson (1968) were very interested in the role of the parent and compared the orthodontists' compliance scores to those of scores from a parent questionnaire, which assessed their attitude to child rearing. There was no significance between parents' attitude to and method of rearing their child and the level of orthodontic compliance, and invasive questionnaires into parents' personal capabilities are not acceptable. They also require interpretation by trained psychologists. A further study by Fields (1980) was basically clinical but also utilized input from a psychiatrist. The advice of the psychiatrist surrounded the issues of communication with the patient. The input from the psychiatrist resulted in appropriate staff training, increased communication with the patient prior to treatment and a reward system, and the study concluded that all three aspects improved patient compliance. As a result, Fields (1980) decided to investigate the possibility of setting up a contract of compliance with the patient and found this influenced the compliance of the child significantly, especially in conjunction with a reward system in which the reward was provided by the parent. The compliance measurement was based on the orthodontists' assessment of appliance wear, attendance at appointments and oral hygiene standards.

The following studies are not psychologically based, although they contain a minimal inclusion of basic attitudinal questions. For example, a more historical study which was reported in 1979, which had very interesting conclusions reported on the patient's attitude towards orthodontic treatment (Clemmer and Hayes, 1979). Patients completed an assessment of their own compliance based on perceived severity of their malocclusion, assessment of their dento-facial aesthetics and their general attitude to orthodontic treatment. The sample was extremely small comprising of 20 patients undergoing treatment in a university clinic. A student orthodontist rated the patients' clinical compliance based on the ability to follow instructions and their rapport with the orthodontist. The degree of clinical compliance achieved was measured using time sheets of actual appliance wear. The most compliant patients with appliance wear also had higher evaluations of compliance by the student orthodontist, were more concerned about their dento-facial aesthetics, were female, perceived their malocclusion as severe and had a better attitude towards orthodontic treatment. The authors concluded that, in an

assessment of patient compliance prior to orthodontic treatment being commenced, consideration should be given to gender of the patient, the degree of sensitivity to their malocclusion and their attitude towards orthodontic treatment. Similarly, in a more recent study, Bos et al. (2005) also found a positive attitude towards orthodontics increased compliance, and this attitude was affected by age of the patient.

Other studies have included assessment of attitude and have found that the patient to orthodontist relationship is very important. A psychologically based study by Albino (2000) investigated patient compliance and found that the patients' perception of appearance and perceived need for orthodontic treatment was the key to patient compliance during treatment. It highlighted the fact that the orthodontists' relationship with both the parent and patient can affect the level of compliance achieved. Following on from this Albino (1981) attempted to develop a reliable self-report for assessing patient attitude towards malocclusion and their resultant desire for orthodontic treatment. Interestingly (i) the perceived need of the child and parent for orthodontic treatment and (ii) concern about the malocclusion by both the child and the parent were the two most important factors. Although when Daniels et al. (2009) reported on perceived need for orthodontic treatment he found that parents normally have a greater level of desire for orthodontic treatment than their children, but it is the child's level of perceived need that determines their level of compliance. This was a cross sectional study and tested a group of children prior to treatment and a different group of children in treatment. In the conclusions, the authors suggested a longitudinal design tracking motivation of the same parent and patient during treatment would be more beneficial. In the Daniel et al. (2009) study, the male patients had a lower perceived compliance with regard to orthodontic treatment and children who were part of the decision to undergo orthodontic treatment were more cooperative.

In contrast to the studies supporting the assessment of motivation and desire for orthodontic treatment, Sergl and Zentner (2000) found that orthodontists usually predict future compliance based on the impression they have of the child's behaviour at the first meeting. Including both their receptiveness and intelligence. Certainly, evidence produced by Rinchuse et al. 1992 who tested academic performance, found that good compliance was correlated to high academic performance and thus would support the findings of Sergl and Zentner (2000). Nanda and Kierl (1992) included intelligence of the child and acknowledged the importance of the parent in predicting the child's

compliance. The approach taken by Nanda and Kierl (1992) was to test as many variables as possible, including psychosocial, motivation for treatment, relationship with the orthodontist, demographics, patient factors (relationship with peers, need for achievement, perceived need, appearance, relative value of treatment), parent factors (marital status, educational level, occupation, income level) against patient compliance measured using the orthodontic patient co-operation scale (OPCS). In the bi-variate statistical analyses, there were moderate correlations found between the OPCS and females, suburban area of living and relationship with the orthodontist. The variables were basically analysed in large multivariate logistic regressions and non-significant variables were removed until only significant variables remained. It appeared that similar variables cancelled out the others' effect in the regression models and only one significant variable remained, the orthodontist-patient relationship. The significant finding of the orthodontist-patient relationship was also reported to be significant in studies by Sinha et al. (1996), Mehra et al. (1998) and Bos et al. (2005). Mehra et al. (1998) rated desire (perceived need) for treatment as the most significant and relationship with the orthodontist as being the fourth most significant factor.

Most studies focused on level of compliance in terms of mainly good compliers. Mandall et al. (2008) reported on patients' who failed to complete treatment due to poor compliance. The level of compliance was assessed by Mandall et al. (2008) based on the CCEM. The study concluded that, age, gender, socio-economic status, type of appliance, and clinical treatment need (IOTN) are not useful in helping a clinician to choose potentially co-operative patients. The findings regarding age and socio-economic status were also found not to be significant in the study by Nanda and Kierl (1992).

In the Mandall et al. (2008) UK study the patients were treated under the public service in the university hospital, free provision for orthodontic treatment. Parents and children did not have to worry about payment of treatment, and this may be a reason that socio-economic status had no impact. The Nanda and Kierl (1992) study treated a sample of patients in the graduate school, and it does not indicate whether the patients paid for treatment. The study was longitudinal and assessed potential compliance and actual compliance against a variety of factors. Mandall et al. (2008) used time points as, prior to commencement of treatment and the completion of treatment, analyzing compliance as the main reason for failure of completion of the course of orthodontic treatment. Both studies showed no association between social status and compliance of the child although

this has been previously reported historically as important (Starnbach and Kaplan, 1975). Socio-economic evaluation in terms of healthcare provision has not been reported.

2.5.6. A summary of the relevant findings from the patient compliance studies reported in the orthodontic literature

1. CCEM is the method of choice for clinically based studies. This method assesses evidence-based indicators of patient compliance in clinical trials; oral hygiene, appliance wear, appliance maintenance and appointment attendance.
2. The time points for measurement of patient compliance are significant and the time points reported in the orthodontic literature include pre-treatment plus during treatment.
3. There is a paucity of orthodontic studies assessing the same cohort of patients longitudinally pre-treatment and in-treatment. Prospective studies using the same sample are not present in the current body of the literature. An accurate comparison of pre-treatment and in-treatment compliance could be gained from a longitudinal study.
4. Factors that affect patient compliance include; age, gender, decision to undergo treatment, severity of malocclusion, income (social status), perceived need for orthodontic treatment, perceived dental and facial appearance, parental influence and the relationship with the orthodontist.
5. The payment or non-payment of fees by the parent may or may not be a factor in patient compliance. There is no evidence that the motivation of the parent to influence their child to attain good outcomes may be influenced by the healthcare funding system the child received treatment in.
6. The CCEM method can be administered in controlled clinical environments for example dental hospitals with smaller samples, but the Rinchuse and Zullo (1992) protocol whereby orthodontists assess patient OH, as a proxy measure of compliance, is a more plausible methodology in terms of administration in multi-centre longitudinal trials, which rely on busy practices with limited staff to fill out questionnaires. The questionnaires although straightforward, require manpower, which may be inadequate in busy practices.

2.6. More recent reports from the literature

2.6.1 Relevant modern concepts for orthodontic perceived need

Perceived need is one of the factors that determines demand for orthodontic treatment but also could contribute to patient motivation. Motivation can be defined as a concept that describes the conscious or unconscious stimulus for action toward a desired goal (Pabari et al., 2011). The modern specialist orthodontist tries to ascertain the type of motivation the patient has (if any) and attempts to maintain this during treatment. This seems to be important if successful outcomes are to be achieved. Experienced clinicians know that, if motivation is lost, there is a danger that a patient's compliance will suffer; this may lead to premature termination of treatment, a compromised result or even potential damage to the patient's dentition (Pabari et al., 2011). Studies that investigate the factors that influence patient perceived need, give the clinician more insights for determination of motivation and thus aid in managing patient expectation of possible treatment outcomes, based on their pre-treatment level of motivation. Managing patient expectations is important in both public and private healthcare settings. No single definition of expectations in healthcare exists; patient expectations develop from several sources, such as experiences in the related setting, word of mouth and family experiences, and in media and advertising (Newton and Cunningham, 2013). Certainly, a child's perceived feelings of being unattractive and different to other people is made worse by the expression of supposed societal norms, through peer group pressure and images in the media. Children may avoid having their photograph taken or may be embarrassed by their photograph being shared on social media (Hensen et al., 2011). In the present societal climate of increased use of social media, this may increase perceived need levels in children, with a possible increase in demand for orthodontic treatment.

Studies on perceived need aid in the pre-treatment assessment of the patient and help manage the patient in the modern climate of social expectations and the use of social media.

2.6.1. Relevant modern concepts for compliance

Understanding of orthodontic treatment plays a major role in the consent process (Macklin, 1999). In some dental procedures, a patient can understand and consent to treatment without remembering the details of the procedure after a few weeks. However,

greater in-depth understanding and recall are important in orthodontic treatment because it requires long-term co-operation by the children and their parents (Mortensen et al., 2003). Patients must maintain good oral health and monitor their diets, adjust their appliances as often as several times a week, as well as maintaining a good retention protocol after active treatment. Parents must help their children follow these guidelines and bring the child to scheduled appointments. For these reasons, both children and their parents need to be aware of and understand their responsibilities in the treatment process before starting orthodontic treatment (Mortensen et al., 2003).

Few studies have assessed patient compliance longitudinally, yet such studies are crucial to the understanding of the application of compliance factors by the patient, that are discussed during informed consent. Also, judgement of the ability of the patient to mentally retain this information during protracted orthodontic treatment. Longitudinally one assumes, that there is reinforcement of compliance requirements at each visit with the orthodontist.

A systematic review by Al-Moghrabi et al. (2022) reported on the use of mobile applications to produce behavioural changes during orthodontic treatment. Only a very low to moderate level of evidence supports the effects of mobile applications in producing positive behavioural changes in orthodontic patients. More high-level studies are required.

2.6.2. Relevant modern concepts for willingness to pay

The overarching protocol for the present study was necessary for the introduction of the IOTN DHC and AC into NHS public healthcare system to limit access to the provision of free orthodontic treatment for patients with little or no normative need. Since the introduction of IOTN into the NHS in NI in 2006, perceived need literature has reported more studies that link the desire for orthodontic treatment with quality of life, general wellbeing and overall health as described by the WHO.

This has led to an audit of the NHS system provision for the purpose of determining if scarce resources are being allocated correctly and if there is a benefit to the continuation of funding orthodontic treatment., individually and societally.

A study by Vernazza et al. (2018) did confirm that using WTP, that the increasing levels of need using IOTN generated higher levels of WTP valuation. Fleming et al. (2021)

advised further that the decision to undergo orthodontic treatment was influenced by family income, cost, the aetiology of malocclusion, age, self-esteem/confidence. It was felt that free NHS treatment should be prioritised for children 18 years of age and under where self-esteem and confidence is impaired. In other words, there may be a shift towards more holistic factors rather than following just the arrangement of teeth.

CHAPTER 3

AIMS AND HYPOTHESES

3.1. The North/South Collaborative Project Objectives

A research proposal was submitted to the HEA in December 2003 to obtain funding for a collaborative North/South study in Ireland on Orthodontic services and from this study secondary research was planned. The proposal included funding for two PhD posts, one in NI and one in RoI.

The research objectives of the primary study, the Northern Ireland (NI) and Southern Ireland (RoI) HEA funded collaborative project, were as follows:

1. Determine the psycho-social benefits of orthodontic treatment for the patient.
2. Assess the relationship between professionally determined treatment need and subsequent treatment outcome.
3. Estimate the value placed by parents and their child's orthodontic treatment.
4. Compare and contrast the orthodontic delivery system North and South.

Research Objective One to examine psychosocial changes reported by the patients was investigated by student Anita Van Den Heuvel in an MPhil research Thesis (Research post one funded by the HEA project). Research objective two by the team. Research objective three was investigated by the author (not funded by the project). A third researcher from NI intended to investigate objective four but unfortunately left the project after one year to pursue her studies in law (Research post two funded by the HEA project). This research post was re-filled but the PhD was not adopted by the new research assistant.

3.2. Aims of the thesis using data from the North/South collaborative study

1. To investigate clinical and non-clinical factors influencing pre-treatment perceived need (which contributes to demand) for orthodontic care by both parent and child in their decision to seek orthodontic care in fee-paying (private) and non-fee-paying (public) healthcare systems.

2. To determine the amount a parent is willing to pay (WTP) pre- and post-treatment to obtain the benefit of straight teeth for their child in fee-paying (private) and non-fee-paying (public) healthcare systems.

3. To investigate factors that influence patient compliance (in terms of hygiene compliance) during treatment in fee-paying (private) and non-fee-paying (public) healthcare systems.

3.3. Null Hypotheses

3.3.1. Patient Perceived need: How do you think your teeth look?

H_0: Pre-treatment Patient Perceived Need is not significantly associated with the demographic factors (1) age of the child, (2) the gender of the child, (3) the type of healthcare funding system in which the child received orthodontic treatment, and (4) the income of the household in Euros. Professional normative clinical need assessment factors (1) IOTN DHC and (2) IOTN AC. Bullying factors, the child being teased about how their teeth look. Societal factors comparison of their looks to their peers.

3.3.2. Parent Perceived Need: How important to you is it that your child has straight teeth?

H_0: Pre-treatment Parent Perceived Need is not significantly associated with the demographic factors (1) age of the child, (2) the gender of the child, (3) the type of healthcare funding system in which the child received orthodontic treatment, and (4) the income of the household in Euros. Professional normative clinical need assessment factors (1) IOTN DHC and (2) IOTN AC.

3.3.3. What is the maximum amount you would you be willing to pay for your child to have straight teeth?

H_0: Pre-treatment Willingness to Pay is not significantly associated with the demographic factors (1) age of the child, (2) the gender of the child, (3) the type of healthcare funding system in which the child received orthodontic treatment, and (4) the income of the household in Euros. Professional normative clinical need assessment factors IOTN AC. Parent perceived need, based on the importance of straight teeth for their child. Bullying had the child been teased about how their teeth look.

3.3.4. Compliance: The orthodontist records the patients level of oral hygiene as a proxy measure of compliance

H_0: In-treatment Compliance is not significantly associated with the demographic factors (1) age of the child, (2) the gender of the child, (3) the type of healthcare system in which the child received orthodontic treatment, and (4) the income of the household in Euros. Professional normative clinical need assessment factors (1) IOTN AC and outcome measures using (2) PAR. Economic factors willingness to pay.

All hypotheses will be analysed for an overall combined and separate public and private healthcare systems in an Irish sample. In the public healthcare system parents pay no fees and in the private system parents pay fees. The fee-paying parents either pay market value fees in privately owned practices or dental hospital subsidized fees.

CHAPTER 4

PARTICIPANTS AND METHODS

4.1. Collaborative Project design

A prospective clinical study of orthodontic patients was conducted in Ireland which included Northern Ireland (NI), which is part of the UK and the Republic of Ireland (RoI). The title of the project was 'A longitudinal study of the benefit, outcome and cost of orthodontic treatment'.

A section of data collected from that collaborative study was the focus of this thesis and therefore the pertinent methodology impacting this thesis is presented in this Chapter.

Section 4.2 presents the general methodology common to the overall NI/RoI collaborative study and this thesis.

Section 4.3 describes methodology pertinent to the aims of this thesis:

1) Methods to determine the perceived need of the patient and parent.
2) Methods to determine the value placed on treatment by the parent using their willingness to pay.
3) Methods to determine the compliance of the patient during treatment.

Section 4.4 deals with data entry and statistical analysis

4.2. General collaborative study design

The study was designed by Professor Donald Burden Queens University Belfast (NI) and Professor Martin Kinirons University College Cork (RoI). A prospective longitudinal clinical study of orthodontic patients was conducted in two locations in Ireland. One location was in Belfast, Northern Ireland (NI), which is part of the UK and the other was in Munster, Republic of Ireland (RoI).

4.2.1. The sample

A two-stage sampling design was employed, where orthodontists were invited to participate in the study in Belfast NI and Munster RoI. A consecutive sample of patients was selected from each participating orthodontist's waiting list. Patients were followed up at monthly intervals until completion of their treatment and at one-year post treatment. Several measures were recorded including, demographic, socio-economic, perceived need willingness to pay, self-esteem, quality of life, treatment need indices, treatment

outcome indices and patient compliance. Patients were recruited in a convenient manner and were removed consecutively from the waiting lists and assessed using inclusion and exclusion criteria.

The waiting lists were a convenient method of accessing orthodontic patients who had been assessed as being in need of orthodontic treatment. The patients on the waits lists were not all necessarily going to need fixed orthodontic appliances, but to reduce selection bias they were removed in chronological order. Due to the selection process the age of the subjects could not be standardised. Criteria for inclusion and exclusion was applied to each subject before consenting them for inclusion in the study.

4.2.2. Inclusion criteria

- Need orthodontic treatment.
- Extractions may be part of the treatment.
- Fixed appliances including adjunctive appliances; headgear, facemask, maxillary expanders, Nance button or trans-palatal arch may be required.
- Treatment time to completion estimated at two years.
- No exclusion based on IOTN DHC or IOTN AC.

4.2.3. Exclusion criteria

- Severe medical, physical or intellectual disabilities.
- Mixed dentition where treatment that may take more than two years to complete.
- Complex cases involving major surgery.
- Patients from the Southern Health Board public system [thesis sub-study only]

4.2.4. Ethical approval

Full ethical approval was granted for the study was obtained from Cork Teaching Hospitals Ethics Committee (Appendix A) and the Queens University of Belfast Teaching Hospitals Ethics Committee (Appendix A). Each patient was provided with an information sheet detailing the proposed treatment involved (Appendix A). Each patient signed a consent form (Appendix A).

4.2.5. Power of the sample for the collaborative study

The target population was all orthodontic patients commencing treatment in Ireland. It was planned to select a sample 400 patients, 200 patients from NI and a further 200 from RoI. Thus, the sample size was estimated using data from a study in the General Dental Services in England and Wales (www.statistics.gov.uk) investigated by (Richmond et al., 1993,1996). It was expected that 400 patients would provide a reasonable number of cases across the three IOTN AC categories of orthodontic treatment need, this would be estimated at: 19.3% IOTN AC (1-4), 39.7% IOTN AC (5-7) and 41% IOTN AC (8-10) as per the Schanshieff report (1986). The aim of the collaborative study being the determination of the necessity to introduce the Index of Orthodontic Treatment Need guidelines into the Public Health Services in Ireland to control waiting lists. Recruiting from both the Public and Private sectors of healthcare created the necessary spread of IOTN (AC) in the target population. The UK, Schanschieff report (1986) highlighted the payment of treatment for cases with 'little or no need' by the NHS in England. The Schanscieff report (1986) provided information about the spread of IOTN cases in a representative sample from the UK, NHS. It formed the basis of the sample selection for the collaborative stud, thus the sub-study.

4.2.6. Primary sampling unit-the orthodontists

Northern Ireland

In Northern Ireland the orthodontists were recruited using convenience sampling. All part-time orthodontic instructors at the Queens University Orthodontic teaching unit were invited to participate. There were thirteen orthodontists who agreed to take part in total and a range of 2-30 patients each were treated. The orthodontists worked in private practice settings in NHS funded practices, in close proximity to Queens University Belfast Dental School and Hospital.

Republic of Ireland

In the ROI orthodontists were recruited from the Munster region based on a convenience sample that were within a reasonable commuting distance from the Cork University Dental Hospital. The recruitment was also based on healthcare system and included private clinics and public Southern Health Board clinics and the Cork University Dental Hospital clinic.

The author was involved with the thesis supervisor in constructing the letter that was sent to orthodontists practising in private practices and the Southern Health Board (SHB) clinics, inviting them to take part in the study. The SHB clinic in Waterford agreed to take part, unfortunately the SHB orthodontic clinics in Cork, Limerick and Tipperary declined. Three private practice orthodontists out of a possible fifteen orthodontists agreed to take part. The three orthodontists working in the Cork University Dental Hospital including the author were willing to take part in the study. The total number of orthodontists was nine with a range of 2-30 patients, except for the author who recruited 79 patients.

Donald Burden met with orthodontists in NI and in the RoI the author and the supervisor met with invited orthodontists to explain the study protocol.

All the Orthodontists who were engaged in the project on a voluntary basis were not reimbursed for their time or that of their staff. A reimbursement fee of 160 euro per patient was payable to cover the laboratory costs for the orthodontic plaster study models.

4.2.7. Secondary sampling units- the patients and their parents

The recruitment centres.

The target recruitment was 30 orthodontists and approximately 15 patients per orthodontist giving a target sample size of 420 patients (to allow for a dropout rate of 5%). The recruitment numbers achieved for orthodontists was a total of 22. The orthodontists did not recruit an even number of patients, as this was dependent on the extent of their waiting lists, the suitability of patients and staffing. Thus, within the time limitations of the study and the money available the total number of patients recruited was 401 including patients that further on in the study withdrew or were excluded at the time of records see table 15.

Table 15. Shows the sample stratified into private (fee-paying) and public (non-fee-paying), the number of patients recruited and the percentages

Health Care System	Number of patients recruited	Percentage of patients recruited	North and ROI combined into stratified groups
NHS practices (NI)	177	51.62%	Non-fee paying
Southern Health Board (ROI)	30		
Dental Hospital (ROI)	133	48.38%	Fee-paying
Private Practice (ROI)	61		
Total	**401**	**100%**	

The recruited number of patients in the RoI specialist orthodontist private practices and the SHB was lower than expected Table 16. Thus, to meet the required target sample number, the author treated 79 patients in the cork university dental hospital, and they were fee-paying.

Table 16. The number recruited of primary sampling units and secondary sampling units. The numbers planned and the numbers achieved.

	Private funding Fee-paying	Public funding Non-fee-paying
NI PSU's		13
NI SSU's planned		210
NI SSU's recruited		177*
RoI PSU's	6	3
RoI SSU's planned	120	90
RoI SSU's recruited	177*	30

**17 of the patients reported in Table 15 later withdrew or were excluded at the records stage*

The equal numbers of patients recruited in the public funding system and the private funding system underpinned the aims of the thesis which included an overall analysis of the data recorded for the overall sample and also a comparison between public and private healthcare systems in relation to perceived need, willingness to pay and compliance.

The public patient sample in NI was not combined with the RoI public sample because the social differences were extreme and the variance that this would have created could not have been controlled.

Thus, by using the sample purely as a sample of private (fee-paying) and public (non-fee-paying) this negated the sample being representative of NI or the RoI healthcare systems individually.

However, it is important to note that, even though the public/private split removes the NI/RoI representation for this thesis. The standalone NI patient sample is representative of the societal norm in NI in 2004. The combined public and private sample (50/50) is representative of the societal norms in the RoI in 2004. In 2004 the Government published a report by the House of the Oreichtas which showed that 50% of 12 years olds in the RoI qualified for treatment. That meant the 50% would seek treatment in privately owned practices and pay fees. This thesis sub-analysis uses the sample in its 50-50 form to create the ideal real-life scenario in the RoI that would occur if all approved children had a 100% uptake (Appendix D).

Table 17. The timelines for recruitment of SSU's in the PSU's

Timeline for recruitment	
January 2004	Invitation sent out to Orthodontists
April 2004	Recruitment of patients Private practice orthodontist withdraws
August 2004	Review of recruitment
August 2004	Problem with SHB recruitment Problem with PP recruitment Problem with the NI recruitment Meeting of research team
September 2004	Alternative recruitment plan to Increase recruitment at CUDSH

4.2.8. Staff training

Training evenings were organised at the School of Dentistry, Belfast and Dental Hospital Cork, for the participating orthodontists and their receptionists to familiarise them with the protocol and the methodology. A similar training approach has been successfully employed previously by members of the research team in a randomised clinical trial among general dental practitioners in Northern Ireland. Each orthodontist and receptionist were reimbursed for their attendance at the postgraduate education allowance rate.

4.2.9. Calibration of clinical examiners

Professor Donal Burden, one of original teaching team for IOTN and PAR Training, supervised the calibration of examiners/orthodontists. All examiners had weighted Kappa scores greater than 0.8 for IOTN DHC and for IOTN AC indicating good agreement (Landis and Koch 1977; Fleiss 1986).

4.2.10. Instruments

Two of the three patient questionnaires were purchased for the study, a validated Self Esteem Index (SEI) and a validated Quality of Life instrument (QoL). These two instruments were self-administered by the patient at their orthodontic monthly appointments and alternated during treatment at the scheduled monthly orthodontic visits. The last SEI and QoL instruments were completed at the appointment immediately after the orthodontic appliances were removed. These two questionnaires are not relevant to this thesis and are therefore not shown in this thesis.

The third patient questionnaire was a structured questionnaire, designed by the research team, piloted in CUDSH and administered prior to the commencement of orthodontic fixed appliance treatment. The author and the two research assistants were responsible for designing the questionnaire in accordance with the aims of the study and presenting it to the team for approval. The questions were based on questions used in the orthodontic literature. The questions were pre-tested on a cross sectional sample of patients (20) being treated in CUDSH by the author, for both clarity and understanding.

Post piloting any questions that needed greater clarification were changed and the questionnaire was returned to the team for final verification.

The structured questionnaires were administered in a face-to-face based interview, enabling the patient to clarify any questions they did not understand with the interviewer. The research assistants in NI and RoI performed the face-to-face interviews. They were not dentally qualified and therefore could not bias the process. The questionnaire contained questions about demographics, school, peers, dental hygiene, and perceived need visual analogue scales. Only a selection of questions from the overall questionnaire that met the research objectives and aims of the present thesis, were utilised in the data analysis. The full questionnaires are presented in Appendix B.

4.3. Methodology relevant to the thesis

4.3.1. Power of the sample for the thesis aims

4.3.1.1. Power of the sample for aim 1 'Perceived Need'.

Holmes, (1992) looked at perceived need levels in a representative UK sample. The results showed from the sample that; for Group 1 IOTN AC (1-4) 37% had a perceived need and Group 2 IOTN AC (5-10) 72% of children had a perceived need. Using the results of Holmes, (1992) that reported a 35% between the two groups of IOTN AC an appropriate sample size required to detect a difference of 35% with 95% confidence level and 80% power for the thesis, requires 28 patients in each IOTN AC category for both the public and private healthcare systems.

4.3.1.2. Power of the sample for aim 2 'Willingness to Pay'.

As per Ozolins et al. (2004), the reported a difference in WTP was 45% of market value between public and private healthcare systems. A sample size of 10 parents in each system, public and the private, would be required to detect a difference of 45% of market value at a 95% confidence level and 80% power.

To detect a difference in WTP between three sub-groups of the overall sample Group 1 (the public), Group 2 (the private) and Group 3 (the subsidized private) of 25% of market value at a 95% confidence level and 80% power, would require 24 parents per sub-group,

4.3.1.3. Power of the sample aim 3 of the thesis Patient compliance.

Richter et al. (1998) investigated oral hygiene levels and used Group 1 (72 above average) and Group 2 (72 below average) compliers to detect a difference in oral hygiene compliance scores of 29% between the groups.

To detect a difference of 29% in compliance scores between two groups, at 95% confidence level and 80% power. The thesis sample size requires 40 above average and below average compliers in each healthcare system (public and private).

4.3.2. Instruments used for data collection

The study consisted of a patient questionnaire, two parent questionnaires and one clinician-based questionnaire. The questionnaires were simplified version of the main questionnaires and the included questions that were selected on the basis of the aims for the present study (section 3.2). These included demographic information, perceived need for orthodontic treatment measurement using visual analogues scales and literature based questions on explanatory variables. The parental questionnaire included socioeconomic status (income), the value parents place on orthodontic treatment (willingness to pay), perceived need for orthodontic treatment for their child (visual analogue scale) and from the literature external factors that may influence their level of perceived need. The normative need of the subjects using the Index of Orthodontic Treatment Need was graded using study models of the subjects' malocclusion, performed by calibrated examiners. A visual analogue scale was used to determine perceived need levels according to the importance of straight teeth to the parent and the satisfaction with the present appearance of their teeth by the patient. The visual analogue scale was reported as the most reliable method of assessing perceived need IOTN AC (Flores-Mir et al., 2004).

4.3.2.1. Perceived need questionnaire relevant to this thesis

The literature review also clearly shows that perceived need is influenced by appearance. The Visual Analogue Scale that measured 'dissatisfaction with appearance' (Shaw, 1981). The VAS scale was 100mm in length, and the patient was asked to make a mark on the line (table 18). The zero represented 'not dissatisfied with the appearance of their teeth' and the 100mm represented 'very dissatisfied with the appearance of their teeth'. The results were converted to percentages to determine the level of dissatisfaction with

appearance. A selection of answers to demographic and psychosocial questions was chosen to be used for the present study analysis and were selected based on the literature (table 19) derived from (Shaw, 1981), with the addition of willingness to pay with parent perceived need. There are no studies in the literature on an Irish sample and therefore the testing of evidence-based factors was method of choice.

Table 18. The Visual analogue scale used to measure patient perceived need

Perceived need dependent variables for the patient	
Visual analogue scale 100mm How nice do your teeth look now? _____	
Look very bad	Look very good

The aim of the structured questionnaire was to capture the following dimensions of the patient's characteristics and possible explanation of their perceived need Table 19.

Table 19. Relevant demographic and explanatory variable questions for patient perceived need

Gender	**Male/Female**
How old are you?	1=under 11, 2=11, 3=12, 4=13, 5=14, 6=15, 7=16 8=17, 9=18, 10=over 18
Have you ever been teased or given a nickname because of the way your teeth look?	1=Yes 2=No
How do you think your teeth looked compared to others?	1=Same 2=Worse 3=Better

4.3.2.2. Parent perceived need questionnaire

The parent answered one VAS question, that asked 'How important is it to you to have straight teeth for your child'. The VAS score was measured on a scale from 0 to 100mm (table 20). Zero represented the fact that the parent did not think that straight teeth were important and the 100mm represented the score for a parent who thinks straight teeth are very important. The mm scale was converted to percentages and was analysed in terms of level of demand present. The VAS score was used to assess how important straight teeth were to the parent.

Table 20. The visual analogue scale used to measure parent perceived need

Perceived need dependent variable for the parent	
Parent visual analogue scale 100mm How important is it to you that your son/daughter have straight teeth?	
Very unimportant	Very important

4.3.2.3. Parental Willingness to Pay questionnaire

For this analysis an open ended contingent valuation (CV) method of questioning, was used to elucidate from the parents, a monetary value for orthodontic treatment at the pre-treatment and end of treatment time points (table 21). Child, parent and professional characteristics were elucidated, from the child and parent questionnaires, in order to identify the main factors that influenced the parent's monetary values in terms of their WTP. In the literature the open-ended contingent valuation elicitation technique was used in four studies that were reviewed in Chapter 2. The respondents were asked how much they were WTP for the intervention presented or to avoid the negative consequences of not having the intervention. Many respondents find this a difficult concept, particularly where patients are not generally familiar with payment for health care. In open-ended CV the respondent is not given any guiding price, and this can make it difficult. Thus, in this methodology the patient was asked a guiding price first (a single bounded dichotomous question) and then an open-ended contingent valuation question. For

parents in the public system the WTP was hypothetical, but their child was in treatment already so answering strategically was reduced and there was no reluctance to answer the WTP due to a fear of non-acceptance for treatment, based on their answers.

Table 21. The Willingness to pay questions asked of the parent.

1. Leaving aside the actual cost of treatment, if any, I will read you a random amount_____? and please tell me Yes or No if you would be willing to pay that random amount_____? for your son's/daughter's braces. *Random amounts* RoI Euros: (950, 1400, 1850, 2300, 2750, 3200, 3650, 4100, 4550, 5000 Euros) NI Sterling: (250, 500, 750, 1000, 1250, 1500, 1750, 2000, 2250 Sterling)
2. Again, leaving aside the actual cost of treatment, if any, and assuming payments would be spread out over the treatment, what is the maximum amount you would be willing to pay in total for your son's/daughter's treatment?_____
3. Please indicate your current income bracket in thousands. (<10)(11-20)(21-30)(31-40)(41-50)(51-60)(61-70)(71-80)(81-90)(91-100)(>100)

4.3.2.4. Compliance instrument

The orthodontist filled in a compliance questionnaire for the patient and the time points were at three months from the placement of fixed appliances and at the end of active treatment (table 22). The level of hygiene was measured as very poor to very good on a Likert scale and numbered: 1=very poor, 2= poor, 3= average, 4= good, and 5=very good. The orthodontists by virtue of their training would have a standardized approach to assessment of hygiene practice levels and also a standardized approach to oral hygiene instruction for orthodontic patients. The level of hygiene was measured by the amount of plaque present on the teeth and attached to the fixed appliance, and if there was gingival inflammation associated with the plaque accumulation. The scores were as follows No plaque=very good, <15% plaque=good, >15% and <30%=average, >30% and <50% poor, >50% very poor.

Table 22. The compliance instrument used to measure compliance for the thesis

Patient compliance question relevant to this thesis
Please rate the patient's compliance with oral hygiene instructions (circle a number from 1 to 5) for the previous three months of active treatment very poor 1 2 3 4 5 very good

4.3.3. Data collection

To ensure that the disruption to the daily routine of the orthodontist was kept within an acceptable limit, the data collector (research assistant/s) of the research team played a major role in supporting the orthodontists and their receptionists. A variety of questionnaires were administered during the course of this study and were completed when the patient and their parents' attended the orthodontists' surgery.

The patients' first appointment after being removed from the waiting list was with the orthodontist for a clinical examination. On the basis of this examination the orthodontist was able to inform the research assistant if the patient was eligible for the study. Patients who met the inclusion criteria were then appointed for the pre-treatment x-rays, photographs and impressions of their teeth with the orthodontist and it was arranged that the research assistant would attend at the same time for this appointment, where they would meet the patient and parent. At this appointment the research assistant/s was assigned an office space, this was quiet and private although in close proximity to the clinic.

The research assistant explained the purpose of the research project, the different questionnaires that would need to be completed and the different time points associated with individual questionnaires. The patient was shown the different questionnaires and their content, and their purpose was explained. It was also explained to the patient the method by which they would be administered. There would be a face-to-face interview with the research assistant at the beginning and end of treatment, but during treatment the dental receptionist would give forms which they would complete during their orthodontic appointment whilst in the dental chair. As part of the study the parents would have face-

to-face interviews at the pre-treatment and end of treatment time-points. Consent forms were signed at this meeting.

The impressions taken at the records appointment were sent to a dental laboratory to be cast into study models using orthodontic plaster as a record of the patient's malocclusion. These models were then used by the orthodontist at the following pre-treatment appointment which was treatment consent. At this appointment patients and parents reviewed the x-rays, photographs and study models. A treatment plan was proposed by the orthodontist and if it was acceptable to the patient and the parent, consent for treatment was signed. The orthodontist explained the risks and benefits of orthodontic treatment including oral hygiene, the importance of attending all scheduled appointments and care needed to avoid breakage of the appliances which would delay treatment and affect the result. A record of these three behaviours would be kept in their chart and as part of the study, a form would be completed by the orthodontists every three months, this would be given to the research assistant/s. It would be stored in their research file with their completed questionnaires. The file would have a number only on the outside and the number key would be stored in a computer file on the research assistant's computer only.

Following treatment consent with the orthodontist, the patient was interviewed in the clinic and the parent was asked to take a seat in the waiting room. The patient's face-to-face interview was completed first and then the patient was left to complete the SEI and QoL forms in a self-administered manner.

During this time the parent was interviewed in a face-to face manner in a quiet office close to the waiting area. This method of completing the questionnaires enabled any questions from the parent or patient to be answered immediately. It also resolved any misunderstanding of the questions, which could be re-worded until a level of understanding was reached and an answer obtained. This method ensured valid answers and clarity of questioning. The visual analogue scales were marked in front of the researcher assistant/s thus ensuring that the mark was placed towards the end that was intended, by the parent and patient. The interview paperwork questionnaires and instruments were placed in numbered envelopes and sealed for transportation to the relevant University clinic/s.

4.3.4. Study Model Grading

4.3.4.1. The Index of Orthodontic treatment need (IOTN) and Peer Assessment Rating Score

The IOTN of the patient was determined using their study models. The models from the recruitment centres in the North were amalgamated at the dental hospital Queens University Belfast and in the RoI at the dental hospital University College Cork after collection by the research assistant from the individual primary recruitment centres. The measurements were performed by the calibrated examiners at QUBDSH and CUDSH respectively. The examiners graded all pre and post treatment orthodontic models.

The research assistant/s prepared the models for inter- and intra- examiner reliability testing. On each set of models, the name was covered over to ensure anonymity, tape was placed over the name which was then written on using a thick blacker marker pen. The marker was used to write a unique identification number, which replaced the patient's name. The study models were assessed and graded by five calibrated examiners, three of whom were participating orthodontists. The intra- and inter- examiner reliability was tested on a selection of models. The examiners were blinded to the patients' identification and did not assess their own patients' models.

Index of Orthodontic Treatment Need Aesthetic component (DHC and AC) are presented in the Appendix F the PAR score measurements are included in table 23 and Appendix F. A customized measuring instrument was used for recording the measured IOTN DHC, IOTN AC and Peer Assessment Rating Score (PAR) table 23.

Table 23. The recording sheet used for each patient to record IOTN DHC, IOTN AC and PAR scores

Normative need assessed on study models	
Index of Orthodontic Treatment Need-Dental Health Component	Grade one = no need Grade two = little or no need Grade three = borderline need Grade four = great need Grade five = very great need
Index of Orthodontic Treatment Need-Aesthetic Component	Grades 1-2 = no need Grades 3-4 = little need Grades 5-7= moderate need Grades 8-10= great need
Outcome measures Peer Assessment Rating assessed on models	
Measurement and score	**Weightings**
Crowding 1, 2, 3, 4, 5	1
Buccal segment relationship (AP 0,1,2; V 0,1; T 0,1,2,3,4)	1
Overjet 0, 1, 2, 3, 4	6
Overbite 0, 1, 2, 3, 4	2
Centrelines 0, 1, 2	4

4.4. Data analysis

Data analysis on the collected data was conducted via SPSS version 16.0. Raw data was entered into SPSS continually from the beginning of the data collection in 2004 both in the North and South of Ireland. The databases were amalgamated in 2008. The statistical analysis of the database descriptive, bivariate, regression, and multivariate regression, was carried out by Dr Patricia McDermott, under the professional guidance of Margaret Cole statistician. Dr Patricia McDermott qualified with a certificate in statistical analysis, given by Trinity College, Dublin. The qualification was funded by the research study. The certificate was taken by distance learning and consisted of nine modules.

4.4.1. Data analysis:

1. Descriptive statistics of the sample.

2. To determine and properly construct the four dependent variables in order to fulfil the aims of this study. Perceived need patient from the basis of dissatisfaction with the appearance of their teeth, perceived need parent from the basis of the importance of straight teeth for their child, willingness to pay at two time points, compliance at two time points.

3. The conversion of VAS scores to continuous dependent variables.

4. The conversion of the compliance assessments to one continuous patient (OH) variable.

5. The conversion of age, income, healthcare system, IOTNDHC, and IOTN AC categorical variables.

6. Bivariate correlations in order to investigate the relationship of independent variables to each other.

7. Bivariate correlations to investigate the relationship of independent variables to the dependent variables.

The incorporation of significantly related independent and dependent variables into regression models in order to determine the influence of independent variables on the seven dependent variables. A backward process of non-significant variable elimination was applied. The explanatory factor with the highest non-significant p-value was removed and the model re-fitted. This process was repeated and addtitional cases were included when a non-significant variable with missing data was excluded from the analysis.

4.4.2. Critique of methodology

1. The sample size was calculated on two basis a. to enable a spread of malocclusion from low normative need (mild) to great normative need (severe) malocclusions (collaborative study) and b. to be a representative sample of patients who would ordinarily present for orthodontic treatment.

2. In terms of type of malocclusion this could not be controlled in the present methodology as the study used consecutive selection. Although this did not allow for selection of type of malocclusion it did remove any bias from patient selection. By incorporating public service patients with more severe malocclusions and private patients with mild to moderate malocclusions it was possible to ensure a satisfactory spread of malocclusion in terms of severity. The sample was dependent on the recruitment of orthodontists and thus to a degree was under the control of external factors.

3. Ideally the number of patients from each type of healthcare service should have been balanced. The numbers were balanced between Northern and Southern Irish patients and thus it was not possible to balance the numbers from each type of heath care service. This strengthened the sample in terms of a single uniform service in Northern Ireland but weakened the effect within each type of healthcare service in Southern Ireland.

4. The aim of the study was to test fixed appliance orthodontic treatment and the sample with combined numbers of Northern and Southern Ireland were sufficient to address the aims of the study.

5. The data was collected in a standardised methodology which was conveyed to all administrative participants in training days conducted both at UCC and UBQ,

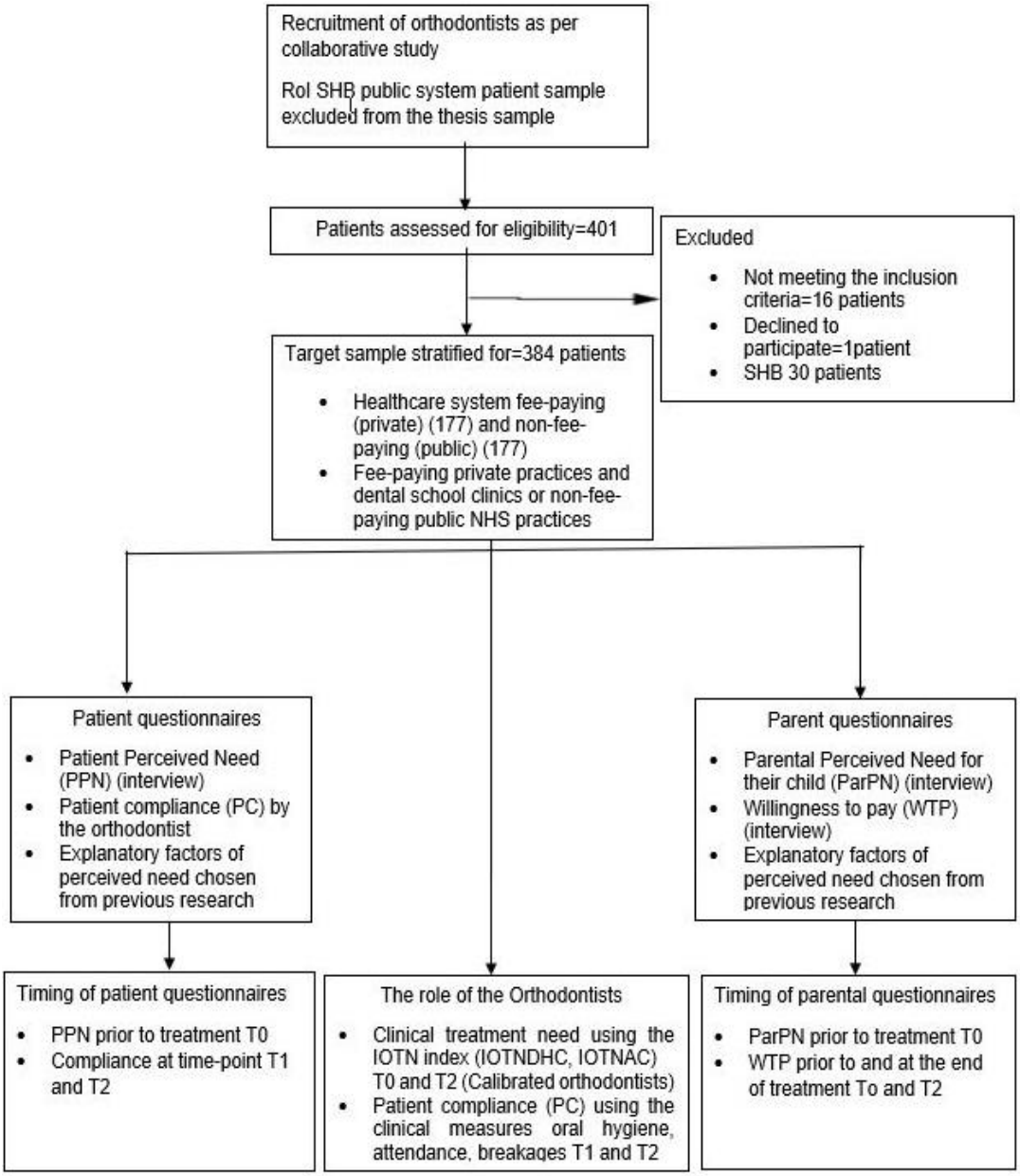
6. The interviews were performed using a face-to-face methodology and thus enabled the patient to clarify any questions they did not understand. The patient and parent questionnaires were piloted on patients that were attending the UCC orthodontic clinic. The questionnaires were adjusted appropriately before being used on the study sample. The interviewers were not dentally trained and this reduced potential bias.

7. The parental information which was sensitive because it revealed their income was kept confidential and the responses placed in sealed envelopes by the parents.

8. The professional assessment of normative need and compliance was performed by trained professionals.

9. For normative need assessment the models were blinded to the calibrated examiner. The professional performing orthodontic treatment did not also perform normative need assessments on their own patients. For WTP parents were unwilling to give income information as per Smith and Cunningham (2004), but unlike that study which substituted income with postal codes, no postal codes were available in RoI in 2004. Compliance questionnaires relied heavily on administrative support staff in busy practices and unfortunately 23 were missing pre-treatment and 64 at the end of treatment. There were 311 patient models submitted at the end of treatment, but only 259 compliance questionnaires submitted for same patients. The number were still in line with the calculated power of the study.

Figure 2. Summary diagram of data collection for the thesis that was derived from the collaborative study



T0=Pre-treatment T1=3 months from the placement of fixed appliances

T2=The end of active treatment and the removal of fixed appliances

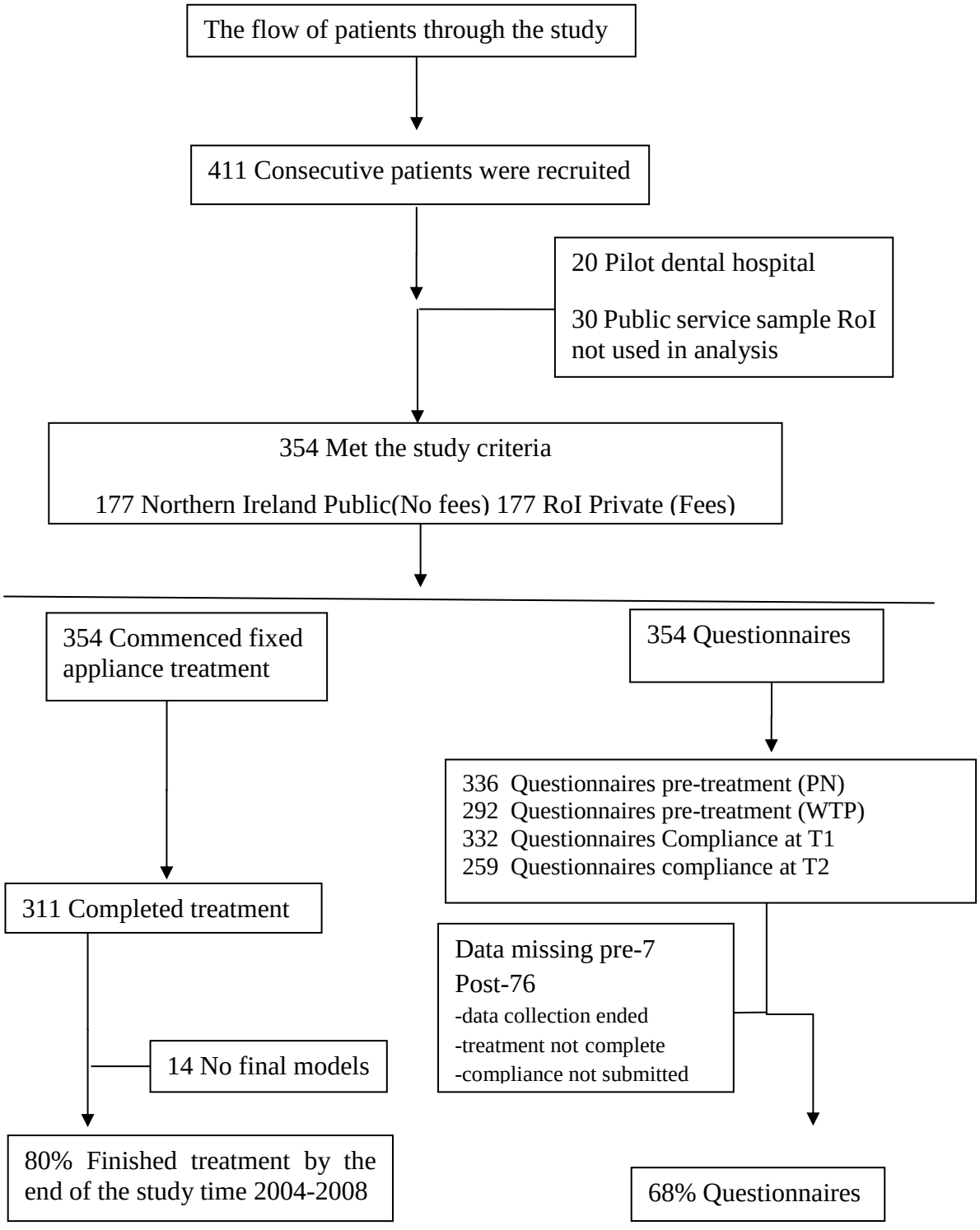
Orthodontic study models were available at T0 and T2 for the grading of IOTN DHC and IOTN AC by calibrated orthodontists.

**The author completes all Peer Assessment Rating Scores post-treatment*

Note: Missing data was minimal pre-treatment so for PPN and Par PN not problem. Reduced numbers for compliance and WTP.

4.4.3. The sample numbers and data

Figure 3. A flow diagram to show the data collection pathways and the numbers in sample at significant time points in the study.



CHAPTER 5

PERCEIVED NEED RESULTS

5.1 Patient and Parent Perceived Need Results

5.1.1. Introduction

Perceived need is simply the perception that as an individual, group, or society, that a good or service is needed without evidence as to how much or how many are needed. A perceived need for orthodontic care is the perception that an individual, group, or society, requires orthodontic care without being clinically assessed or without medical evidence as whether care is required or the extent to which care is needed. The literature on patient perceived need indicates that the perceived need of the patient is influenced societal expectations. However, societal expectations may also inflate the perceived need for care increasing further the burden on public sector providers.

Variables such as gender, dental appearance, normative need, and socio-economic status have been identified in the literature to have an influence on perceived need, and require further investigation. Both historical studies and recent studies show dental appearance as one of the main motivators of patients' to seek orthodontic treatment and is independent of the country of origin of the study.

The main aim of Chapter 5 is to investigate clinical and non-clinical factors influencing pre-treatment perceived need for orthodontic care for both parent and patient from public and private healthcare funding systems.

The factors identified in the orthodontic literature that influence perceived need include: healthcare funding system, socio-economic status using household income as a proxy, gender, age of the patient, IOTN AC, IOTN DHC, peers and teasing. The results of the analysis of patient perceived need pre-treatment are presented descriptively and empirically. Tables 24 and 25 below shows the descriptive statistics for these variables.

5.1.2. Data and Methods

Patient and Parent Perceived Need (mm) were measured on a visual analogue scale (VAS) section 4.3.2 materials and methods. The recruitment of the patients was from two different healthcare funding systems. These included, the public funding system (PUFS), and the private funding system (PRFS). As per section 4.2.1, the origin of the sample in the PUFS was Northern Ireland (NI) and the origin of the PRFS sample was the Republic of Ireland (RoI). The PUFS system provided 100% payment of fees for the orthodontic

treatment administered, under the National Health Service (NHS) funding scheme and governed by the UK and in the PRFS there was self-funding and the parent paid fees. These PRFS fees were determined by societal norms.

In the PUFS and PRFS groups no professionally measured dental criteria was in place for qualification for treatment. The impact of the sub-groups of the PRFS will only be explored in section 5.2.1 to 5.2.6 for PPN. The analysis of the relationship between funding mechanism and perceived need, will explore the sub-groups within the PRFS system, the private practice system (100%) of societal fees and dental hospital which charged subsidized fees.

Following the literature review and based on professional experience, our investigation now explores the impact of the following explanatory variables on the perceived need of the patient pre-treatment: healthcare funding system, socio-economic status using household income as a proxy, gender, age in years, the index of orthodontic treatment need (dental health and aesthetic component), the influence of peers and teasing by peers. The ParPN analyses consisted of the explanatory variables: healthcare funding system, socio-economic status using household income as a proxy, gender, age in years, the index of orthodontic treatment need (dental health and aesthetic component) and is covered in sections 5.3.1 to 5.3.6.

The demographic variable Household Income (HI)Euro was measured in categories of €10,000 beginning at zero and increasing in steps of €10,000 up to >€100,000. The mid-point income value for each household was computed. The max mid-point value of household income was either €110,500 in the RoI and €163,540 in NI after conversion from sterling.

In this section the results of the analyses of PPN (sections 5.1.2 to 5.2.8) and ParPN (sections 5.3.1 to 5.3.6) are presented descriptively and empirically for one time-point; baseline (pre-treatment).

5.1.3. Descriptive Analysis of Patients with Perceived Need Scores

A total of 336 patients out of 343 in the Study data base (Age <=18 years) had a perceived need score recorded. Therefore, only seven patients (4 public and 3 private) had missing data for this variable. Table 24 below shows the demographics of the sample; gender,

age, socio-economic status and healthcare funding system where treatment was received, for patients who had a valid perceived need score recorded and were ≤18 years of age.

Table 24. The frequency counts and percentages of the patient characteristics by funding system; for patients who had a valid perceived need recorded and are ≤18 years of age.

Characteristic	Public Funding System (PUFS)		Private Funding System (PRFS)		Overall sample	
	n	%	n	%	n	%
Gender						
Male	67	38.7	69	42.3	136	40.5
Female	106	61.3	94	57.7	200	59.5
	173	100	163	100	336	100
Age						
10-12 years	53	30.6	61	37.4	114	33.9
13-14 years	114	65.9	88	54.0	202	60.1
15-18 years	6	3.5	14	8.6	20	6.0
	173	100	163	100	336	100
Socio-economic status (Income Euro)						
<10,000	31	19.3	3	3.1	34	13.1
11,000-20,000	32	19.9	8	8.2	40	15.4
21,000-30,000	37	23.0	11	11.2	48	18.5
31,000-40,000	27	16.8	17	17.3	44	17.0
41,000-50,000	16	9.9	17	17.3	33	12.7
51,000-60,000	6	3.7	11	11.2	17	6.6
61.000-70,000	4	2.5	8	8.2	12	4.6
71,000-80,000	4	2.5	9	9.2	13	5.2
81,000-90,000	2	1.2	7	7.1	9	3.5
91,000-100,000	0	0	4	4.1	4	1.5
>100,000	2	1.2	3	3.1	5	1.9
	161	100	98	100	259	100
Funding system	173	51.5	163	48.5	336	100

In the overall sample there were more females (60%) than males (40%) and the same pattern of distribution can be seen in the PUFS and PRFS healthcare systems. The majority of the sample were in the 13-14-year-old age group, and the mean age was 13.34years. The majority of the sample (76.7%) have a total household income below €50,000 per annum. In the PUFS 62.2% of the households have a total income less than €30,000, in the PRFS only 22% of households have a total income below €30,000. In the PUFS 4 children are missing PPN scores. In the PRFS, 11 of the 177 are older than eighteen and 3 are missing PPN scores. The remainder 336, are ≤18 with PPN scores.

Table 25 shows descriptive statistics for the explanatory variables; the index of orthodontic treatment need, peers and teased, again for patients who had a valid perceived need score recorded and were ≤18 years of age.

Table 25. Possible Explanatory variables for patient perceived need

Explanatory variable	Public Funding System		Private Funding System		Overall sample	
	n	%	n	%	n	%
Teased						
Yes	15	8.7	16	9.8	31	9.3
No	157	91.3	147	90.2	304	90.7
	172	100	163	100	335	100
Peers						
Worse	83	49.1	49	30.1	132	39.8
Same	75	44.4	96	58.9	171	51.5
Better	11	6.5	18	11.0	29	8.7
	169	100	163	100	332	100
IOTN DHC						
2	3	1.8	5	3.1	8	2.4
3	44	27.0	27	16.7	71	21.2
4	114	69.8	104	64.2	218	65.1
5	12	7.4	26	16.0	38	11.3

Explanatory variable	Public Funding System		Private Funding System		Overall sample	
	n	%	n	%	n	%
	173	100	162	100	335	100
IOTN AC						
2	4	2.3	5	3.1	9	2.7
3	8	4.6	10	6.2	18	5.4
4	34	19.7	9	5.6	43	12.8
5	12	6.9	18	11.1	30	9.0
6	18	10.4	35	21.6	53	15.8
7	27	15.6	24	14.8	51	15.2
8	40	23.1	44	27.1	84	25.1
9	25	14.5	14	8.6	39	11.6
10	5	2.9	3	1.9	8	2.4
	173	100	162	100	335	100

For the overall sample 9.3% of the patients were teased because of the appearance of their teeth. Compared to their peers 40% of the overall sample think they look worse but 60% feel they look the same or even better. The majority of the sample has an IOTN DHC of 4&5, although the sample does have a cohort of patients are borderline need or no need for treatment (24%). Aesthetically 40% of the overall sample have a great need for treatment and are in IOTN AC categories 8-10.

5.2. Factors Influencing Patient Perceived Need Pre-treatment

In this section the eight variables, demographic variables [funding system, socio economic status (SES), gender, age] and possible explanatory factors [IOTN AC, IOTN DHC, peers, teased] at pre-treatment are analysed with PPN. The dependent variable Patient Perceived Need (PPN) is presented in Table 26, for the level of PPN in the overall sample and the two healthcare funding systems (public and private).

5.2.1. Impact of Healthcare Funding Systems on Patient Perceived Need

The distribution of patient perceived need (PPN) pre-treatment is presented in Figure 4.1, for the Public Funding System and the Private Funding System groups.

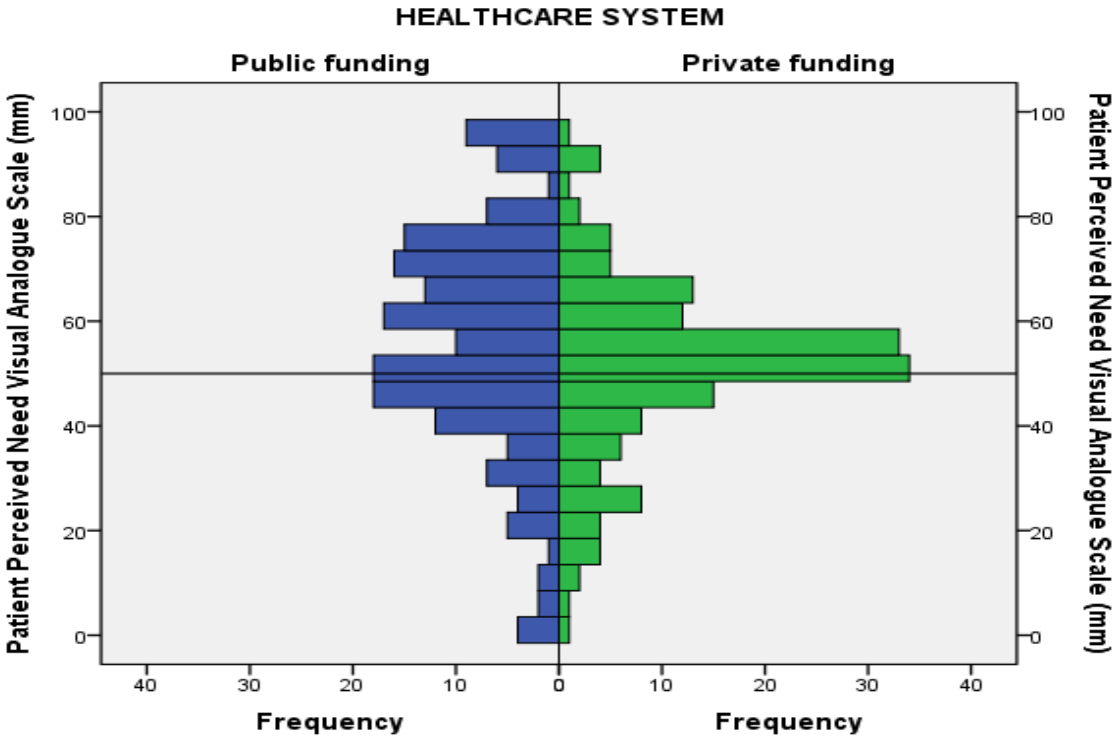


Figure 4. The Frequency distribution of PPN (mm) for Orthodontic Treatment in Publicly versus Privately Funded Payment Systems.

Note: Patient Perceived Need (mm) was measured on a VAS scale where, 0mm represented satisfied with the appearance of their teeth to 100mm very dissatisfied with the appearance of their teeth. Patients in PUFS paid zero fees and in 2004 with no qualifying professionally measured dental criteria. Patients in the PRFS, paid full fee in the private practice delivery sector and subsidized fees in the dental hospital delivery system, also with no professionally measured dental criteria.

Figure 4 shows that in our sample of patients their perceived need scores were quite normally distributed. The public healthcare funded system had a much wider spread of scores with a greater number of patients reporting 80 plus PPN scores, with a cluster of private patients around PPN 50-60 scores. A t-test (equal variance not assumed) indicated that the mean PPN was greater for the public group [Mean=56.58] than for the private group [Mean=50.64], $t_{df=320.287} = 2.771$, p=0.006 (Table 18). The frequency distribution of PPN for the sample when the private system is divided into the sub-groups subsidized and non-subsidized is shown in Figure 5.

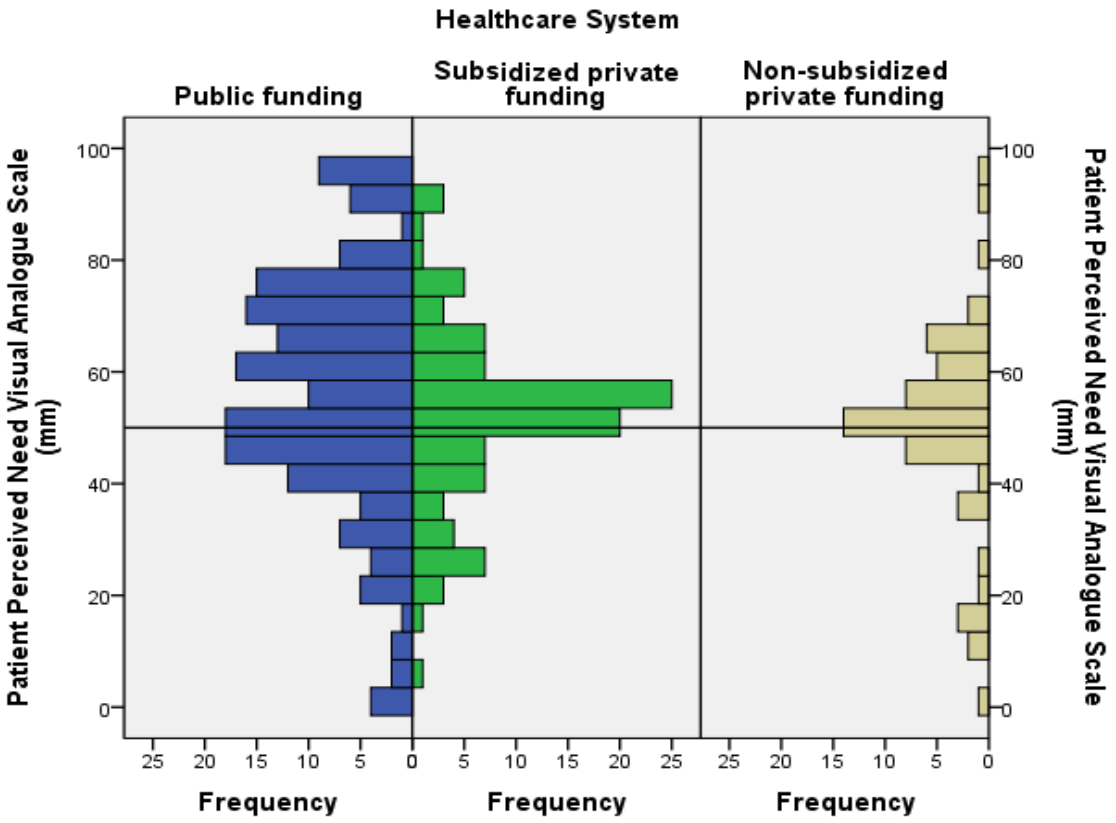


Figure 5. The Frequency distribution of PPN (VAS in mm) for Orthodontic Treatment in the Publicly Funded, Subsidized and Non-Subsidized Privately Funded, Healthcare Systems.

The mid-point VAS score of 50mm is marked on Figure 4 and this is used as a reference line to measure the percentages of patients above and below this line, in each funding system. The public funding system had 109 out of 173 (63%) with a PPN above 50mm. The subsidized-private funding system subsidized had 68 out of 105 (64.8%) above 50mm and the non-subsidized 36 out of 58 (62.1%) above the 50mm level.

Differences between the funding systems, the public, the combined private and the individual private (subsidized and non-subsidized), were analysed and are presented in Table 1. A one-way Anova was applied and the homogeneity of variance assumption was rejected by Levene's test (p=0.023). Therefore, the Welch robust test of equality of means was utilised which showed that there was a significant difference in parent PPN (mm) between the three funding groups (Welch =3.82, $df1=2$, $df2=157.89$, p=0.024). Table 25 compares VAS scores between the funding systems.

Table 26. Patient Perceived Need (VAS in mm) pre-treatment for public, combined private, subsidized private and non-subsidized healthcare funding systems.

Healthcare funding system	Public funding (a)	Combined Private funding (b+c)	Subsidized private funding (b)	Non-subsidized private funding (c)
Patient responses	173	163	105	58
Mean VAS	56.58	50.64	51.01	49.98
SD	22.17	16.91	16.22	18.21
Levene's Test for t-test (a) vs (b+c) F=16.812, p<.001 Levene's Test for Anova for groups (a), (b), (c), F=3.819, p=0.023				
Comparisons for the funding systems	Mean Difference	95% Confidence Interval for the difference in means	t- value, df, p-value	Anova Adjusted significance+
Two group comparison				
Public funding (a)versus Combined Private funding (b+c)	5.94	1.69 to 10.19	t=2.749 df= 334; p=0.006	
Three Groups Multiple comparisons				
	Mean Difference	95% Confidence Interval for the difference in means	Welch Statistic, df1,df2, p-value	Anova Adjusted significance+
Public funding (a)versus Subsidized private funding(b)	5.57	0.12 to 11.24	Welch=3.829 df1=2 df2=157.9	p=0.044
Public funding (a) versus Non-Subsidized private funding (c)	6.60	-.34 to 13.54		p= 0.067
Subsidized private funding (b) versus Non-subsidized private funding (c)	1.03	-5.79 to 7.84		p= 0.932
	+ Games-Howell multiple comparison test for unequal variances was implemented pairwise comparisons amongst the three funding systems (a),(b),and (c).			

In Table 18 the results of the pairwise comparisons of the three funding systems are shown with adjusted significance levels for multiple testing, and confirmed that the mean PPN for only the public system was significantly higher on average by 5.57 points (95% CI: 0.12 to 11.02) than the mean for the subsidized private system.─Overall patients in the publicly funded healthcare system had higher levels of perceived need than those in the privately funded system and show greater levels of dissatisfaction with the appearance of their teeth.

5.2.2. Impact of Socio-Economic Status (SES) measured using Household Income (Euro) on Patient Perceived Need.

For this analysis total household income was used as an indicator of socio-economic status (SES). Household income was measured in categories of €10,000 beginning at zero and increasing in steps of €10,000. The mid-point income value for each household was computed. The max mid-point value of household income was either €110,500 in the Republic of Ireland and €163,540 in Northern Ireland after conversion from $. A total of 289 subjects had measurements for VAS and household income.

Pearson's correlation was computed to assess the strength of the linear relationship between the two variables, household income and VAS (mm). In the overall sample the total income of the household and PPN had a weak negative correlation which was not statistically significant Table 19 We further investigated the relationship between VAS (mm) and household income (€) for the sample, when sub-divided into those from public and private funding systems. For both, VAS was not significantly correlated with household income.

Table 27. The relationship between the level of PPN (mm) and Household Income (Euro) in the Public, Private, Subsidized private and Non-Subsidized private funding healthcare systems.

Healthcare Funding System	Equation of the line	Pearson's correlation coefficient r(n); p(value)
Overall sample	PPN=57.61-6.65E-5 HI(€)	*r*(289)=-.095; p=.109
Public Funding	PPN=58.96-5.7E-5 HI(€)	*r*(164)=-.077; p=.330
Private Funding	PPN=55.21-6.32E-5 HI(€)	r(125)=-.105; p=.242

A univariate GLM was used to test if the slope of the line VAS versus income differed between the two healthcare systems. The interaction term was non-significant ($F_{1, 285}$ = 0.005, p=.942). Sub-groups of the private funding system (subsidized and non-subsidized private funding) were investigated for changes in VAS with household income using Pearson's correlation coefficient. Within both sub-groups the correlation coefficients were non-significant.

In summary, patient perceived need as measured by VAS in mm was not influenced by household income in the study and thus we can conclude that patient perceived need was unaffected by socio-economic status for out sample.

5.2.3. Impact of Gender on PPN pre-treatment

Pre-treatment patient perceived need were completed by 136 males and 200 females. The distributions of PPN (mm) for males and females are shown in Figure 5 and appear to have a reasonably normal distribution.

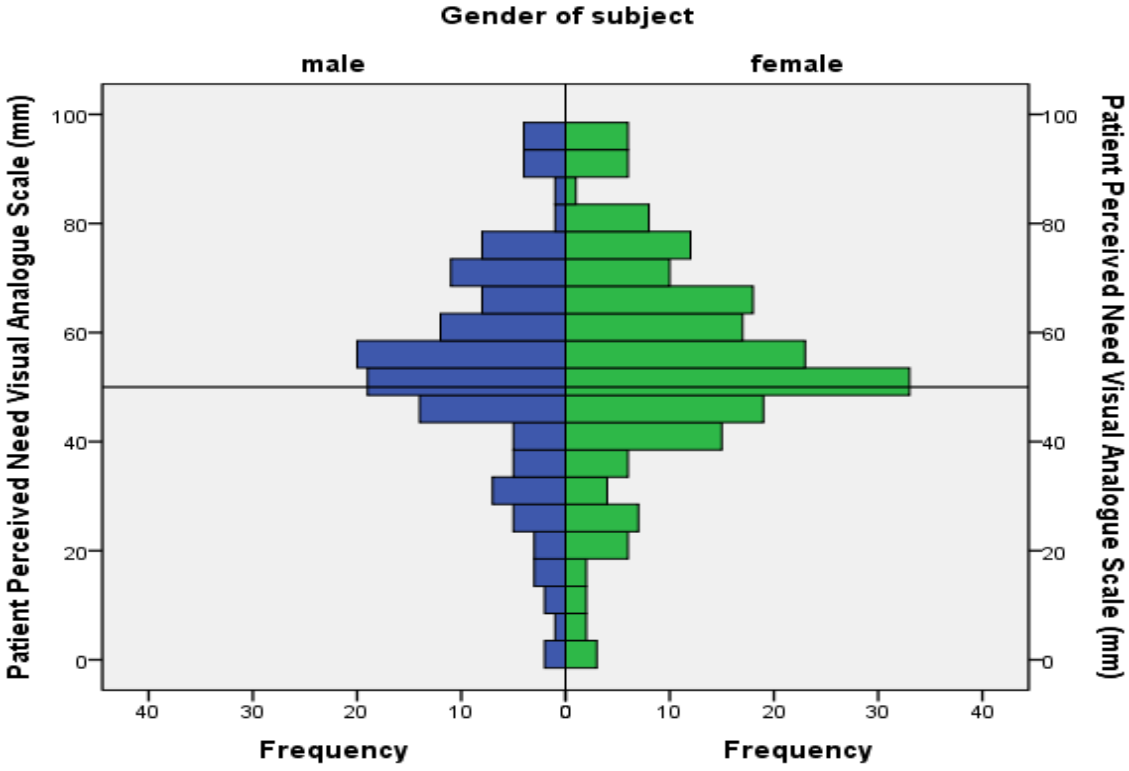


Figure 6. Frequency histograms of levels of PPN (VAS mm) pre-treatment for male and female subjects in an Irish sample from both public and private Healthcare Funding Systems in 2004.

The majority of females 129 out of 200 (64.5%) had levels of dissatisfaction with their appearance at or above the mid PPN value of 50mm. The percentage was slightly lower for males where 84 out of 136 (61.8%) had levels of dissatisfaction at or above the mid PPN of 50mm. A t-test showed no significant difference in mean PPN levels between males and females. (table 28).

The overall sample was subdivided into two funding systems, public and private. The mean PPN value for males and females within each funding system was compared using a t-test. The mean PPN levels were similar for males and females within both groups (Table 26).

Table 28. Comparison of PPN (VAS mm) Pre-Treatment by Gender For The Overall Sample

Pre-treatment PPN(mm)		**Mean difference**	**95% (CI) Confidence interval**	**t-statistic degrees of freedom p-value**
Males (N=136) Mean (sd)	**Female (N=200) Mean (sd)**			
53.17(20.36)	54.07(19.77)	-0.896	-5.27 to 3.43	t=-0.403 df=334 p=0.687
Levene's test of equality of variances: F=0.063, p=0.802				

Table 29. Comparison of PPN (VAS mm) by Gender in the private and public funding systems

Healthcare Funding System	**Public Funding System**		**Private Funding System**	
	Male n=67	**Female n=106**	**Male n=69**	**Female n=94**
Mean (sd)	56.18 (21.5 9)	56.82 (22.67)	50.23 (18.82)	50.95 (15.45)
Mean difference 95%(CI) t-test	-0.642 (-7.49 to 6.22) t= -0.185 df=171 p=0.854		-0.715 (-6.02 to 4.59) t=-0.266 df=161, p=0.791	
Levene's test of equality of variances:	F=0.056, p=0.814		F=1.219; p=0.271	

A GLM was used to test if the mean PPN difference between males and females was similar in both healthcare systems (HS) by fitting a model with main effects HS and gender plus the interaction term HS by gender. The interaction term non-significant ($F_{1, 332}$=0.000, p=0.986).

Further comparisons for PPN between males and females were conducted within two sub-groups of the private funding system and again no gender differences were found within either of those two subgroups. (Table 28). A GLM was used to test if the mean PPN difference between males and females was similar in the three healthcare systems by fitting a model with main effects HS and gender plus the interaction term HS by gender. The interaction term non-significant ($F_{2, 336}$=0.839, p=0.433).

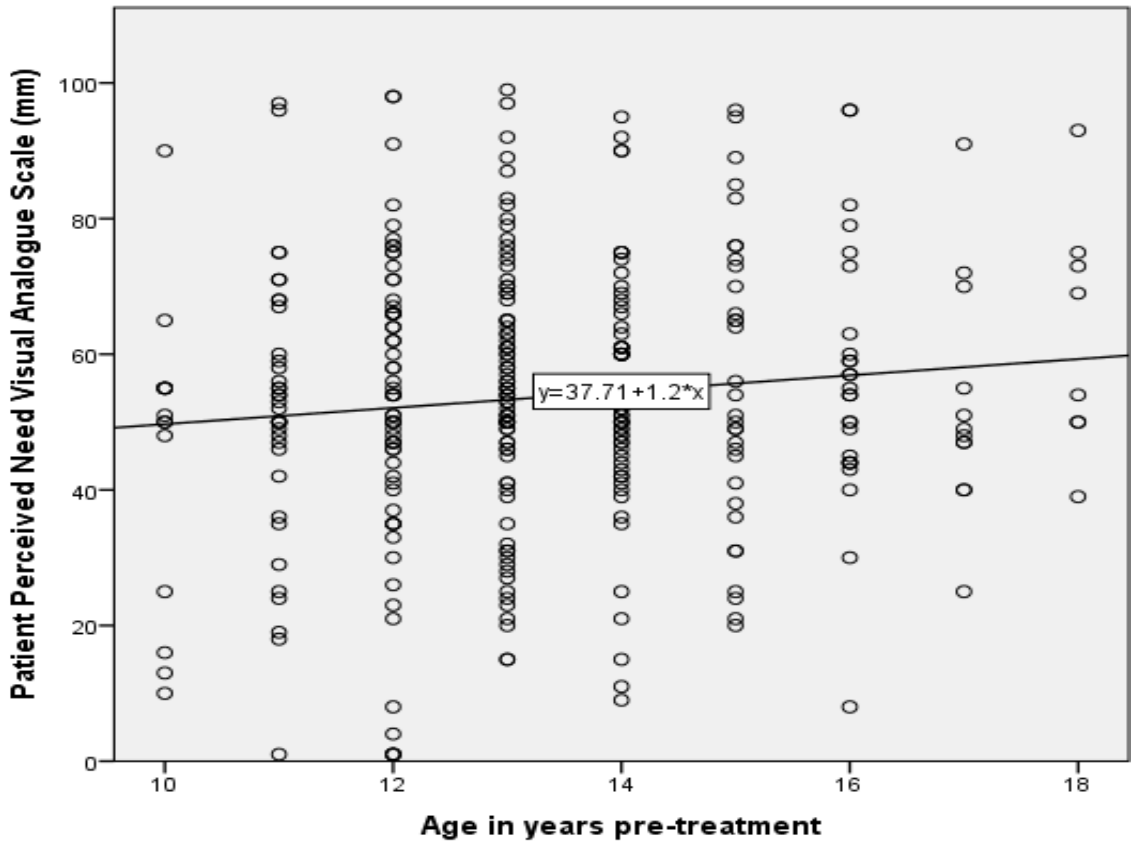
Table 30. Comparison of PPN (mm) levels for male and female subject's pre-treatment in the subsidized and non-subsidized Private Funding Systems

Healthcare funding system (HS)	**Subsidized private funding (SPRFS)**		**Non-subsidized private funding (NSPRFS)**	
	Male n=47	**Female n=58**	**Male n=22**	**Female n=36**
Mean (sd)	52.21 (17.29)	50.35 (15.39)	46.00 (21.57)	52.42 (15.65)
Mean difference (95%CI) t-test	2.178 (-4.15 to 8.51) t=.6830 df=103 p=0.496		-6.42 (-16.22 to 3.39) t=-1.310 df=56 p=0.195	
Levene's test of equality of variances:	F=0.001; p=0.982		F=3.423, p=0.070	

Summary: There was no evidence of a statistically significant relationship between patient perceived need and gender within the healthcare funding systems.

5.2.4. Relationship between Age and Patient Perceived Need

In the overall sample the relationship between patient perceived need (PPN) based on the dissatisfaction with dental appearance and the age of the subject was examined. A total of 336 patients had responses for both variables. A scatterplot summarizes the results with a fit line added (Figure 7).



R^2 Linear = 0.012

Figure 7. A scatterplot to Show the Relationship Between Patient Perceived Need Pre-Treatment and The Age of The Subject In Years

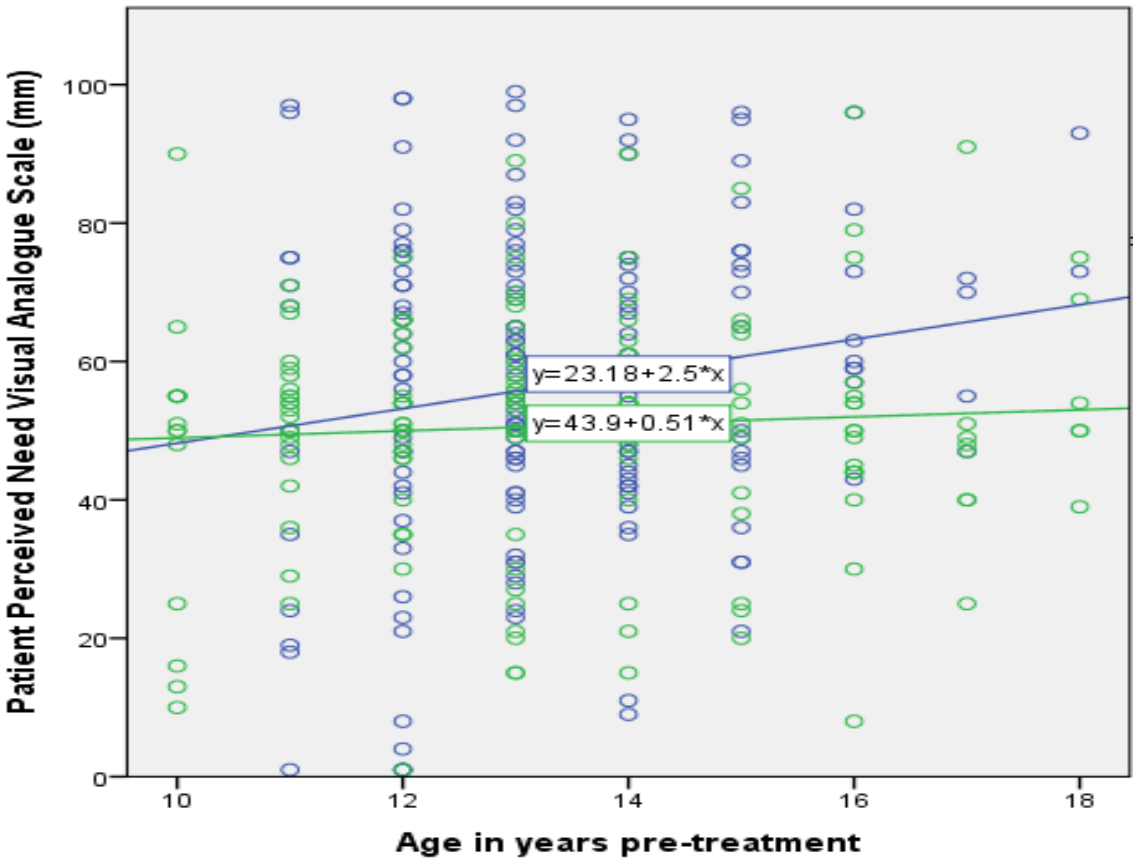
Figure 7 shows that for every one-unit increase in age patient perceived need as measured by VAS in mm increases by 1.2mm.

In Table 31 a Pearson's correlation coefficient was computed to assess the relationship between the level of PPN and age of the patient, for the overall sample. The sample was also divided into two funding payment systems, public and private funding, and the relationship between the variables PPN and age within each funding system explored.

Table 31. The Relationship between the PPN (mm) and Age of the subject in Public, Combined Private, Subsidized Private and Non-Subsidized Private Funding Healthcare Systems.

Healthcare Funding System	Equation of the line	Correlation coefficient Pearson's correlation coefficient, p-value
Overall sample	PPN=37.71+1.2 age	*r*(336)=0.109; p=0.045
Public funding	PPN=23.18+2.51 age	*r*(173)=0.168; p=0.028
Private funding	PPN= 43.9+0.51 age	r(163)=0.064; p=0.419
Sub-groups of the private funding system		
Subsidized private funding	PPN= 57.2 -0.45 age	*r*(105)= -0.061; p=0.539
Non-subsidized private funding	PPN=11.58+3.07 age	*r*(58)=0.298; p=0.023

Table 31 shows a significant positive correlation for the overall sample. However, there was a statistically significant but weak positive correlation between PPN and age within the public funding system. Within the private system no significant relationship between these two variables was evident. Fit lines were superimposed on the scatterplot to show how the relationship varied amongst the two funding systems (Figure 8).



Public Funding: R^2 Linear = 0.028

Private funding: R^2 Linear = 0.004

Figure 8. A scatterplot to show the relationship between PPN (mm) and Age of the subject pre-treatment within Public and Private Healthcare Funding systems in 2004.

The scatterplot in Fig8 illustrates that the fit lines are divergent with opposite patterns. The fit lines demonstrate a positive relationship between PPN and age within the public funding system and no relationship within the private funding system.

A univariate general linear model (GLM) with healthcare system (HS) and age was used to test if the slope of the line PPN versus age differed between the healthcare systems by fitting a model with main effects HS and age and an interaction term between HS and age. The interaction term was non-significant (p=0.110) indicating that the slopes did not differ between the two healthcare systems.

The relationship between PPN with age was examined within two sub-groups of the privately funded group (subsidized and non-subsidized private funding groups). A significant positive correlation was found between the two variables within the non-subsidized funded group (r=0.289, p=0.023). The relationship between PPN and age was non-significant for the subsidized private funding group (Table 29).

A regression model was fitted to the data to test if the three slopes differed with PPN as dependent variable, age as an independent variable, healthcare funding system as a factor with 3 levels and an interaction term between funding system and age. The interaction term in the model was significant ($F_{2, 330} = 3.407$, p=.034) indicating that the slopes of the lines were statistically different. Further examination of the parameters of the model indicated that the slopes of the regression lines were similar for both the public and non-subsidized private funding systems (p=.751) but that each of these differed significantly from the subsidized private funding system with p=0.028 and p=0.040 respectively.

In summary, the evidence indicated that PPN increases with age in the overall sample, and this is mainly influenced by the public and the non-subsidised private system.

5.2.5. Relationship between Patient Perceived Need (PPN) and Index of Orthodontic Treatment Need Aesthetic Component (IOTN AC).

The IOTN AC was recorded by the orthodontist to represent the patients' objective treatment based on the arrangement of their front teeth. Patient perceived need (PPN) was measured based on the dissatisfaction of the child with their appearance for an overall sample of 335 subjects. Figure 9 is a scatterplot demonstrating the relationship between PPN and IOTN AC for patients below 19 years of age.

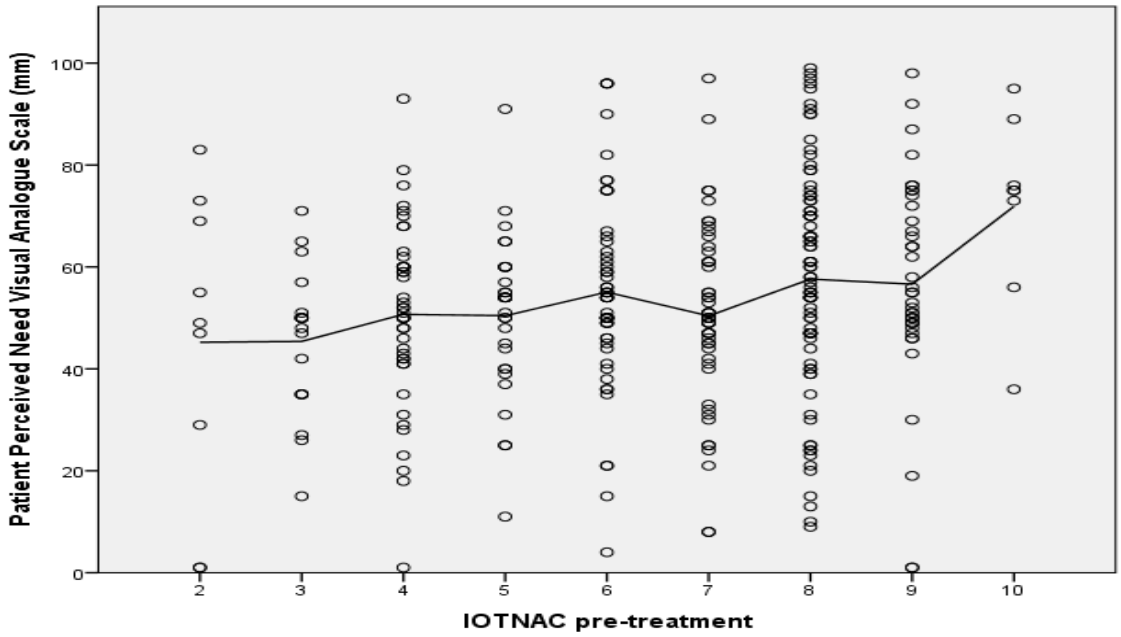


Figure 9. Relationship between PPN (mm) and IOTN AC for the Overall Sample with an Added Interpolation Line.

For the overall sample there was evidence of a positive statistically significant relationship between PPN and IOTN AC (Spearman's rho=0.194, n=335, $p<0.001$). Figure10 shows a scatterplot for the subgroups of the overall sample, public and private healthcare funding systems with PPN.

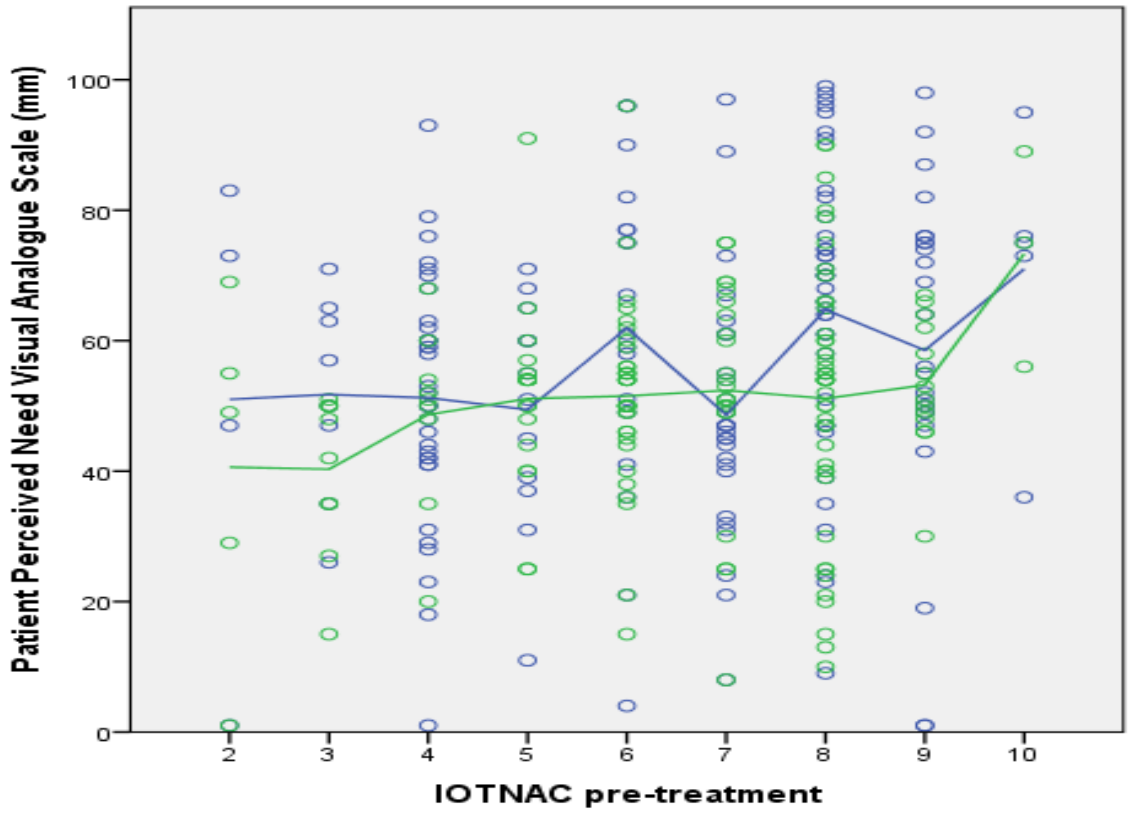


Figure 10. A scatterplot for the relationship of PPN with IOTN AC pre-treatment for the public and private funding systems; with interpolation lines added.

There was a significant positive correlation between PPN and IOTN AC for the sample in the public funding system and also in the private funding system. Spearman's rho (public: rho=0.218, n=173, p=0.004; private: rho=0.181, n=162, p=0.021).

For the public system there is very little change in mean PPN for the categories of IOTN AC (1-5). There is a increase in mean PPN≥60mm, in categories IOTN AC 6, 8, and 10. Category IOTN AC7 exhibits the lowest mean PPN and this is below 50mm. For the private sysyem the mean PPN for all categories is below 60mm except category 10 which has a PPN of 70mm. The lowest mean PPN of 40mm occurs in categories IOTN AC 2 and 3.

A univariate general linear model (GLM) with healthcare system (HS) and IOTN AC was used to test if the slope of the line PPN versus IOTN AC differed between the systems by

fitting a model with main effects HS and IOTN AC and an interaction term between HS and IOTN AC. The interaction term was non-significant (F(1,331)=0.079, p=0.779).

In Figure 11 the private system was divided into sub-groups; subsidized private funding and non-subsidized private funding and the analysis repeated for the three funding systems.

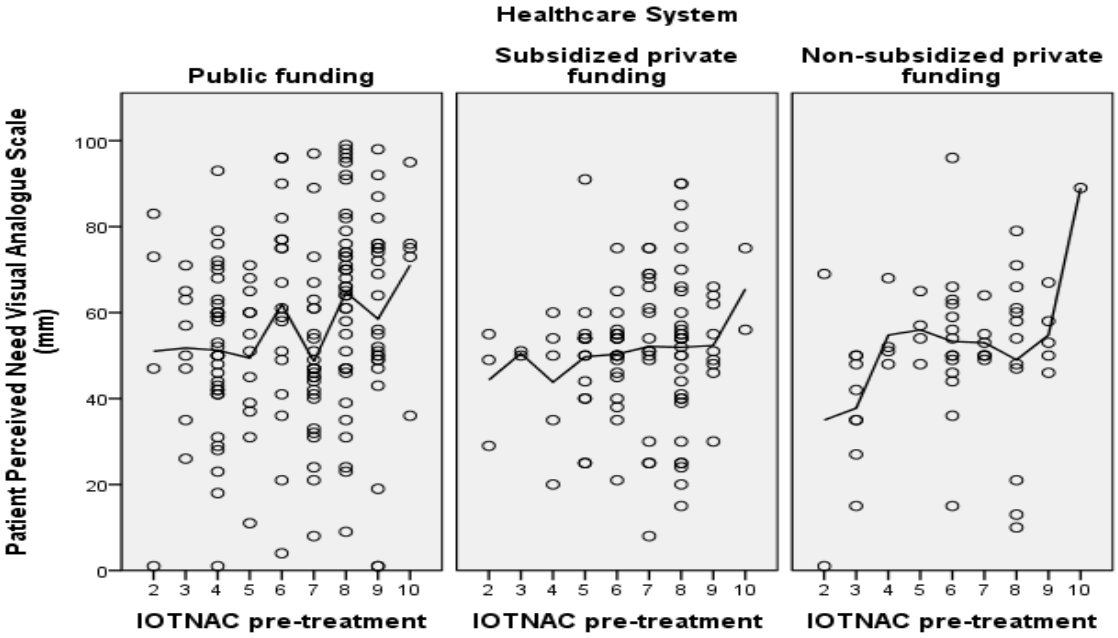


Figure 11. Relationship between PPN and IOTN AC within the Public, Subsidized Private and Non-Subsidized Private Funding Systems; Interpolation Lines Added.

For the subsidized private system there was no significant relationship between PPN and IOTN AC Spearman's rho=0.149, n=105, p=0.130. The Non-subsidised private system showed a weak (non-significant) positive correlation between PPN and IOTN AC, Spearman's rho=0.254, n=57, p=0.056, (Figure 10).

Summary: For both the private and public systems there was evidence of a positive statistical relationship between PPN and IOTN AC. However, the relationship within the subsidised private systems showed little or no change in mean PPN over the range of IOTN AC (Figure 11).

5.2.6. Impact of the Index of Orthodontic Treatment Need Dental Health Component (IOTN DHC) on Patient Perceived Need (PPN)

The IOTN DHC which measures objective professionally determined need where grade 1 and 2 are little or no need, 3 is borderline need, 4 is need and 5 great need, for orthodontic treatment. A total of 335 cases had values for IOTN DHC and PPN. None of the patients in the study were classified as Grade 1, and only 7 as Grade 2. Therefore, for this analysis IOTNDHC grade 2 was combined with IOTNDHC grade 3 because of the very small sample numbers in grade 2. The scatterplot below (Figure 12) shows the relationship between IOTNDHC and their perceived need, with interpolation line added.

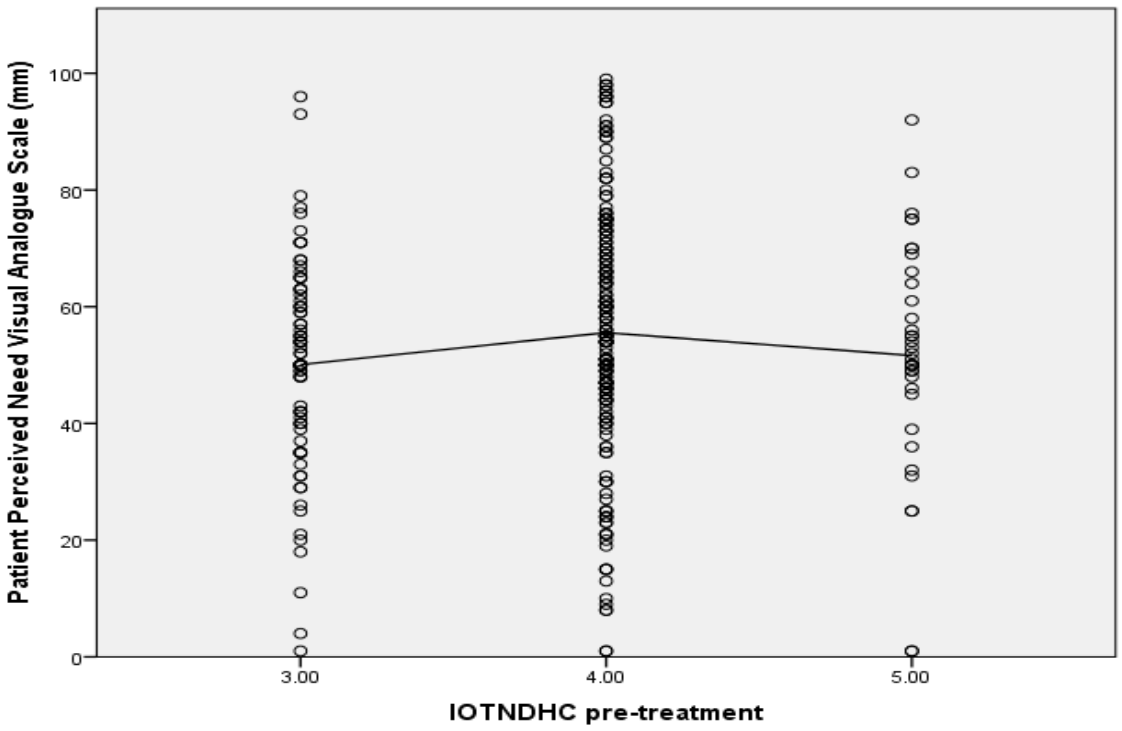


Figure 12. Relationship between PPN And IOTN DHC with Interpolation Line.

The scatterplot shows that mean PPN is higher for subjects in the grade 4 IOTN DHC category than those in grade 3 and 5.

Table 32 shows means values of PPN for the overall system, public and private system, and the sub-groups of the private system.

Table 32. Effect of Patients' IOTN DHC Pre-Treatment on their Perceived Need. PPN for the Sample and Funding Sub-Groups.

Dependent variable Peers	n	Mean	sd	Levene's Test	Anova F(df1,df2)	Significance p value
Overall sample						
Little or Borderline Need	79	50.08	17.97	F(2,332) =1.147 p=.319	F(2,332) =2.426 p=.472	p=0.086
Need	218	55.55	20.54			
Great Need	38	51.63	19.24			
Public funding system group						
Little or Borderline Need	47	50.66	21.28	F(2,170) =0.442 p=0.644	F(2,170) =2.382	p=0.095
Need	114	58.99	21.84			
Great Need	12	56.75	26.11			
Private funding system group						
Little Borderline Need	32	49.19	11.79	F(2,159) =2.533 p=0.083	F(2,159) =0.428	p=0.653
Need	104	51.77	18.38			
Great Need	26	49.27	15.15			
Private funding system sub-group: Subsidised private funding						
Little or Borderline Need	18	46.5	12.59	Check df1,df2 F(2,102) =1.139 p=0.324	F(2,102) =0.912	p=0.405
Need	70	52.27	17.65			
Great Need	17	50.59	12.96			
Private funding sub-group: Non-Subsidised private funding						
Little or Borderline Need	14	52.64	10.06	F(2,54) =1.389 p=0.258	F(2,54) =0.293	p=0.747
Need	34	50.74	20.04			
Great Need	9	46.78	19.25			

Table 32 shows that for the overall sample of 335 patients examined, 79 or (24%) were IOTN DHC grade 2/3, and had a mean PPN (VAS in mm) of 50.08. The majority of the sample (65%) were grade 4 and had a mean PPN (VAS in mm) of 55.55. Surprisingly those 38 (11%) patients of grade 5 had a lower PPN (VAS in mm) of 51.63. The numbers in the sample in each IOTNDHC sub-category for some healthcare sub-groups are relatively small and therefore the means are poorly estimated, and caution is required when interpreting the results.

A univariate GLM was used to test if the mean PPN difference between IOTNDHC categories was similar in both healthcare funding systems (public and private), by fitting a model with main effects; healthcare system and IOTNDHC and an interaction between healthcare system and IOTNDHC. The interaction term was non-significant ($F(2,329)=0.063$, $p=0.533$). Similarly for the three healthcare systems the interaction term was non-significant ($F(4,326)=0.549$, $p=0.667$).

Summary: The majority of patients (65%) in our sample were of IOTN DHC grade 4. These patients were also found to have the highest level of patient perceived need. Patients in the public system had a higher PPN that those in the private system. There are no significant differences between all three healthcare systems for patient perceived levels for each category of IOTN DHC.

5.2.7. Impact of Peers on Patient Perceived Need

The patient was asked ‘How do you think your teeth look compared to others?’ and this variable is labeled ‘Peers’. The response options were ‘worse, same or better’. A total of 332 patients (<19years of age) responded to both the the PPN and Peers questionaires. The scatterplot below (Figure 13) shows the relationship between ‘Peers’ and their perceived need (PPN).

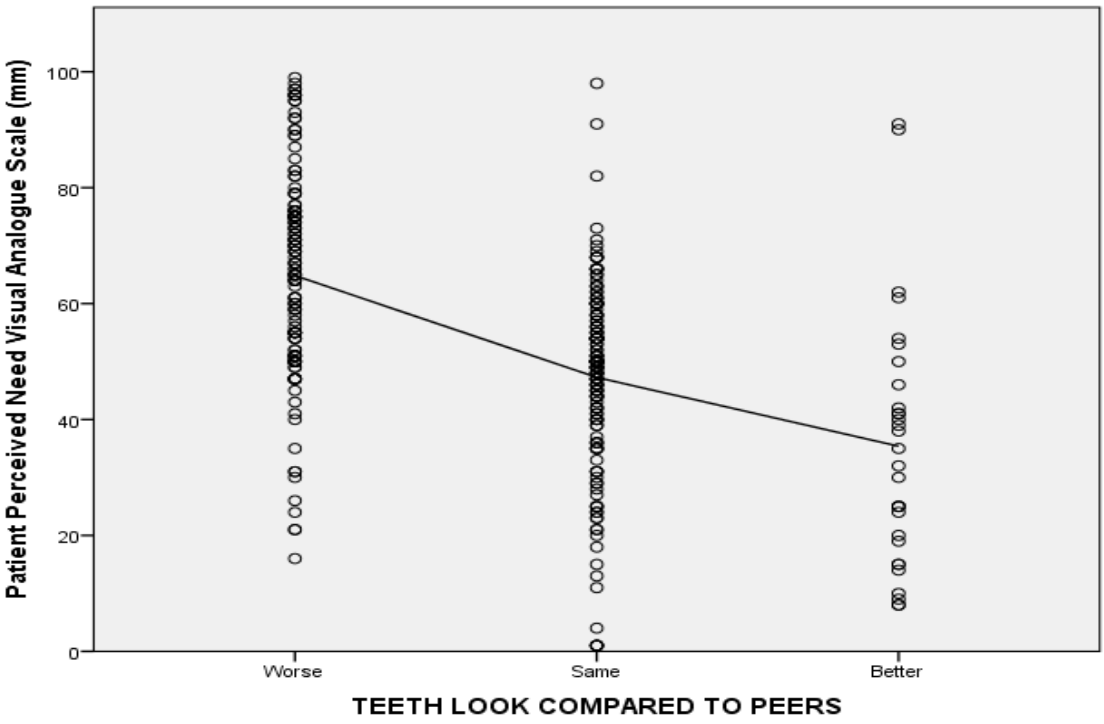


Figure 13. The Relationship between Patient Perceived Need and Peers Based on the Overall Sample, n= 332.

The interpolation line in Figure 13 indicates a decrease in the mean percieved need of the patient in line with their own perception of how their teeth looked relative to their peers.

In Table 33, overleaf, an analysis of variance was conducted to compare the effect of ‘Peers’ on patient perceived need.

Table 33. Effect of Patients' View of their Teeth (Compared with their Peers on their Perceived Need (VAS Score) for the overall sample and sub-groups.

Dependent variable Peers	N	Mean PPN	Standard. Deviation	Pairwise Comparisons	Mean Difference (I-J)	Adj.[1] Sig	95% Confidence Interval
Overall sample							
Worse	132	65.72	17.60	Worse vs Same	18.37	.000	13.55, 23.20
Same	171	47.35	16.20	Worse vs Better	29.58	.000	21.05, 38.12
Better	29	36.14	21.73	Same vs Better	11.21	.004	2.85, 19.57
Levene's Statistic; (F(2, 329) =3.328, p = .037); Welch Statistic; F(2,74.002)=52.912, p<0.001							
Public funding system group							
Worse	83	68.04	18.79	Worse vs Same	20.81	.000	13.42, 28.70
Same	75	47.23	19.83	Worse vs Better	33.95	.000	19.06, 48.83
Better	11	34.09	17.48	Same vs Better	13.14	.106	-1.84, 28.12
Levene's Statistic; (F(2,166) = 0.017, p =.984); F(2, 166) =31.262, p<0.001)							

Dependent variable Peers	N	Mean PPN	Standard. Deviation	Pairwise Comparisons	Mean Difference (I-J)	Adj.[1] Sig	95% Confidence Interval
Private funding system group							
Worse	49	61.80	14.74	Worse vs Same	14.36	.000	7.98, 20.73
Same	96	47.46	12.79	Worse vs Better	24.41	.000	14.40, 34.42
Better	18	37.39	24.37	Same vs Better	10.05	.030	0.72, 19.38
Levene's Statistic; ($F(2,160) = 6.707$, $p = .002$); Welch Statistic; $F(2, 39.909)=19.345$, $p<0.001$							

1:Bonferroni adjusted significance level was applied when equal variances were assumed; Games- Howell adjustment was used when equal variances were not assumed.

Levene's test for lack of homogeneity between the groups was significant ($F(2,329) = 3.328$, $p=0.037$) therefore the Welch's robust test for equality of means was used. This showed that Peers had a significant effect on mean PPN values ($F(2,74.002)=52.912$, $p<0.001$). The mean VAS scores for the three Peers categories (worse, same, better) all differed significantly from each other (Table 33), with those giving a 'worse' response having the largest mean VAS (65.72) followed by 'same' (47.35) and 'better (36.14).

The results from one-way Anova showed evidence of a significant effect of Peers on mean VAS values within each funding system (Public; $F=31.262$, $df1=2$, $df2=166$, $p<0.001$; Private; Welch $F=19.345$, $df1=2$, $df2=39.909$, $p<0.001$). In the Public System the mean VAS values for categories Peers (worse, same, better) showed that comparisons of means for 'worse' versus 'better' and 'worse' versus 'same' were significantly different, but the comparison 'same' versus 'better' was not ($p=0.106$). However, in the combined private system the mean VAS values for (worse, same, better) were significantly different from each other.

Within these two funding systems the effect of Peers on VAS scores was significant (Subsidised private; Welch $F=15.457$, $df1=2$, $df2=34.948$, $p<0.001$; non-subsidised private; $F=11.106$, $df1=2$, $df2=55$, $p<0.001$). Within the subsidized private funding system patients who considered their teeth looked 'worse' than their peers did demonstrate a significant mean PPN difference 13.88, $p<0.001$) from those who considered their teeth look the 'same' as their peers. A degree of caution needs to be exerted when interpreting results for the non-subsidized private group as the numbers in the 'better' category (just 2 patients) was too small to provide statistics. Nonetheless a similar trend is visible for all sub groupings.

A univariate GLM model was fitted to the data with dependent variable PPN and independent variables healthcare system (Public, Private), Peers (worse, same, better) and their interaction. The interaction effect was non-significant ($F_{2,326}=1.596$, $p=0.204$) indicating that the pattern was similar for the two groups.

Summary: The variable Peers had a large effect on a patient perceived need. For both healthcare funding systems the patients had higher mean levels of perceived if they felt their teeth look worse compared to their peers.

5.2.8. Impact of Teasing on Patient Perceived Need

In this section, we investigate the relationship between patient perceived need as measured in terms of their VAS (mm) scores and the impact of being teased at pre-treatment. Patients (n = 335) were asked if they had ever been teased about the appearance of their teeth. Just 31 of those surveyed had been teased.

The distributions of VAS (mm) for both groups, teased and not teased, are shown in Figure 14.

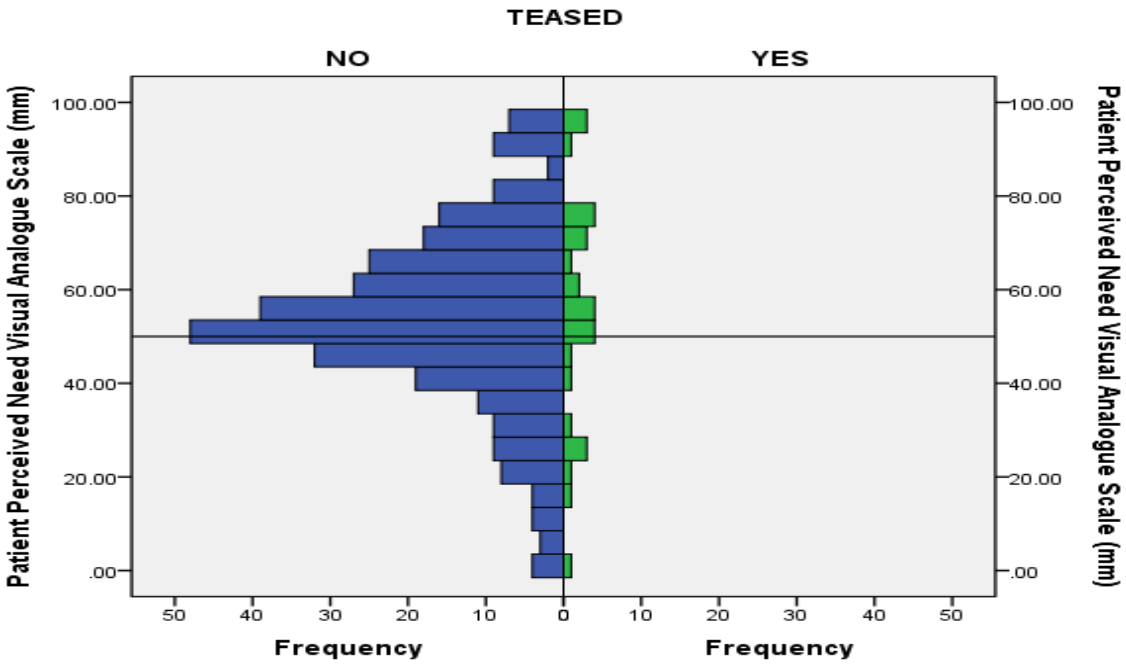


Figure 14. The Frequency Plot of Levels of VAS (mm) Pre-Treatment for Subjects Teased (No/Yes). The Frequency Applies to The Overall Sample.

The 'not-teased' groups had a reasonably normal distribution, and the normality assumption was not rejected by a Shapiro-Wilk test (p=0.541), the histogram of this group shows that the normality assumption is reasonable. The majority of subjects 'not teased' pre-treatment 195 out of 304 (64%) had levels of dissatisfaction with their appearance at or above the mid VAS value of 50mm. The percentage was slightly higher for patients 'teased' where 23 out of 31 (74%) had levels of dissatisfaction at or above the mid VAS of 50mm. Table 34 presents a comparison of the VAS scores between patients being teased and those not subjected to teasing.

Table 34. Comparison of VAS (mm) for Patients Teased or Not Teased for the Overall Sample

Healthcare Funding System	Overall sample	
	Teased Yes n=31	**Teased No n=304**
Mean (sd)	55.84(24.61)	53.56 (19.48)
Mean difference[1] (95% CI) t, df, p-value	2.28 (-6.98, 11.54) t=0.500, df=33.94, p= 0.620	
Levene's test of equality of variances:	F (1,333)=3.867, p=0.050	

1 Mean difference = mean for 'yes' minus mean for 'no'

A t-test, with equal variances not assumed, did not show a significant difference in mean PPN between the groups (Table 34). Further analysis was not performed due to the small number of patients who were teased within the public (n=15) and private (n=16) healthcare systems.

5.2.9. Multivariate Analysis of Factors Influencing Patient Perceived Need

In the previous sections of bivariate analyses, the relationships between the dependent variable patient perceived need (PPN) pre-treatment and each the independent variables; (age, gender, teased, peers, IOTN AC, IOTN DHC, healthcare funding system and household income euros) were examined. The bivariate analysis indicated that age, funding system, IOTN AC, IOTN DHC, and peers significantly influenced patient perceived need as measure by their VAS (mm) scores. These variables were entered into a General Linear Model (GLM) in SPSS to determine which combination of these independent variables were best predictors of patient perceived need.

The factor variables in the model were healthcare funding system, IOTN DHC and Peers. The IOTN DHC had three categories 3,4,5 due the small sample numbers in category 2, it was combined with category 3. The variable Peers was recoded into 2 categories '*same or better'* or 'worse', with the 'better' and same' being amalgamated into one category. In the bivariate analysis the 'better' category had very small numbers in the public healthcare system. Age was included as a continuous type of variable, as was IOTN AC for this analysis.

The full model was fitted to the data and 330 cases had information recorded for all of these variables. A backward elimination process was applied (see methodology section). The final model was based on 331 cases. In the final model only one factor remained that was statistically significant Peers (p <.001) Table 35. Levene's test indicated the variance of PPN was equal across groups (F=(1, 330)=0.472, p=0.492), and for the model R^2(adjusted)=0.236. The normality plot for the standardized residuals of the final GLM, were assessed and showed normal distribution, confirming the validity of the regression model.

Table 35. Parameter estimates for the final General Linear Regression Model showing the significant explanatory factor of PPN

Parameter	β	SE	t	P value	95% confidence interval
Intercept	45.720	1.240	36.857	p<0.001	43.280, 48.160
Worse Same or Better (ref.[1])	20.000 0.00	1.967	10.166	p<0.001	16.130, 23.870
R^2 adjusted =.236					

1: Reference group

In the final model only one factor remained that was statistically significant Peers (p <.001) Table 33. Levene's test indicated the variance of PPN was equal across groups (F=(1, 330)=0.472, p=0.492), and for the model R^2(adjusted)=0.236. From the model, subjects who think their teeth look the same as others (Peers same), had a mean PPN of 45.720 (Intercept). For subjects who think their teeth look worse than others, their PPN increases by a value of 20 (45.72+20=65.72).

The final model is equivalent to carrying out a two sample t-test comparing the two groups which shows that patients who think their teeth look *worse* than their peers reported on average a 20 (95% CI 16.130 to 23.870) points lower PPN value than those who think their teeth are the *same or better* than their peers (Table 36).

Table 36. Comparison of PPN pre-treatment (mm) by Peers for the overall sample

Pre-treatment PPN(mm)		Mean difference	95% (CI) Confidence interval	t-statistic degrees of freedom p-value
Worse (N=132) Mean (sd)	Same or Better (N=200) Mean (sd)			
65.72(17.60)	45.72(17.50)	19.99	16.13, 23.87	t=10.166 df=330 p<0.001
Levene's test of equality of variances: F=0.472, p=0.492				

Summary: The variable Peers accounted for 23.6% of the variation in PPN for subjects pre-treatment. It was the most significant factor in the perceived need of orthodontic patients aged 18 years and below.

5.3. Factors Influencing Parent Perceived Need Pre-Treatment

5.3.1. Impact of Healthcare Funding Systems on Parent Perceived Need

The distribution of parent perceived need (ParPN) pre-treatment is presented in Figure 1, for the Public Funding System (PUFS; N=165) and the Private Funding System (PRFS; N=144) for children ≤age 18 years. Both distributions had a similar pattern and were negatively skewed with a trend towards higher perceived need values for the parents in both funding systems Figure 15.

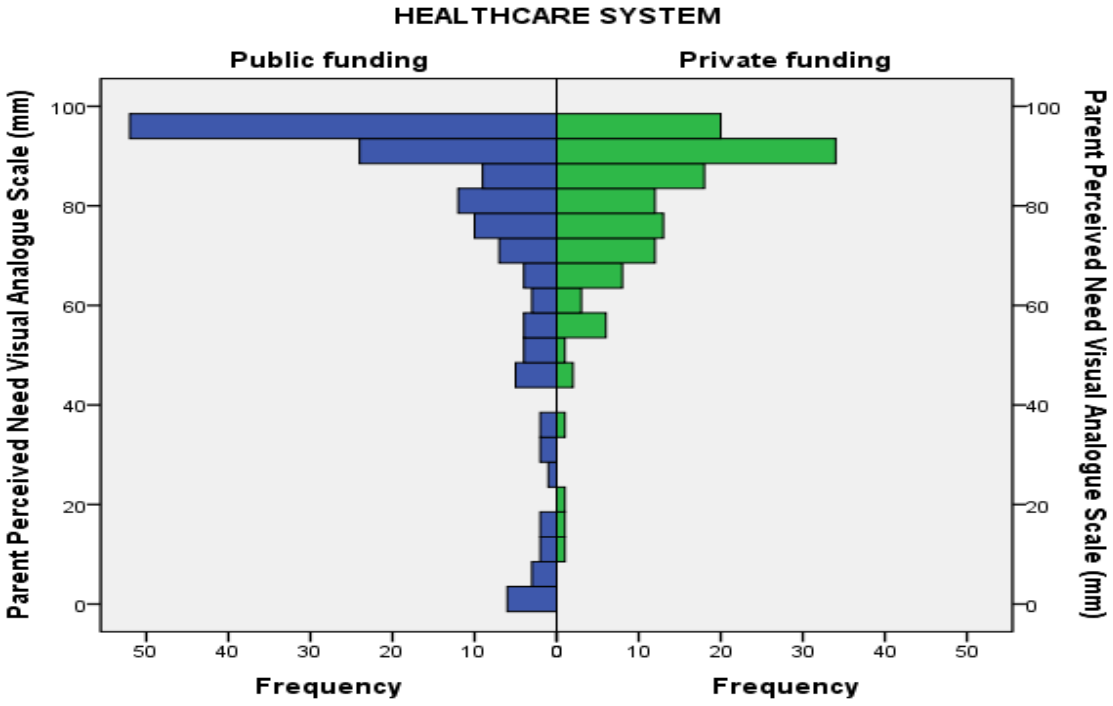


Figure 15. The Frequency distribution of ParPN(mm) for Orthodontic Treatment in Publicly versus Privately Funded Payment Systems.

Note: Parent Perceived Need (mm) was measured on a VAS scale where, 0mm represented straight teeth unimportant to 100mm very important. Patients in PUFS paid zero fees and in 2004 with no qualifying professionally measured dental criteria. Patients in the PRFS, paid full fee in the private practice delivery sector and subsidized fees in the dental hospital delivery system, also with no professionally measured dental criteria.

A Mann-Whitney test indicated that Parent Perceived Need distribution did not differ significantly (*U=11,922, p=.509*) between the PUFS group [median=91mm] and the PRFS group [median=87mm] (Table 37).

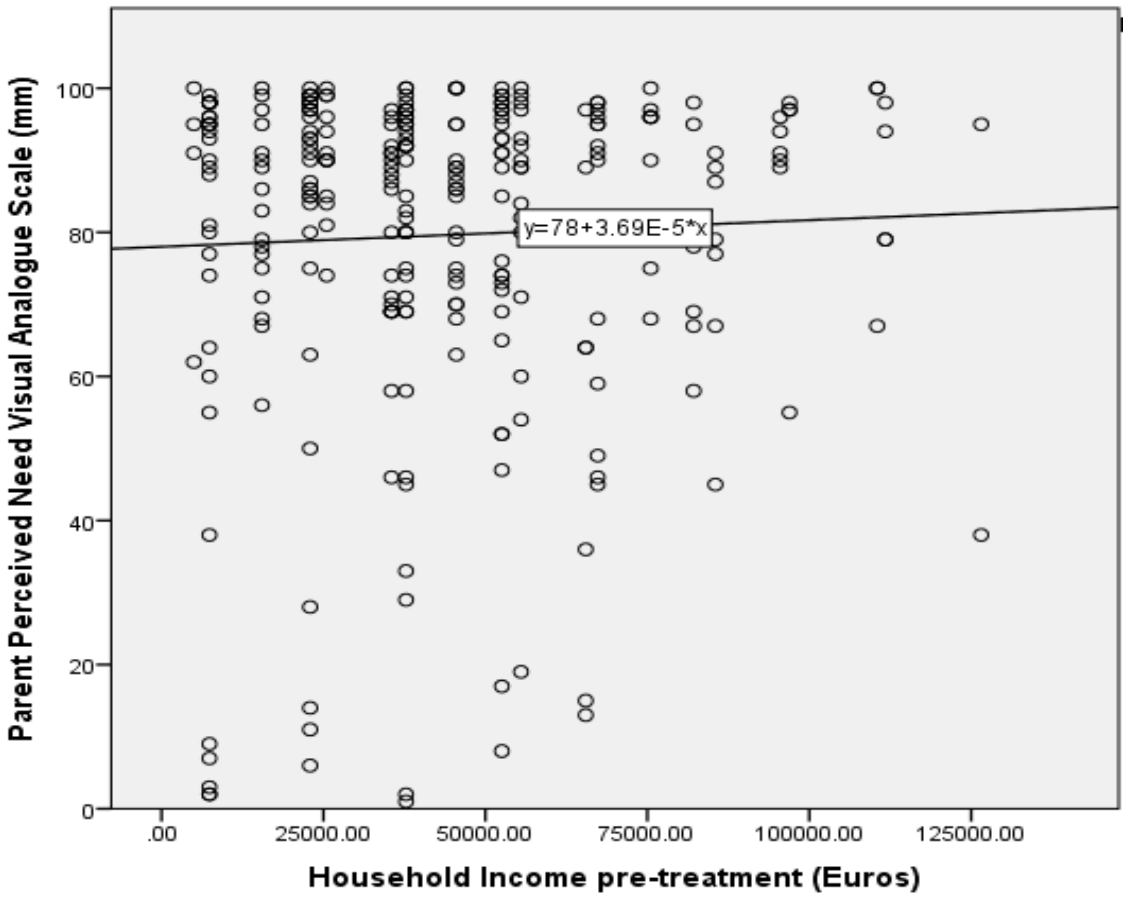
Table 37. Parent Perceived Need (ParPN mm) pre-treatment for overall, public, and private healthcare funding systems.

	Overall sample	Public system	Private system
Valid responses	316(89%)	165(52%)	151(48%)
Median PPN	89mm	91mm	87mm
25th percentile	72.25mm	69mm	74mm
75th percentile	96mm	97mm	94mm
Mann U Whitney test		*U= 11,922.00* *p=0.509*	

Summary: Patients in the publicly funded healthcare system had median values for the level of parent perceived need, that were higher than the median values for parents in the privately funded system but these were not significantly different. The median values for parent perceived need were very high in both the publicly and privately funded healthcare systems.

5.3.2. Impact of Socio-Economic Status (SES) measured using Household Income (Euro) on Parent Perceived Need.

In this Study the Total household income was used as an indicator of socio-economic status (SES) see section 4.3.2 for a description. A total of 281 subjects had measurements for ParPN and Household income. A scatterplot (Fig 16) demonstrates the relationship between the variables.

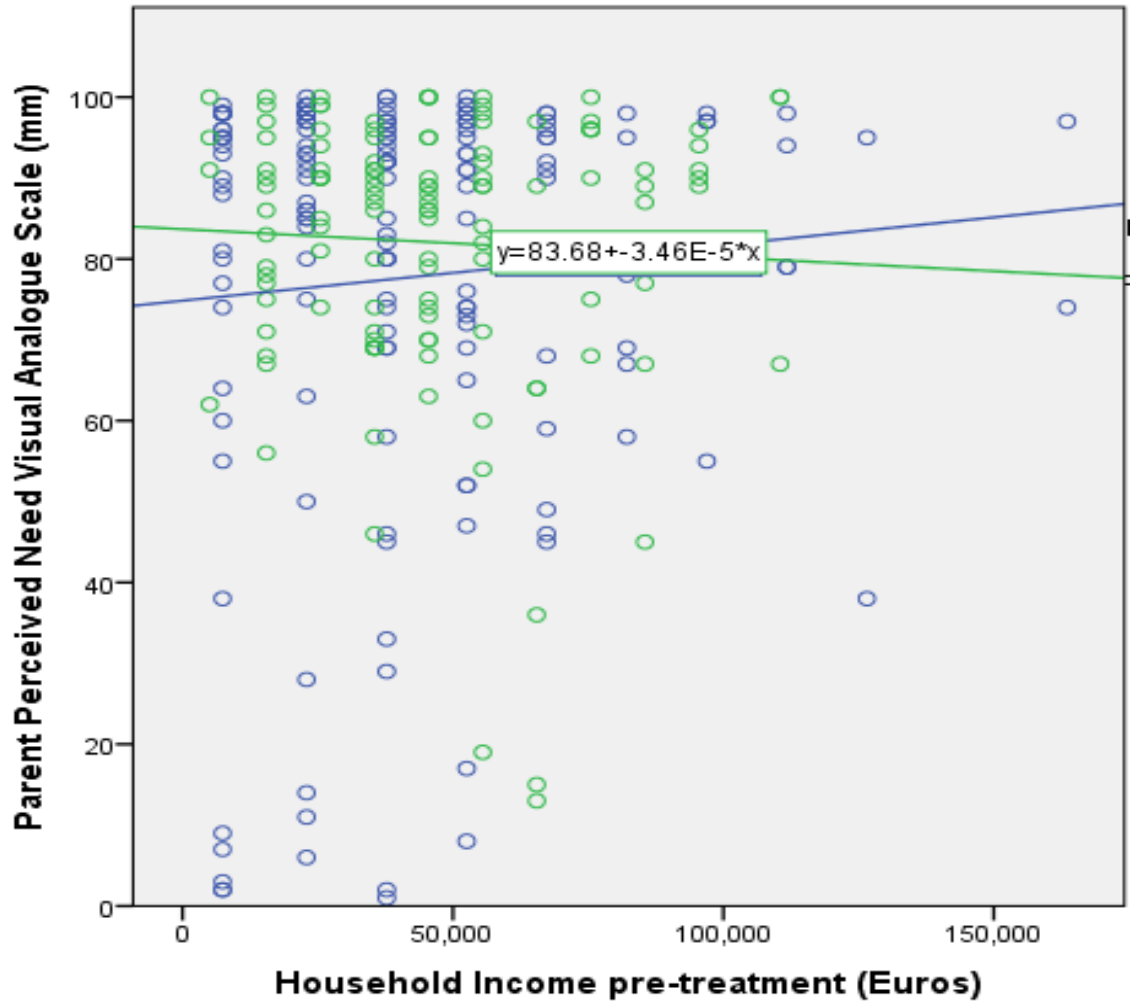


R^2 Linear = 0.002

Figure 16. The relationship between the level of ParPN (mm) and Household Income (Euro) in the overall sample.

For the sample, Household Income and ParPN had a weak positive correlation which was not significant (Table 38).

The relationship between ParPN and Household Income (Euro) for the sample, when sub-divided into those from public and private funding systems, was examined within the two Healthcare funding systems. Fit lines were superimposed on the scatterplots to show how the relationship between ParPN and income, differed amongst the two systems (Figure 17).



HEALTHCARE SYSTEM

Public funding
Private funding
Public funding
Private funding

Public funding: R^2 Linear = 0.006

Private funding: R^2 Linear = 0.003

Figure 17. The relationship of the level of ParPN and Household Income (Euro) within the Private and Public Funding Systems

For both the private and public funding systems, ParPN (mm) was not significantly correlated with household income (Euros) (Table 38).

Table 38. The relationship between the level of ParPN (mm) and Household Income (Euro) in the Public and Private funding healthcare systems.

Healthcare Funding System	Equation of the line	Spearman's correlation coefficient rho; (n); p(value)
Overall sample	ParPN=77.64+4.21E-5 HI(€)	*r*(281)=-.011; p=.849
Public Funding	ParPN=74.84+6.87E-5 HI(€)	*r*(159)=-.014; p=.861
Private Funding	ParPN=83.03-2.61E-5 HI(€)	*r*(122)=-.002; p=.981

A univariate GLM was used to test if the slope of the line ParPN versus Income differed between the two healthcare systems by fitting a model with main effects HS and income and an interaction term between HS and Household Income. The interaction term was non-significant ($F_{1, 277}$) = .862, p= .354).

This analysis was repeated using a Log transformation of the reflected variable (Max Value+1-parent perceived need Value) due to negative skewness of the parent perceived need before transformation and after transformation) which seriously affected the normality assumption of the residuals from the first model. This analysis confirmed the non-significant interaction effect between Healthcare system and household income pre-treatment on ParPN term $F(_{1,277}) =0.051$, p=0.821).

Summary: ParPN was not influenced by household income in the study and therefore may be unaffected by socio-economic status.

5.3.3. Impact of Gender on Parent Perceived Need pre-treatment

Pre-treatment parent perceived need (ParPN) visual analogue scales were completed by 123 males and 193 females. The distributions of ParPN (mm) for males and females are shown in Figure 18 and appear to have a reasonably normal distribution.

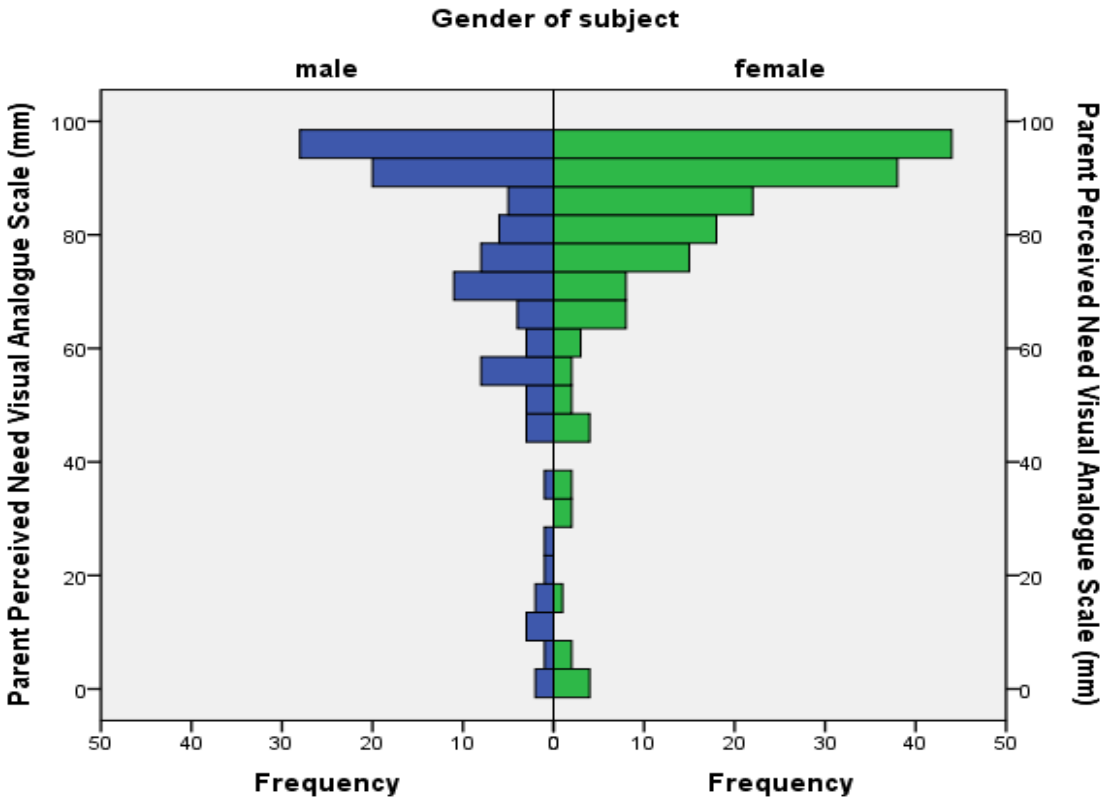


Figure 18. Frequency histograms of levels of ParPN (mm) pre-treatment for male and female subjects in an Irish sample, a combined group of subjects from both public and private Healthcare Funding Systems in 2004.

The majority of parents of females 177 out of 193 (94.7%) had levels of ParPN above the mid PPN value of 50mm. The percentage was slightly lower for parents of males where 107 out of 121 (88.4%) had levels of perceived need at or above the mid PPN of 50mm. A Mann Whitney U test showed no significant difference in ParPN levels between males and females in the overall combined sample (Table 39). This was also shown in the analysis on the separate groups, the public and the private funding systems (Table 40).

Table 39. Comparison of ParPN pre-treatment (mm) by Gender for the overall combined funding systems

Gender	Male n =121	Female n =188
Median ParPN	89mm	89mm
25th percentile ParPN	67mm	75mm
75th percentile ParPN	96mm	96mm
Mann-Whitney U=12,087.50, p=.352		

Table 40. Comparison of ParPN (mm) by Gender of the child in the private and public funding systems

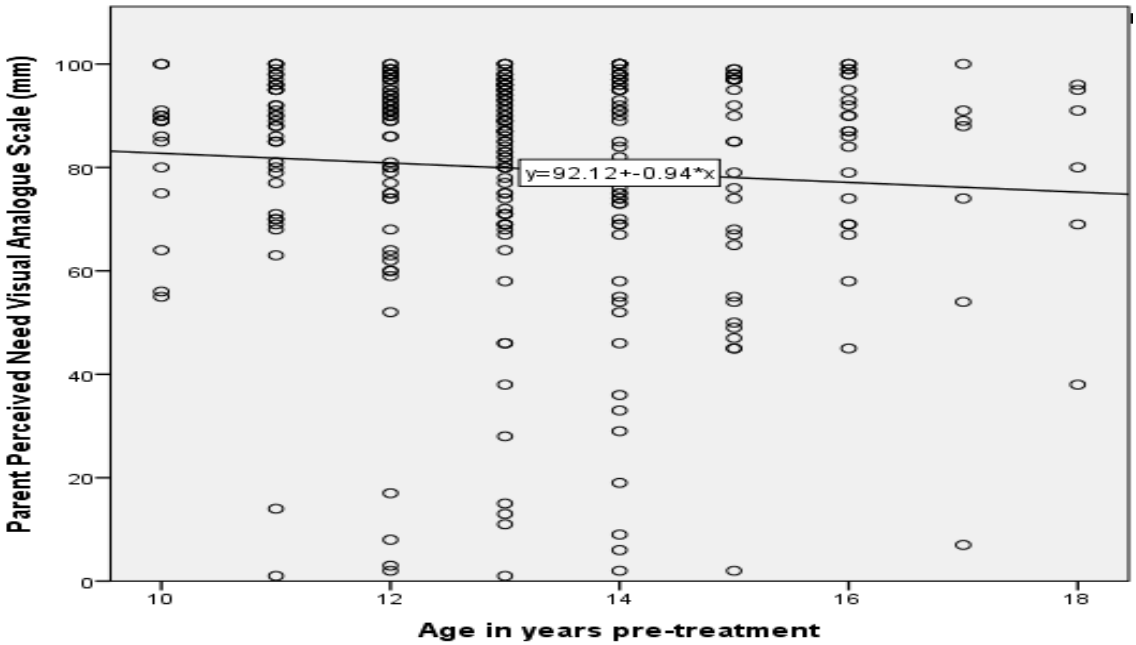
Healthcare funding system	Public funding system		Private funding system	
	Male n=61	Female n=104	Male n=60	Female n=84
Median ParPN	86mm	91.5mm	89mm	87mm
25th percentile ParPN	59mm	77.5mm	70.5mm	75mm
75th percentile ParPN	96mm	91.5mm	95mm	91mm
Mann-Whitney Test	*U =3,657.00 p=0.101*		*U= 2,403.00 p=0.635*	

A GLM was used to test if the mean ParPN difference between males and females was similar in both Healthcare systems by fitting a model with main effects HS and Gender plus the interaction term HS by Gender. Using the transformed ParPN this interaction was significant F(1,305)=4.110, p=0.043.

Summary: There was no evidence of a relationship between patient perceived need and gender within the public and private healthcare funding systems. There was a significant interaction between, healthcare system, gender and transformed ParPN.

5.3.4. The impact of Age of Patient on Parent Perceived Need

In the overall sample the relationship between parent perceived need (ParPN) and the age of the subject was examined. A total of 309 parents had responses for both variables for children aged 18 years and under. A scatterplot summarizes the results with a fit line added (Figure 19).



R^2 Linear = 0.005

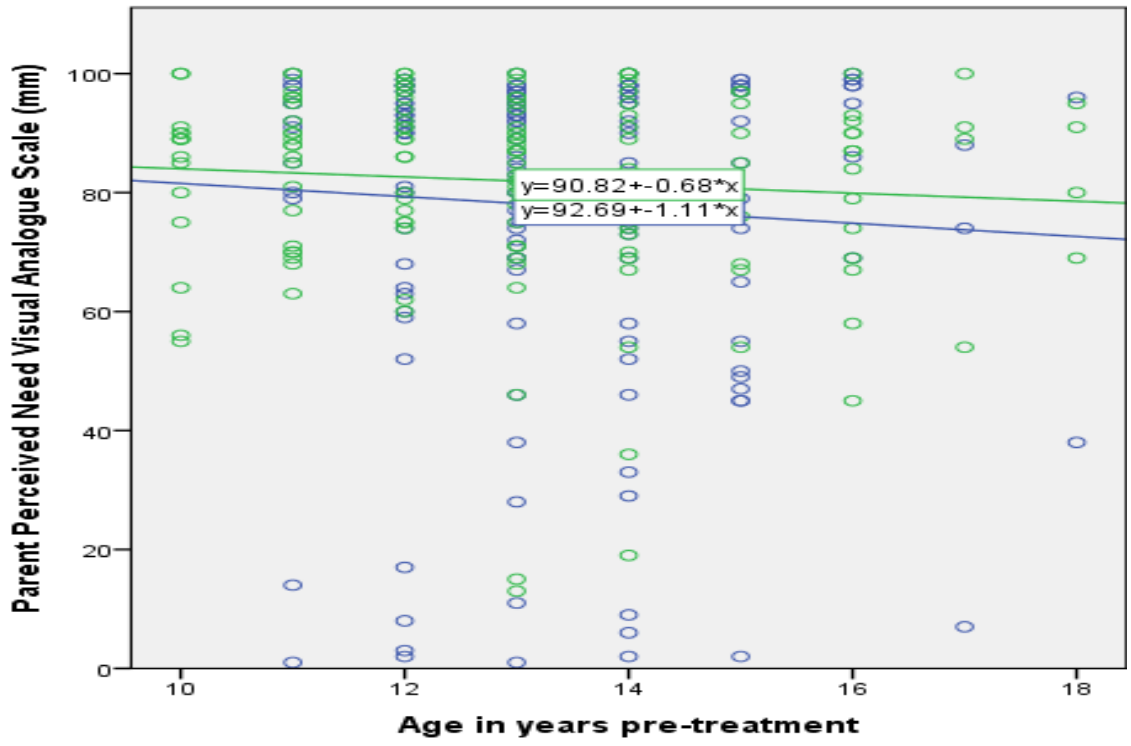
Figure 19. A scatterplot to show the relationship between Parent Perceived Need pre-treatment and the Age of the subject in years.

A Spearman's correlation coefficient was computed to assess the relationship between the level of ParPN and Age of the patient, for the overall sample, (Table 41).

Table 41. The relationship between the ParPN (mm) and Age of the subject in Public and Private Healthcare Systems.

Healthcare Funding System	Equation of the line	Spearman's correlation coefficient rho, p-value
Overall sample	ParPN=392.12-0.94 Age	*rho*(309)=-.068; p=.234
Public funding	ParPN=92.69-1.11 Age	*rho*(165)=-.041; p=.600
Private funding	ParPN= 90.82-0.68 Age	*rho* (144)=-.078; p=.350

The overall sample was divided into two funding, payment systems, public and private funding and the relationship between the variables ParPN and Age within each funding system explored. There was a weak negative correlation between ParPN and Age within the Public and Private Funding systems, and both were not statistically significant (Table 41). Fit lines were superimposed on the scatterplot to show how the relationship varied amongst the two funding systems (Figure 20).



Public funding: R^2 Linear = 0.004

Private funding: R^2 Linear = 0.007

Figure 20. A scatterplot to show the relationship between ParPN (mm) and Age of the subject pre-treatment within Public and Private Healthcare Funding systems in 2004.

The scatterplot illustrates that the fit lines are fairly parallel with the same patterns.

A univariate general linear model (GLM) with healthcare system (HS) and Age was used to test if the slope of the line ParPN versus Age, differed between the Healthcare systems, by fitting a model with main effects HS and Age and an interaction term between HS and Age. Because the distribution of ParPN was highly skewed, a transformation was applied

(LG10 (101-ParPN)) for this analysis. The interaction term was non-significant (F(1,305)=.003, p=.954) thus the slopes did not differ between the two healthcare systems.

Summary: The evidence indicated that ParPN was not related to Age of the patient in the public and the private funding systems and the combined systems.

5.3.5. Relationship between Parent Perceived Need (ParPN) and Index of Orthodontic Treatment Need Aesthetic Component

Both IOTN AC and ParPN were recorded for 308 cases in the overall sample. Figure 21 is a scatterplot which demonstrates the relationship between ParPN and IOTN AC for children 18 years and under.

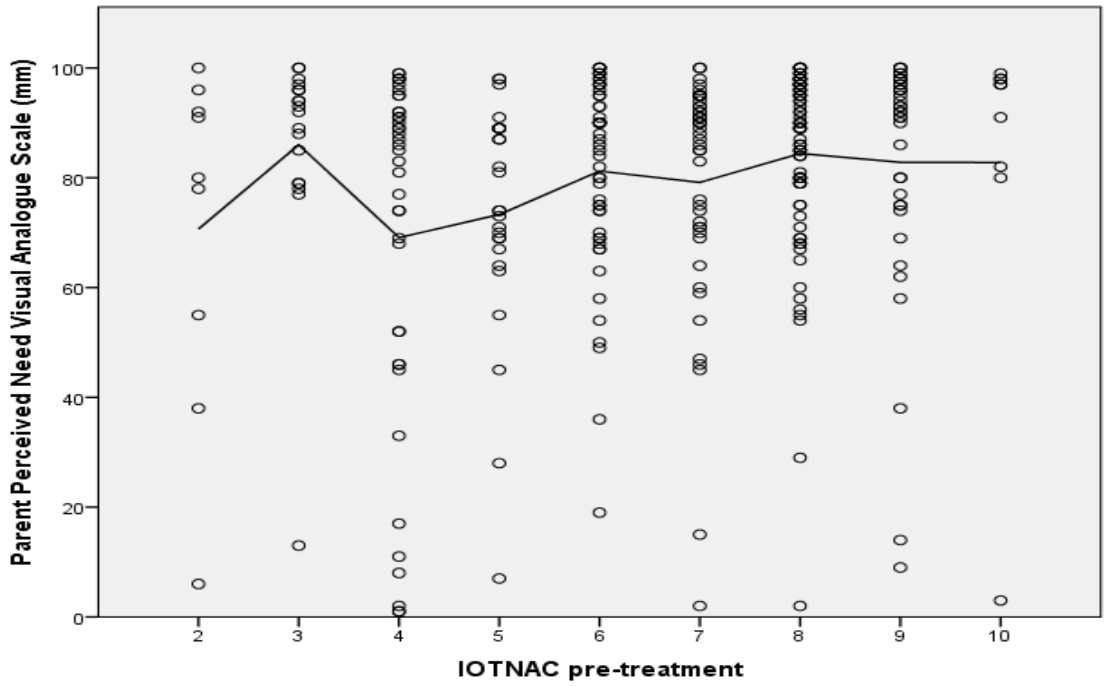


Figure 21. Relationship between PPN (mm) and IOTN AC for the overall sample with an added interpolation line.

For the overall sample there was a weak positive relationship between ParPN and IOTN AC (Spearman's rho=.162, n=309, p=0.004). Figure 22 shows the corresponding scatterplot for the public and private healthcare funding systems.

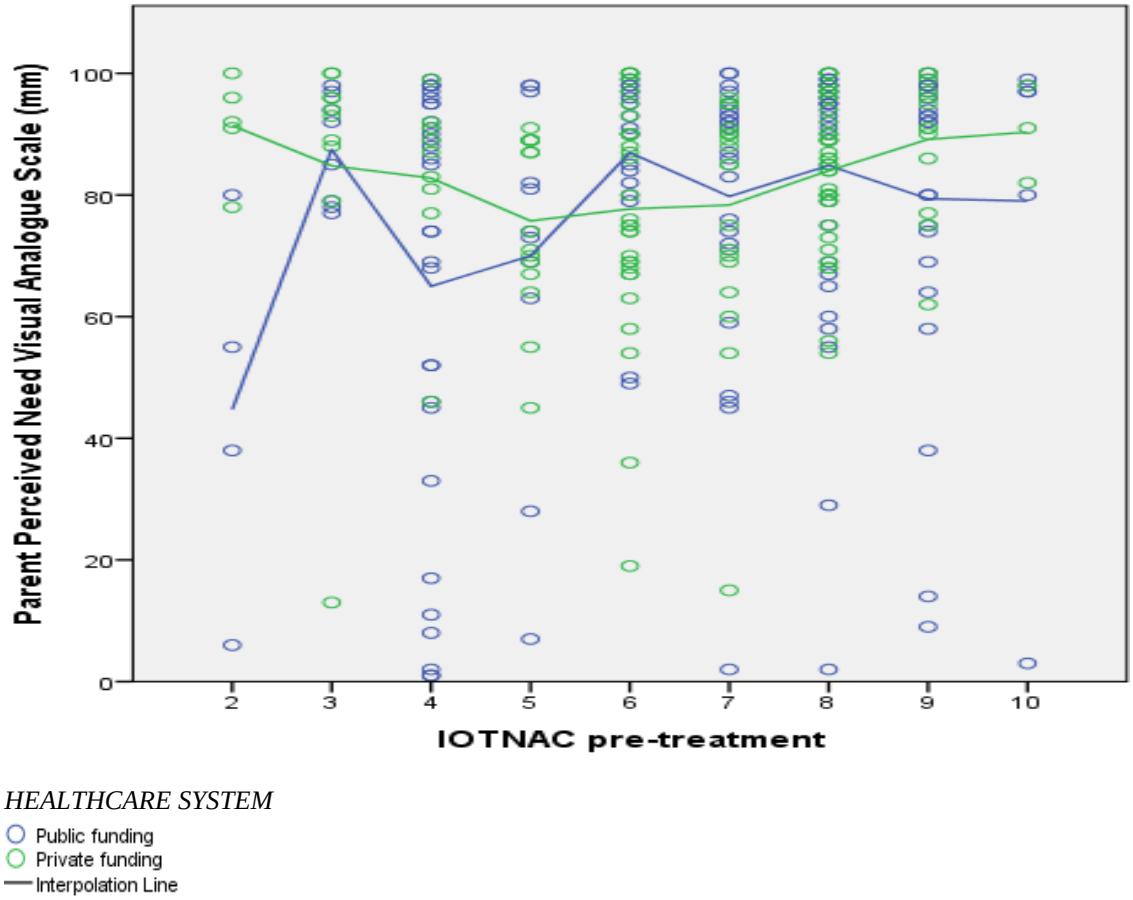


Figure 22. A scatterplot for the relationship of ParPN with IOTN AC pre-treatment for the public and private funding systems; with interpolation lines added.

There was a significant positive correlation between ParPN and IOTN AC for the public funding system and a non-significant correlation in the private funding system. Spearman's rho (Public: rho=0.226, n=165, p=0.004; Private: rho=0.068, n=143, p=0.419). If IOTN AC is re-categorized into three groups (AC 2-4, AC 5-7, and AC 8-10). In the Public system there was a statistically significant difference for levels of ParPN, between the IOTN AC groups H(2) = 9.822, p<0.001 and AC7, for IOTN AC 2-4 (n=24), AC 5-7 (n=56) and AC 8-10 n=67). When analysed in more detail there was a significant difference was between AC2-4 and AC8-10 H(2)=-3.131, p=0.002. In the private system there was also a significant difference, H(2) =10.152, p=0.006; IOTN AC 2-4(n=24), 5-7(n=66), 8-10(n=53); particularly AC5-7 with AC 8-10 H(2)=-2.462, p=0.041 and between AC5-7 with AC2-4, H(2)=2.747, p=0.018.

A univariate general linear model (GLM) with healthcare system (HS) and IOTN AC(1-10) was used to test if the slope of the line ParPN versus IOTN AC differed between the

Healthcare systems by fitting a model with main effects HS and IOTN AC(1-10) and an interaction term between HS and IOTN AC(1-10). The interaction term was non-significant ($F_{(1,306)}$=20.926,(1,304)=2.667; p=0.103). For this analysis the transformation of ParPN was used (LG10 (101-ParPN). IOTN AC 3 groupings is used (2-4, 5-7 and 8-10), there is a significant interaction with health system (HS), $F_{(1,304)}$=4.289, p=0.042 for LGRfleParPN.

Summary: In the public system evidence of a significant positive relationship between ParPN and IOTN AC. The Nonparametric Analysis with 3 groupings for AC and Lg10 Reflected Transformation Analysis indicated significant differences across the three grouping of IOTN AC, representing AC2-4 little or no need, AC5-7 moderate need and AC 8-10 definite need for need.

5.3.6. Impact of the Index of Orthodontic Treatment Need Dental Health Component on Parent Perceived Need (ParPN)

The IOTN DHC which measures objective professionally determined need; Grade 1 and 2 are little or no need, Grade 3 is borderline need, Grade 4 is need and Grade 5 great need, for orthodontic treatment. A total of 308 cases had values for IOTN DHC and ParPN. None of the patients in the study were classified as Grade 1, and only 7 as Grade 2. Therefore, for this analysis IOTN DHC grade 2 was combined with IOTN DHC grade 3 because of the very small sample numbers in grade 2. The boxplot (Figure 23) shows the relationship between IOTN DHC and ParPN.

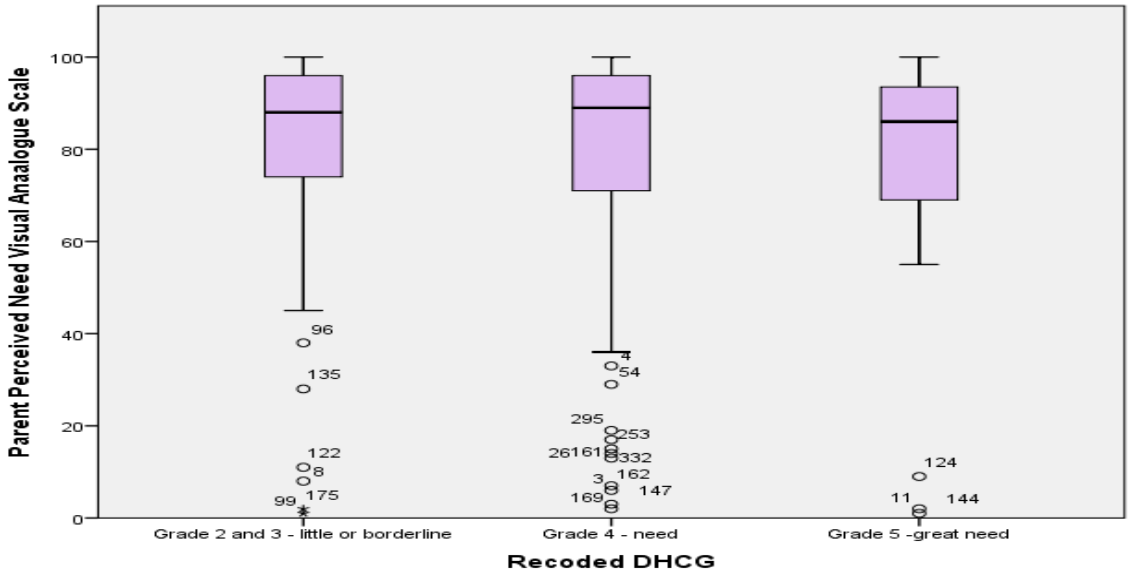


Figure 23. Boxplot of Parent Perceived Need by IOTN DHC grade

A Kruskal-Wallis test was conducted and confirmed that the distribution of ParPN was similar across the three recoded categories of IOTN DHC grade (Table 42). Figure 24 shows the boxplots of ParPN versus IOTN DHC grade for the Public and Private funding systems. A separate Kruskal-Wallis test was applied for the Private and Public system and confirmed that the distribution of ParPN was similar across the three recoded categories of IOTN DHC in both systems (Table 42).

Table 42. Effect of patients IOTN DHC pre-treatment on their parents' perceived need ParPN for the sample and sub-groups.

Dependent variable IOTN DHC	**N**	**Median**	**Q1, Q3**	**Kruskal-Wallis**
Overall sample				
Little or Borderline Need	73	88	74,96	n=308 F(2,306)=1.066 p=0.587
Need	200	89	71,96	
Great Need	35	86	69,93.5	
Public funding system				
Little or Borderline Need	44	85.50	66,97	n=165 F(2,163)=0.932 P=0.052
Need	109	92	74,97	
Great Need	12	77	32,89.5	
Private funding system				
Little Borderline Need	29	89	77,93	n=143 F(2,141)=1.790 p=0.409
Need	91	85	71,91	
Great Need	23	90	77.50,95	

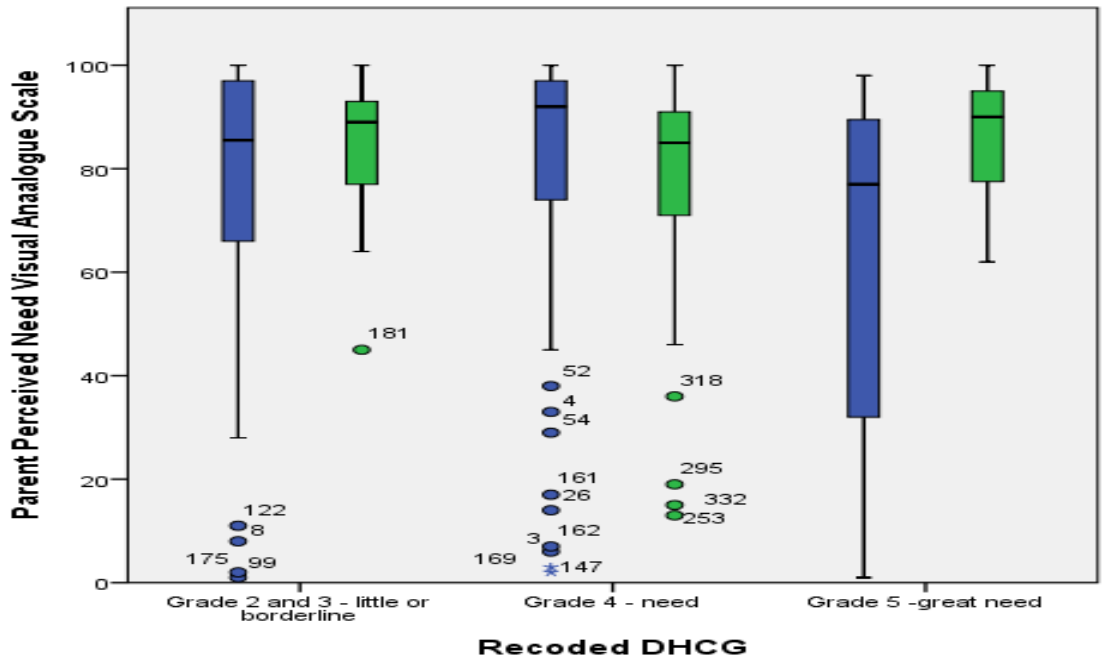


Figure 24. Boxplots of Parent Perceived Need versus IOTN DHC for the Public and Private Funding Systems.

A univariate GLM was used to test if the mean ParPN (had to transform data, due to skewness Log 10 for Reflected ParPN variables (LG10 (101-ParPN)) difference between IOTN DHC categories was similar in both healthcare funding systems (public and private), by fitting a model with main effects; HS and IOTN DHC and an interaction between HS and IOTNDHC. The transformation of ParPN was used (LG10 (101-ParPN)) in this analysis. The interaction term was significant ($F(2,302)=3.048$, $p=0.049$). The distribution of the residuals and the Q-Q plot indicated that the assumption of normality for the residuals was reasonable. The assumption for equal variance was also acceptable as seen in the plot of standardized residuals versus predicted values.

Summary: There is no significant differences in the distribution of ParPN across categories of IOTN DHC overall and within the Public and Private health care systems and between all three healthcare systems for parent perceived levels for each category of IOTN DHC. Although, the GLM shows a significant interaction exists between public and private healthcare systems and IOTN DHC that effects the level of parent perceived need.

5.3.7. Regression Model for ParPN:

In the previous sections of bivariate analyses, the relationships between the dependent variable parent perceived need (ParPN) pre-treatment and each of the independent variables; (age, gender, IOTN AC, IOTN DHC, healthcare funding system and household income euros) were examined. The bivariate analysis indicated that the following variables were associated (at $p<.10$ level) with ParPN either in the overall sample; or within public system or private system sub-samples or in an interaction term with funding system were: healthcare funding system (private or public), gender, IOTN AC, IOTN DHC. These variables were entered into a General Linear Model in SPSS to determine which combination of these independent variables were best at predicting parent perceived need (ParPN).

The main factors variables in the model were healthcare funding system, gender, IOTN DHC (3-categories) and IOTN AC (3-categories). The interaction terms included in the model were funding system by Gender, funding system by IOTN AC (3-categories) and funding system by IOTN DHC (3-categories).

The full model was fitted to the data and 308 cases had information recorded for all of these variables. A backward elimination process was applied (see methodology section X). The final model was based on 308 cases. In the final model the terms that remained were healthcare funding system (HFS), Gender, IOTN AC, HFS*Gender and HFS*IOTN AC. The two interaction terms were statistically significant (see Table 43) and the corresponding model parameters are shown in Table 44. The normality plot for the standardized residuals of the final GLM, were assessed using a histogram and the normal Q-Q plot and showed reasonable adherence to the normality assumption of the residuals. The standardized residual versus the predicted values were plotted and the spread in residuals decreases a little with increasing predicted values but overall, it is similar enough across the range of predicted values.

Table 43. Terms in final regression model for the transformed Parent Perceived Need (mm)

	Sum of squares	df	Mean square	F value	P value
Intercept	304.619	1	304.619	128.450	<0.001
Healthcare Funding System	.359	1	.359	1.508	0.220
Gender	.167	1	.167	.703	0.402
IOTN AC (3 categories)	1.705	2	.852	3.583	0.029
Healthcare Funding System*Gender	1.256	1	1.256	5.279	0.022
Healthcare funding system*IOTN AC	2.591	2	1.296	5.446	0.005
R^2 (adjusted)=.056 n=308					

Table 44. The parameter estimates from the final General Linear Regression Model for the transformed dependent variable ParPN[a]

Parameter	β	SE	t	P value	95% confidence interval
Intercept	1.046	.075	14.019	<.001	0.899 to 1.193
AC 1-4	-.065	.120	-.541	.589	-0.301 to 0.171
AC 5-7	0.198	.090	2.203	.028	0.040 to 0.028
AC 8-10	0[b]				
Gender					
Male=1	-.084	.083	-1.010	.313	-0.247 to 0.079
Female=2	0[b]				
Healthcare System					
Public=1	-.170	0.100	-1.691	.092	-0.367 to 0.028
Private=2	0[b]				
Male* HS Public	.264	.115	2.298	.022	0.038 to 0.490
Male*HS Public	0[b]				
Female*HS Public	0[b]				
Female*HS Private	0[b]				
AC 1-4*HS Public	.415	-.154	2.697	.007	0.112 to 0.719
AC 1-4*HS Private	0[b]				
AC 5-7*HS Public	-.078	.126	-.622	.534	-0.327 to 0.170
AC 5-7*HS Private	0[b]				
AC 8-10*HS Public	0[b]				
AC8-10*HS Private	0[b]				
R^2 adjusted =0.056					

a: is transformed Par PN (Log10 (Max ParPN+1-ParPN)

b: This parameter is set to zero because it is redundant

The R^2 adjusted was very low explaining only 5.6% of the variation in the transformed Parent perceived need.

For ease of interpretation of the model Table 45 and Table 46 show the estimated marginal mean values from the model for ParPN-which were converted back to the original scale, for the significant interactions of IOTN AC and Gender with healthcare system from Table 43.

Table 45. The estimated marginal means for the interaction for IOTN AC * healthcare system converted from Par PN (Log10 (Max ParPN+1-ParPN) to original scale

	Parent perceived need (mm)			
IOTN AC	FS N	Mean	Upper bound	Lower bound
AC 2-4	Public 42	80.25	86.40	71.50
	Private 24	92.30	95.47	87.31
AC 5-7	Public 56	88.90	91.93	84.59
	Private 66	85.05	88.86	80.05
AC 8-10	Public 67	91.74	93.95	88.83
	Private 53	90.90	93.56	87.28

Table 45 for IOTN AC with healthcare system, shows that ParPN higher in the private system (92.30) compared to the public system (80.25) in subjects where there is little or no need for treatment (IOTN AC 1-4). The ParPN for this category of IOTN AC 1-4 (92.30) is marginally higher than for category IOTN AC 8-10 (90.90) in the private system. The ParPN values in the public system increase as the IOTN AC category increases. 'Surprisingly' the private system parent after starting with a high PN value for AC1 – 4 recorded a drop for AC 5-7 and an increase for AC 8-10.

Table 46. The estimated marginal means for the interaction for Gender * healthcare system converted from Par PN (Log10 (Max ParPN+1-ParPN)

Parent perceived need (mm)					
Gender	HFS	N	Mean	Upper bound	Lower bound
Male	Public	61	84.65	88.76	79.17
	Private	59	90.84	93.49	87.25
Female	Public	104	90.20	92.32	87.57
	Private	84	88.68	91.43	85.13

Table 46 shows that ParPN is higher for males in the private system and slightly higher for females in the public system.

Summary: The predictive model for ParPN was tenuous with only 5.6% of the variation in transformed ParPN variable explained by the model. The pattern of ParPN increased with increasing IOTN AC as expected in the private system but not so in the public system. In the public system parents expressed more need for females than males. In contrast, the parents in the private system reported similar need for both genders.

5.4. Discussion Patient and Parent Perceived Need

This investigation was based on the fact that normative need, patient-perceived need, parent-perceived need, and the patient's willingness to have treatment can all affect the demand for, and provision of, publicly and privately funded orthodontic treatment. Understanding the factors involved in the demand for orthodontic treatment in a particular population enables better use of resources as well as a better assessment of treatment needs and priorities (Marques et al., 2009).

Perceived need contributes towards demand and there has been an increased demand for orthodontic treatment, thus increasing the strain on the public and private healthcare systems (de Oliveira et al., 2008). For the present study the aim was to discern what factors contribute to patient and parent perceived need levels in both publicly and privately-funded healthcare systems on the island of Ireland.

The NI sample taken on its own merits was representative of what occurred in NI at the time of the study with 100% of children being treated in the public healthcare system (paid for by the UK, NHS funding body). In the RoI in 2004 the prevalence of twelve-year-old children qualifying for treatment funded by the public healthcare service under the 1985 guidelines was 50% and the uptake of treatment was two-thirds of those who qualified (Appendix 9.4). Leaving one third of the 50% of qualified twelve-year-olds with unmet treatment need. The non-qualifying 50% self-funded their treatment in privately owned clinics and dental hospitals. The combined (NI plus RoI) sample was representative of what was occurring in the RoI in 2004, with 50% of the orthodontic population qualifying for publicly funded treatment and 50% having to self-fund their treatment privately.

A review group was setup in 1998 and 2004 by the RoI government to analyse orthodontic services. The trend being reported at that time was based on dental appearance rather than considerations of health or function, and this formed the basis for demand for orthodontic treatment by patients and their parents in the RoI. This trend is supported by many researchers whose results show that perceived need which contributes to demand for treatment is based largely on appearance caused by tooth irregularities and the effect this has on the child's well-being (Albino et al., 1981; Tulloch et al., 1984; Melsen B (ed): 1991; Burden, 1995).

The RoI review groups concluded that, many permutations of orthodontic deviation are, in fact, compatible with both acceptable function and aesthetics. Therefore, it would be necessary for publicly funded systems to distinguish between demand for treatment and the need for it (normative need). Public expenditure is controlled by controlling the level of normative need that qualifies for treatment, thus reducing the influence of demand. Privately funded orthodontic treatment demand is controlled by the willingness and ability to pay for treatment by the parent.

In 2006 the NHS primary care orthodontic services made up around a tenth of the budget for NHS primary care dentistry in the United Kingdom (Chestnutt et al., 2006). The cost of NHS primary care orthodontic services was reported to have almost doubled in the decade after 1992, which was linked to a general rise in the expectations of people regarding their dental appearance (de Oliveira and Sheiham, 2003). This trend in demand for orthodontic treatment has since continued due to increasing public awareness of the benefits of orthodontic treatment and the increased social acceptance of fixed orthodontic appliances (Jawad et al., 2015).

The result of the present investigation provides a new insight into the relationship between demand and perceived need, within and between, healthcare funding systems on the island of Ireland. In the overall sample 335/343(97.7%) of the children completed the 'child questionnaire';173/177(97.7%) in the public system and 163/166(98.1%) in the private system. Patient perceived need (PPN) was measured using a visual analogue scale (VAS); the higher the score the more dissatisfied the patient was with the appearance of their teeth. The analysis confirms that there was a significant difference in the levels of patient perceived need (PPN), between the funding systems; PPN levels [Public=56.68; Private=50.64, $p<0.001$]. The PPN levels 'based on the dissatisfaction with their appearance' were relatively low and very low compared to their parents' perceived need levels. The PPN levels do not fit in with the evidence that 'dissatisfaction with appearance' increases perceived need for treatment levels, but the VAS methodology has not been used in this age group of patients before to measure perceived need (Flores-mir et al., 2004). Basically, this was mainly a young sample and they seemed to accept the appearance of their teeth as normal. For the age range of the sample, many of the abnormalities in dental appearance could be perceived to be normal tooth development occurring, with tooth alignment going through rapid developmental changes. The levels

could also have been low because the children were about to start treatment, so any dissatisfaction with appearance was going to be transient, not permanent.

Parental perceived need (ParPN) was measured as 'the importance of straight teeth for their child' on a visual analogue scale and high levels indicate that straight teeth for their child was important. Therefore, the ParPN results do build on existing evidence, as early as 1979, it was recognised in parents and their children, that the reason for demand, was cited as patients and parents believing that straightening teeth would enhance the individual's social acceptance, appearance and self-esteem (Shaw et al., 1991).

As stated in a previous paragraph, parents had much higher levels of perceived need than their children; ParPN levels [Median values: Public=91; Private=87; p=0.509] but there was no significant difference in ParPN levels between the two healthcare systems. The high ParPN levels may partly explain the demand on the public services and explain why parents are willing to pay privately for orthodontic services.

5.4.1. Factors that influence perceived need

The results of the study of perceived need indicate that.

1. Patient perceived need was increased by how the patient felt they looked compared to their peers, particularly if they felt their teeth looked worse than others.

2. Parental perceived need was influenced by IOTN AC (pre-treatment aesthetics).

3. Age, gender, clinical treatment need, being teased and household income were not useful factors in predicting perceived need.

4. Patient perceived levels differed significantly between the public and private healthcare systems, but parental perceived levels did not.

The PPN regression analysis showed that 'peers' was the most significant factor influencing perceived need levels for the overall combined sample of patients. Peers represented the variable 'How children felt their teeth looked compared to others'. The variable Peers accounted for 23.6% of the variation in PPN for subjects' pre-treatment. The PPN was significantly higher for children who felt their teeth looked worse than others, independent of which healthcare system they were being treated in. The sample

was comprised mainly of adolescents and in adolescence a parents influence decreases and peer influence possibly increases (Albino et al., 1981; Albino and Tedesco, 1991; Burden, 1995). Also, Tulloch et al. (1984) found that peer influence was an important reason for children seeking treatment. Children seeking orthodontic treatment have been found to have poorer aesthetics than their peers, but whether poor aesthetics alone generates greater treatment demand has not been determined (Mandall et al., 2000).

The present results build on existing evidence from a number of authors, that children have actually developed, an oral perceptual awareness, based on how they think their teeth look compared to their peers (Shaw, 1981; Lindsay and Hodgkins, 1983; Tulloch et al., 1984; Roberts et al., 1989). These studies indicated that as perceptual awareness increases, so does the perceived need for treatment. As far back as Shaw, (1981) perceptual awareness and dissatisfaction with their appearance were proven to increase perceived need for treatment in children.

The present data provides a clearer understanding of the association between oral perceptual awareness and dissatisfaction with appearance, children had a perceptual awareness towards peers but not high levels of dissatisfaction with appearance. Basically the study shows that 23.6% of the dissatisfaction with their appearance originated from how they feel their teeth look compared to others. Mobile phones and social media were not as prevalent in 2004 as they are today but this may have been indicative of the start of the comparison of dental appearance with friends. Especially with the appearance of teeth and wearing of braces being highlighted by the sharing of personal images on social media channels. Burden, (1995) reported that the uptake of orthodontic treatment by friends and acquaintances had a greater influence on the child's decision to embark on orthodontic treatment than either social class or gender.

The attitude of a child's peers towards the appearance of their teeth, has also been reported as being an important factor in the child's oral perceptual awareness (Albino, 2000). Interestingly in this study the majority of children reported that they were not teased about the appearance of their teeth by their peers, approximately 10% of the sample had been teased and it was not an influence on their perceived need levels.

Perhaps lack of bullying and/or teasing was related to the age of the child. The majority of the sample were young, and the results indicate that although young children were less dissatisfied with how their teeth looked, dissatisfaction did increase with age. The range

of perceived need for the patients in the sample showed children aged 10 years had a perceived need level of 48% and at 18 years of age a perceived need level of 60%. A US study reported that as children get older, they are more likely to be critical of their teeth and to want to have orthodontic treatment (Christopherson et al., 2009). Possibly, as age increases, PPN levels are not influenced as much by parents, because of increasing independence from parental influence with age. There was an age barrier to treatment for the NI sample, with the age of qualifying for free orthodontic treatment being 18 years of age or under. It is likely that in NI the closer to age 18 the more concerned the patient would be about not qualifying. This may explain higher perceived need levels at this age and also explain the significantly higher perceived need levels in the public system.

Parent perceived need levels ranged from 84% for children aged 10 years down to 78% for children aged 18 years, with no difference in levels between the healthcare systems. It would appear that parents see a need to treat at an early age, an age when their children often do not perceive a problem. Parents in the private system felt it was more important that males have straight teeth and in the public system females. Some studies have reported higher normative treatment needs for males than females (Keruoso et al., 2000; Holmes, 1992; Burden, 1995).

In the overall sample the total percentage of females was 59.5% [Public=61.3%; Private= 57.7%] and males total was 40.5% [Public=38.7%; Private=42.3%]. PPN levels were high for both males and females and the levels in both healthcare systems were not significantly different. The results do not confirm the theory that females desire treatment to a greater extent than males due to dissatisfaction with their dental appearance, usually the irregularity of their anterior teeth (Albino, 1981; Shaw, 1981; Ng'ang'et al., (1997); Josefsson et al., (2005); Dias and Geiser, (2010). Therefore, while previous research placed emphasis on females being more aware of their appearance, this study's results demonstrate that males are equally concerned about how their teeth look, thus possibly indicating a societal change since the previous studies were completed. The results of this study therefore provide a new insight into the relationship between perceived need measured using dissatisfaction with appearance and gender.

Parents had the same levels of perceived need for both males and females. In the ParPN regression analysis there was a significant interaction between IOTN AC and gender, showing that perceived need levels for both male and female children were motivated by dental appearance of their anterior teeth.

It is important to compare the professional measure of appearance (IOTN AC), PPN and ParPN. Previous studies using IOTN AC have shown that patients judge their appearance more favourably than professionals. In most previous research studies, the methodologies were based on patients self-judging their appearance. The patient identified the photograph that most resembled their own teeth on the IOTN AC scan of 10 photographs. The present study methodology compared professional IOTN AC to the PPN and ParPN measured on visual analogue scales. The parent and child perceived need appears to reflect the professional assessment of the child's anterior tooth alignment as ranked using IOTN AC. In a previous systematic review it was reported that patients who seek orthodontic treatment are undoubtedly concerned with improving their appearance and social acceptance (Zhang et al., 2006) and the present study has added to the evidence by showing a similar finding in an Irish sample. The parent perceived need regression analysis also showed IOTN AC was significantly related to the parental assessment, thus parents appear to agree with the professional assessment of appearance. Parents may have believed that tooth irregularities which do detract from appearance (Lewitt and Virolainen, 1968; Shaw et al., 1991), result in the social well-being of their child being compromised (Baldwin, 1980; Shaw et al., 1980; Helm et al., 1985).

As part of this study, the Index of Orthodontic Treatment Need Dental Health Component was used to determine the normative need of the sample. Hamdan (2004) found that measuring normative need only, may not be useful for predicting demand or for manpower planning. In the present study normative need (DHC) was shown not to influence PPN or ParPN, either in the overall combined system or within the separate public and private systems. Even though the levels of PPN and ParPN were high across all normative need (DHC) categories. Parents had high levels of perceived need even at relatively low normative need (DHC) levels [overall ParPN=88].

In the sample there were more children with lower normative need levels in the public system than in the private system [IOTN DHC3; Public=27%; Private=20%]. The range of need in the NI sample clearly showed there were patients with low-normative need accessing publicly funded treatment. The range of normative need in the RoI sample, showed that there were patients with high-normative need self-funding treatment. This may have been due to a desire or need to access treatment sooner than public system waiting list times allow.

The results of the range of malocclusions treated in the public service sample, builds on existing evidence that the desire for orthodontic treatment was primarily influenced by demand and not always need (Mandall et al., 2001). The mismatch between normative need, PPN and ParPN highlights questions about whether need should be assessed solely normatively or whether the 'patients' and 'parents' perspectives should also be taken into account. There are no societal barriers for patients whose parents have the ability to pay for private treatment. There's also no barrier to treatment in the public system for patients who have the correct normative need or whose parents have the ability to pay privately.

The ability to pay can depend on the household income which contributes to the overall socio-economic status of the family. It is widely accepted that normative need does not vary by SES (socio-economic status) (Chestnutt et al., 2006; Tsakos, 2008). However, the evidence concerning the relationships between SES and other orthodontic variables is conflicting. For example, there is some evidence suggesting that SES is associated with patient-perceived need, utilisation, and treatment outcomes (Tickle et al., 1999;Mandall et al., 2000;Turbill et al., 2003; Chestnutt et al., 2006; Morris and Landes, 2006; Joury et al., 2011) while other studies suggest that there are no associations (Mandall et al., 2005, 2008; Tsakos et al., 2006;Christopherson et al., 2009;). Subjects' social backgrounds have been found to influence perceived treatment need (Proffitt, 1998; Tickle and Bearn, 1999) although other studies have found no associations (Burden, 1995; Kerosuo et al., 2004).

The results indicate that ParPN and PPN were not significantly related to household income (SES) in this study. This was contrary some earlier studies listed above which reported an association between SES and perceived need. However, the later studies listed 2008-2015 reported no association between perceived need and socio-economic status. Two studies by the same researchers Mandall et al. (2000) and (2008) were conflicting and the (2008) study reported no relationship which was a societal change compared to the (2000) study which did report an association. The present, NI-RoI longitudinal study (2003-2008) took place during the same years as the two Mandall et al. studies, supported the evidence of societal change. The relationship with SES in the present study shows that even the lowest income groups had high levels of perceived need.

In previous research children from certain social classes showed little interest in treatment and may not have been exposed to peers with braces. The barriers to orthodontic

treatment for all social classes have been broken down. This may be the influence of media, television, social media apps and exposure to advertising. It is unclear why it is the case but variations in individuals' self-esteem and health beliefs (which affect individuals' attitudes towards orthodontic treatment) may also play a role. For example, the differences in the importance placed on dental aesthetics could explain the differences in patient-defined need.

5.4.2. Critique of methodology for perceived need

A visual analogue scale (VAS) is a measurement instrument that attempts to measure a characteristic that ranges across a continuum of values and cannot easily be directly measured (Crichton, 2001). The VAS is a straight horizontal line of fixed length, usually 100 mm. The ends are defined as the extreme limits of the parameter to be measured orientated from the left (worst) to the right (best) (Streiner et al., 2015). The participant marks a point on the line that they feel represents their perception of their current state; the VAS score is determined by measuring in millimetres from the left-hand end of the line to the point that the patient marks. The VAS is widely used due to its simplicity and adaptability to a broad range of populations and setting.

Flores-Mir et al. (2004) evaluated self-perceived orthodontic treatment need in a university population using three scales: IOTN AC, the Oral Aesthetic Subjective Impact Scale (OASIS) and a visual analogue scale (VAS). They observed that the AC component of the IOTN presented some difficulty for the subjects. Instead of selecting the most appropriate photograph that had the same level of aesthetic appeal as their own, some subjects were trying to look for the photograph that most resembled their own teeth. The VAS score was recorded by asking the subjects: rate your aesthetic perception of your teeth by putting a cross on the line between the two extremes where 0 is the worst aesthetics you could imagine and 100 the most ideal aesthetics you could imagine.

According to the results, the VAS seemed to be the most easily understood patient perceived treatment need scale to be used by the university students. The VAS score was more related to the IOTN AC in the sense that it evaluated the appearance of the anterior teeth, but without the use of photographs as facilitator stimuli. The study concluded that the use of VAS is as valid as the IOTN AC or OASIS in determining self-perceived treatment need.

Based on the evidence this was the method chosen for this study. Being the easiest to understand it was the most appropriate for adolescents aged 10-14 years who formed the majority of the sample. On the visual analogue scale (VAS) —subjects marked their aesthetic perception of the appearance of their own teeth on a 100 mm line. They were asked: 'How dissatisfied are you with the appearance of your teeth?', by putting a cross on the line between the two extremes where 0 is the least dissatisfied and 100 the most dissatisfied?

The children and their parents were separated when answering the perceived need questionnaires. The collection of the perceived need data was face-to-face which facilitated the respondents with the understanding of the questions. Interviews took place in quiet areas and not in the orthodontic clinic. Petersen and Dahlstrom, (1998) found that dentists and orthodontists perceived orthodontic treatment needs differently to adolescents using VAS methodology. The interviewers had no dental background and would not have been familiar with judging dental appearance, therefore would not have biased the children's VAS scores. The interviews taking place outside the clinic also ensured that the orthodontists or dental staff could not influence the child.

This also applied to the parents' interviews. The VAS scale question was different for the parents: they were asked: 'How important is it to you that your children have straight teeth?', by putting a cross on the line between the two extremes where 0 is not important and 100 the very important (Petersen and Dahlstrom, 1998).

A systematic review reported a lack of agreement between the child and parent perception of aesthetic treatment need in children with malocclusion (Livas and Delli, 2013). Using VAS scales this study supports this finding, validating the VAS methodology.

5.4.3. Limitations of the study

A weakness and a strength of the study is that the children had already been accepted for treatment. This may have affected perceived need levels, but it does add to the body of orthodontic literature by being a sample in a country not investigated before and being a sample that was already committed to treatment.

The data collection involved consecutive patients therefore gender balance could not be controlled but nevertheless the sample was consistent with that time when more females than males were interested in wearing braces.

It proved difficult to recruit a sample from the public service in the RoI but nonetheless in this study it was possible to compare a private sample and a more homogenous public sample. The results are much clearer because there were no extra variables incorporated by combining two different public healthcare samples to make up the public healthcare component.

5.4.4. Future studies

Initiatives to decrease the influence on the public service of non-need factors such as SES form a major part of NHS policy (Department of Health, 2010; Ministry of Health, 2014; NHS England, 2009) and recently the HSE RoI body. It will be important to monitor whether or not both the care provided by the NHS and HSE RoI orthodontic service, and the outcomes achieved, vary by socio-economic status. A study that incorporates greater numbers of deprived households would be useful to bring further knowledge to the findings of the present study that household income is not a barrier to parent perceived need.

Since the development of the occlusal indices (Brook and Shaw, 1989; Espeland et al., 1993; Richmond et al., 1993; Daniels and Richmond, 2000) severity of malocclusion has been quantified in an objective manner by professionals (normative need). Future studies could compare subject perceived need levels in a sample of children being treated who were assessed as having high normative need.

The influence of social media on perceived need would also give an insight into the influence of this medium on perceived need and the resultant demand on public health services, particularly as the main influence on perceived need appears to be peer opinion. This potential research could also include questions regarding the influence of technology such as mobile phones and the use of social media including the sharing of images (either privately or publicly), would appear to be important.

In addition to maximising the health of the population using limited resources, public healthcare systems aim to ensure that they fulfil their core principle of providing services according to need, irrespective of factors such as socioeconomic status (SES), as set out in both the recently published constitution (NHS England, 2009) and the original 1944 governmental white paper on the creation of the NHS (Ministry of Health, 2014). The NHS white paper outlined the founding values of the NHS by stipulating that the service

would ensure that ‘every man, woman and child can rely on getting all the advice and treatment and care they may need [and] that their getting these shall not depend on whether they can pay for them or any other factor irrelevant to real need’. While these are good principles, healthcare systems could consider freeing-up space in the system by removing people who can afford to access treatment through other means. Poverty should enable immediate access for the poor and wealth a potential barrier for the rich to free up waiting lists. This raises the controversial question about whether the public orthodontic service should be means tested? Future studies should include what impact means testing would have on provision of the orthodontic service and waiting lists.

5.5. Conclusions

Parents of adolescents may contribute more to the demand for orthodontic treatment than their children because they have higher perceived need levels. High parent perceived need levels were found to exist at low normative need levels (IOTN DHC). Parents tended to agree with the professional assessment of appearance (IOTN AC) and this formed the basis of their perceived need and their demand for orthodontic treatment in both healthcare funding systems. High parental perceived need levels exist for all categories of IOTN AC. Parent perceived need levels were similar for both low and high household incomes and private and public healthcare systems.

Peers were found to have the most influence over patient perceived need for treatment which may explain why they seek treatment. Adolescent males and females had the same levels of perceived need and were equally dissatisfied with their appearance. Societal deprivation did not appear to change perceived need levels.

CHAPTER 6

WILLINGNESS TO PAY RESULTS

6.1. Willingness to Pay for Fixed Appliance Orthodontic Treatment Results

6.1.1. Introduction

Based on expert opinion, and following the literature, a dichotomous single bounded and open-ended contingent valuation (CV) methods of questioning were proposed to elucidate, from the parents, a monetary value for orthodontic treatment both at the pre-treatment and at completion of treatment.

The healthcare system on the island of Ireland for the funding of orthodontic treatment consists of two distinct funding mechanisms, those publicly funded by the healthcare system or funded privately by the patient. The data used in this investigation was elucidated from a database containing information recorded about a sample of participants from waiting lists for orthodontic care sourced both in Northern Ireland (NI) and, the Republic of Ireland (RoI), n = 354. Subjects in the public non-fee-paying funded system (NI), n = 177 and, the private fee-paying funded system (RoI), n = 177, participated in this study. All subjects in NI were aged ≤18 years and the number in the sample for RoI was n=166 for subjects ≤ 18 years of age. The privately funded system consisted of two subgroups; the subsidized fee-paying system (n=108) for subjects recruited from the university dental hospital and the non-subsidized private fee-paying system (n=58) for subjects from privately owned dental clinics.

The results in this section of the thesis only, are analysed for the overall private funding system and its sub-groups (subsidized fee-paying and non-subsidized fee-paying). This is because WTP is an economic evaluation and within the two private fee-paying structures, the parents were paying substantially different fees.

The results of the analysis of WTP are presented descriptively and empirically. The parental WTP analysed was only for parents of subjects aged ≤ 18years. This section is structured as follows.

In section 5.2 the WTP for both funding systems is analysed and in 5.3 a descriptive and empirical analyses of patient/ parent characteristics with WTP are presented as an overall sample and as funding systems. Section 5.4 is pre and post treatment WTP and 5.5 is pre

and post between the funding systems. The final sections 5.6 and 5.7 is the regression analyses of the private fee-paying and public non-fee-paying funding systems.

6.1.2. WTP and funding system

This analysis was based mainly on 272 out of 343 (79.3%) parents who took part in the study and responded to the willingness to pay question. The 272 parents were representative of two funding systems, public non-fee-paying 137(50.4%) and private fee-paying 135(49.6%). The distribution of parental willingness to pay (pre-treatment) is presented in Figure 25 for the patients in public funding system and the overall private funding system.

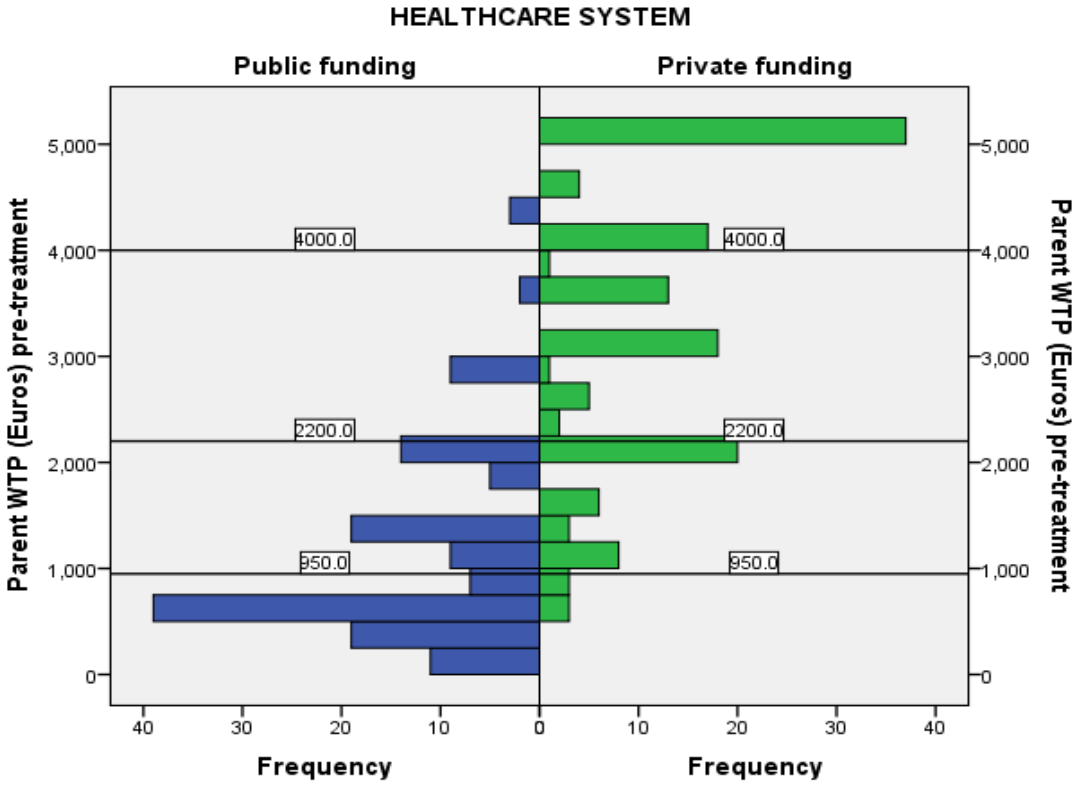


Figure 25. Frequency of WTP (€) for Orthodontic Treatment in the Public versus Private Funding Systems.

Notes: ***Public funding system [PUFS]****: zero monetary cost to the patient (Cost to NHS, market value average = €2,200 or £1,500).* ***Private funding system [PRFS]:*** *Patients pay either a lower fee to the dental school and hospital or a full-market value fee to private practice which is non-subsidised).* ***a: Dental hospital fee:*** *Patients' are treated in the dental school and hospital and pay a reduced fee of €950 which is independent of the severity and the length of the fixed appliance treatment.* ***b: Private Practice:*** *Patients' are treated in orthodontists private practice and pay full market value which is dependent on the severity and length of the fixed appliance treatment with a standard range from €2,500 to €4,500 (market value average = €4,000).*

The distributions are highly skewed in opposite directions, and it shows that parents in the PRFS were willing to pay more than those in the PUFS. Figure 26 highlights that 76

of the 137 (55%) public system respondents were willing to pay between 0 and €1,000, whereas in the private system 57 out of 135 (42%) respondents were willing to pay between €4001 and €6,000. A Mann-Whitney test indicated that WTP was greater for the private group [median= €3,500] than for the public group [median=€740], U= 16367, p<.001, n=272.

Sub-groups of the private funding system; subsidized fee-paying 84 (24.5%) and non-subsidized fee-paying 51(18.7%) were investigated for WTP independently. Figure 26 presents the frequency of WTP for orthodontic treatment across the PUFS, SPRFS and NSPRFS. The frequency distribution of WTP for PUFS is highly skewed and in the opposite direction to SPRFS and NSPRFS.

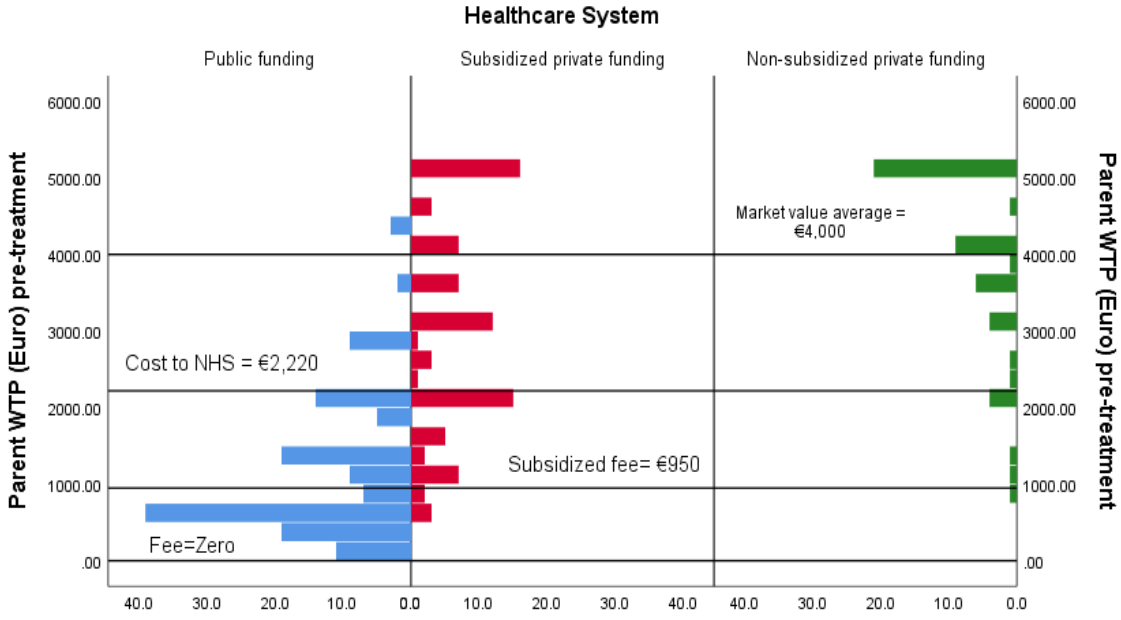


Figure 26. Frequency of WTP (€s) for Orthodontic Treatment in Public, Subsidised and Non-Subsidized Funded Payment Systems in 2004 with Added Reference lines

***Note**: **Public funding**: zero monetary cost to the patient. **Subsidized funding**: patient pays subsidized fee of €950 for treatment compared to market value. The Orthodontists' salary is funded by the state. **Private funding**: Patients' are treated in orthodontists', private practice and pay full market value which is dependent on the severity and length of the fixed appliance treatment with a standard range from €3,500 to €4,500.*

Figure 26 shows that the majority of parents, 108 out of 137 (63.5%), in the public system recorded WTP values less than €1,500 for orthodontic treatment. The SPRFS and NSPRFS both have parents willing to pay €5,000 or more for fixed braces.

In Table 47 we highlight parental willingness to pay pre-treatment for the three funding systems.

Table 47. Parental Willingness to Pay (€s) pre-treatment within and between public, subsidized private and non-subsidized funding systems.

Funding system	**Public (PUFS) N=177**	**Subsidized private (SPRFS) N=108**	**Non-subsidized private (NSPRFS) N=58**
Valid responses rate	137 (77.4%)	84(70.6%)	51(87.9%)
Median WTP	€740	€3,000	€4,100
25th percentile	€740	€2,000	€3,350
75th percentile	€1480	€4,000	€5,000
Pairwise comparisons for the three funding systems			
	Test statistic	**Significance**	**Adjusted significance+**
PUFS versus NSPRFS	-89.471	0.000	0.000
PUFS versus SPRFS	-129.350	0.000	0.000
SPRFS versus NSPRFS	-39.609	0.004	0.013
+Significance value has been adjusted by Bonferroni.			

The differences between the three funding systems were analysed further (Table 47, Figure 26). A Kruskal-Wallis test was applied and there was a significant difference in the distributions of parent WTP (€) between the three groups (H (2) =129.258, p=<0.001). Table 45 highlights the results of the pairwise comparisons of the three funding systems with adjusted significance levels for multiple testing, and all three pairwise comparisons showed a statistically significant difference between all groups. The median WTP values in the PUFS was lowest (median=740Euro) followed by (median =3,000 Euro) in the SPRFS and highest (median=4,100Euro) in the NSPRFS group.

The reference lines superimposed on the graph (Figure 26) represent the mid-point market value for orthodontic treatment in the public (€2,200), the fixed fee for the subsidised private patients (€950), the non-subsidized private (€4,000) midpoint of a range €3,500 to €4,500.

The median WTP of €740 for the public funding system was below the market value of €2,200; 10% (n = 14) of the respondents had a WTP above market value; 10% (n = 14) had a WTP at market value; 80% (n = 109) had a WTP below market value. The median WTP was €3,000 for the subsidized private funding system was lower than the mid-point market value of €4,000. Of those surveyed 25% (n = 21) had a WTP above market value; 6% (n = 5) a WTP at market value; 69% (n = 58) a WTP below market value. The median WTP was €3,500 for the non-subsidized private funding system. For this system, 34% (n = 46) had a WTP above market value; 8% (n = 11) had a WTP at market value; 58% (n = 78) had a WTP below market value.

The dichotomous single-bounded contingent valuation results

Table 48 below shows the frequency of parental willingness to pay when presented with a range of suggested prices. A dichotomous answer 'Yes or No' was elicited from the parent on their WTP the suggested price. One price was presented to one parent only and in this way overall trends within the funding systems may be determined

Table 48. Hypothetical price suggested to the parent with a 'YES or NO' answer of willingness to pay the hypothetical fee.

Suggested cost price	WTP=NO (n)	WTP=YES (n)	Total (n)
Public Funding System Hypothetical WTP values			
£250	3	19	22
£500	6	17	23
£750	5	10	15
≤£750	14	46	60
£1000	10	15	25
£1250	5	14	19
£1500	10	8	18
≤£1,500	25	37	62
£1750	13	4	17
£2000	12	8	20
£2250	9	2	11
≤£2,250	34	14	48
Total	**73**	**97**	**170**

Suggested cost price	WTP=NO (n)	WTP=YES (n)	Total (n)
Private Funding System Hypothetical WTP values			
€950	0	15	15
€1400	1	12	13
€1850	2	8	10
≤€1,850	3	35	38
€2300	0	9	9
€2750	2	7	9
€3200	2	5	7
€3650	4	10	14
≤€3,650	8	31	39
€4100	3	15	18
€4550	5	5	10
€5000	8	9	17
≤€5,000	16	29	45
Total	**27**	**95**	**122**

The WTP range of suggested fees used for the PUFS were, (£250, £500, £750, £1,000, £1,250, £1,500, £1,750, £2,000, and £2,500, for the PRFS (€950, €1,400, €1,850, €2,300, €2,750, €3,200, €3,650, €4,100, €4,550, €5,000).

The majority of parents in PUFS (170/177=96%) answered the dichotomous WTP question and in the PRFS (122/166=73.5%).

The market value for the PUFS was £1500 (€2,200) and 83/122 (68%) of parents were WTP the market value and the values below, 39/122 (32%) were not WTP market value and the values below. For values above the market value 34/48 (71%) were not WTP the suggested prices.

The market value for the PRFS was between €3,500 and €4,500, and in the PRFS and 66/77 (86%) parents were WTP the market value and values below, 11/77(14%) were not WTP these values.

There were parents WTP more than the highest value in the range of market values 17/45 (38%), and 8/45 (1.78%) were not WTP suggested prices higher than market value.

Summary: In the PUFS the majority of parents (68%) were willing to pay, the market value or less. In the private funding system, the majority of parents (86%) were willing to pay, the market value or less. In both systems there were parents willing to pay above the market value, 29% in the PUFS and 64% in the PRFS.

6.2. Factors Influencing Willingness to Pay Pre-treatment

In this section an empirical analysis is undertaken of the possible factors influencing willingness to pay (WPT) for orthodontic treatment. The following patient variables were chosen for this analysis: gender, age, teased about facial appearance (yes/no), and IOTN AC. The parent variables chosen were the parent's Perceived Need VAS score and Household Income.

6.2.1. Descriptive statistics

A descriptive analysis of both patient and parent characteristics overall and within the funding systems is presented in Table 49 and Table 50.

Table 49. Patient characteristics by funding system.

	Funding System			
Patient characteristic	**Public (PUFS) N=137**	**Subsidized private (SPRFS) N=84**	**Non-subsidized private (NSPRFS) N=51**	**All Groups n=272**
Gender				
Male	46(34%)	37(44%)	19(37%)	102(37%)
Female	91(66%)	47(56%)	32(63%)	170(63%)
Age				
Age 10-12	42(30.7%)	29(34.5%)	26(51.0%)	97(35.7%)
Age 13-14	71(51.8%)	33(39.3%)	20(39.2%)	124(45.6%)

	Funding System			
Patient characteristic	**Public (PUFS) N=137**	**Subsidized private (SPRFS) N=84**	**Non-subsidized private (NSPRFS) N=51**	**All Groups n=272**
Age 15-18	24(17.5%)	22(26.2%)	5(9.8%)	51(18.7%)
Teased (n=271)[1]				
Yes	10(7.4%)	11(13.1%)	4(7.8%)	25(9.2%)
No	126(92.6%)	73(86.9%)	47(92.2%)	246(90.8%)
IOTN AC				
Categories 1-4	33(24.1%)	10(11.9%)	13(25.5%)	56(20.4%)
Categories 5-7	47(34.3%)	40(47.6%)	22(43.1%)	109(40.1%)
Categories 8-10	57(41.6%)	34(40.5%)	16(31.4%)	107(39.5%)

[1] *The numbers of subjects with WTP response and characteristics variable*

If the funding system are split into three groups then, the majority of the patients in this investigation were from the publicly funded system (50.4%). Of the patients examined, 63% were female. In terms their age profile, the majority were aged 13 to 14 (45.6%). Patients were assessed as regards being teased about their facial appearance, and 9.1% of those assessed felt they were teased. The dentist assessment of the patients' teeth was assessed using IOTN AC and 79.6% of patients were assessed as moderate to severe.

Table 50 highlights the parent's perception of their child's need using a Visual Analogue Scale (VAS) and summarises the distribution of household income.

Table 50. Parental Characteristics: Perceived Need (VAS score) and Income Distribution (€)

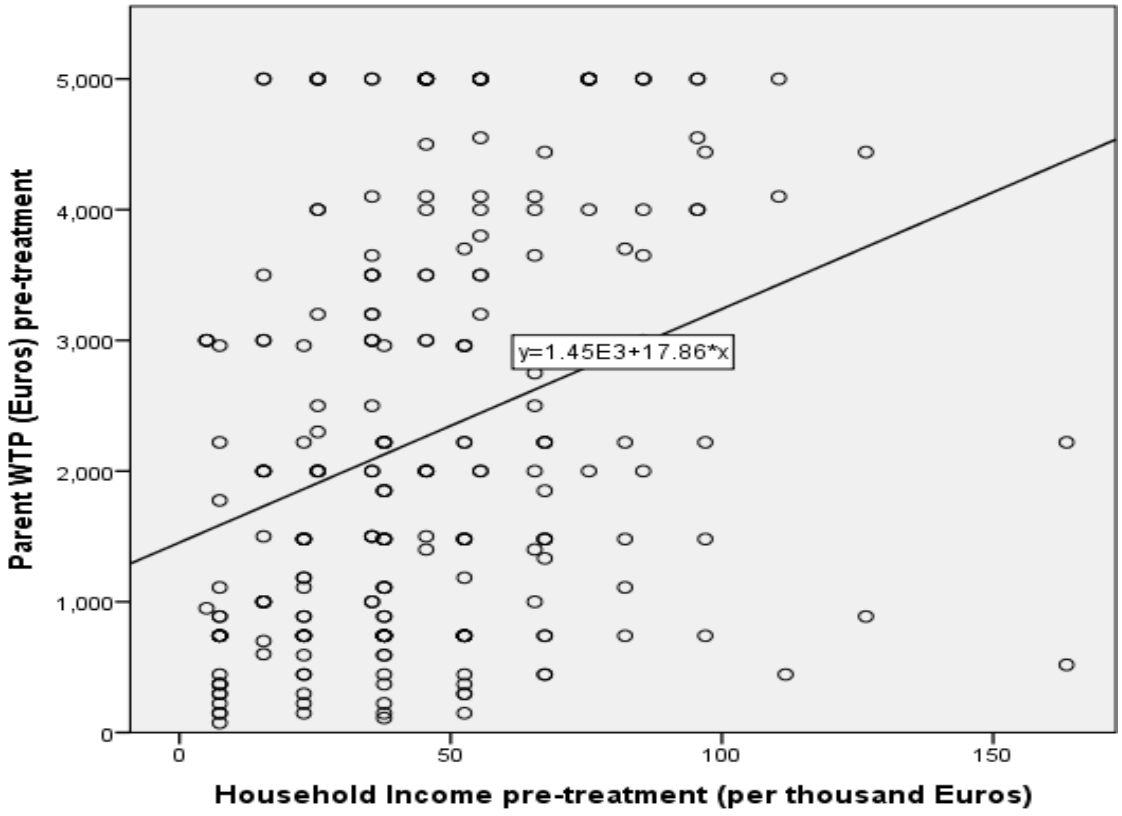
	Funding System			
Parent characteristic	**Public (PUFS) N=137**	**Subsidized private (SPRFS) N=84**	**Non-subsidized private (NSPRFS) N=51**	**Total number**
Perceived Need VAS score (mm)				
Number of subjects[1]	n=132	n=84	n=48	n=264
Median	92mm	86mm	90mm	
25th percentile	73.25mm	71.50mm	80mm	
75th percentile	97mm	92.75mm	96mm	
Household Income (Euro)				
Number of subjects[1]	n=131	n=74	n=46	251(100%)
Median	€37,740	€35,500	€55,500	
25th percentile	€22,940	€23,000	€45,500	
75th percentile	€52,540	€55,500	€75,500	

[1] *The number of subjects with response to WTP and characteristic*

Of the parents surveyed whose children were seeking orthodontic treatment 60.4% were in the public system. With the VAS scale ranging from 0 to 100mm, most parents assessed their children as having very high levels of need. Parental income ranged between €5,000 and €110,000. The median parental income was €37,740 in the publicly funded system, €35,500 in the subsidized private and €55,500 in non-subsidized private, both represent private funding systems.

6.2.2. Relationship between Household Income and Willingness to Pay Pre-treatment

In this section parental and patient characteristics that influence parental willingness to pay pre-treatment are investigated. Firstly, we explore the extent to which household income influences WTP. In Figure 27, a scatterplot of the overall relationship between household income and WTP is presented. Household income was measured in categories of 10,000 beginning at zero and increasing in steps of 10,000. The mid-point income value for each household income category was computed. The maximum mid-point value was £110,500, which converts to €163,540 at a conversion rate of £1= €1.48. Income per €1,000 Euros has been computed to calculate the change in WTP for every €1,000 Euros change in Income.



R^2 Linear = 0.096

Figure 27. Relationship between Parent WTP (€) Pre-treatment and Household Income (€)

A Spearman's correlation coefficient was computed to assess the strength of the linear relationship between the level of household income and amount of parent WTP (€) pre-treatment. There was a positive correlation between the two variables, r_s= 0.310, n=251,

p=<.001. A scatterplot summarizes the results with fit line (WPT = €1,450 + 17.86xHousehold Income ('000)) added to indicate the approximate trend (Figure 27).

In Table 51 willingness to pay (€) is regressed on household income for the four funding categories to assess the relationship between WTP and Household Income (€'000).

Table 51. Relationship between Parent WTP (€) and Household Income (€'000) in the Public, Private, Subsidised private and Non-Subsidised Private Funding Systems.

Healthcare system	Equation of fit Line	Spearman's Correlation coefficient	p (value)
Public n=131	WTP = 772 + 10.67HI	r_s = 0.332	p<0.001
Private n=120	WTP = 2,270 + 23.54HI	r_s =0.420	p<0.001
Subsidised private n=74	WTP = 1,920 + 26.2HI	r_s =0.427	p<0.001
Non-subsidised Private n=46	WTP=3,750 + 4.66HI	r_s =0.112	p<0.457

Note: WPT = Willingness to pay; HI = Household Income (per 1,000 Euros)

When the sample was sub-divided into public and private funding system groups, the results showed that within both groups there were significant positive correlations between WTP (€) and household income (Table 51).

The scatter plots in Figures 28 and 29 further support the positive relationship between WTP and household income. The rate of increase in parent WTP (€) was greater with increasing income for the private funding system compared to the public funding system as indicated by the slopes (Figure 28).



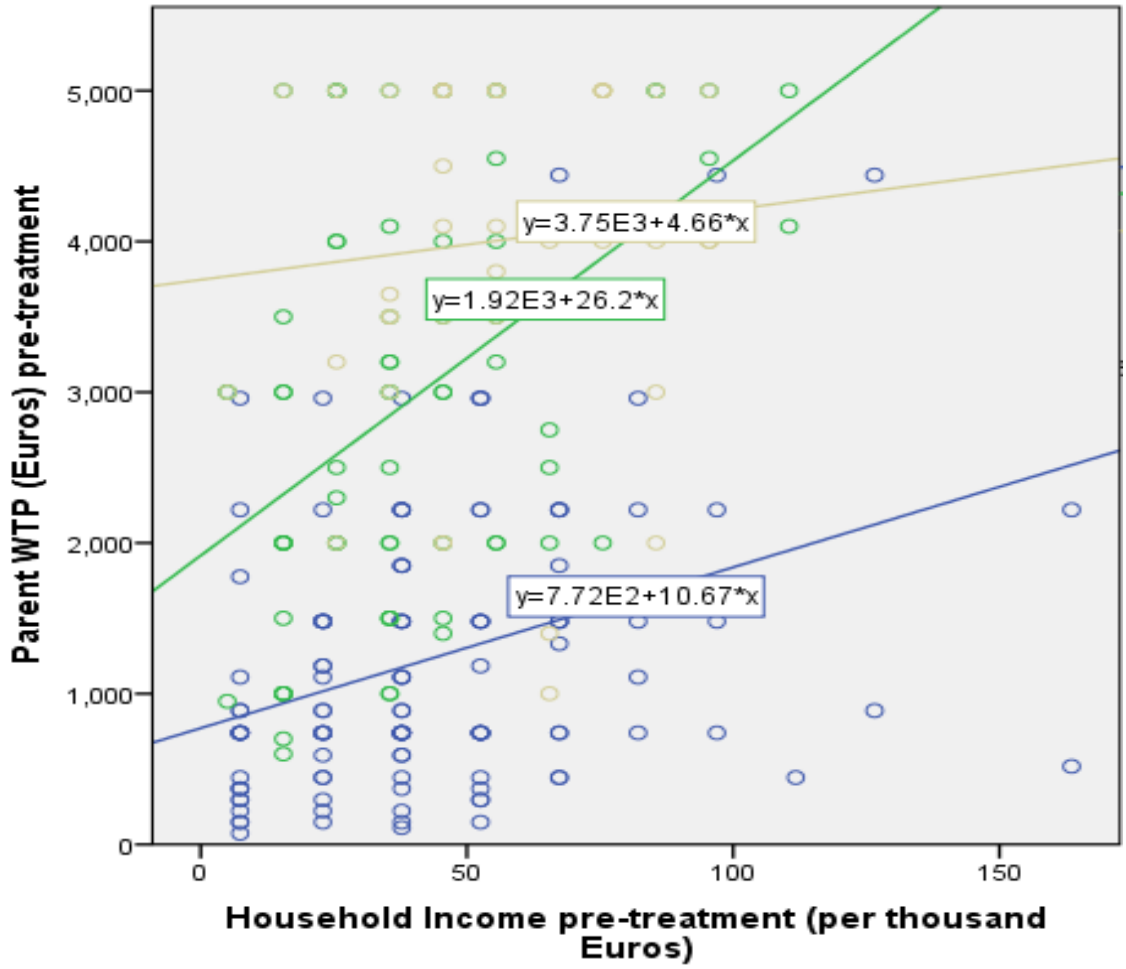
HEALTHCARE SYSTEM

Public funding
Private funding
Public funding
Private funding

Public funding: R^2 Linear = 0.116
Private funding: R^2 Linear = 0.174

Figure 28. Bivariate Relationship between Parent WTP (€) pre-treatment and Household Income (€) pre-treatment in the Public and Private Funding Systems in 2004.

The Private Funding System (PRFS) consists of two sub-groups, subsidised (SPRFS) and non-subsidised (NSPRFS) funding systems, which were investigated further for changes in parent WTP (€) with household income. The fit lines show very different relationships between parent WTP (€s) and Household Income (€s) in the three funding systems. In the publicly funded and the subsidized privately funded healthcare systems there was a significant positive correlation between the level of Household Income (€s) and parent WTP (pre-treatment). There was no evidence of a correlation in the non-subsidized privately funded group (Table 51).



Healthcare System

Public funding
Subsidized private funding
Non-subsidized private funding
Public funding
Subsidized private funding
Non-subsidized private funding

Public funding: R^2 Linear = 0.116

Subsidized private funding: R^2 Linear = 0.202

Non-subsidized private funding: R^2 Linear = 0.009

Figure 29. Relationship between Parent WTP (€) and Household Income (€), for Orthodontic Treatment in Public, Subsidised and Non-Subsidised private, Funding Systems in 2004.

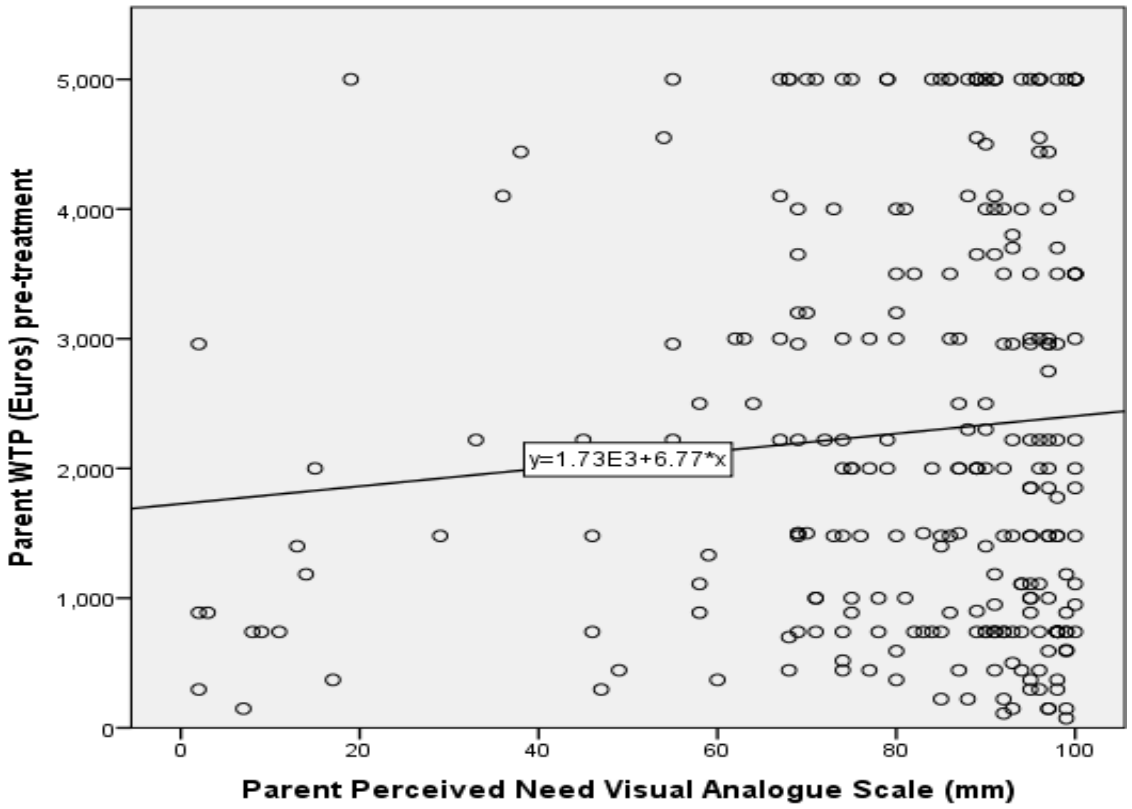
The values of the slopes are utilised here to give approximate effects of household income (€) on parent WTP (€s) pre-treatment. The coefficient of the slope in the equations of the line for the public system show that for every €1,000 increase in income the WTP increases by €10.67 + 772 Euros (for every €10,000 increase in income the WTP increases by €106.70+772 Euros), in the subsidised system for every €10,000 change in income the

WTP increases by €235.40 +€1,920 cents and in the non-subsidised private funding for every €10,000 increase there is €46.60 + €3,750 change in WTP.

Summary: The relationship between WTP (€s) pre-treatment and household income is influenced by the type of funding system that is providing the orthodontic treatment to the patient.

6.2.3. Impact of Parent Perceived Need on Parental Willingness to Pay

Parent perceived need was measured on a 100mm visual analogue scale (VAS). The question was as follows; 'How important is it to you that your child has straight teeth?' Spearman's correlation coefficient was computed to assess the strength of the relationship between parental WTP (€) and the level of parent perceived need. A scatterplot (Figure 30) summarizes the results with an added fit line just to indicate the trend.

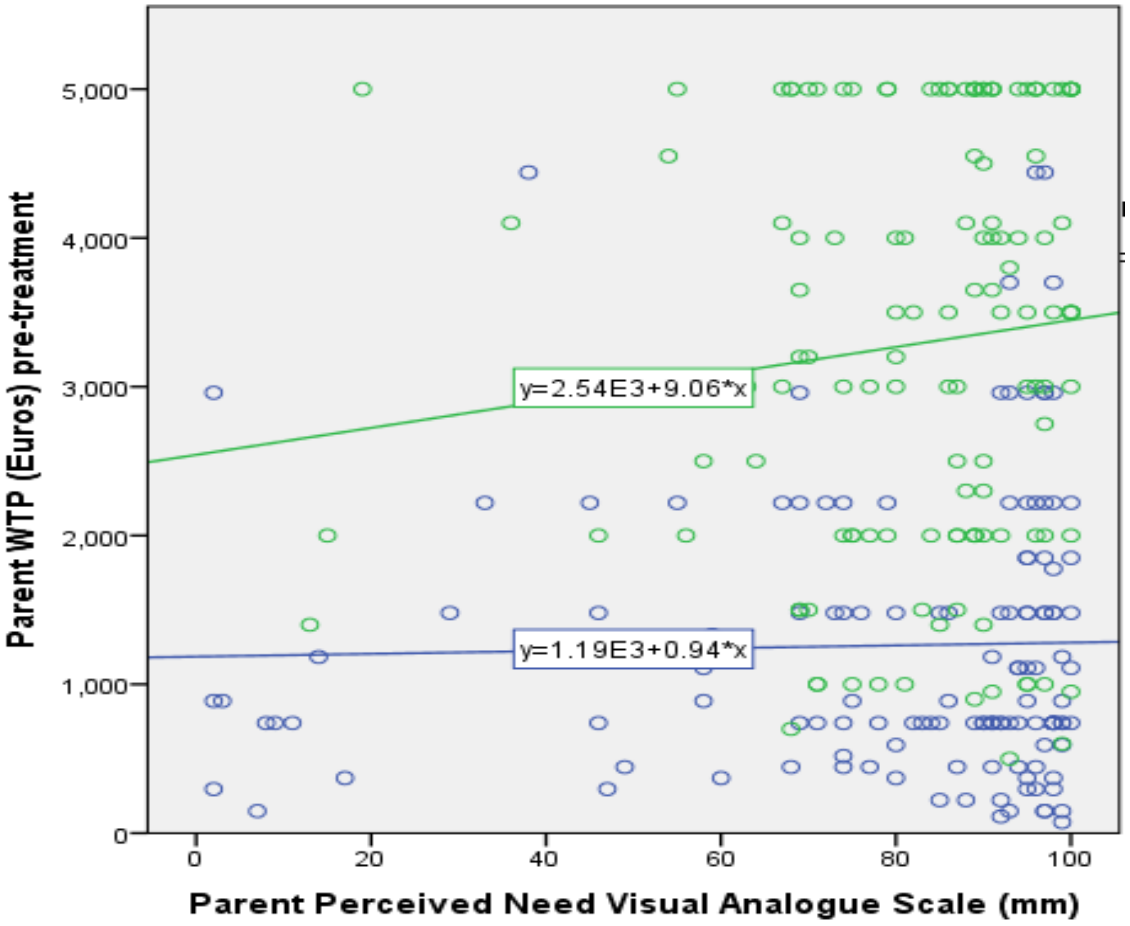


R^2 Linear = 0.009

Figure 30. Relationship between WTP (€) pre-treatment and Parent Perceived Need pre-treatment for the overall sample.

Overall, there was little or no correlation *(r_s = 0.093; n=264; p=0.133)* between level of parent perceived need and the amount of parental WTP (€).

The sample was further divided by funding system into PUFS and PRFS. Figure 31 shows the relationship of parent WTP (€) pre-treatment, within the two systems and the differences between the systems. The parent WTP (€) remains the same with increases in parent perceived need within the public system but increases in the private system with increases in parent perceived need.



Healthcare System

Public funding
Private funding
Public funding
Private funding

Public funding: R^2 Linear = 6.479E-4

Private funding: R^2 Linear = 0.011

Figure 31. The relationship between Parent WTP (€) and Parent Perceived Need (VAS Score in mms), for Orthodontic Treatment in Public and Private Funding Systems.

The private system was further divided into subgroups (subsidised and non-subsidised), Spearman's correlation coefficients were generated for each funding system between

parent WTP (€) and parent perceived need and none of these were statistically significant (Table 52).

Table 52. Bivariate Relationship between WTP (€) and Perceived Need (VAS) in Publicly, Subsidised privately and non-subsidised privately funded healthcare systems.

Funding System	Equation of Line	Spearman's Correlation coefficient	p(value)
Public n=132	WTP = 1,190 + 0.94 VAS	r_s =0.021	p=0.812
Private n=132	WTP = 2,540 + 9.06 VAS	r_s =0.104	p=0.237
Subsidised private n=84	WTP = 2, 4100 + 6.4 VAS	r_s =0.110	p=0.320
Nonsubsidised Private n=48	WTP = 3,490 + 4.99 VAS	r_s = 0.075	p=0.614

Note: *WTP = Willingness to pay; VAS = Visual Analogue Scale in millimetres*

Summary: There is no significant relationship between parent perceived need and WTP for the overall sample or within the funding systems.

6.2.4. Impact of Gender on Parental Willingness to Pay

The purpose of this section is to assess the relationship between the gender of the patient and their parent's willingness to pay. Pre-treatment parental WTP (€) values were completed by parents of 102 males and 170 females. The parental WTP (€) frequency distributions for males and females are shown in Figure 32 and these are clearly non-normally distributed.

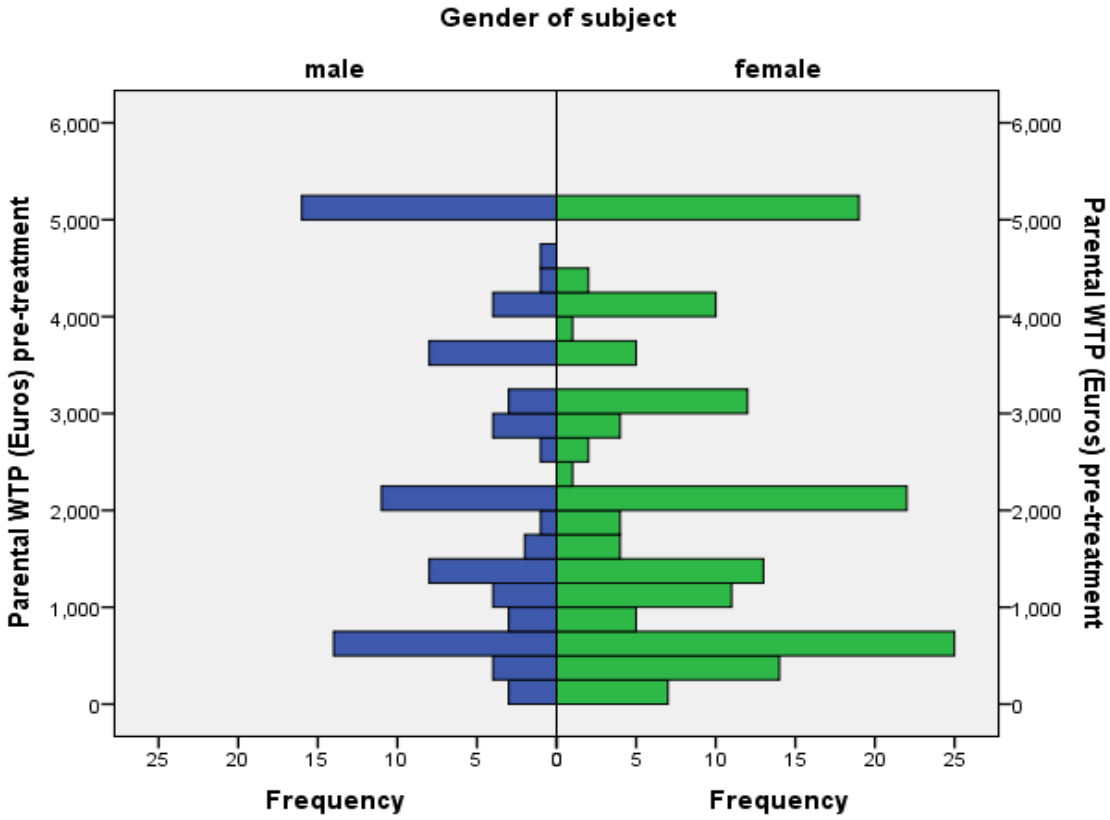


Figure 32. Frequency Plot of Parental WTP (€) Pre-treatment for Male and Female Subjects in an Irish Sample from both the Public and Private Funding Systems in 2004.

The parent WTP (€) for males (median = €2,220), was greater than for females (median = €1,850). Table 53 presents a statistical distribution of parents' willingness to pay by gender.

Table 53. Statistical Distribution of Parent WTP (€s) pre-treatment by Gender

Gender	**Male n =102**	**Female n =170**
Median WTP	€2,220.00	€1,850
25th percentile WTP	€888.00	€740.00
75th percentile WTP	€4,000.00	€3,000.00
Mann-Whitney U=7,559.00 p=0.076		

The Mann-Whitney test in Table 53 indicates that WTP was not significantly influenced by gender. Figure 33 shows the relationship between WTP, and gender disaggregated by funding system.

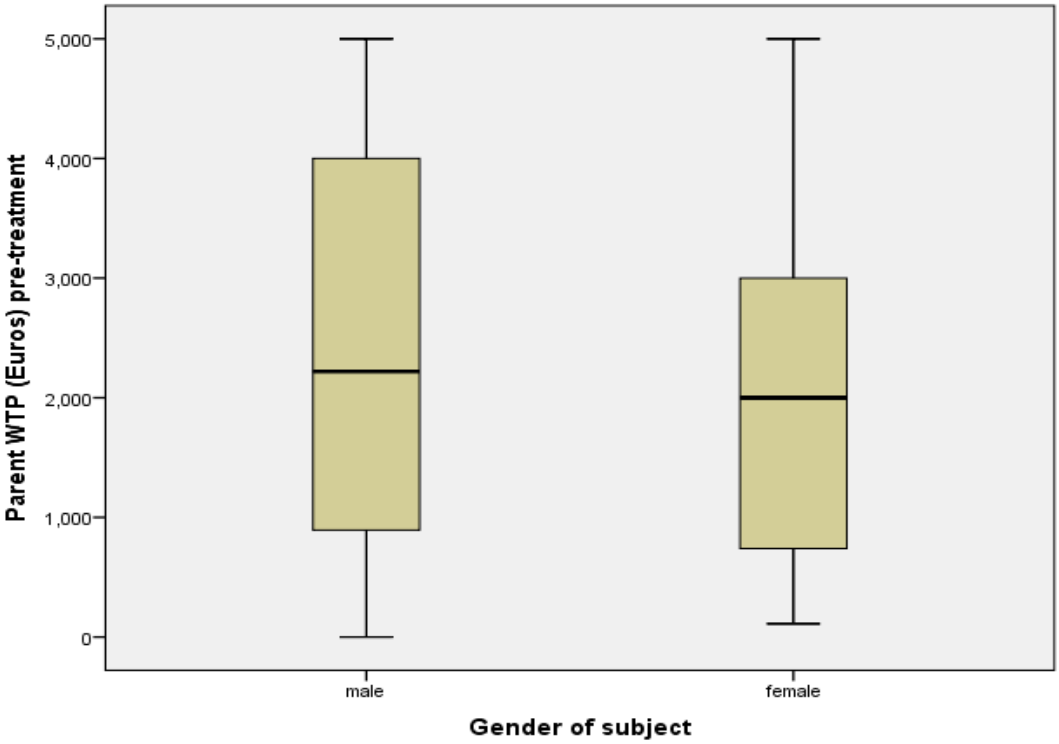


Figure 33. Box Plot Showing the Median Parent WTP (€) Data for the Overall Sample for Male and Female Subjects.

Figure 33 highlights that the median parental WTP was slightly higher for males with a greater standard deviation, but as previously stated the difference was not statistically significant. The relationship between parental WTP (€) and gender was investigated within two funding systems, public and private (Table 54).

Table 54. Analysis of Parent WTP (€s) pre-treatment and Gender in the Public and Private Funding Systems.

Funding system	Public		Private	
	Male n=46	Female n=91	Male n=56	Female n=79
Median WTP	€888	€740	€3,650	€3,000
25th percentile	€740	€592	€2,000	€2,000
75th percentile	€2,220	€1,480	€5,000	€4,325
Mann-Whitney	*U = 1,955.00 p=0.525*		*U= 1,940.00 p=0.219*	

Table 54 indicates that parent WTP (€) and gender was not significant within the two systems. Further comparisons for parent WTP (€) between males and females were conducted within two sub-groups of the private funding systems (Table 55).

Table 55. Parental WTP (€) pre-treatment by gender in the Public, Subsidised Private and Non-Subsidised Private Funding Systems

Funding system	Public		Subsidised-private		Non-subsidised private	
	Male n=46	Female n=91	Male n=37	Female n=47	Male n=19	Female n=32
Valid responses	46	91	37	47	19	32
Median WTP	€888	€740	€3,500	€2,500	€4,000	€4,050
25th percentile	€740	€592	€2,000	€2,000	€3,500	€3,000
75th percentile	€2,220	€1,480	€5,000	€3,500	€5,000	€5,000
Mann-Whitney	*U = 1,955.00 p=0.525*		*U= 699.000 p=0.122*		*U = 289.500 p=0.769*	

Table 55 shows that the median parent WTP (€s) was higher for males (median = €3,500) than females (median = €2,500) in the SPRFS and marginally lower for males (median =

€4,000) than for females in the NSPRFS (median = €4,050). The Mann-Whitney test indicated that the two groups did not differ significantly (Figure 34, Table 55).

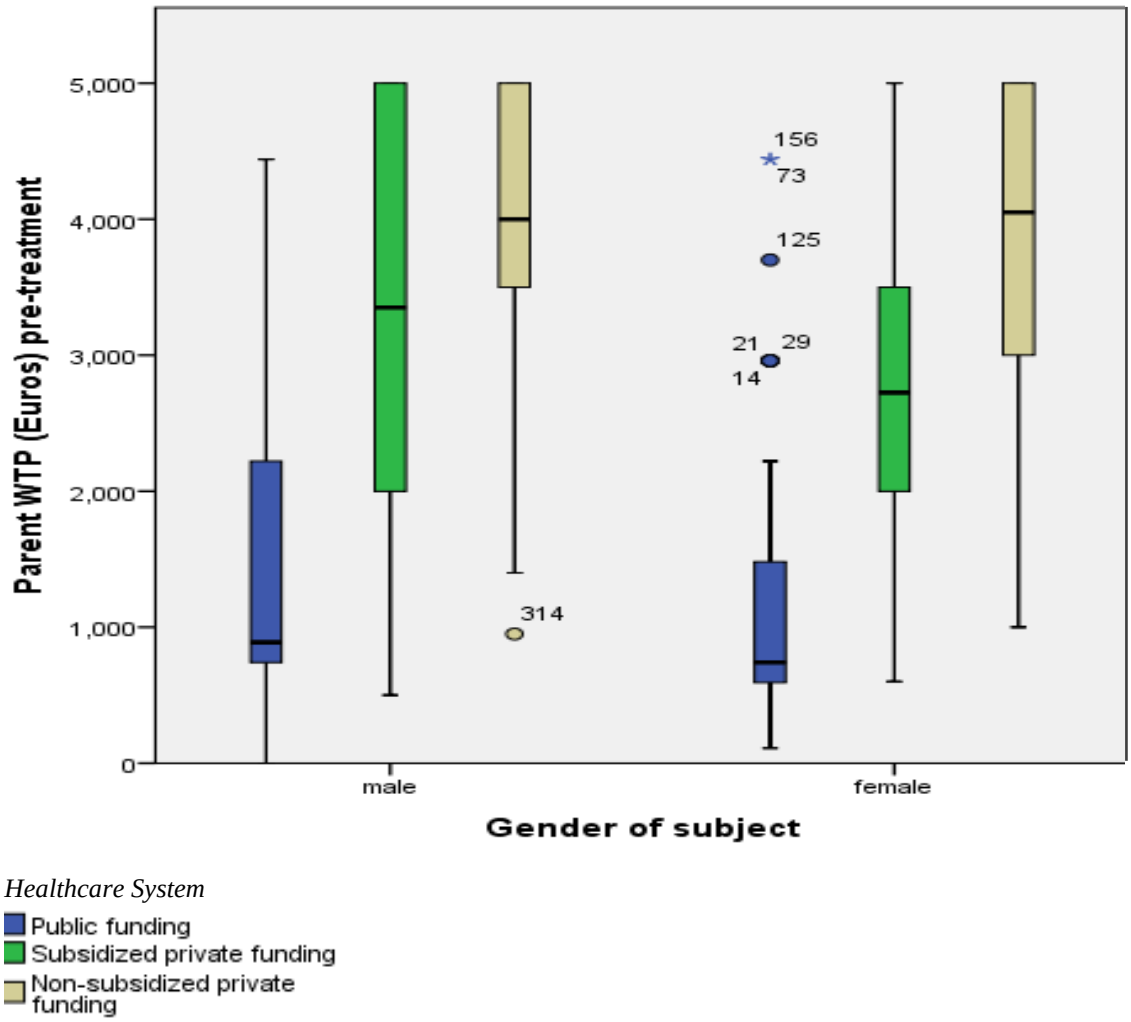
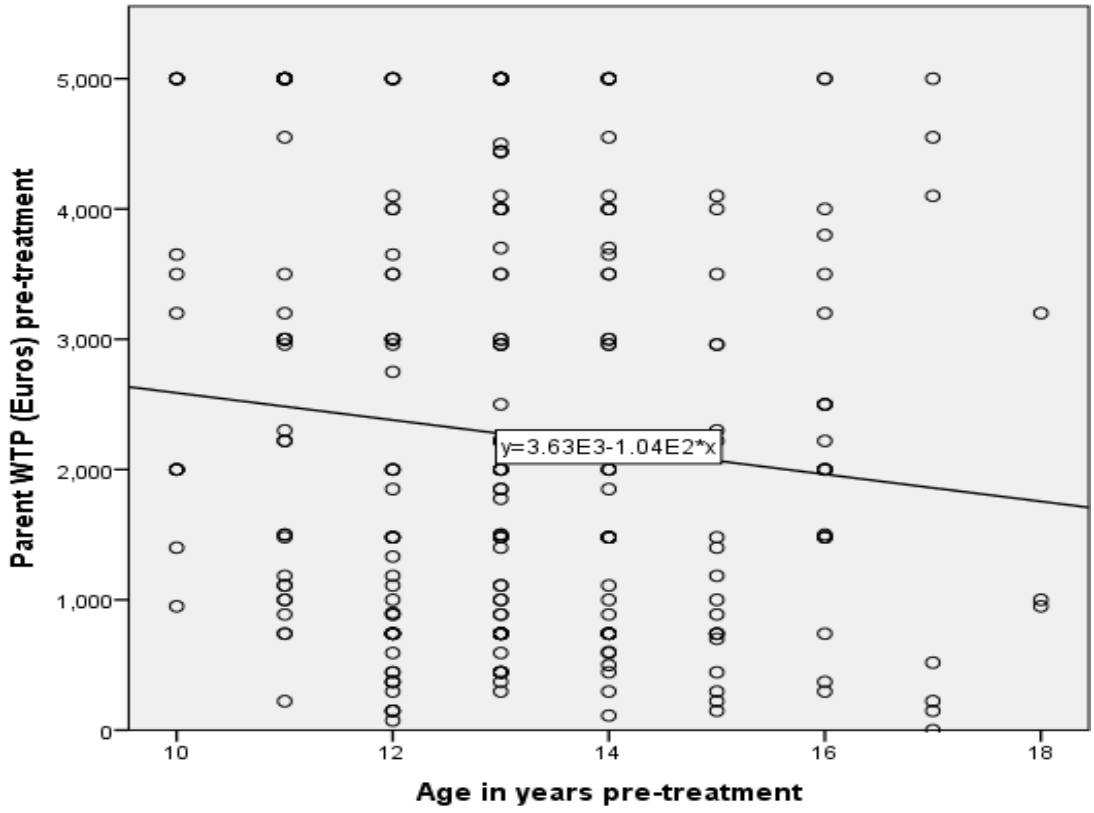


Figure 34. A Box Plot Showing the Median Parent WTP (€) Data in the Public, Subsidised Private, and Non-Subsidised Private Funding Systems for Male and Female Subjects.

Summary: Parents are not WTP significantly more for males compared to females in the overall sample or within the funding system.

6.2.5. Impact of Age of Patient on Parental Willingness to Pay

In this section the relationship between the age of the patient and the parent's willingness to pay for treatment is investigated. Examining the relationship between parent WTP (€s) pre-treatment and age of the subject, Spearman's (r_s) correlation coefficient was computed. A scatterplot summarizes the results with a fit line added to show the trend (Figure 35).

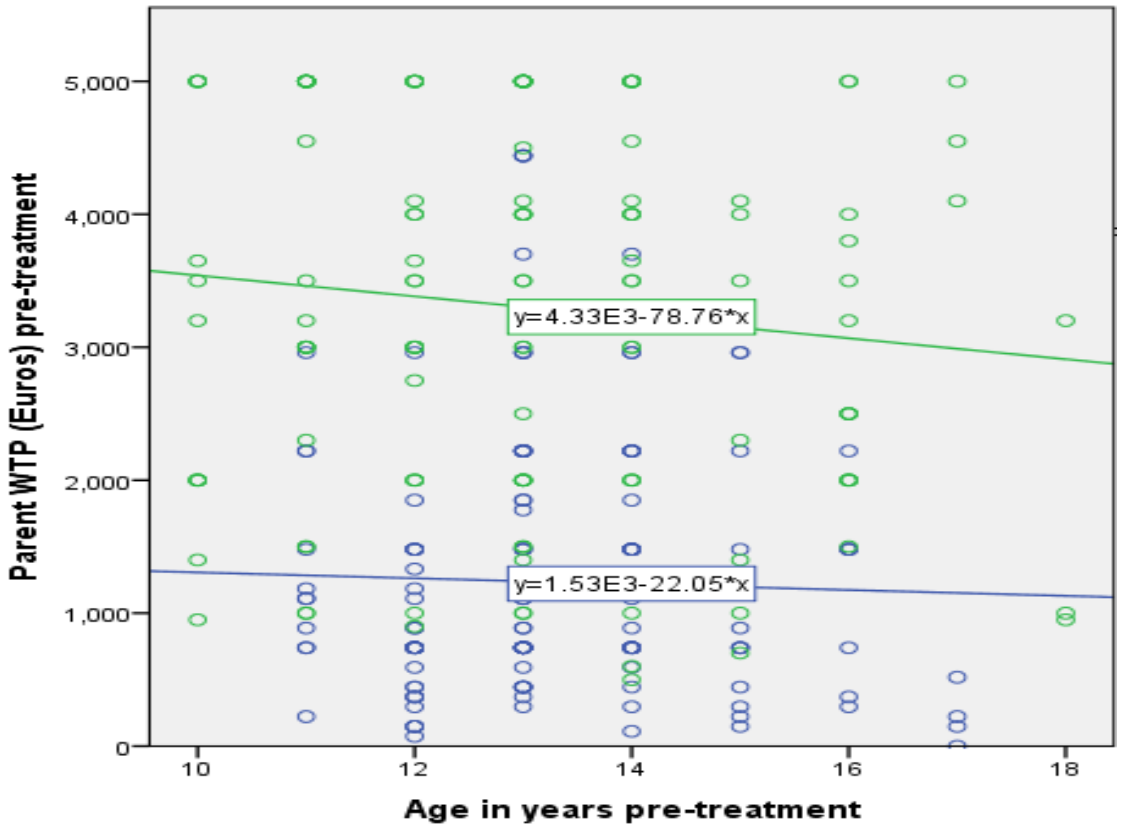


R^2 Linear = 0.013

Figure 35. Scatterplot of Parent WTP (€) pre-treatment and Age of the Patient.

Figure 35 shows that parents' willingness to pay for orthodontic treatment declines with age. However, correlation between the two variables was not statistically significant at the 95% level (r_s = -0.103; n = 272; p=0.088). Parental WTP (€) with age of the subject, was also investigated within two funding systems, public and private.

Fit lines were superimposed on the scatterplot to show that the relationship between WTP and age varied amongst the two funding systems (Figure 36).



Healthcare System

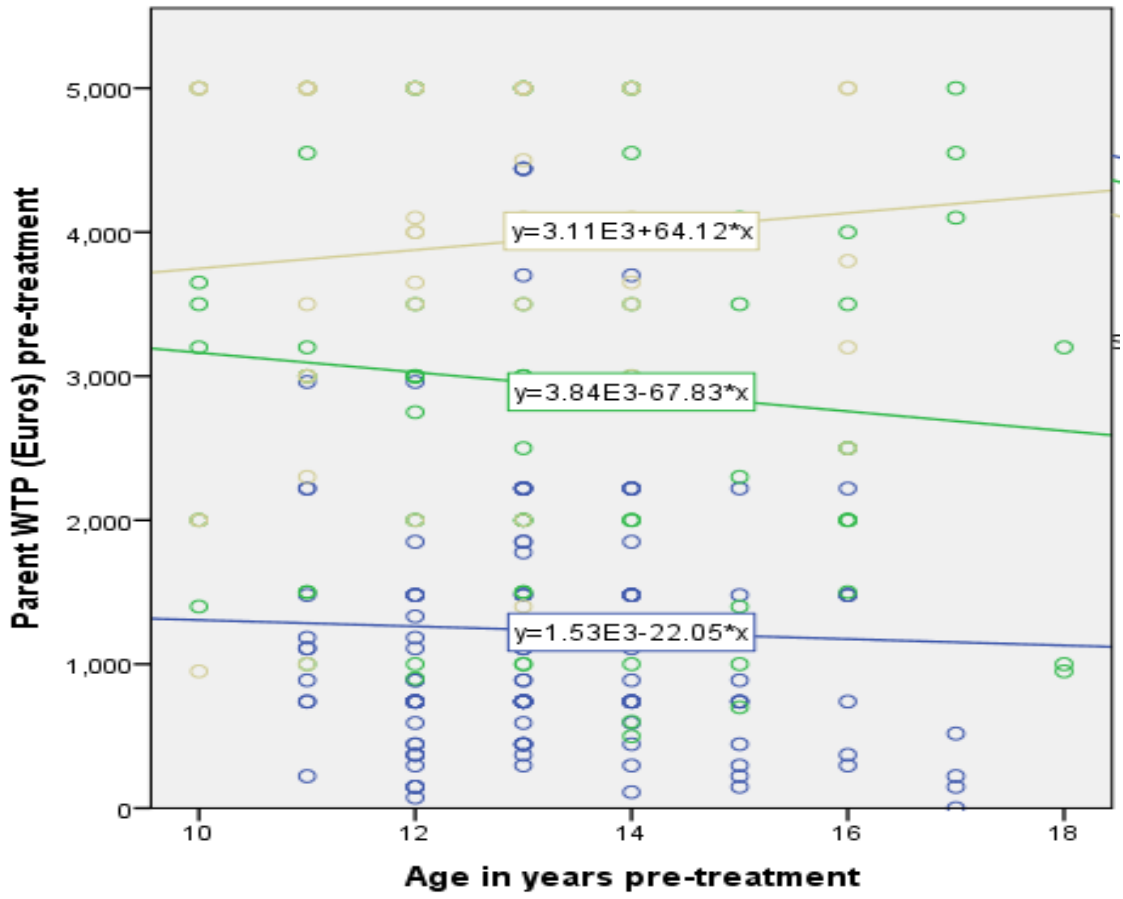
Public funding
Private funding
Public funding
Private funding

Public funding R^2 Linear = 0.001
Private funding R^2 Linear = 0.012

Figure 36. The relationship between parent WTP (€) pre-treatment and Age of the subject pre-treatment within the Public and Private Funding Systems in 2004.

The fit lines show parent WTP (€) decreases with increase of age and this effect is seen to a greater degree within the private funding system.

Further comparisons for parent WTP (€) with age were conducted within two subgroups of the private funding system. Fit lines were superimposed on the scatterplot to show that the relationship varied amongst the three funding systems (Figure 37).



Healthcare System

- Public funding
- Subsidized private funding
- Non-subsidized private funding
- Public funding
- Subsidized private funding
- Non-subsidized private funding

Public funding: R^2 Linear = 0.001
Subsidized private funding: R^2 Linear = 0.010
Non-subsidized private funding: R^2 Linear = 0.008

Figure 37. Relationship between parent WTP (€) Pre-treatment and Age of the subject pre-treatment in the Public, Subsidised Private and Non-Subsidised Private Funding Systems in 2004

The fit lines show that, within the non-subsidised private funding system the parent WTP (€) increases with increase of age. Within the subsidised group there is a decrease of WTP with increase of age. Table 56 shows the relationship between Parent WTP (€) and Age Pre-treatment in Public, Private, and Subgroups of Private.

Table 56: The Relationship between Parent WTP (€) pre-treatment and Age in the Public, Private, and Subgroups of Private funding system

Funding System	Equation of Line	Spearman's Correlation coefficient	P(value)
Public funding n=137	WTP = €1,530 - 22.05Age	r_s =-.004	*p=.962*
Private funding n=135	WTP = €4,330 - 78.76Age	r_s =- .096	*p=.266*
Sub-groups of the private system			
Subsidised private funding n=84	WTP=€3,840 - 67.83Age	r_s = -.092	*p=.404*
Non-subsidised private funding n=51	WTP = €3,110+ 64.12Age	r_s = .011	*p=.939*

Table 56 shows that for the three funding systems (public, subsidised private and non-subsidised private) there were no significant correlations. The public system follows this trend but to a lesser degree. There were no significant correlations within the two funding systems for parent WTP (€) pre-treatment and age (Table 56).

Summary: There was no significant relationship between WTP and age within the different funding systems.

6.2.6. Impact of being Teased on Willingness to Pay

The patient's answered 'yes' or 'no' to the structured question 'Have you ever been teased about how your teeth look?' (Yes: n =25, No: n=246). Figure 38 shows the frequency distribution of parent WTP (€) and teased for the overall sample (teased: n=25, not teased: n=246).

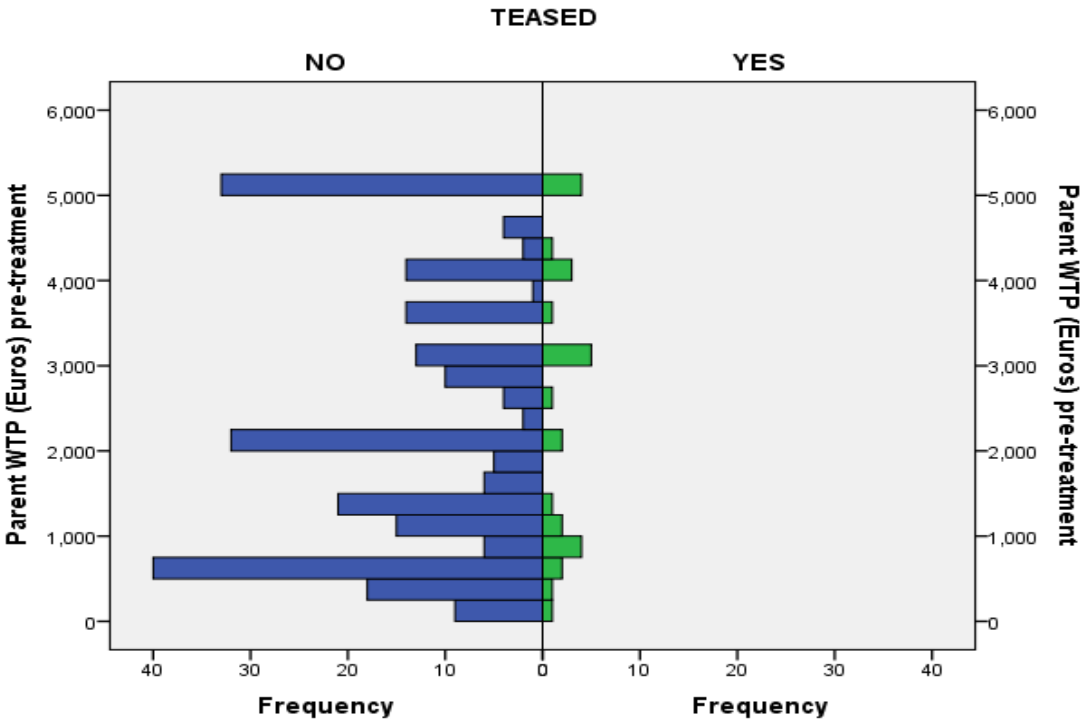


Figure 38. Relationship between WTP (€) Pre-treatment and Teased pre-treatment for the overall sample.

Figure 38 shows that in the overall sample that parents of 9 out of 25 (36%) children who reported being teased had a WTP above €3,000 and parents of 73 out of 246 (29.7%) whose children were not teased were WTP below €1,000.

Table 57 shows the relationship between parental willingness to pay and being teased or not being teased for the overall sample.

Table 57. Relationship of Parental WTP (€) and being Teased

Teased	**Yes n=25**	**No n=246**
Median WTP	€2,000.00	€2,000.00
25th percentile WTP	€888.00	€740.00
75th percentile WTP	€4,000.00	€3,500.00
Mann-Whitney	*U=3,310.000; p=.631*	

The median parental WTP for subject's who had been teased was the same as for those who had not been teased (median=€2,000.00) for the overall sample. There was not a significant difference between the median WTP for teased and not teased in the overall sample (Mann Whitney p=.631). The WTP is higher for patients who have been teased pre-treatment in the 75th percentile of the sample. Figure 39 presents a scatterplot that shows the pattern of WTP within the public and private funding systems, for patients teased and not teased.

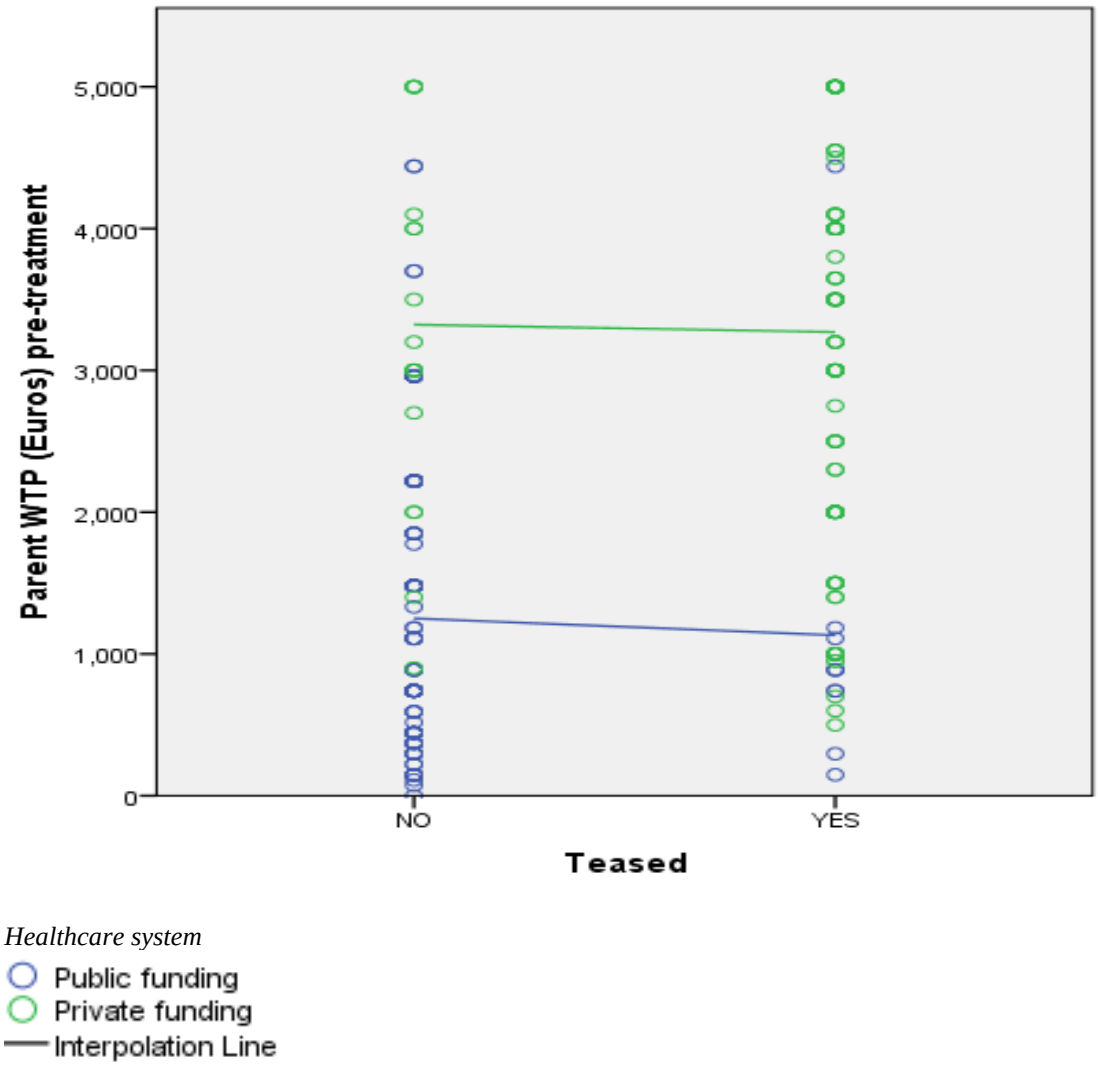


Figure 39. Parental WTP (€) for Teased Subjects in Public and Private Healthcare Funding Payment Systems in 2004.

Figure 39 shows that parental WPT is greater for those in the private funding system and marginally higher if not teased. Table 58 shows the relationship between WTP and being teased disaggregated by payment system.

Table 58. Mean Parental WTP (€s) in Publicly Funded and Privately Funded Systems for Teasing (Yes or No)

Funding System	Private		Public	
	Yes Teased	***No Teased***	***Yes Teased***	***No Teased***
Valid responses	15	120	10	126
Median WTP	€3,200	€3,500	€888	€740
25th percentile	€2,000	€2,000	€740	€740
75th percentile	€5,000	€5,000	€1,110	€1,776
Mann-Whitney	*U=903.500 p=0.980*		*U=578.500 p=0.664*	

Table 58 shows that the highest median level of parental WTP (€3,500) was for patients who were not teased in the private funding system and lowest (€740) for patients who were subjected to teasing in the publicly funded system. The numbers in the table 58 show that the majority of children in both funding systems were not teased. Between the two funding systems, there were no significant differences in parent WTP (€) between those teased and not teased. The sample numbers for not being teased were too small and therefore sub-groups of the private system could not be analysed.

Summary: Parental WTP is not significantly different for children who have been teased compared to those who have not. The system where the child was treated did not influence parental WTP when their child had been teased or not teased.

6.2.7. Impact of IOTN AC on Willingness to Pay

The Index of Orthodontic Treatment Need Aesthetic Component (IOTN AC) was the measure used to determine orthodontic treatment need based on the appearance of the anterior teeth. A scatterplot in Figure 40 shows the relationship between WTP and IOTN AC.

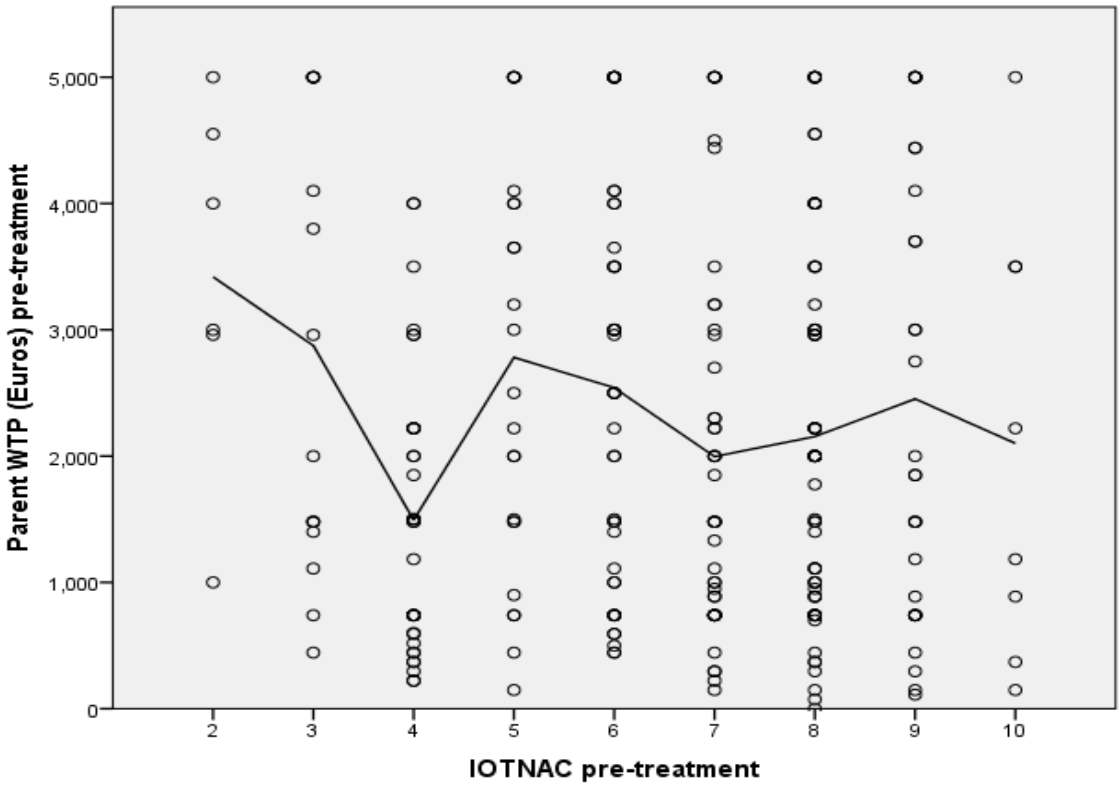


Figure 40. Relationship between WTP (€) and IOTN AC for the overall sample with an added interpolation line.

For the overall sample there was no evidence of a relationship between parent WTP (€s) and IOTN AC (Spearman's r_s=-0.029, p=0.637, n=272). The relationship is counter intuitive with patients willing to pay more for lower categories of aesthetic need.

The overall sample was then divided into public and private funding systems (subsidised and non-subsidised) in Figure 41 and the scatterplot generated shows the relationship between the funding systems and IOTN AC.

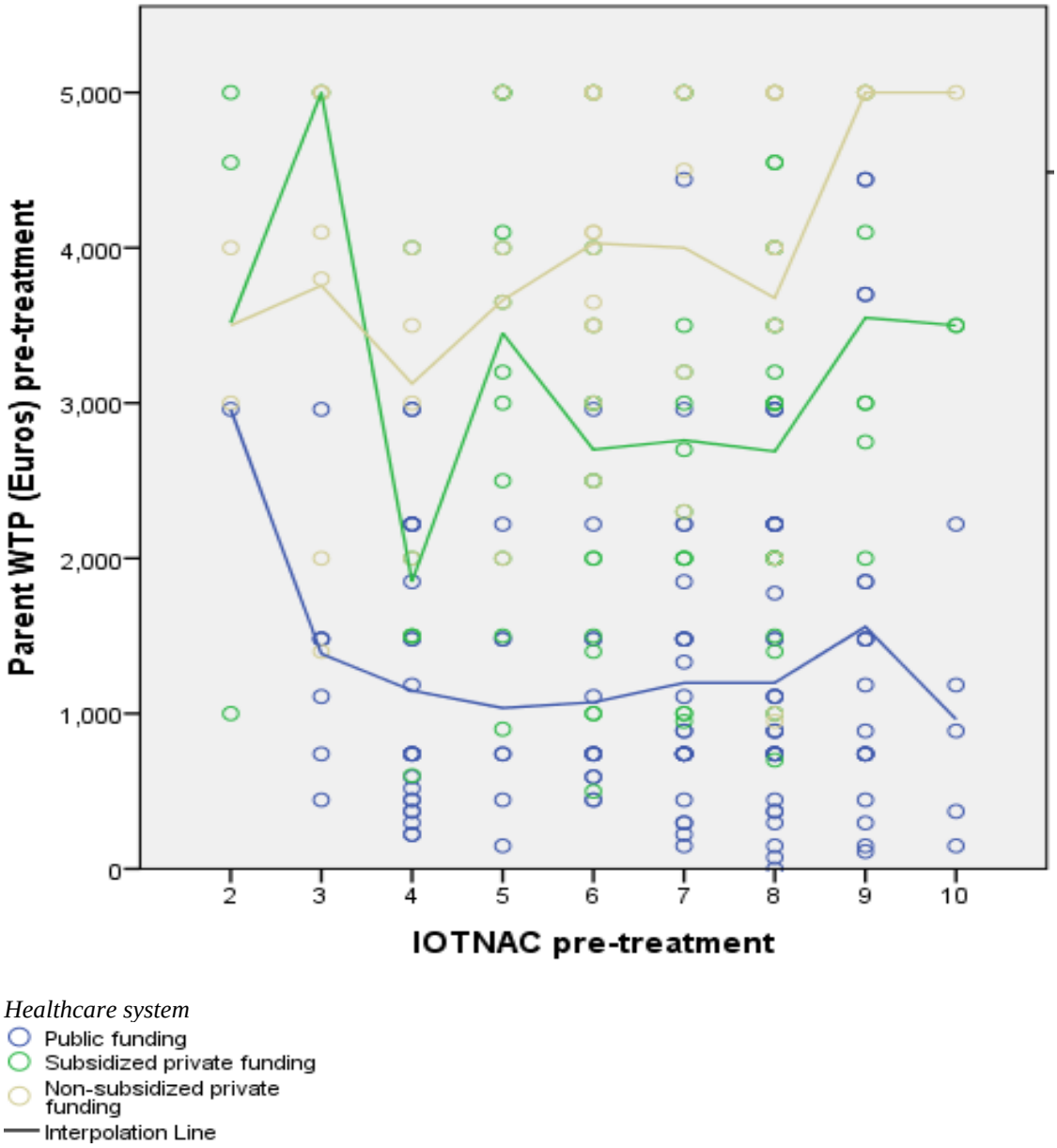


Figure 41. Relationship with Parent WTP (€) Pre-Treatment and IOTN AC for the Public, Subsidised Private Funding Systems and Non-Subsidised Private Funding System.

Figure 41 shows that parents of patients in the SPRFS and NSPRFS were willing to pay more at all levels of IOTN AC than parents from the PUFS. The correlation between parent WTP (€s) and IOTN AC for the PUFS was not statistically significant (Spearman's r_s = 0.015, p=0.866, n = 137) and nor the PRFS (Spearman's r_s = -0.005, p=0.955, n = 135) or sub-groups of the private system.

Summary: There is no significant relationship between the aesthetic component of professionally judged orthodontic treatment need IOTN AC and parental WTP.

6.2.8. Comparison of Pre-treatment and Post-treatment Parent WTP.

A total of 186 parents had completed the WTP questionnaire pre- and post- treatment (excluding cases with WTP (€) >= 8000). Parametric tests were carried out on the data to access the level of Normality and Skewness in the distribution of the data. The results are presented in Figure 42 below.

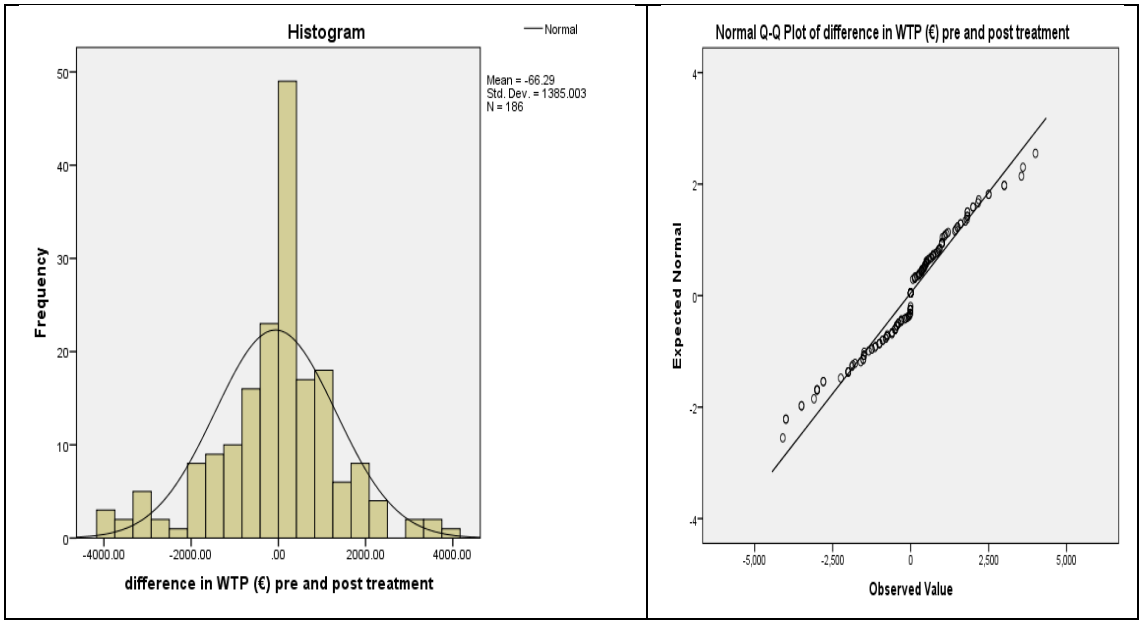


Figure 42. Histogram and Normal Q-Q Plot of Difference Post Minus Pre WTP (€) Overall Groups

The histograms in Figure 42 show that a parametric statistical test, can be applied, as the distribution is not too skewed and is largely symmetrical. However, it failed the normality test primarily due to kurtosis (Shapiro Wilks test =0.954; df=186; p<0.001).

Table 59 shows the comparison of pre and post-treatment parent WTP (€) using a paired t-test analysis of the difference in the means. A paired samples t-test was conducted to compare parent WTP pre- and post-orthodontic treatment.

Table 59. Comparison of Pre-Treatment and Post-Treatment Parent WTP (€) using a paired t-test analysis of the difference in the means

Funding System	**Pre-treatment mean parent WTP(€)**	**Post-treatment mean parent WTP(€)**	**Mean difference parent WTP (€s) (post-pre)**	**95% confidence intervals**	**t-statistic (df)** ***p-value***
Overall n=186	2,439.80	2,373.51	-66.30	-266.64 lower 134.06 higher	*t=-0.653 df=185 p=0.515*
Public funding system n=73	1,251.41	1,332.50	81.09	-143.04 lower 305.22 higher	*t=-0.721 df=72 p=0.473*
Private funding system n=113	3,207.52	3,046.02	-161.50	-459.26 lower 136.25 higher	*t= -1.075 df=112 p=0.285*
Overall repeated with same parent n=79	2,594.69	2,601.02	6.32	-319.90 lower 332.55 higher	*t=0.039 df=78 p=0.969*

Table 59 shows that overall the mean WTP pre-treatment is €2,440 and €2,374 post treatment. The maximum mean parental WTP is €3,894 pre-treatment in the non-subsidies private system and the minumum WTP is €1,251 in the publicly funded system. There was no statistically significant difference in the level of overall parental WTP pre-treatment ($\overline{X}$ = €2439.80; s = €1,606.79) and post-treatment ($\overline{X}$ = €2,373.51, s = €1,558.77); $t_{(191)}$ =-0.653, p = 0.515 (Table 59). A comparison of pre versus post WTP for each of the funding systems showed no significant change in this monetary measure within sub-groups.

6.3. Comparison of the Difference in WTP pre- and post-treatment between the Funding Systems

Parental WTP (€s) was analysed for the two funding systems Public (PUFS n=73) and Private (PRFS n=119) for subjects whose parents answered pre- and post-treatment WTP questions. A two-sample t-test was conducted to compare the difference (Post-Pre WTP) between the PUFS and the PRFS; the two groups showed a similar change in WTP (Mean Difference =217.64; 95% CI 143.44, -578.73; t =1.189, df=190, p=0.236; equal variance not assumed). The PRFS was sub-divided into two groups for further enquiry into the effect of private systems.

A one-way Anova was conducted to compare the effect of the three funding systems (public, subsidised private and non-subsidised private), on the difference between pre-treatment and post-treatment parental WTP (€s). An analysis of variance of the effect of funding system on the computed difference pre-treatment and post-treatment parent WTP (€) showed that the variances were unequal across the groups (Levene Statistic=4.358; p=0.014) and that the change in WTP was not significant (Welch's $F_{(2,92.766)}$=1.024; p=0.361).

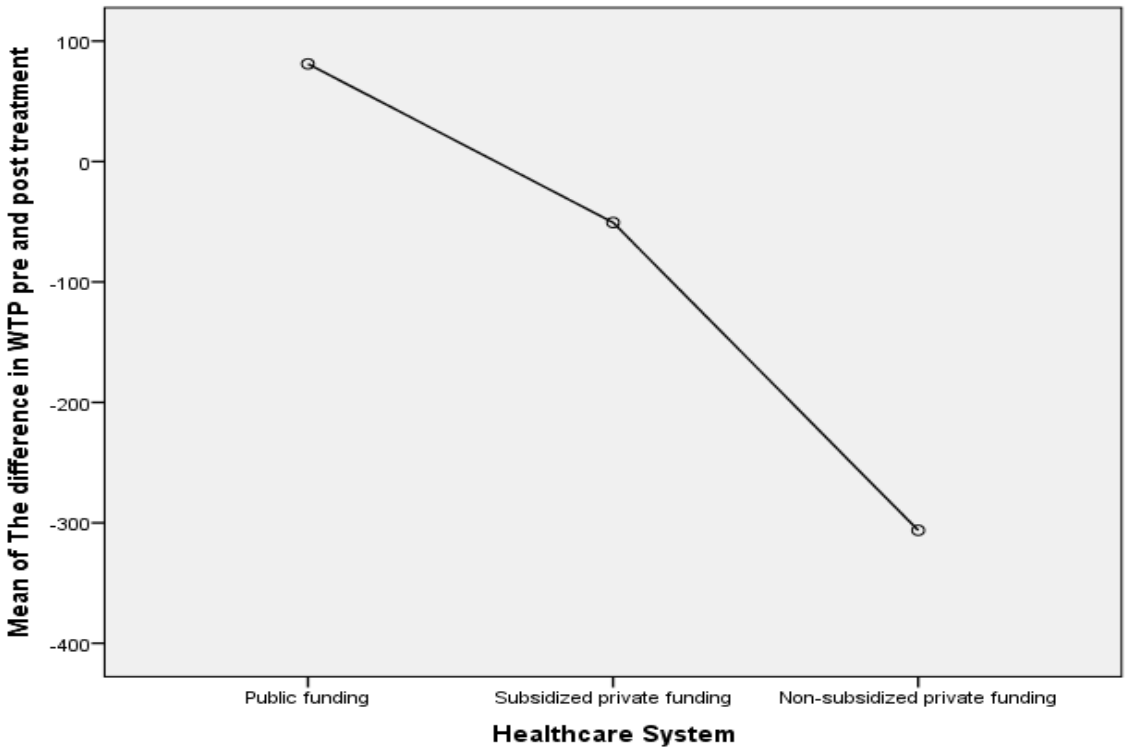


Figure 43. The Difference in Mean Parent WTP (€) Between the Three Funding Systems Public, Subsidised Private and Non-Subsidised Private.

6.4. Regression analysis

The overall sample consists of a combination of parents from the public and private funding systems, which in relation to WTP are quite divergent in the WTP monetary values they placed. The distributions are highly skewed in opposite directions, and it shows that parents in the PRFS were willing to pay more than those in the PUFS as shown in section 6.2, Figure 25. To address this divergence a transformation of the data was required. It was difficult to find a suitable transformation of the data or to form a regression model that met the heteroskedasticity assumption for the regression analysis. The two healthcare systems operate quite differently as can be seen by Figure 44.

The distributions shown in Figure 44 are skewed in opposite directions for WTP, even though the Household income distribution shown in Figure 45 is quite similar for both groups.

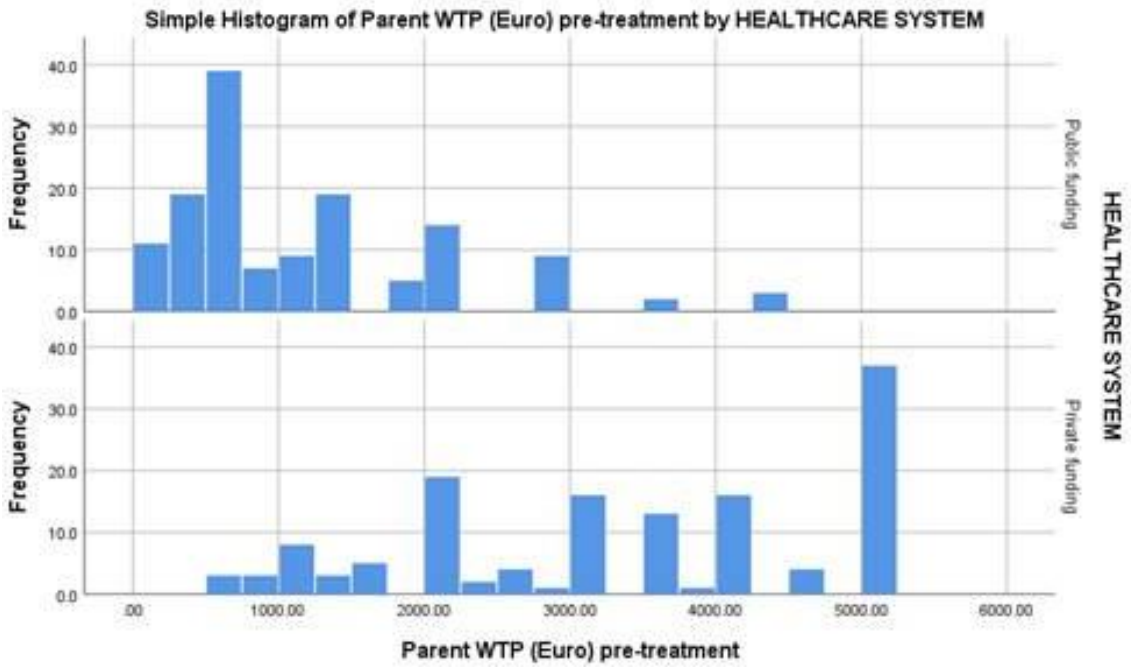


Figure 44. WTP frequency pre-treatment

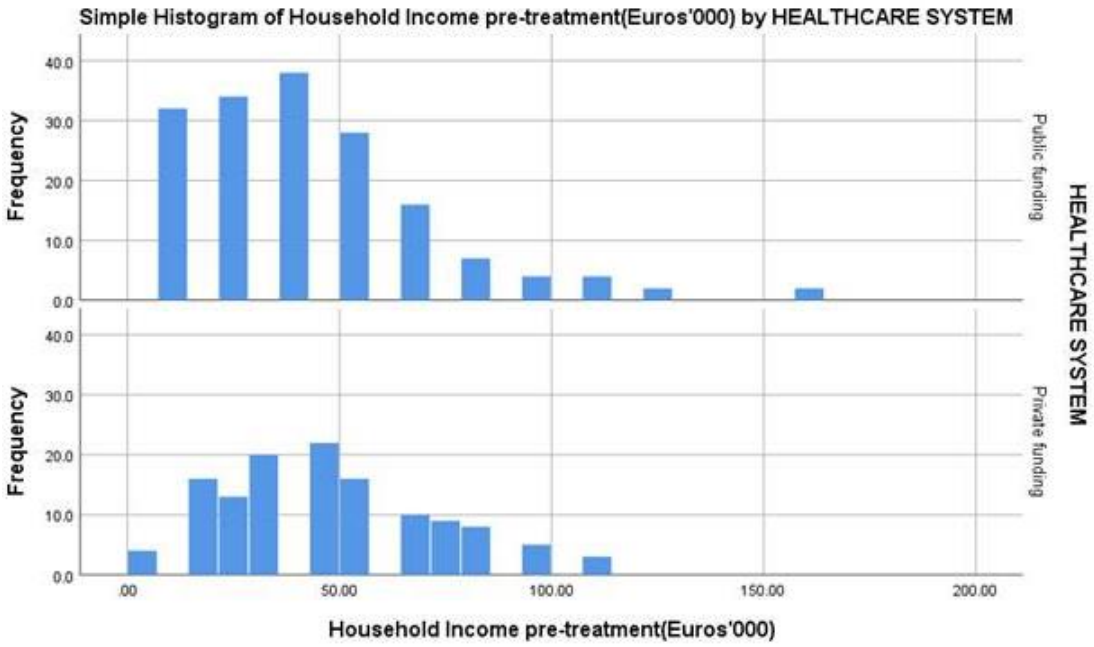


Figure 45. Household income frequency

Using the untransformed data (WTP and HI1000), the Healthcare system (funding system) alone explains approximately 45% of the variation in WTP, and Household Income explains only a further 7% of the variation in WTP. For the transformed data (LnWTP and LNHI100) the corresponding values are 435 and 8%). An overall regression with combined public and private data was not possible due to the heteroskedasticity. Therefore, the regression analyses are performed separately for the Private system in section 6.5.1 and the Public system in 6.5.2 because of the divergence in WTP between the systems.

6.4.1. Private funding systems: Regression analysis for Parent WTP

A regression analysis, using the general linear model (GLM) procedure, was used to determine the best predictors of parent WTP (Euro) pre-treatment in the Private healthcare funding systems.

A full model using WTP(Euro) pre-treatment as the dependent variable, was fitted to the data. There were 116 cases with completed information for the independent variables at this step. There were 46 out of 166 (28%) that had missing data for both WTP and Household Income, some parents did not accompany their child to the appointment or refused to answer the questions. Given the sensitive nature of the variables the response rate of 72% was good. The independent variables included; age, IOTN AC, parent

perceived need, household income pre-treatment (Euro) as covariates, and gender and teased as factors.

Non-significant indepenent variables were removed from the model by a backward elimination process. The linear model seemed reasonable and a transformation was not necessary, (although some were tried because the distributions of the WTP and Household income were different; WTP was negatively skewed and Houshold Income was positively skewed but none improved the model assumptions or fit).

In the 3rd last model Gender (p=.058) failed to read statistical significance but ParPN was significant (p=.032). After removing Gender then ParPN in the pen-ultimate model just failed to reach statistic significance (p=.051) and was removed. In the final model only one of the six variables (Household income (Euro) pre-treatment) remained which was significant at < .001 level. The final model was based on 120 cases.

A plot of the standardized residuals versus the predicted values showed that the variation in the residuals tend to decrease at the very high predicted values, indicating some lack of homoskedasticity of variance. This was due in the main to the small number of cases with high household income showing little variation in WTP amount. The majority of standardized residuals were between -2 and +2. A histogram and normal Q-Q plot of the standardized residuals were generated and indicated that the distortion was not serious.

The relationship between WTP and Household Income is represented by the graph in Figure 46 with regression line fitted (already shown in the bivariate analysis section 6.3.1). The parameters of the regression are given in Table 60, indicating the average amount a person is willing to pay increases-with increasing household income.

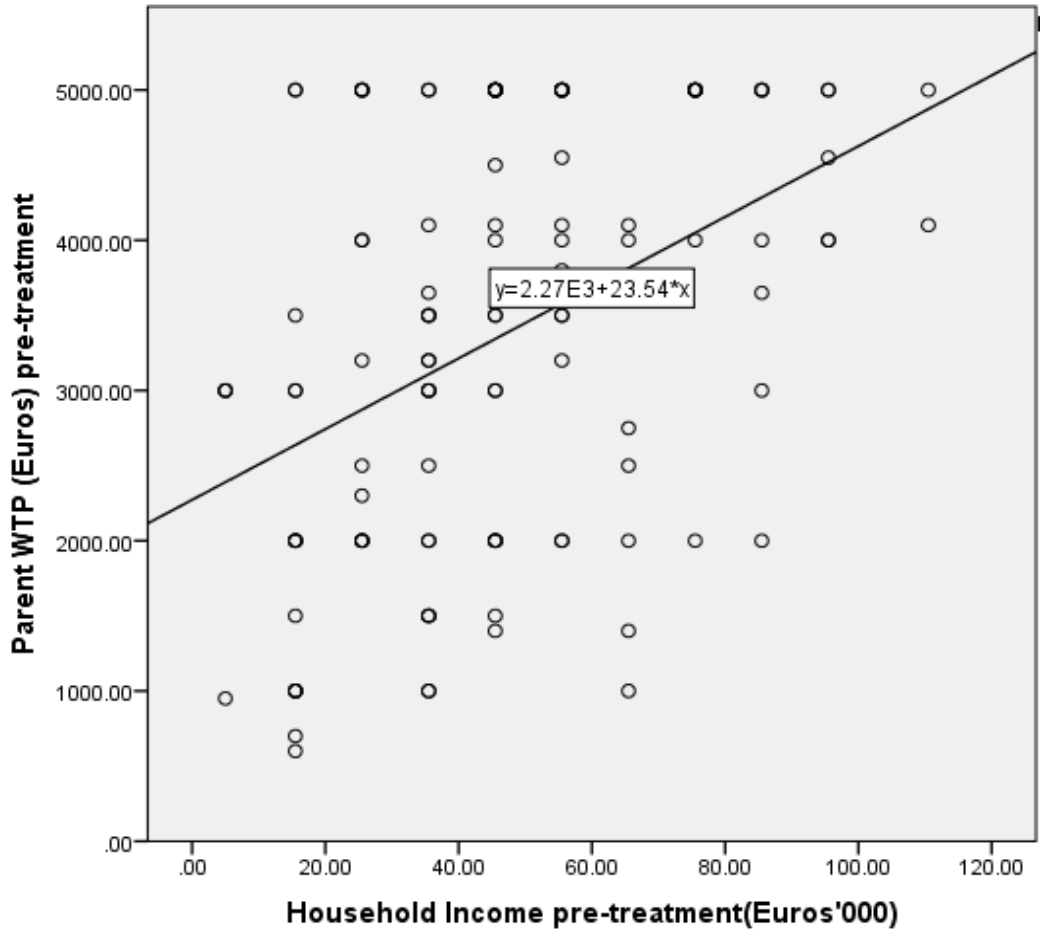
Table 60. Combined Privately Funded Group: Parameter estimates for the final Regression Model showing the significant possible explanatory factor of WTP.

Parameter	β	SE	t	P value	95% confidence interval
Intercept	2272.27	248.09	9.159	0.000	1780.98 to 2763.55
Household Income (Euros'000)	23.541	4.728	4.980	0.000	14.179 to 32.903
R^2 =0.174 (adjusted = 0.167) The lack if fit statistic F=2.088, p=0.037 which shows the model is a reasonable fit.					

For every 1,000 euro increase in income a parent is willing to pay on average 23.5 euro more. The lack of fit statistics was significant p=0.037.

The R Squared =0.174 (Adjusted R Squared =0 .167) for the model. The R squared value means that the model has a predictive value of 17. 4%.

To summarise the result a box plot (Figure 47) was used which shows the upward trend in WTP values as well as the large variation in values within each income category Table 61. The median WTP values are both above and below 'Market Value' €4,000 and above 'dental hospital costs' €950.



R^2 Linear = 0.174

Figure 46. The relationship of WTP(Euro) and Household income (Euro) pre-treatment represented by the regression line

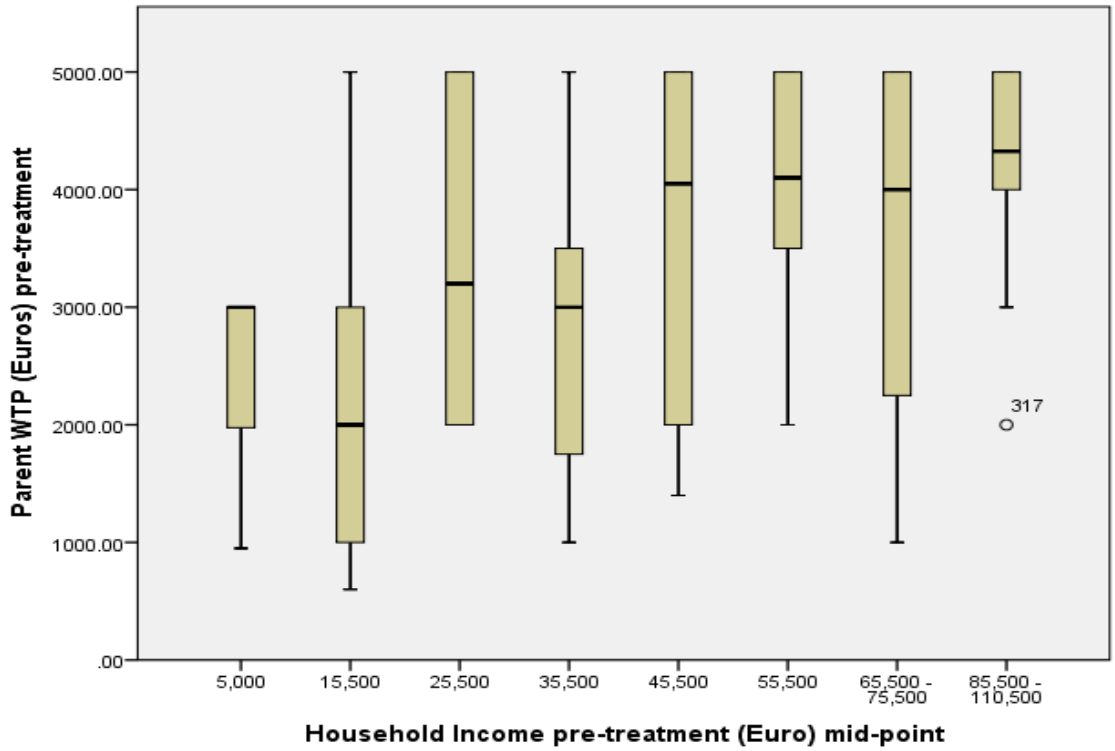


Figure 47. Boxplot of WTP pre-treatment (Euro) by Household Income Category (Euro)

Table 61: Combined privately funded Group: Frequency (%) of mid-point Household Income (Euro) Category

HI Categories (Euros'000)	Frequency	Percentage
5,000	4	3.3
15,500	16	13.3
25,500	13	10.8
35,500	20	16.7
45,500	22	18.3
55,500	15	12.5
65,500	8	6.7
75,500	8	6.7
85,500	7	5.8
95,500	5	4.2
110,500	2	1.7
Total	120	100%

6.4.2. Public funding system: Regression analysis for Parent WTP.

In this section an assessment of the factors influencing parental WTP of the publicly funded patient group was performed. A regression analysis, using the general linear model (GLM) procedure, was used to determine the best predictors of parent WTP (Euro) pre-treatment in the Public funding system. The distribution of both variables was positively skewed. Using untransformed data, and either a transformed WTP or transformed household income, a satisfactory model that met the assumptions could not be formed and two variables parent WTP (Euro) and Household Income (Euro), were transformed using natural logs.

A full model using Ln WTP(Euro) pre-treatment as the dependent variable, was fitted to the data. There were 126 cases with completed information at this step. There were 46 out of 177 (26%) that had missing data for both WTP and Household Income, some parents did not accompany their child to the appointment or refused to answer the questions.

The dependent variable WTP pre-treatment was transformed using natural log + constant. A zero amount was a recorded value and the constant used was set to the minimum non-zero amount recorded (74Euro 50Sterling equivalent). The independent variables included; age, IOTN AC, parent perceived need, Ln household income (Euro '000) as covariates, and gender and teased as factors. Non-significant variables were removed from the model by a backward elimination process. The explanatory factor with the highest non-significant p-value was removed and the model re-fitted. This process was repeated and additional cases were included when a non-significant variable with missing data was excluded from the analysis.

In the final model only one of the six variables (Ln Household income (Euro) pre-treatment) remained which was significant at the .05 level. This model was based on 131 cases. The relationship is represented by the graph Figure 48, with regression line fitted. The log-log regression model is equivalent to fitting a model in the form : $Y = A*X^K$; Ln Y = Ln A +K LnX.

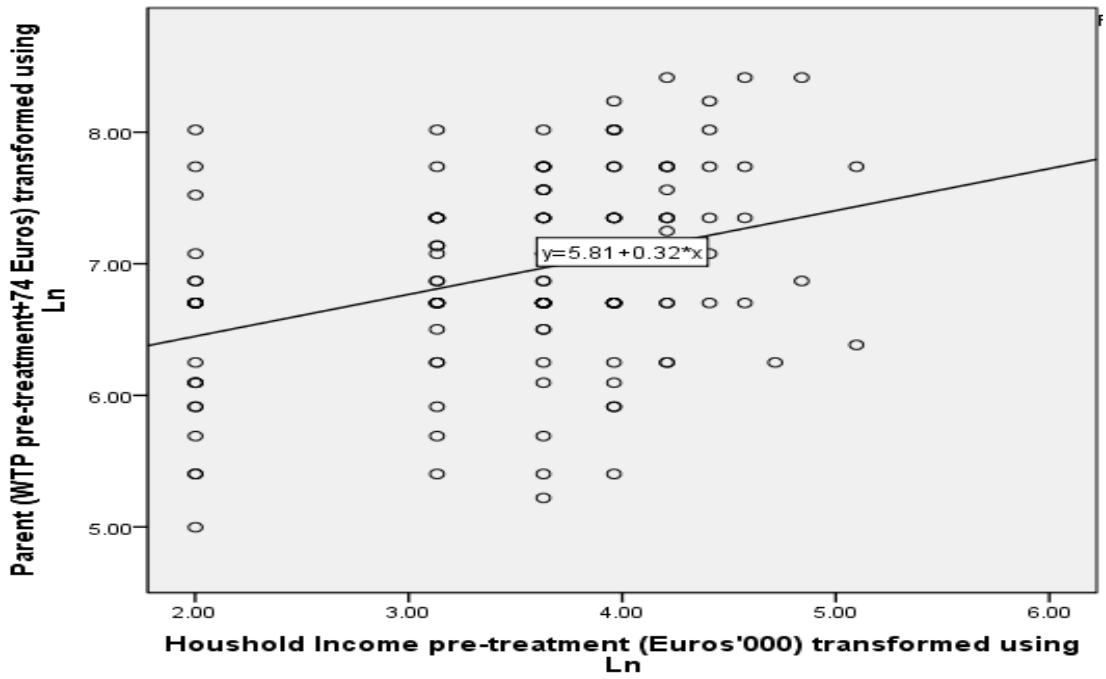
Where K = slope of line (0.319) ; Ln A= constant (5.812) and A= 334.3.

Table 62. Publicly Funded Group: Parameter estimates for the final General Linear Regression Model with dependent variable Ln (Parent WTP pre-treatment+74) showing the significant possible explanatory factor of WTP.

Parameter	β	SE	t	P value	95% confidence interval
Intercept	5.812	.267	21.779	0.000	5.284-6.340
Ln Household Income (‘000)	0.319	0.075	4.274	0.000	0.171-0.466
R^2 adjusted = 0.124 The lack if fit statistic F=0.750, p=0.647 which shows the model is a reasonable fit.					

This type of model is used by economists and indicates that values of Y are related to multiplicative values of X, e.g. x^2, x^3, or square root $x^{0.5}$, cubed root $x^{0.33}$. Here on average a public patients is willing to pay approximately 334.3 times the cubed root of their household income (‘000).

The normality plot for the standardized residuals that were assessed and the standardized residuals versus the predicted value were examined for non-linearity and unequal error variance assumptions, these assumptions appeared to be reasonable. Cook’s distance Leverage was plotted and although large values were observed, after examination of the cases they were not removed because they were not out of the line with the rest of the data.



R^2 Linear = 0.124

Figure 48. The relationship of Ln WTP(Euro) and Ln Household income (Euro) pre-treatment represented by the regression line.

To summarise the result a sactter plot (Figure 48) and a box plot (Figure 49) was used which shows the upward trend in WTP values as well as the large variation in values within each income category. The median WTP values are below 'Market Value' €2,486 and 'NHS costs' €2,200.

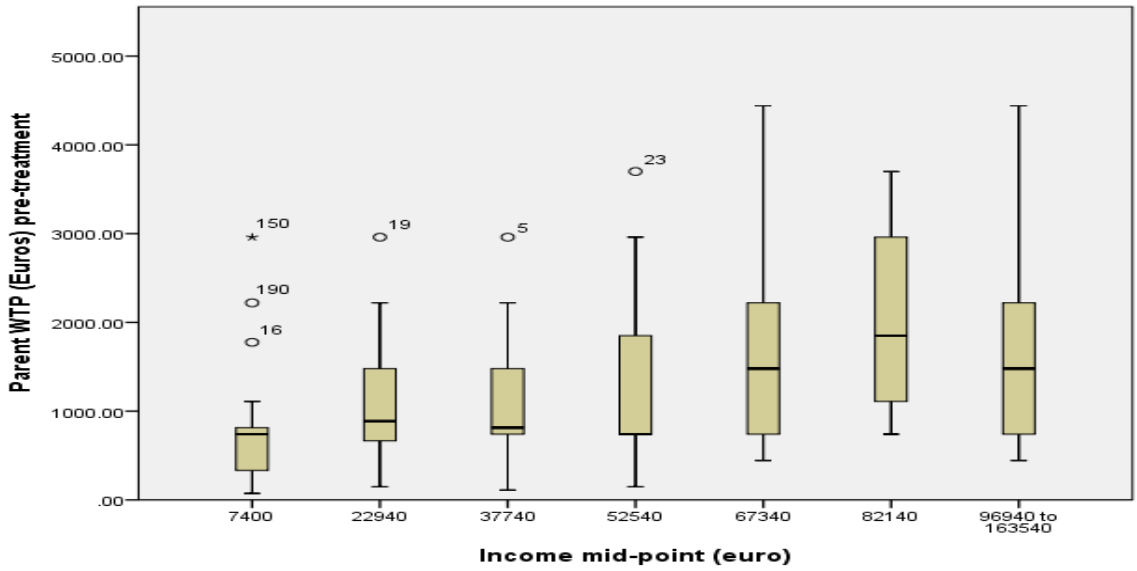


Figure 49. Boxplot of WTP pre-treatment (Euro) by Household Income Category (Euro)

Figure 50 shows the predicted WTP (EURO) pre-treatment values versus household income computed from the regression equation of the form $Y = A*X^K$.

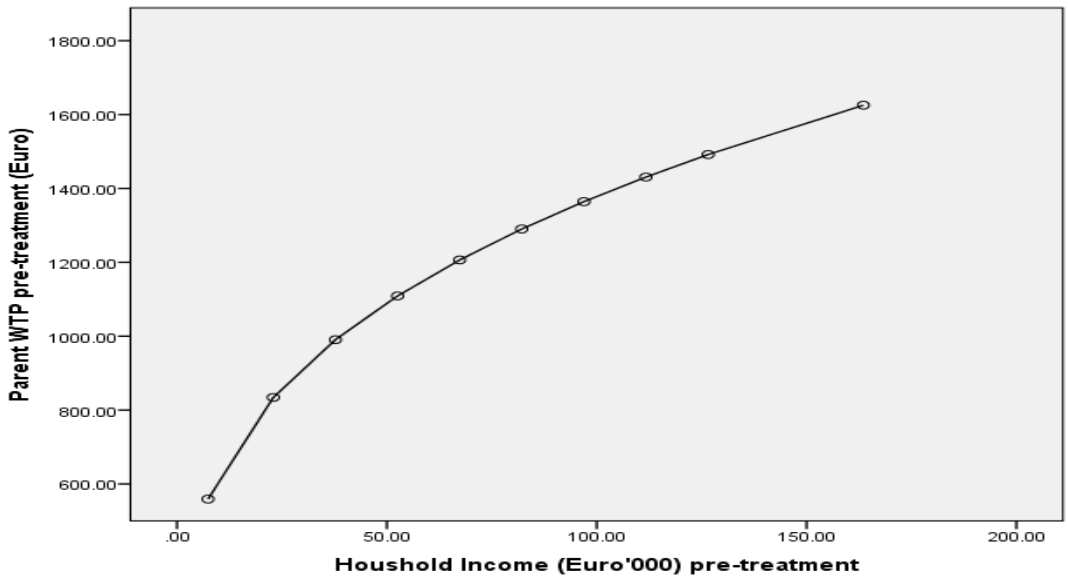


Figure 50. Predicted mean WTP pre-treatment (Euro) versus Household Income (Euro'000)

Table 63 shows the number of cases in the midpoints categories values for Household Income used in the regression.

Table 63. Publicly funded Group: Frequency (%) of mid-point Household Income (Euro) Category

HI Categories (Euros'000)	Frequency	Percentage
7,400	23	17.6
22,940	23	17.6
37,740	34	26.0
52,540	23	17.6
67,340	13	9.9
82,140	6	4.6
96,940	4	3.1
111,740	1	8.0
126,540	2	1.5
163,540	2	1.5
Total	131	100%

6.5. Willingness to Pay Discussion

6.5.1. Introduction

The requirement for all healthcare programmes, policies and interventions to be economically evaluated has increased in recent times, and economic evaluations are now considered an accepted tool for the appraisal of healthcare programmes (Cunningham, 2000). While in the United Kingdom (including NI), the National Institute of Health and Clinical Excellence (NICE) routinely uses economic analyses when developing clinical programmes. No equivalent system exists in the Republic of Ireland (RoI). With increasing healthcare cost and scarce resources, a perennial but vitally important question is: Where should money be allocated most appropriately? With increasing financial pressures on healthcare policymakers, research does provide high-quality evidence to aid decision making.

6.5.2. Discussion of methodology

Willingness-to-Pay is a method of measuring benefit in monetary terms in a cost-benefit analysis (CBA). In the present study, two methods of eliciting WTP were used, the single bounded dichotomous choice (SBDC), and open ended (OE) contingent valuation methods. In the WTP (SBDC) contingent valuation method the parents answered 'yes' or 'no' to a single bid, in a ‘take or leave it’ type scenario. The respondents accepted or rejected the bid, on the basis that consumers are accustomed to ‘yes or no’ to prices for goods or services. No complex explanation was required. In the WTP (OE) contingent valuation the parents were asked “What are you willing to pay to obtain straight teeth for your child?” and they placed their own monetary value on treatment and outcomes. The OE willingness to pay refers to the maximum amount in monetary terms that the parents were willing to sacrifice to obtain the benefits of an orthodontic programme

6.5.3. Aims of the study

The aims of the study were to use the WTP contingent valuation method of economic evaluation to investigate how an overall sample of parents from the Island of Ireland valued fixed appliance orthodontic treatment for their children. To elicit the WTP by dichotomous single bounded choice followed by open-ended contingent valuation methods. Secondly, to compare the WTP values between three groups within the overall sample: ‘zero fees’ (public healthcare), ‘subsidized fees’ (dental hospital), non-subsidized

fees (private practice). Thirdly to investigate if any demographic and socio-dental factors influence WTP: age, gender, parent perceived need, teasing, treatment need and household income.

6.5.4. Demographics

The overall WTP sample had equal numbers of public healthcare and private healthcare respondents who were parents of the adolescents being treated orthodontically. The average age of the participants was 13.34 years. There were more female participants 205(59.7%) than males 138(40.2%).

The combined overall sample consisted of 177 adolescents from both the public and private healthcare funding systems, making a total of 354. However, eleven participants in the private system sample were ≥18 years of age and their data was not used, which left 343 in the final analysis. The sub-groups of the private system had the following number of participants, the dental hospital (84) and private practice (51).

No normative need qualifying criteria existed at that time for access to treatment in either the publicly-funded or privately-funded healthcare systems. The overall sample was representative of the RoI societal model for orthodontic service in 2004, which was 50% publicly- funded and 50% privately funded. On a stand-alone basis the NI sample, represented the NHS system in 2004 with 100% of the adolescents being publicly funded. This forms the basis for analysis of the combined overall sample and the two healthcare systems seperately.

A WTP questionnaire designed by the health economist Professor Ciaran O'Neill was used to elicit parental WTP. The questionnaire was piloted using 27 dental hospital parents not taking part in the study. This ensured that the questions were correctly worded and understood by participants. By using the questionnaire, a surrogate measure of societal preferences was obtained. Zarnke et al. (1997) provided evidence that a public viewpoint may not be necessary because the monetary values obtained from an aggregation of individual preferences, may reflect the societal value placed on the programme of interest. Previous studies have used a public sample for example Smith et al. (2004), whereas the present study did not, mainly because the sample originated from two different societal backgrounds.

Previous WTP studies have reported an issue about who judges the WTP. If it is a patient or in the present study the parent, then the stakes are higher, compared with members of the public (Zarnke et al., 1997). However, the higher stakes bias had been eliminated for this cohort of parents because their children were guaranteed treatment.

The questionnaires were completed by an interviewer face-to-face, using experienced PhD students. Arrow et al. (1993) recommended the adoption of in-person close attention to the details of the WTP scenarios. interviews by experienced professional interviewers to motivate respondents to pay

6.5.4.1. Elicitation of WTP monetary values

In the private system parents paid directly 'out of pocket' but in the public non-fee-paying system, parents pay indirectly through taxes. The parents who paid treatment fees had 'real life' WTP elicited, and in contrast parents who paid no fees had 'hypothetical' WTP elicited. Care was taken to ensure that parents in the public system knew that their answers were not going to make a change to their no-fees status (Whynes, et al., 2005).

6.5.4.2. Single bounded dichotomous choice elicitation

Respondents were offered a single-bid from a range of different values for the public and private respondents; public system ranges (£250, £500, £750, £1,000, £1,250, £1,500, £1,750, £2,000, £2,500); private system ranges (€950, €1,400, €1,850, €2,300, €2,750, €3,200, €3,650, €4,100, €4,550, €5,000). The selection of the bid per respondent was random but the full range of bids were applied.

6.5.4.3. Discussion of SBDC

There was a higher response rate (170/177(96%)) in the public system to the SBDC question ['yes' or 'no' to a given price for treatment] compared to the private system (122/166=73.5%). There were a total of 97/170(54.8%) of the public parents who said yes to the bid offered and 95/122(77.9%) of the private sector. The difference in the number of respondents saying 'yes' to the bid prices, highlighted that more parents in the privately funded system had a WTP attitude to orthodontic treatment fees. There could be an expectation to pay in a healthcare system that has a mixture of parents who 'pay' and 'do not pay' for orthodontic treatment rather than a society where no-one pays. A

study by Tulloch et al. (1984) reported that, "American parents were willing to pay for orthodontic treatment at societal rates, because they expected to have to pay them".

The data showed that for both healthcare systems the respondents said 'yes' mainly to prices below the societal market values. The publicly and privately funded systems had significantly different societal market values (£1,500 and €4,000 respectively), and this differential made it difficult to compare the WTP between the two systems. Therefore, it was easier to perform a within systems comparison of respondent's WTP answers with their societal market values.

The public system data suggested that 54.8% were willing to pay for treatment, the majority of those being willing to pay ≤66% of the societal market value of £1,500. Overall, 83/170 (48%) parents said yes to the 'market value or below' and only 14/170 (8.2%) said yes to 'market value or above'. The prices were hypothetical but there was a definite trend towards being willing to pay market value or less, rather than market value or more. Of the 18 respondents that were offered the market value bid of £1,500, 10/18(55%) refused to pay.

Knowledge of the 'highstreet price' may have influenced their WTP answers. However, for the majority there appeared to be an expectation that healthcare bodies should be at least subsidizing fees, if they were expected to pay 'out of pocket' for orthodontic treatment. The lowest bid offered was £250 and 3/22(13.6%) said no to this, so for this cohort free treatment may have been the expectation.

The private system data suggests that 71.7% of parents were WTP for treatment. For the lowest bid of €950, 15/15(100%) all respondents answered yes, so there was an expectation by parents having to pay something towards treatement rather than expecting free treatment. Of the overall, 56/122 (46%) were WTP 'market value or below' rather than 'market value of above' 39/122 (32%) of the sample. The majority of respondents 61/77(79.2%) were WTP €3,650 Euros or below, which was greater than two-thirds of market value.

This method of SBDC bidding certainly highlighted societal differences in parental attitudes towards paying for orthdontic treatment. The NHS in the UK had been in existance for 60 years at the time of the study and parents were not accustomed to paying for health services and in the RoI HSE due to restricted access to free treatment, parents were accustomed to paying for treatment. The overarching research protocol was to

determine if qualifying criteria should be introduced into the NI NHS system. This study confirms the hypothesis that if parents have to pay for treatment by restricting an all encompassing access to free treatment, then parents are more willing to pay. By restricting access to treatment then parents have to pay, although this may cause hardship for those chidren whose parents do not have the ability to pay and whereby the only means of access is judged by severity of the malocclusion.

Past studies claim that the SBDC method has been found to result in the inflation of mean WTP amounts. Apparently due to a 'yea-saying' problem, where respondents register a positive vote for the treatment offered but in reality they would pay a much lower amount. For this study the results using the SBDC method, showed no inflated WTP responses and the bias of 'yea-saying' was not apparent and the values placed rarely exceeded market values (Fatani and Al-Yousef, 2016).

This methodology although normally applied to large societal surveys worked for this smaller study with over-inflated bids being largely rejected. Of course, it is possible that most parents were aware of the societal market value rates but that is unknown. It would be important for future studies to establish the level of knowledge of parents, particularly their knowledge of the market value price they would pay, if they had to pay.

6.5.4.4. Open-ended contingent valuation method

The suitability of the sample size makes OE the preferred choice for the numbers in the present study. The open-ended response allows smaller sample sizes, but is alleged to have incentive compatibility problems (Klose, 1999). However, incentive bias was reduced because the parents were incentivised by the same health gain. Essentially, WTP analysis provides a cost-benefit framework, focusing on an individualistic foundation and relying on the the elicitation of the individual's WTP for health gain. Since WTP is closely associated with the ability to pay, a health state valuation based on WTP alone will disadvantage those with lower incomes by directly linking health effects to individual economic means (Hurley, 2000). However a range of socio-economic groups were included in this study with overlapping findings, despite this diversity.

The response rate for the OE contingent valuation method was 272/343 (79.3%) for the overall sample, with sub-groups, 137/343(39.94%) public; 135/343(39.36%) private; ≤18 years old). In the private system 31 parents did not answer the question; for the public 18 parents answered 'zero', 11 answered 'unsure' and 11 'did not answer'. OE valuation

questions may encourage item non-response, since they can be harder for respondents to answer than simple yes/no alternatives. The 18 parents with zero WTP could have been incentivised to strategically vote for no change in the provision of NHS funded orthodontic treatment for adolescents ≤18 years of age (18/137=13%). The 18 zero responses were not used in the analysis and it is unkown if they were protest votes.

The results indicate a significantly different WTP between the public and private healthcare systems and possibly societal difference between NI and RoI respondents. The median values for WTP [RoI private group median=€3,500, NI public group median=€740], were significantly different (Mann U= 16367, p<.001, n=272).

Within the RoI societal group, the private system was sub-divided; the dental hospital subsidized group with a median WTP of €3,000 for 84/135 (62%) parents; the private non-subsidized group with a median WTP of €4,100 for 51/135(38%) parents; the median values were significantly different (p<0.013). The payment of different fees within the same societal group produced significantly different WTP values. The subsidized group parents were willing to pay three times the amount they were being charged (€950) and within this group there were parents in the 75th percentile who were WTP market value of €4,000.

The median income level of the public system parents was €37,740 and the subsidized private group €35,500. The public group had equal or more means to pay but the median WTP values did not reflect this (€740 public compared €3,000 subsidized private). The public group may have expressed a strategic vote or parents who pay even subsidized fees rather than no fees value are then willing to pay more.

6.5.4.5. Comparing the elicitation methods

This study demonstrates a correlation between the DC and OE methodologies. The results indicate that using the SBDC and OE and methodology, similar ranges of WTP were identified. In the private system more respondents said 'yes' rather 'no' to the range of WTP prices of €3,200 to €4,100 and had median OE elicitations between €3,000 and €4,000. In the public non-fee-paying system most of the sample said yes to paying <£1,000 using the DC method and in the OE method the majority were WTP <£1,000.

The SBDC and OE data suggests that parents who were experiencing 'real fees', valued orthodontic treatment more. However, socio-economic status must be considered in

relation to WTP elicitation. In the public system 46 households had incomes ≤€22,940 and in the private system 33 households had incomes of ≤€25,500. It may be beneficial for policy makers to means test households when considering the introduction of a subsidized payment system rather than free treatment or limiting access to treatment by virtue of malocclusion traits alone. This would ensure no disadvantage is experienced by low income households.

Statistically for the OE methodology mean WTP values can be calculated and be inclusive of all income levels across the sample. The mean WTP value pre-treatment for the public system households was €1,251.41 (£854.54) and the private system €3,3207.52. The post-treatment WTP values were €1,332,50 (£900.3) and €3,046.02. These figures represent WTP elicitation from the same parent pre-and post-treatment. The pre-treatment WTP is 57% of market value for the public system and 80% for the private system. The higher income category ≥€67,340 had (28/131(21.4%) of the sample for the public system and 30/120(25%) for private system. The mean WTP for the public system was low despite 21.4% of the parents having increased means, thus indicating a possible societal influence, conditioning to free NHS treatment, voting strategically or knowledge of market values.

How and if parents had prior knowledge of the 'NI market value' needs to be established in future studies. The parents in low income with less ability to pay may not have voted strategically and their low WTP values are more legitimate due to a reduced ability to pay. High income households may feel they have already paid for treatment through their higher taxes. Policy makers may like to consider tax incentives for high earners to encourage them to seek treatment in private fee-paying clinics. This would free up the system for children from low-income households. Provided that their low income status is taken into account during the qualification process.

6.5.4.6. Critique of methods

Johannesson et al. (1996) advocate the use of a binary technique when eliciting WTP. The present study used a binary question followed by an OE question. Drummond at al. (1997) discussed the risk of anchor-point (starting point) bias. Traditional binary contingent valuation questions give respondents only one bid belonging to a market situation since individuals are accustomed to deciding whether or not to buy a good at a specific price. The present study used this methodology by giving individuals the

opportunity to reject or accept one bid in a binary contingent valuation approach, and the sample was of adequate size to divide and stratify the individuals into sub-samples of healthcare systems, public and private. The individuals were given a second open-ended question to make it possible to calculate the mean WTP. While consideration was given to the risk of starting-point bias, it was felt that the risk of non-responses would be greater with just a single open-ended question. The variance within the distribution of the respondents' WTP results, above and below the bid, showed that the respondents did make an active choice.

Biases based on methodology could have occurred when respondents received information, processed information or reported their answers in face-to-face interviews Bayoumi (2004). To avoid strategic bias precautions were taken. The interviewers were two highly educated academics, recruited to be PhD students on the project, one from within UCC (RoI) and an external appointment in QUB (NI). Both administered the data collection and performed interviews in their jurisdictions. Both had personnel- and behaviour-related training and experience in conducting interviews in their research. They had no professional dental background or health economics background, which decreased the risk of them influencing the respondents. The interviewers read the WTP question completely according to the interview requirements and repeated the question if something was unclear to the respondent. The public system respondents appeared to understand the presented hypothetical scenario, which is of potential importance in CVM studies (O'Brien and Gafni, 1996).

The interviews and meeting places required the interviewers to commit extensive time and effort to travelling to practices, particularly in the RoI. The interviews and questionnaires were also completed in separate offices or quiet areas in private dental clinics which were deemed neutral meeting places, away from clinical areas where their children were being treated. These precautions could be considered to have reduced the risk of biases.

If the respondents wrote a zero value for the WTP, the interviewer asked if that corresponded with their true value in order to avoid 'non-responses or protest zero bias'. Zero valuations and outliers existed in the present study and were not used in the final analysis. Dental clinics were offered a small compensation towards study model expenses as encouragement, which of course could have some effect, especially to

increase participation. The risk that the compensation influenced the answers is not plausible.

The interview technique being face-to-face contributed to the reduction of hypothetical and yea-saying biases. Hypothetical, and yea-saying bias can produce inflated responses but there were only 2/ 272 inflated of WTP monetary values 8,000 and 10,000 Euros, confirming that reduction of bias was achieved with careful attention being placed on the interview process.

Since WTP is associated with the ability to pay, some postulate that it may lead to skewed resource allocations that favour the rich rather than most of the population (Donaldson, 2001). This would be true in cases where the sampling is not representative of the target population, which is not the case in this study. Suggestions to circumvent this include an examination of preferences across different social classes, which has also been achieved in the present study; 35.2 % of the public sample had incomes < €22,000 and 27.4% of the private sample had incomes <€25,000.

Both elicitation methods produced similar WTP values, the WTP values were less than market value for both healthcare systems. This study contributes to the validation of using OE methodology that is reported to be susceptible to high rates of questionable and highly skewed responses. There was no starting point bias, and the OE valuations were not open-ended by virtue of combining the methodologies and using dichotomous choice to guide the respondent.

6.5.5. Discussion of Factors

The results of the study indicate that.

1. WTP was higher for higher income households and increased as income increased.

2. Age, gender, clinical treatment need (IOTN AC), being teased or parent perceived need were not useful factors in identifying what influences parental WTP.

6.5.5.1. Relationship between Income and WTP

The total number of parents who were willing to share their income information was 251 out of 343 (73.1%). Separate regression analyses were performed for the public and private systems. For both multivariate regression models Household Income was the most significant variable, the WTP amount increased proportionately with family income. The R squared value means the model had a predictive value of 12.4% public and 17.4% private. For both regression models WTP increased with household income.

A critical review of the WTP literature by Tan et al. (2017) examined eleven studies of WTP and income. They reported that for eight out of 11 studies that assessed income, there was a statistically significant association between income and WTP. In cases where income was related to WTP, the tendency was for higher WTP values with higher incomes. These 11 studies included dental studies that support the results of the present study (Matthews et al., 1999;Shackley et al., 2000), other dental studies could find no relationship between income and WTP (Smith et al., 2004;Matthews et al., 2002;Birch et al., 2004).

There is a scarcity in the current literature of studies that compare publicly and privately funded systems for orthodontic treatment. Only two studies reported on different funding systems and WTP for orthodontic treatment. In a study by Srivastava et al. (2014), higher income was associated with higher WTP in a public funding scenario, but no statistically significant relationship was detected for an out-of-pocket payment scenario. Garni et al. (2012) found that the WTP amount increased with income and a higher mean WTP was found for private clinics compared to government dental clinics (β=1.073; p=0.03). Widström et al. (2012) found that an annual income of €25,000 to more than €50,000 was positively associated with a higher WTP when compared to an income of less than €10,000. Pavlova et al. (2004) found this not to be the case for the parents with incomes between €10,000-€25,000 compared to those on a societal basic wage.

The median income levels for each group were €37,740 for public non-fee-paying; €35,500 for subsidized private fee-paying; €55,000 for non-subsidized private fee-paying. For incomes above €65,000 the median WTP for 30 respondents was €1,480 and for 28 respondents €4,100 from the public and combined private groups respectively. The WTP was significantly different at similar income levels $p<0.001$, suggesting a societal difference with the ability to pay being equal.

There was very little difference in the range of incomes for parents in the public and subsidized private systems, the 25th and 75th percentiles for range of household incomes were €22,940, €52,540 and €23,000, €55,000 with respondent numbers of 46 and 43 for income ≤€22,940 and €23,000 respectively. Again, the WTP levels were significantly different between these two low income groups, €740 and €3,000 respectively ($p<0.001$). With similar sample numbers in the lowest income category and the same ability to pay, it is not possible to explain the significantly different WTP values by using income level. Again this is indicative of societal differences. It is noteworthy to mention that while the ability to pay may be the same based on income, it is unequal in terms of the market values that would have to be paid if the parents had to pay privately (€2,000 NI, €4,000 RoI).

Another method of viewing WTP is by calculating the median WTP values as percentages of household income, as described by Damschroder et al. (2007). The present results show that parents were willing to sacrifice the following percentages of their income: 1.96% public; 8.5% subsidized; 7.5% non-subsidized private fee-paying. The public system parents were willing to sacrifice a much lower percentage of household income compared with the parents from either sub-group of the private system. Dramschroder et al. (2007) found that the percentage WTP of the respondents total financial resources to be unrelated to income. However, using percentages had better WTP distribution properties, greater sensitivity to the severity of health issues, and fewer questionable WTP values.

Public healthcare managers deciding a possible introduction of subsidized fees rather than free treatment for all, could introduce evidence-based scales based on percentages derived from WTP income studies. Certainly in this study, parents who paid subsidized fees rather than with no-fees, appear to value treatment more. Also, the low WTP values even at higher income suggests that NI parents may have been conditioned to expect free-treatment by virtue of the NHS system philosophy that there is free healthcare for all, independent of income. However, introducing restrictions to treatment based on malocclusion alone, could disadvantage low socio-economic groups with no ability to pay. Instead, a blended approach could be considered.

6.5.5.2. Age, Gender, Teasing, IOTN AC, Perceived need

The age ranges of the sample were 10-12 years (38.7%), 13-14 years (45.6%), 15-18years (18.7%), most of the sample were in the normal age range for orthodontic fixed appliance treatment (84.3%) and 18.7% marginally older. Age was not a significant variable in the regression analysis. Other studies report the same findings (Pavlova et al., 2004; Smith et al., 2004). In this study the bivariate analysis, showed no correlation between age and WTP, the trend was for parents to be willing to pay more for younger children (r_s= -0.103), which was close to being significant p=0.088. The opposite was the case for a study on sealants and fillings for children of a similar age to the present study, the parental WTP was higher for older children (Tianviwat et al., 2008).

The sample consisted of 170 females and 102 males that had a measure of parental WTP. In the bivariate analysis parents were WTP more for males (€2,200) compared to females (€1,850) but this was not significant (p=0.076). Tan et al. (2017) reported on thirteen publications that reported no significant difference in parental WTP for females and males. However, studies have reported a significant gender difference, with females exclusively having a higher WTP (Leung and McGrath, 2010;Augusti et al., 2014; Vernazza et al., 2015).

In the present study, bullying was investigated using the child's experience of being teased about how their teeth looked. Twenty-five children answered yes to the question about being teased because of the appearance of their teeth. The system where the child was treated did not influence parental WTP for children being teased.

Using IOTN AC there were overall 20% with little or no need; 40% with definite need; 40% with great need. If this is divided into public non-fee-paying; 24% had little or no need; 34% definite need; 42% great need and private fee-paying; 17% little or no need; 46% definite need; 37% great need. There was no correlation between parental WTP, and the treatment need level of their children. The severity of the malocclusion did not explain the parental WTP values placed on fixed appliance orthodontic treatment. At the time of the study the public service also paid for children who had little or no need for treatment. This study does not support the hypothesis that if a child has a greater objective need for treatment their parents will value treatment more.

The perceived need level reported by parents was highest in the public non-fee-paying system (VAS, 92mm compared to 86mm subsidized private and 90mm non-subsidized

private), even though their WTP valuation was the lowest. This was not significant in the regression analysis. It is possible that the level of perceived need is higher in a public system because parents may feel the need to be demanding to secure the actual service for their children. For public system parents, having high perceived need values does not equate to a higher willingness to pay for treatment if parents had to pay out-of-pocket for it.

6.5.6. Limitations of the study

Not being able to use a cohort of non-fee paying RoI parents did not weaken the study. The aim of study was comparison of WTP values between non-fee paying and fee-paying respondents and this was achieved and it highlighted the importance of societal differences. However, the societal differences which emerged made direct comparison between the healthcare systems more complex. Strategic bias was more apparent in the public sample. Policy makers in the RoI may benefit by analysing the WTP values placed on orthodontic treatment using a sample of publicly funded and privately funded respondents with no societal differences.

The same parent being asked their WTP could improve the study in terms of pre- and post-treatment data. If a parent does not attend the appointment on the day allocated to administration of the WTP questionnaire, then a phone interview should be arranged. If new technology of video calling was used, then it would equate to face-to-face interactions, thus ensuring the same reduction in biases. Using a phone methodology would also reduce missing data. Ethical approval for this study did not include permission to contact parents outside of clinical appointments.

6.5.7. Future studies

Future studies should establish the parents' ability to pay within the WTP questionnaire. In previous studies patients were asked to consider their ability to pay while reporting their WTP for example in the studies by Pavlova et al. (2004) and Vernazza et al. (2015) they used a separate ability to pay questionnaire. Their questions emphasized whether or not respondents "have this much less money per month to spend or save" and are to "assume payment" is "from (their) own money "or loan "funds from bank".

Future studies for Ireland should include an assessment of the level of education of the parents. Higher education was positively related to a higher WTP in two publications in

the literature (Tianviwat et al., 2008; Leung and McGrath, 2010). WTP values have been compared between respondents with a minimum of a graduate university (Srivastava et al., 2014), university (Pavlova et al., 2004), or secondary school education (Tianviwat et al., 2008; Leung and McGrath, 2010).

Future studies should concentrate on low socio-economic groups who do not qualify for treatment, especially if normative need is used as the only measure for access to publicly funded orthodontic treatment. Future studies should consider exploring the effect of unmet need on this group as a result of their economic means and whether parental 'ability to pay' should be part of the initial assessment in public health systems.

6.6. Conclusions

The WTP values suggest parental knowledge of market values for orthodontic care. Results suggest a societal difference in attitude to payment for orthodontic care. The level of perceived need is higher in public healthcare systems. Having high perceived need values does not equate to a high willingness to pay for treatment if parents had to pay out-of-pocket. Higher household income does not translate to higher WTP values in the public healthcare system investigated in this study. Within both publicly and privately funded healthcare systems WTP values increase with increased household income.

CHAPTER 7

COMPLIANCE

7.1. Patient Compliance Oral Hygiene

7.1.1. Introduction

The aims of Chapter 7 are to; (a) Investigate compliance which, by definition for this study is: The average compliance of an individual determined by the treating orthodontist three months into treatment and at the end of treatment. The compliance measure used was the level of oral hygiene as assessed by the clinician, (b) investigate if factors such as age, gender, healthcare funding system, parental willingness-to-pay (WTP) and professional normative need (IOTN AC) influenced patient compliance during orthodontic treatment, (c) to investigate if treatment outcomes measured by PAR are related to patient compliance, (d) to investigate the changes in compliance during treatment, by comparing the changes in the compliance measured at three months (T1) and the compliance at the end of treatment (T2).

The orthodontist recorded the level of oral hygiene over the first 3 months of treatment and again in the final 3 months of treatment, using the specially constructed compliance questionnaire. Each assessment therefore represented an assessment of oral hygiene over a three-month period. The orthodontist completed the questionnaire at the 3rd fixed appliance appointment after the appliances were placed (T1) and the last appointment when the appliances were removed (T2).

The average compliance variable was named patient compliance (OH) which was computed by taking the average of the oral hygiene scores recorded at T1 and T2. Patient compliance (OH) was analysed for patients who were aged 18 years and under pre-treatment. Prior to treatment commencing the level of patient oral hygiene was deemed acceptable by each treating orthodontist. The judgement of oral hygiene levels by the orthodontist during treatment, was therefore a measure of improvement, maintenance of the standard, or a deterioration from the original acceptable level.

The results were analysed using data from the overall patient sample and separately for the patients in the public and private healthcare funding systems, within the overall sample. The overall sample will be referred to as the combined sample in the analysis presented. The analysis is presented as follows (1) the patient compliance (Oral Hygiene), Section 7.2; (2) overall descriptive statistics, Section 7.3; (3) bivariate analysis to identify variables significantly associated with patient compliance, Section 7.4; (4) multiple

regression of patient compliance Section 7.5; (5) the outcome of treatment measured using PAR and the association of PAR with patient compliance Section 7.6; and (6) the change in individual compliance scores from T1 to T2 Section 7.7.

7.1.2. Patient Compliance (Oral Hygiene) during treatment and funding system

Orthodontists recorded oral hygiene levels (OH) as below average (scores 1-2), as average (score 3) and as above average (scores 4-5). OH was measured at T1 and T2 and Appendix 9.8 Table 81 gives the detail of OH levels at T1 and T2 for the Public and Private Systems as well as the combined total for the entire sample. The migration of cases into the different categories of OH between T1 and T2 is shown in section 7.7.

For this analysis, we have taken the average of the two readings (T1 and T2) and formed a new variable namely Patient Compliance (OH) during treatment, where 1.0-2.5 was labelled as below average, 3.0-3.5 as average, 4.0 to 5.0 as above average compliance. Table 64 demonstrates the average level of compliance over the course of fixed appliance treatment using the average of compliance for T1 and T2 (patient compliance OH) for the combined samples, as well as the level of compliance in the public system and the private system.

Table 64. The frequency of levels of patient compliance (average oral hygiene) for the private and public healthcare systems and for the combined sample.

Patient Compliance (OH) level	Public Healthcare System (PUHS) n(%)	Private Healthcare System (PRHS) n(%)	Combined sample (PUHS + PRHS) n(%)
1.0-2.5 Below average	15(14.9)	20(14.0)	35(14.3)
3.0-3.5 Average	26(25.7)	42(29.4)	68(27.9)
4.0-5.0 Above average	60(59.4)	81(56.6)	141(57.8)
Total	101 (100%)	143 (100%)	244 (100%)

In the combined sample the majority of patients had above average compliance (57.8%) and this pattern is reflected within each healthcare system (PUHS 59.4%; PRHS 56.6%). The percentage of patients with below average compliance (OH) levels in the combined sample was (14.3%). The majority of patients (85.7%) had an acceptable level of compliance (oral hygiene average or above average) during treatment Table 62. Figure 51 illustrates the frequency levels of patient compliance (OH) across the public and private Healthcare systems.

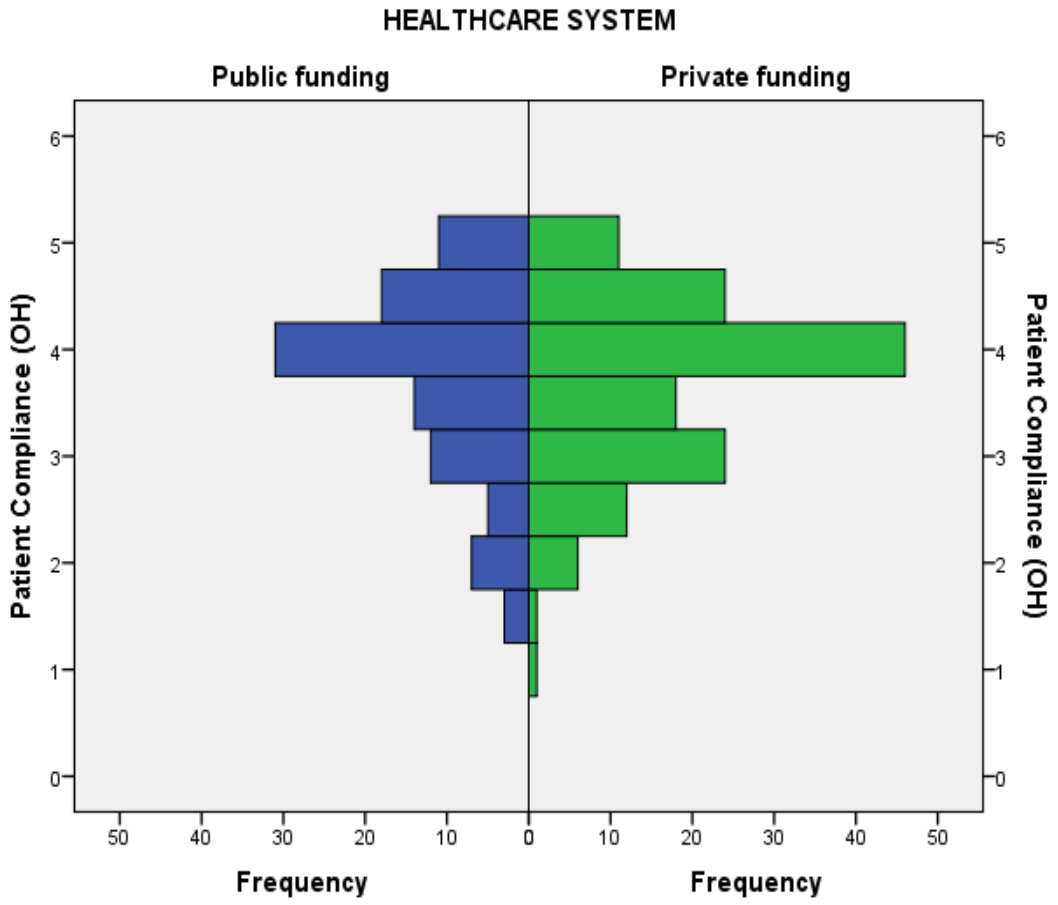


Figure 51. The frequency distribution of Patient Compliance (OH) values for the Public (publicly funded) and Private (privately funded) Healthcare Systems.

The graph illustrates that the majority of patients had OH levels above the average score of 3.0. It also illustrates that there were patients receiving treatment in both systems with below average compliance levels (< 3.0). The median (Q1, Q3) Patient Compliance (OH) was 4.0 (3.0, 4.5) for the combined sample with a similar distribution in the public and private healthcare systems Table 65.

Table 65. The frequency of levels of Average Compliance (patient compliance OH) for the overall, private and public healthcare funding systems

Patient Compliance (OH) level	Public System n(%)	Private System n(%)	Overall sample n(%)
1.0-2.5 Below average	15(14.9)	20(14.0)	35(14.3)
3.0-3.5 Average	26(25.7)	42(29.4)	68(27.9)
4.0-5.0 Above average	60(59.4)	81(56.6)	141(57.8)
Total	101 (100%)	143 (100%)	244 (100%)

The median scores for the level of patient compliance in the public and private systems was 4.0. A Mann-Whitney U test showed that the distribution of patient compliance was similar across both healthcare funding systems (Mann-Whitney U= 6,900.00, p=0.545, n=244).

Summary: For the combined sample, and the public and the private healthcare systems separately, the median compliance values during treatment were average or above average for the majority of the sample, and there was no significant difference between the public and private healthcare systems.

7.2. The factors that influence patient compliance (OH).

7.2.1. Descriptive statistics

Patient and parent characteristics are presented in Table 66 and Table 67 for those cases where an average compliance was recorded (patient compliance OH).

In the sample 71.1% (244/343) had an oral hygiene measurement recorded by the treating orthodontist at the two time-points. A breakdown by funding system revealed that 76/177(42.9%) of the public patients and 23/166 (13.9%) of the private patients were missing this computed measurement. Twenty-three of the public system and private system had not completed treatment at the end date of the study time period and 53 of the public patients were missing either the T1 or T2 or both compliance measures.

Table 66. The frequency counts and percentages of the patient characteristics for patient compliance (OH) by healthcare system.

Characteristic	Healthcare system		
	Public (PUHS) n=101	**Private (PRHS) n=143**	**Combined sample n=244**
Gender			
Male	37(36.6%)	58(40.6%)	95(38.9%)
Female	64(63.4%)	85(59.4%)	149(61.1%)
Age			
Age 10-12	32(31.7%)	51(35.7%)	83(34.1%)
Age 13-14	66(65.3%)	80(55.9%)	146(59.8%)
Age 15-18	3(3.0%)	12(8.4%)	14(6.1%)
Pre-treatment IOTN AC*	n=101	n=143	n=244
Categories 1-4 (mild)	19(18.8%)	23(17.1%)	42(17.2%)
Categories 5-7 (moderate)	38(37.6%)	68(47.6%)	105(43.4%)
Categories 8-10 (severe)	44(43.6%)	52(36.3%)	96(39.4%)

**The Index of Orthodontic treatment need aesthetic component prior to treatment.*

The majority of the combined sample were female, aged 13-14 years and were in Category (5-7) of IOTN AC. Both the public and private systems had (18.8% and 17.1%) respectively in categories (1-4) of IOTN AC with little or no need for treatment.

Table 67. Parental Characteristics: Household Income Distribution (€) and WTP (€) by funding system.

Healthcare Funding system			
	Public (PUFS)	**Private (PRFS)**	**Overall sample**
Household Income (HI) pre-treatment: Parental factor			
Household Income level Euros	n=96	n=109	n=205
≤30,000	35(36.5%)	30(27.5%)	65(31.7%)
30,000-60,000	38(39.6%)	49(45.0%)	87(42.4%)
60,001 thru 165,000	23(23.9%)	30(27.5%)	53(25.9%)
Willingness to Pay (WTP) pre-treatment: Parental factor			
Willingness to Pay level Euros	n=78	n=117	n=195
<1500	57(73%)	19(16.2%)	76(38.9%)
1501-3500	16(75%)	44(37.6%)	60(30.8%)
3501 thru 6000	5(6%)	54(46.2%)	59(30.3%)

Table 67 reveals that household income was different across the two healthcare system groups, especially the ≤30,000 Euro category, with approximately 10% more households in this range in the public system. There was a sizeable decrease (from n=143 to n=109) in the number of parents responding to the HI question in the private system. WTP was again very different in the two systems, with those in the private system willing to pay substantially more than the public system. For the WTP category ≤1500 there was 73% of public system parents in this range. This resulted in the majority of the combined sample being WTP ≤1500 Euros even though the majority of the private system parents were WTP ≥3500 Euros (3501 thru 6000).

7.2.2. The impact of Age on Patient Compliance (OH)

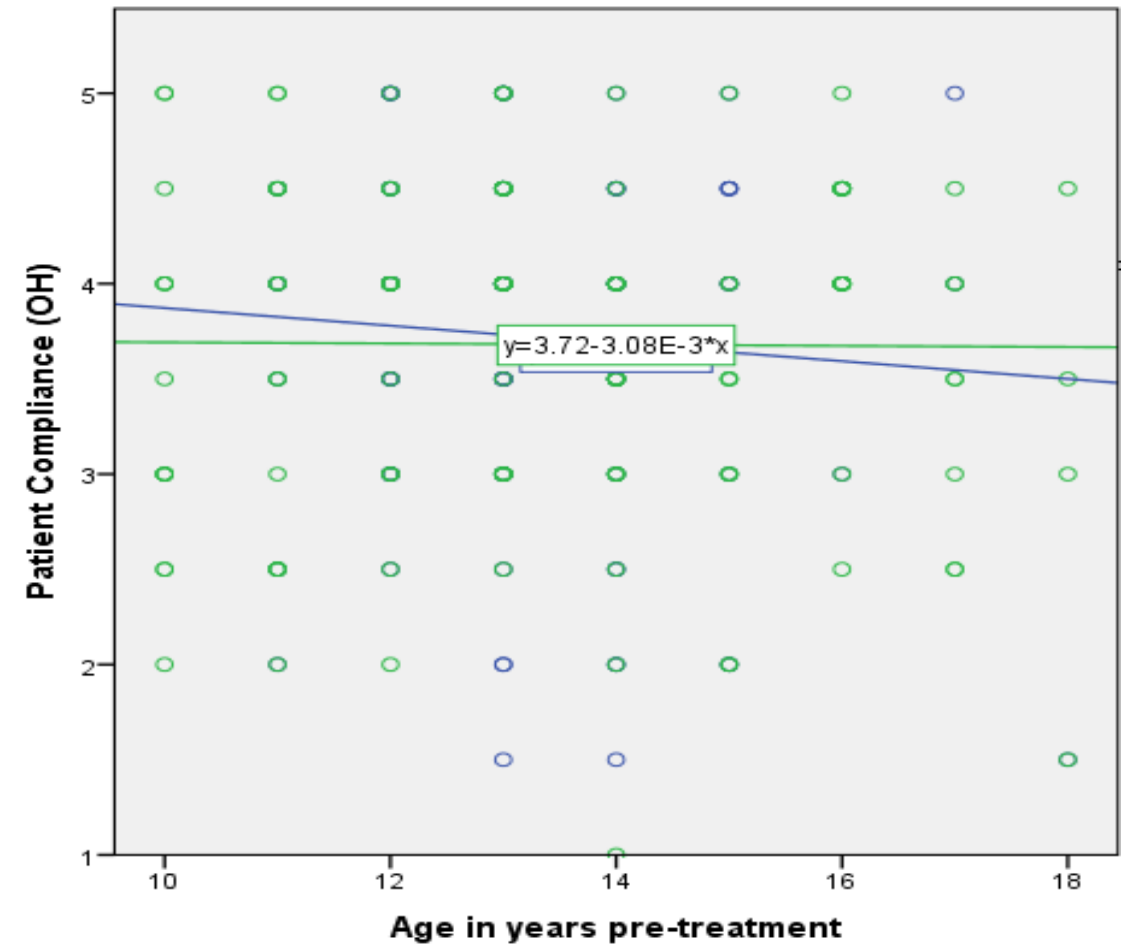
In the combined sample the relationship between patient compliance (OH) and the age of the subject was examined. There were a total of 244 of the sample that had responses for both variables. Spearman's correlation coefficient was computed to assess the relationship between the level of Patient Compliance (OH) and age of the patient, for the combined sample and public and private healthcare systems independently (Table 68).

Table 68. The Relationship between the Patient Compliance (OH) and Age of the subject in the Combined sample, and Public and Private Healthcare Systems.

Healthcare System	Spearman's rho correlation coefficient, number in sample and p-value
Combined sample	$r_s(244)=-0.012$; p=0.858
Public healthcare system	$r_s(101)=-0.013$; p=0.896
Private healthcare system	$r_s(143)=-0.001$; p=0.987

Table 68 shows a non-significant slightly negative correlation for the combined sample. Both funding systems also showed slightly negative correlations and within both the public and private systems no significant relationship between the two variables was evident.

The negative correlation implies that compliance decreases with increase in age. Fit lines were superimposed on the scatterplot to show how the relationship varied amongst the two funding systems (Figure 52).



Private funding: R^2 Linear = 0.005

Private funding: R^2 Linear = 6.328E-5

Figure 52. The relationship between Age and Patient Compliance (OH) for the Public and Private Healthcare systems

A univariate general linear model (GLM) with healthcare system (HS) and age was used to test if the slope of the line average compliance versus age differed between the healthcare systems by fitting a model with main effects HS and age and an interaction term between HS and age. The interaction term was non-significant F(2,240)=0.283, p=0.754 indicating that the slopes did not differ between the two healthcare systems.

Summary: The age of the subject did not appear to influence the level of patient compliance (OH) for the combined sample, or within the public and private healthcare systems.

7.2.3. The relationship between Patient Compliance (OH) and Gender

The number of males and females with a measure of patient compliance (OH) was 95 and 149 respectively. Table 69 shows the median, 25th percentile and 75th percentile values for patient compliance (OH) for males and females in the combined sample.

Table 69. Comparison of Patient Compliance (OH) by Gender in the combined healthcare systems

Gender	Male n =95	Female n =149
Median Patient Compliance (OH)	3.50	4.00
25th percentile Patient Compliance (OH)	3.00	3.00
75th percentile Patient Compliance (OH)	4.00	4.50

Patient Compliance (OH) levels for females (median=4.00) was significantly better than males (median=3.50) for the combined sample Mann-Whitney U=8,469,50, p=0.008 (Table 69, Figure 53).

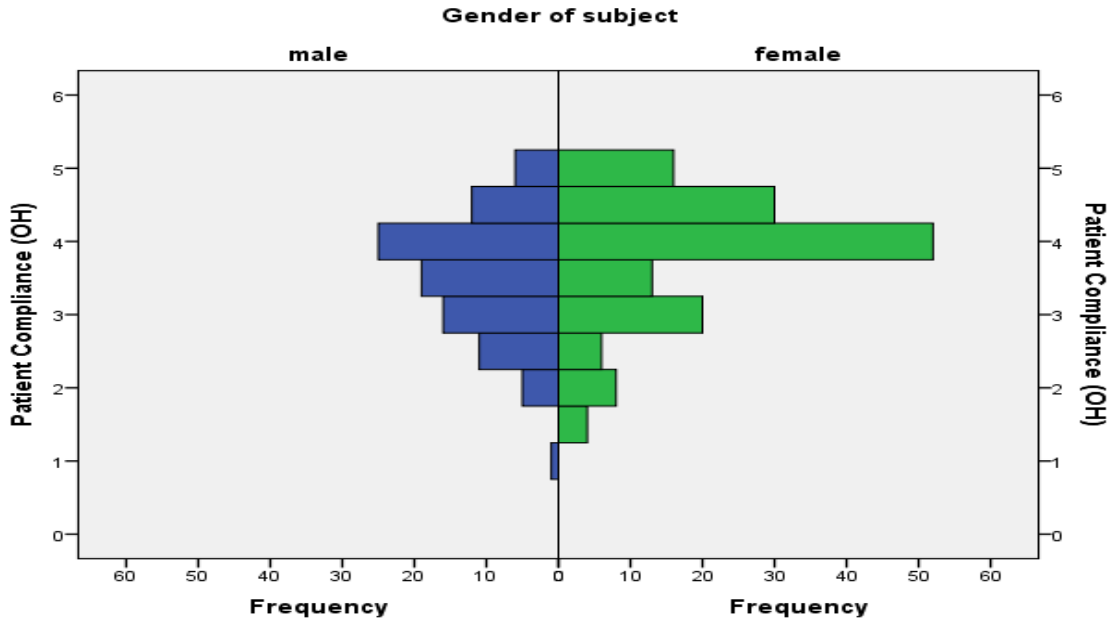


Figure 53. The overall frequency distribution of Patient Compliance (OH) values for males and females.

For males, 51 out of 96 (53.12%) of males and 95 out of 149 (63.76%) of females had average compliance of 4 or above. This difference was shown be significant Table 70 Mann-Whitney U test above. Table 70 shows the median patient levels for males and females within the public and private healthcare systems when analysed separately.

Table 70. Patient Compliance (OH) by Gender in the Public and Private Healthcare Systems

Healthcare system	**Public system**		**Private system**	
	Male n=37	Female n=64	Male n=58	Female n=85
Median Patient Compliance (OH)	4.00	4.00	3.50	4.00
25th percentile	3.25	3.00	3.00	3.50
75th percentile	4.25	4.50	4.00	4.50

There was a significant difference in the distribution of patient compliance levels between males and females in the private healthcare system Mann-Whitney U=3,203.50, p=0.002 but not in the public healthcare system Mann-Whitney U=1,243.50, p=0.669 (Table 70).

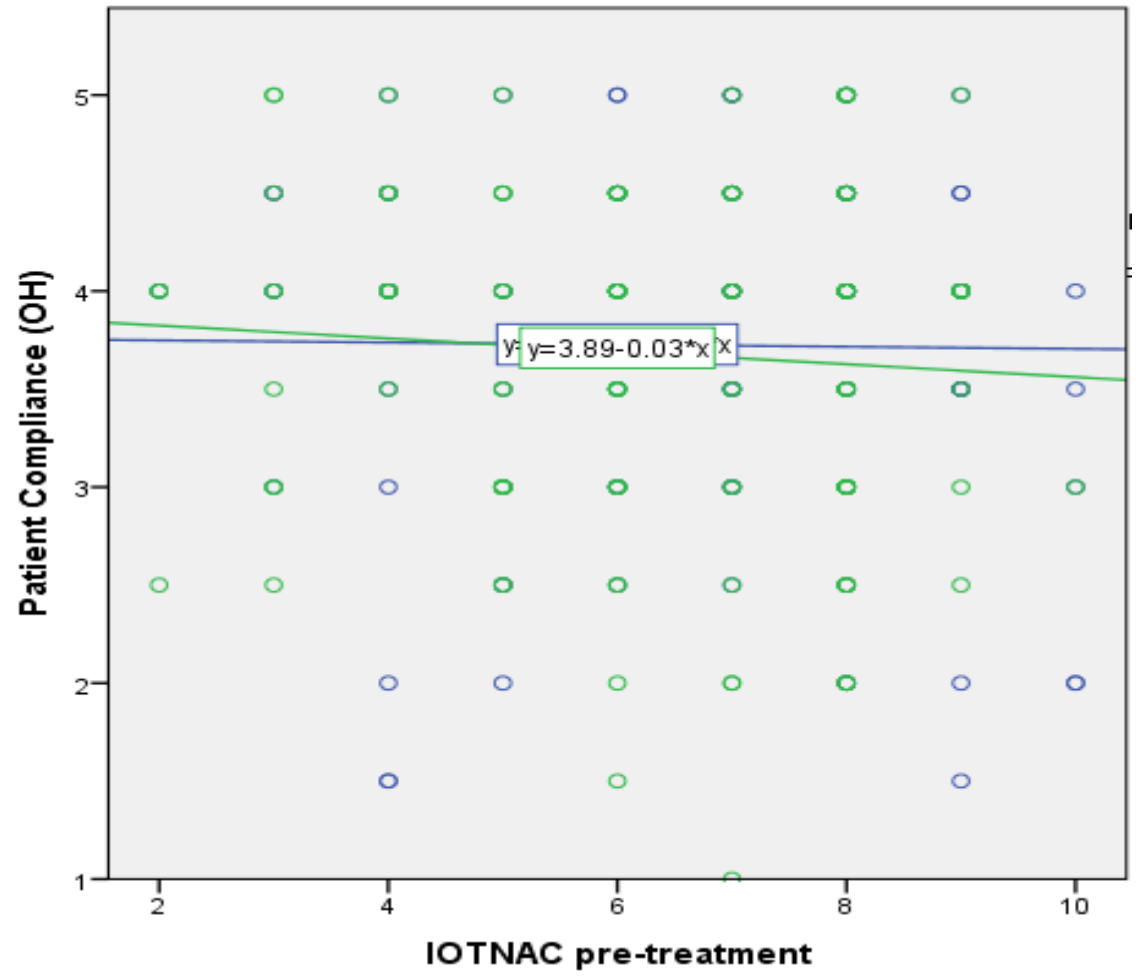
A GLM was used to test if the mean Patient Compliance difference between males and females was similar in both healthcare systems (HS) by fitting a model with main effects HS and gender plus the interaction term HS by gender. The interaction term was non-significant ($F_{1, 240)}$ =3.056, p=0.082).

Summary: When the 'combined' systems were analysed females were found to have higher compliance scores. However, further analysis of the two healthcare systems revealed that this gender difference in compliance only existed within the private healthcare system.

7.2.4. The impact of IOTN AC pre-treatment on Patient Compliance (OH)

The IOTN AC component was recorded to represent the patients' treatment need based on the appearance of their anterior teeth prior to treatment commencing. Both IOTN AC and Patient Compliance (OH) were recorded for 244 cases in the combined sample.

For the combined sample there was no significant correlation between Patient Compliance (OH) and IOTN AC (Spearman's rho=-.043, n=244, p=0.508). Testing the sample when sub-divided into separate healthcare systems, private and public, also showed no significant correlations Spearman's rho (PUHS: rho=-.012, n=101, p=0.907; PRHS: rho=-.073, n=143, p=0.388). Fig 54 shows the corresponding scatterplot for the public and private healthcare systems.



Healthcare System

Public funding
Private funding
Public funding
Private funding

Public funding: R^2 Linear = 2.393E-4

Private funding: R^2 Linear = 0.005

Figure 54: The relationship between Patient Compliance (OH) and IOTN AC (10 categories) within the Public and Private Healthcare Systems.

The sactterplot shows very little change in patient compliance (OH) for categories 1-10 of IOTN AC in either healthcare system.

A univariate general linear model (GLM) with healthcare system (HS) and IOTN AC (10 categories) was used to test if the slope of the line patient compliance (OH) versus IOTN AC (10 categories) differed between the Healthcare systems by fitting a model with main effects HS and IOTN AC and an interaction term between HS and IOTN AC. The interaction was not significant $F(1,239)=0.218$, $p=0.641$ between Healthcare system and IOTN AC in relation to the patient compliance (OH).

The IOTN AC 10 categories were combined into three groups, IOTN AC (1-4), (5-7), (8-10), commonly used groupings that represent (little or no need, moderate need and great need). Table 71 gives summary statistics for the overall, public and private funding systems.

Table 71. Summary statistics for Patient Compliance (OH) within 3 categories for IOTN AC Combined sample and within Public and Private Healthcare Systems

Healthcare System **IOTN AC category**	**Patient Compliance (OH)**		
	n	**Median**	**Q1, Q3**
Combined sample			
Little or No Need IOTN AC (2-4)	42	4	3.5, 4.5
Moderate Need IOTN AC (5-7)	105	4	3, 4.5
Severe Need IOTN AC (8-10)	96	4	3, 4
Public Healthcare System			
Little or No Need IOTN AC (2-4)	19	4	3.25, 4.25
Moderate need IOTN AC (5-7)	38	4	3, 4.5
Severe need IOTN AC (8-10)	44	4	3.5, 4.5
Private Healthcare System			
Little or No Need IOTN AC (2-4)	23	4	3.75, 4.5
Moderate need IOTN AC (5-7)	67	4	3, 4.25
Severe need IOTN AC (8-10)	52	4	3, 4

The public system has better compliance for patients in categories (8-10) of IOTN AC.

Summary: The pre-treatment IOTN AC grouping of the patient did not significantly influence the patient's compliance (OH) during treatment for the combined sample or within the sample within the public and private healthcare systems. The median compliance score was the same for all groups of IOTN AC in the public funding system and private healthcare system.

7.2.5. The impact of Household Income on Patient Compliance (OH)

In the study database 205 parents answered the household income question and there also was a measure of patient compliance (OH) for their child. For the combined sample there was a weak positive relationship between these two variables (p=0.019) Table 72. The sample was sub-divided into public and private healthcare systems and the relationship between household income and patient compliance (OH) re-examined Table 73.

Table 72. The relationship between Patient Compliance (OH) and Household Income (per 1,000 Euro) in the Combined sample and the Public and Private Healthcare Systems.

Healthcare System	Equation of the line	Spearman's correlation coefficient rho; (n); p(value)
Combined	Patient compliance (OH)=3.53+4.59E-3 HI(€)	$r_s(205)=.16$; p=0.019
Public	Average compliance=3.57+3.49E-3 HI(€)	$r_s(96)=.112$, p=0.276
Private	Average compliance=3.47+6.08E-3 HI(€)	$r_s(109)=.21$; p=0.023

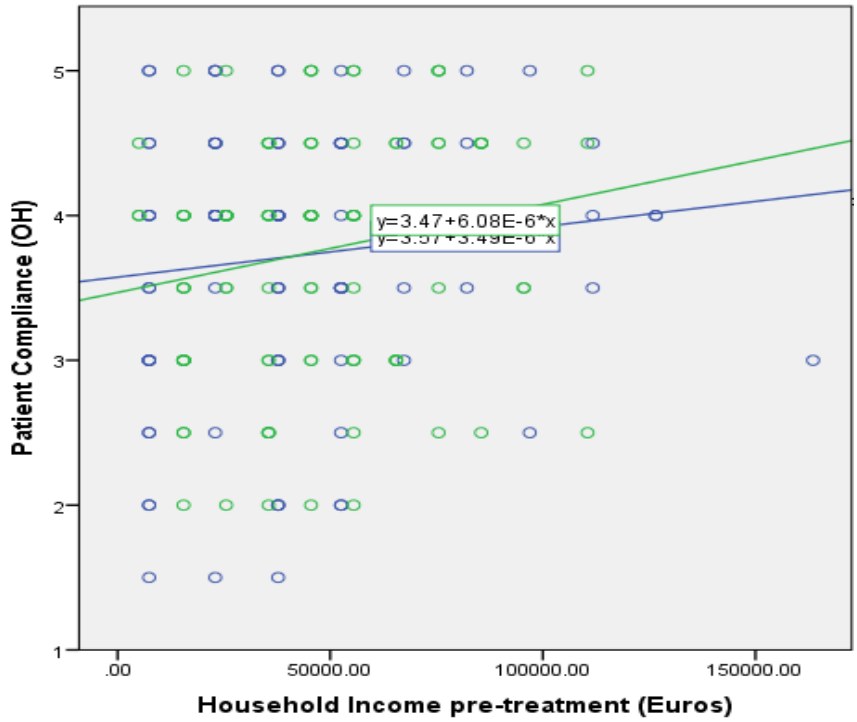
The relationship between compliance and HI is significant for the combined sample and private healthcare system as shown in Table 72. Table 73 shows the mean levels of patient compliance OH for each level of household income, within the public and private funding systems and combined systems.

Table 73. The level of mean patient compliance (OH) for three categories of household income

Household Income level Euros (HI)	Public Healthcare System	Private Healthcare system	Combined sample
	number per HI category, the mean level of Patient Compliance (OH)+sd		
≤30,000	35,3.68(3.33,4.03)	30,3.60(3.21,3.88)	65, 3.65(3.42,3.87)
30,001-60,000	38,3.61(3.29,3.92)	49,3.72(3.48,3.97)	87, 3.67(3.48,3.86)
60,000 thru 165,000	23,4.00(3.72,4.28)	30,3.97(3.67,4.26)	53,3.98(3.78,4.18)
Total numbers	96,3.73(3.54,3.92)	109, 3.76(3.60,3.91)	205, 3.74(3.62,3.86)

The mean level of patient compliance (OH) for three categories of income in the combined and private system increased incrementally with higher income categories. For the public system the mean compliance was higher for the lowest category compared to the middle category of income (30,001 thru 60,000) but increased from the middle category to highest category (>60,000). At the highest income category (>60,000) the mean compliance was similar for the public and private system (4.00,3.97) respectively. The scatterplot below shows the relationship of patient compliance (OH) within and between the private and public healthcare systems.

The scatterplot shows that within both healthcare systems, patient compliance (OH), was positively correlated with household income and this was significant for the private healthcare system (Table 73, Figure 55).



Healthcare System

Public funding
Private funding
Public funding
Private funding

Public funding: R^2 Linear = 0.015

Private funding: R^2 Linear = 0.036

Figure 55. The relationship of Patient Compliance (OH) and Household Income (Euro) within the Private and Public Healthcare Systems

A univariate general linear model (GLM) with healthcare system (HS) and household income (HI) was used to test if the slope of the line Patient Compliance (OH) versus HI differed between the HS by fitting a model with main effects HS and HI and an interaction term between HS and HI. The interaction term was not significant between Healthcare system and HI in the model F(1,201)= .369, p=0.544.

Summary: When the 'combined' sample was analysed with HI, higher compliance scores were significantly associated with higher incomes. However, further analysis of the two healthcare systems revealed that this higher income relationship with compliance only existed within the private healthcare system. Therefore, although patient compliance with oral hygiene was relatively good overall it was a little better for patients being treated in the private system, where the household income was higher.

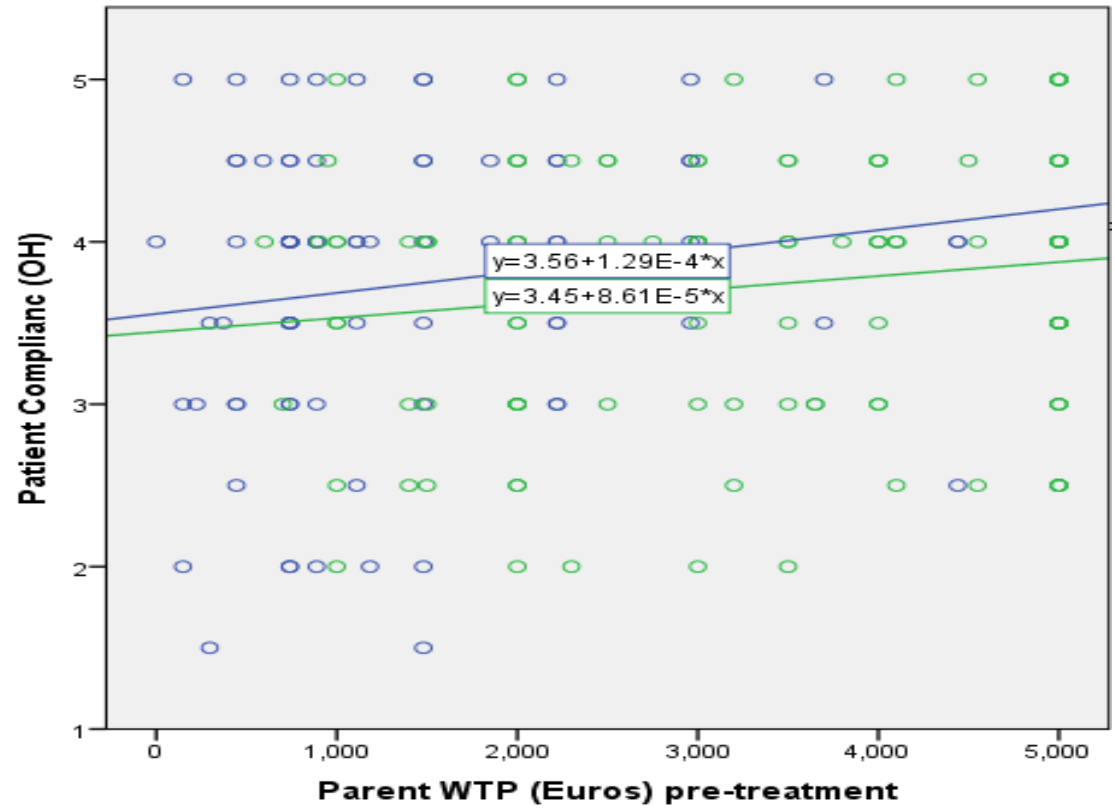
7.2.6. The relationship between parental Willingness to Pay (WTP) pre-treatment and Patient Compliance (OH).

In the combined sample 195 subjects who had a measure of compliance during treatment, also had parents who answered the willingness to pay question. For the combined sample the relationship was relatively weak in a positive direction but was not statistically significant Table 74. The relationship between WTP and patient compliance (OH) was also tested for the individual public and private healthcare systems.

Table 74. The relationship between patient compliance (OH) and WTP (Euro) pre-treatment within the Combined sample and the Public and Private Healthcare Systems

Healthcare System	Spearman's correlation coefficient rho; (n); p(value)
Combined sample	$r_s(195) = .118$; p=0.101
Public system	$r_s(78) = .149$; p=0.192
Private system	$r_s(117) = .151$; p=0.104

For both funding systems and the combined system there was a weak positive relationship between parental WTP and Patient compliance (OH), although all showed no significant correlations were present Table 74. The scatterplot (Figure 56) below shows the relationship between WTP and patient compliance (OH) within the systems.



Healthcare System

Public funding
Private funding
Public funding
Private funding

Public funding: R^2 Linear = 0.022

Private funding: R^2 Linear = 0.023

Figure 56: The relationship of Patient Compliance (OH) and WTP within the Private and Public Healthcare Systems

There is no clear pattern in the relationship between Patient Compliance (OH) with parental WTP within the healthcare systems. There were good and poor oral hygiene levels at all levels of WTP.

A univariate general linear model (GLM) was used to test if the slope of the line Patient Compliance (OH) versus WTP differed between the Healthcare systems by fitting a model with main effects HS and WTP and an interaction term between HS and WTP. The interaction was not significant F(1,191)=.161, p=0.689 between HS and WTP in relation to the Patient Compliance (OH) for the overall sample.

Summary: Parental WTP pre-treatment was not related to Patient Compliance (OH) during treatment for the combined sample and the public and private healthcare systems.

7.3. Multivariate Regression Analysis of Factors Influencing Patient Compliance (OH)

In the previous sections of bivariate analysis, the relationships between the dependent variable patient compliance (OH) and each of the independent variables; (age, gender, pre-treatment IOTN AC, healthcare funding system (HS), household income euros (pre-treatment) and willingness to pay (pre-treatment) were examined. The bivariate analysis indicated that only gender and household income euros (SES) significantly influenced patient compliance (OH). The interaction between gender and HS with respect to patient compliance had a $p<.10$ and was also included as a term in the model. These variables were entered into a General Linear Model (GLM) in SPSS to determine which combination of these independent variables were best predictors of patient compliance (OH). The factor variables in the model were healthcare funding system and gender. Household income euros was included as a continuous variable.

The full model (Healthcare system, Gender, and Household Income Euros and the interaction HS*Gender) was fitted to the data and 205 cases had information recorded for all of these variables. A backward elimination process was applied (see methodology section 4.5.1). The final model was therefore based on 205 cases.

In the final regression model only one factor remained that was statistically significant. Household Income Euros ($p=.029$) Table 6.12. Levene's test indicated the variance of Patient Compliance (OH) was equal across groups ($F=(1,208) =1.434$, $p=.232$) and for the model R^2(adjusted)=0.018.

The normality plot for the standardized residuals of the final GLM, were assessed using the histogram and showed a distribution with some departure from normality for residuals at the lower end. Both Log and Square Root transformations for Household Income were tested, but neither improved the distributions of the residuals. A non-parametric bootstrap method was applied based on 5000 samples stratified by healthcare system, and there was no material change to the results.

Table 75. Parameter estimates for the final General Linear Regression Model showing the significant explanatory factor of Patient Compliance (OH)

Parameter	β	SE	t	P value	95% confidence interval
Intercept	3.533	.113	31.235	p<0.001	3.110, 3.756
Household Income Euros	4.588E-6	2.092E-6	2.193	0.029	4.632E-7, 8.713E-6
R^2 =.018					

For every increase in Household Income by €10,000 there is an increase in patient compliance (OH) of (0.046).

If Household Income is removed from the second last regression model, then gender remains as the only factor in the final model. It is equally significant, and it is important to show this final regression model as of equal importance to the final regression model with Household Income Euros.

Therefore, in a second regression model where only one factor remained that was statistically significant was Gender (p=.027) Table 76. Levene's test indicated the variance of patient compliance (OH) was equal across groups (F=(1,242) =.117, p=.732) and for the model R^2(adjusted)=0.020. There were 149 females and 95 males that had measures of compliance.

Table 76. Parameter estimates for the final General Linear Regression Model showing the significant explanatory factor of Patient Compliance (OH)

Parameter	β	SE	t	P value	95% confidence interval
Intercept	3.795	.070	54.472	p<0.001	3.658, 3.933
Gender=0 Gender=1	-.248 0	.112	-2.220	0.027	-.468, -.028
R^2 =.020 n=244 (Male=95, Female=149)					

Summary: The R^{2-}adjusted value is low (0.018) accounting for 1.8% of the variation in patient compliance (OH) during orthodontic treatment, therefore the predictive value of the model is minimal. Compliance was found to be slightly better in females and households with higher income.

7.4. The impact of Patient Compliance (OH) on treatment outcome

The Peer Assessment Rating (PAR) post-treatment was used to assess if average patient compliance (OH) during treatment was correlated with the final treatment outcome. PAR scores were categorized into three groups, PAR 0-4, PAR 5-10, and PAR>10, for presentation purposes, the full table can be viewed in Appendix D. Section 6.6.1 shows the analyses of the relationship between the outcome measure PAR and patient compliance (OH).

Overall 297/343(86.6%) ≤18 years of the original sample completed treatment and had PAR scores measured prior to the study close date. The remainder of the patients (n=46; 23 Public and 23 Private) were still in treatment or failed to complete treatment. Table 77 shows the frequency values for the grouped PAR scores measured at the end of treatment. The majority (96.7%) had PAR scores ≤10.

Table 77. The frequency for the Peer Assessment Rating (PAR) scores at the end of treatment, in the public and private healthcare systems and combined sample

PAR score at the end of treatment	Public System n %	Private System n %	Combined sample n %
0-4	109(70.8)	92(64.3)	201(67.7)
5-10	38(24.7)	48(33.6)	86(29.0)
>10	7(4.5)	3(2.1)	10(3.4)
TOTAL	154(100)	143(100)	297(100)

7.4.1. The impact of Patient Compliance (OH) during treatment, on treatment outcomes measured using the Peer Assessment Rating Index (PAR)

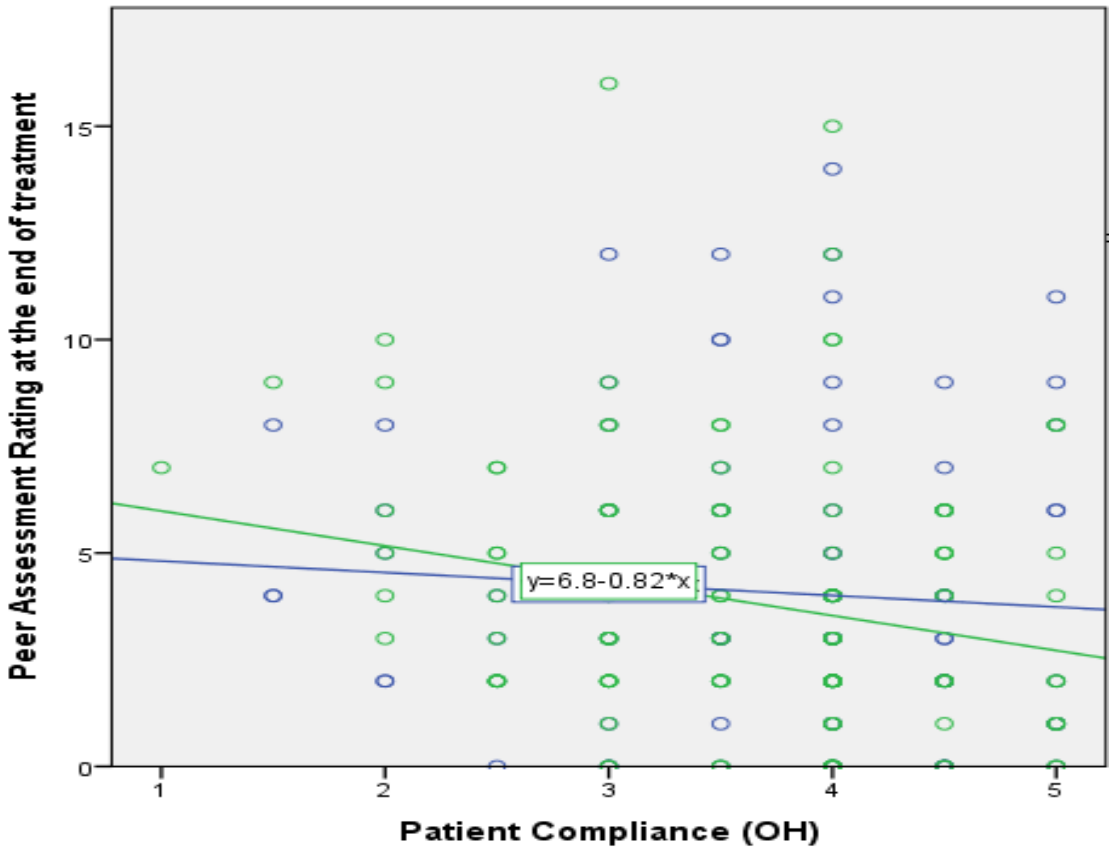
Of the combined sample, 225/343(65.6%) patients ≤18years, had a measure of patient compliance (OH) during treatment and a PAR score at the end of treatment. Low PAR scores indicate better treatment outcome; lower OH scores indicate below average oral hygiene. The Table 78 shows the relationship between the PAR score and patient compliance (OH) for the combined sample, the public and private healthcare systems using the Spearman's test.

Table 78. The relationship between the level of PAR and Patient Compliance (OH) in the Combined System, Public and Private Healthcare Systems.

Healthcare Funding System	Spearman's correlation coefficient, number in the sample, p-value
Combined sample	r_s (225)=-.174; p=0.009
Public healthcare system	r_s (95)=-.117; p=0.259
Private healthcare system	r_s (130)=-.229; p=0.009

There was a significant negative relationship (r_s = -.174, p=0.009, n=225) between Patient Compliance (OH) and PAR (Table 78) for the combined sample. For the public healthcare system there was a negative correlation but no significant relationship (r=-.117, p=0.259, n=95). For the private healthcare system there was a significant negative relationship (r_s =- .229, p=0.006, n=130) between Patient Compliance (OH) and PAR Table 78.

Higher scores for patient compliance (OH) tended to yield slightly better treatment outcomes (i.e. lower PAR scores). A scatterplot showing the difference between the healthcare systems, is illustrated graphically in Figure 57.



Healthcare System

Public funding
Private funding
Public funding
Private funding

Public funding: R^2 Linear = 0.005

Private funding: R^2 Linear = 0.052

Figure 57. A scatterplot that shows the relationship between Peer Assessment Rating (PAR) outcome score and Patient Compliance (OH) during treatment within the Public and Private Healthcare Systems

A univariate general linear model (GLM) with healthcare system (HS) and Patient Compliance (OH) was used to test if the slope of the line Peer Assessment Rating versus Patient Compliance (OH) differed between the Healthcare systems by fitting a model with main effects HS and PC(OH) and an interaction term between HS and PC(OH). A log10 transformation was applied to PAR (lg10(par+1) to reduce the skewness in the residual. The interaction term was not significant between Healthcare system and PC(OH) in the model F(1,221)=1.079, p=.300.

Further insight into the relationship between patient compliance (OH) and final PAR outcome score was aided by the following Table 79, a cross tabulation between three

levels of patient compliance (OH) and three categories of PAR score. The three compliance groups were: below average (1-2.5), average (3-3.5) and above average (4.5-5) and the three PAR categories were PAR scores 0-4, 5-10 and ≥10 (Table 79). The table shows the frequency (%) of patients in each treatment PAR outcome category within each level of patient compliance (OH).

Table 79: A cross tabulation of Peer Assessment Rating outcome category by level of Patient Compliance (OH) during treatment. Total % are out of 225 so that column % add to 100

Peer Assessment rating score post treatment Category	Patient Compliance (OH)			
	1.0-2.5 Below average n %	3.0-3.5 Average n %	4.5-5.0 Above average n %	Total n %
PAR score 0-4	17(54.8)	39(58.2)	93(73.2)	149
PAR score 5-10	14(45.2)	25(37.3)	28(22.0)	67
PAR score >10	0	3(4.5)	6(4.7)	9
Total n %	31(100)	67(100)	127(100)	225(100)

Excellent treatment outcomes are represented by PAR score 0-4. For 58.2% of patients with average compliance levels and 73.2% with above average compliance their outcome measures were excellent. Patients with low levels of compliance also achieved very good orthodontic results. There were 17/31 (54.8%) patients with below average compliance levels during treatment, that achieved an outcome PAR score of 0-4.

Summary: Patients with very good oral hygiene during treatment tended to have a slightly better orthodontic outcome. More than half of patients with lower oral hygiene levels during treatment (below average compliance), still achieved very good orthodontic treatment outcomes.

7.5. The change in the raw scores of compliances from T1 to T2

Table 80 shows a cross tabulation of compliance at time-point T1 and time-point T2. For the cross tabulation, the levels of compliance 1.0, 2.0 and 3.0 were recoded to compliance level A (a combination of average compliance, poor and very poor compliance). Compliance levels 4.0 and 5.0 were recoded to compliance level B (a combination of good and very good compliance).

Table 80. A cross tabulation of recoded compliance level A and recoded compliance level B at time-points T1 and T2.

Compliance levels Average and below=A Above average=B	**T2 Compliance OH Level=A n(%)**	**T2 Compliance OH Level=B n(%)**	**Total**
T1 Compliance OH level=A n(%)	57 (23.4%)	53(21.7%)	110(45.1%)
T1 Compliance OH level=B n(%)	27 (11.1%)	107(43%)	134(54.9%)
TOTAL	84 (34.4%)	160(65.6%)	244(100%)

The cross tabulation showed the migration of total cases from average or below average at T1 to above average at T2 (53/110); and from above average at T1 to average or below at T2 (27/134). The numbers presented in the Table 80 represent the following changes in hygiene compliance from time-points T1 to T2:

11.1%= Dis-improved in hygiene level from T1 to T2

21.7%= Improved in hygiene level from T1 to T2

23.4%=Stayed the same and remained in the lower levels of hygiene A scores (1,2,3)

43.9%=Stayed the same and remained in the upper level of hygiene scores B (4,5)

Summary: In the assessment of the compliance at T1 and the analysis of the impact of this on treatment outcome, it is important to note the variability of compliance during treatment, and the possible migration of the individual between levels of compliance. The individual subject has attained a certain level of oral hygiene prior to treatment in order to have fixed appliances placed, and this may be maintained, improve or deteriorate over the course of fixed appliance therapy.

7.6. Discussion of Compliance results

7.6.1. Demographics

Pre-treatment, time-point T0 consisted of 343 patients ≤ 18 years of age in the combined healthcare systems sample. At time-point T1 there were a total of 322/343(93.9%) measures of compliance and at T2 259/343 (75.5%) measures of compliance. The number of questionnaires completed by orthodontists from T1 (range=first 3 months) to T2 (range=last three months) reduced by 18.4%. The reduction in numbers of completed questionnaires may have been the result of patients not finishing treatment within the timeline of the study. It could also reflect an inability by staff and operators in busy practices, to maintain the same level of completion of questionnaires from the beginning to the end of the study. Missing data has shown that 43 questionnaires were not submitted by practices, even though final treatment models were received and assessed for these patients. Of the overall sample, 244/343(71.1%) had a measure of compliance at both relevant time-points.

7.6.2. Discussion

Oral hygiene level was used to measure compliance and is a common surrogate measure of compliance used by orthodontists in clinical practice. Good oral hygiene during treatment was defined as consistently clean appliances, with minimal gingivitis and minimal plaque accumulation. Being a subjective system and not an objective measure, this may be prone to error. However, this approach was representative of orthodontist's clinical practice during screening, consultation and follow-up visits, among all healthcare systems on the Island of Ireland at the time of the study. All patients in the sample had been accepted for orthodontic treatment and were determined by the treating orthodontist to have a good standard of oral hygiene pre-treatment. Extra support that may have been

provided by hygienists during treatment, either in the private or public system, were not recorded, and remain an unknown factor.

The main aim of the study on compliance, was to compute the average patient compliance longitudinally and determine factors that influence compliance during treatment. The study also investigated if patient compliance during treatment, had an effect on treatment outcomes. The results were analyzed for the combined sample, and the individual healthcare systems (publicly funded and privately funded). This enabled the results from the public and private healthcare systems to be viewed both independently and comparatively.

7.6.3. Factors

The results of the study indicate that:

1. Compliance was slightly better among higher income families and females.
2. PAR outcome was slightly better among those with better oral hygiene compliance.
3. Age, clinical treatment need, and how parents value treatment were not useful factors in identifying compliant or potentially compliant patients.
4. Compliance levels did not differ between the public and private healthcare systems.

The combined sample regression analysis showed an increase in patient compliance with an increase in household income. This was mainly influenced by the private system, where there was a sequential and significant increase in compliance between all 3 categories of income (3.6 to 3.72 to 3.97). The relationship between income and compliance was not as clear cut within the public system because there was a decrease in compliance from the lower income bracket <30,000 to the second income bracket >30,000-<60,000 and then an increase from this bracket to the higher income bracket >60,000. Nevertheless, there was a clear increase in compliance from the lowest income bracket to the highest in the public system (3.68 to 4). The results appear to contradict the claim of Mandall et al. (2008) that compliance is not linked to social deprivation in the public system.

In reviewing the literature, no previous published data were found in relation to the association between household income and oral hygiene compliance as standalone

measures. However, if income is equated with socio-economic status, then these results are in line with previous studies, which incorporate income into much broader definitions of socio-economic status. Cucalon and Smith, (1989) included social status especially material well-being plus educational, residential and other advantages in their SES definition. Socio-economic background and community status were linked together, and higher scores indicated greater material possessions and status. Better compliance was observed with better scores in that study. A study by Blum, (1987) emphasized that the socio-economic relationship to compliance may be related to familial factors, such as supportiveness, communication, and family environment. Other investigators have found the parents' attitude toward treatment has a significant influence over patient compliance (Albino et al., 1991;Tedesco et al., 1991;Bartsch et al., 1993;Bos et al., 2005;Trakyali et al., 2009;Al-Jewair et al., 2011;Krupińska-Nanys and Zarzecka, 2015).

The present results support the hypothesis that parents from higher income households may be more involved with monitoring the oral hygiene practices of their children. For patients with fixed orthodontic appliances good oral hygiene is more challenging because the appliances can be an obstruction to mechanical brushing – food can often get trapped around the brackets and under the arch wires after eating. Orthodontic treatment is lengthy so it can be a challenge to maintain good oral health and avoid enamel demineralization, periodontal disease or halitosis (Erbe et al., 2013). In situations where the accumulation of plaque is not supervised by parents and controlled after applying brackets, gingivitis is more likely to develop after six months (Kim et al., 2010).

Good oral hygiene compliance requires an excellent brushing technique, where possible an electric toothbrush, fluoridated toothpaste, mouth rinses with fluoride, dental floss and oral irrigators (Atassi and Awartani, 2010). Parents with high incomes may have more excess income to support good hygiene practices, by not only buying more aids but by being able to pay for more professional support. The effectiveness of professional support has been demonstrated in patients with fixed orthodontic appliances (Alstad and Zachrisson, 1979). Children from lower income households should not be disadvantaged, therefore oral hygiene supplies and professional support need to be provided from within the healthcare system. In more recent times hygiene services and supply provision, have been integrated into public healthcare clinics in the RoI.

Krupińska-Nanys and Zarzecka, (2015) used tests on oral hygiene and found that females pay more attention to their oral health and have teeth in better condition than males.

Females tend to carry oral hygiene devices with themselves more often and tend to brush their teeth more frequently, as much as three or more times a day. Gender differences in the present study, confirmed that female patients were more compliant with oral hygiene practices, than male patients and this confirmed the findings of previous studies (Russell, 1957; Kreit et al.,1968; Starnbach and Kaplan, 1975; Southard et al., 1991; Nanda and Kierl, 1992; Sergl et al., 2000).

Starnbach and Kaplan, (1975) attributed gender differences, to the fact that orthodontics is concerned with improving appearance, which at that time was of greater concern to girls. Studies based on child perceived need (desire) for straight teeth with compliance, also supported this and confirmed a stronger link with females, (Shaw, 1981; Mehra et al., 1998; Albino, 2000). Perceived need based on appearance could not explain the gender differences in the present study. Males were equally concerned about their dental appearance as females, there were no perceived need differences between males and females.

It should be noted, however, that a gender difference in compliance is not always observed (Sergl et al., 1992;Richter et al., 1998, Mandall et al., 2008; Amado et al., 2008; Bukhari et al., 2016). In the medical field, Jacobson et al. (1987) also found no gender difference in compliance with therapeutic regimens in 9- to 15-year-old adolescents with insulin dependent diabetes mellitus.

Patient or individual characteristics may explain why there were no gender differences in certain studies. Social stereotyping was highlighted by (Bartsch et al., 1993), who interpreted that the characteristics of the patient, family background, conformity and degree of consistent parental support and supervision, were determinants of satisfactory compliance. Cuclaon and Smith (1989) reported that patient characteristics of good compliers included, high self-esteem, pride in their accomplishments and optimistic thoughts about the future. Self-esteem measures were used in the present study, although no analysis of compliance versus self-esteem was performed. Certainly, such an analysis would contribute to the literature because there are many studies that claim that personality characteristics do not sufficiently predict compliance (Egolf et al., 1990; Bos et al., 2003; Amado et al., 2008; Trakyali et al., 2009; Peñacoba et al., 2014).

7.6.4. Treatment outcomes

This experiment provides a new insight into the relationship between compliance and treatment outcomes in the combined healthcare systems on the Island of Ireland. Outcomes measured by the PAR index were shown to be better with higher levels of oral hygiene compliance. The overall result was mainly influenced by the private system which showed a significant relationship between oral hygiene compliance and PAR final scores. This contradicts Dickens et al. (2008) and Berndt, (2010) that Medicaid and Self-Pay patients do not differ in their relationship between compliance and final PAR scores. In the methodology of these previous two studies the measure of compliance and the recruitment of patients differed from the present study, thus making direct comparison of the results difficult. This lack of congruity with previous studies, makes the present study unique and the only one of its kind completed on the Island of Ireland.

The forementioned studies by Camdan et al. (2009) and Dickens et al. (2008) recruited and treated patients from the same clinic and assessed their compliance using an objective compliance model. The payment or non-payment of fees was the only difference in the sample. In the present study, recruitment was from seventeen different clinics again with only two different payment methods. This Irish study replicates more closely the real-world clinical scenario making the results more representative of real-life healthcare systems. The study results certainly influenced the policy in Cork Dental Hospital programme where patients on waiting lists started oral hygiene services, six months in advance of their treatment. Patients who did not reach the required standard within the six months, were recalled regularly, and if they failed to reach the required standard on recall, they were refused treatment. This has had a societal effect and patients now presenting for treatment have a much higher standard of oral hygiene because it is known by word-of-mouth, that the required standard for qualification is high.

The results of the present study also support the theory that achieving excellent PAR scores for average and poor oral hygiene patients was possible. However, although poor oral hygiene may not interfere with outcomes, it may be the precursor to the discontinuation of treatment. Poor oral hygiene compliance can result in dental and gum disease, and ultimately discontinuation of treatment with expected outcomes not being achieved. Discontinuation of treatment rates have been reported to be between 12 and 20 per cent (Haynes and Dantes, 1987; Murray, 1989) increasing to 40 percent in 15- to -17-

year-olds (Haynes, 1991). This has obvious implications in terms of wasted resources, where appliances are placed, but have little occlusal benefit before treatment is stopped.

PAR scores were available for 297 patients ≤18 years of age that completed treatment within the four-year timeline of this study, this meant 46 patients did not complete treatment within this timeline. It is unknown how many of the 46 patients completed treatment eventually and how many discontinued treatments due to poor oral hygiene compliance.

7.6.5. Age, WTP, IOTN AC

This study showed no significant difference in compliance in relation to age, yet other studies have found age to be relevant (Brown and Moerenhout, 1991; Cureton et al., 1993; Bos et al., 2005). However, a trend towards better compliance with increased age could be seen in the scatterplots of the relationship between compliance and age. This could be attributed to maturity, manual dexterity and a greater emphasis placed on a good treatment outcome. Albino, (1981) showed that younger children are more influenced by their parents and that parental influences decrease with increased age of the child. Less parental input in lower income households for younger age groups could be the reason for the trend seen in the results of the present study. In line with the age range of this study, Eid et al. (2014) found that gingivitis was most common in 10-19year-old patients and supervision was needed to maintain good oral hygiene.

Albino, (1981) remarked that the value placed by parents on the outcome of orthodontic treatment influenced compliance, however, the findings of the current study do not support this previous research. This study was unable to demonstrate that parental values measured by WTP had any significant influence on compliance. However, an influence may have been expected because both WTP and compliance levels increased with higher income levels. In future studies it would be interesting to measure the actual direct parental involvement in maintaining their child's oral hygiene.

Previous studies have suggested a strong relationship between compliance and perceived severity of malocclusion (Lewitt and Virolainen,1968; Nanda et al.,1992) and to internal orientation (El-Mangoury,1981; Albino et al.,1991). In the present study IOTN assessment was professionally measured and no significant relationship was found between compliance and malocclusion.

Studies assessing behavior of the child during treatment (Southard et al.,1991;Albino et al.,1991) concluded that, the compliance of a child at the beginning of treatment is predictive of their compliance or behaviour at the very end of treatment. This hypothesis was proven true for only 66% (level 4,5) of the present sample. This means that 34% with decreased hygiene compliance during treatment and had a higher risk of discontinuation of treatment due to caries or periodontal disease.

The current study found that there was no difference in the level of compliance between the patients being treated in the public or private healthcare systems. The public system is not means tested and treatment is provided at zero cost, independent of income level. Likewise, a person from any level of income can access treatment in the private system, provided they meet the costs. This creates in of itself a range of incomes in each system.

Basically, the range of household income levels were not significantly different for public or private healthcare systems. Therefore, the differences in compliance existed within the healthcare systems only, and this was influenced mostly by ranges in income and gender.

There are still many unanswered questions about healthcare systems and compliance. Not least because there are several potential explanations for differences within the systems other than the level of income of the parents. These include oral hygiene support within the healthcare system, communication with the orthodontist, oral hygiene instructions, adaptation to fixed appliances and patient-related psychological factors.

7.6.6. Limitations of the study

1. Method of assessing compliance

A scientific standardized method of assessing compliance such as the Salzmann Index was considered to not be practical within the time constraints of the clinicians recruited in the present study. Objective compliance models used in research, tend to work better in smaller samples and controlled hospital environments for example in the study by Al-Jewair et al. (2011) which was performed within the dental unit, at the University of Toronto, Canada. The application of complex measures across a large number of busy orthodontic practices recruited for the present study was considered to be impractical.

A further limitation was the subjective method used by the orthodontists to monitor oral hygiene compliance. Smartphones are now often used and they have been found effective in various fields including nursing, medicine, and pharmacy. Reminders on smart phones could be provided to the patient through a smart-phone app, which may result in improved maintenance of oral hygiene and behaviour modification.

2, Informed consent

Informed consent is reported in the literature as being important for oral hygiene practice and this was standardized in the present study, using verbal and written oral hygiene instructions. Patients have been shown to forget verbal instructions in as little as 30 minutes (Mortensen et al. 2003). Thomson et al. (2001) advised reinforcement of verbal advice with written instructions. Ackerman et al. (1995) found that in severe malocclusions, computer imaging could facilitate communication with parents and patients. Lees and Rock, (2000) tested verbal, written and video instructions and found no difference.

Studies have also shown that children from low-income families do not seem to adequately understand the information given to them during informed consent (Mortensen et al., 2003). Should smart-phones be provided to children from lower-income families? Would it save healthcare systems money in the provision of fixed appliances by decreasing treatment times and reducing the number of hygiene sessions required per patient?

Possibly a limitation of the present study was that no video or computer imaging was used during oral hygiene instruction. A method such as computer imaging that is standardized and seen by each subject in the study would create a more standard approach to oral hygiene instruction.

3. The orthodontist-patient relationship

A third limitation was the unknown relationship with the orthodontist. Sinha et al. (1996) were interested in the behaviours of the orthodontist and found the patient orthodontist relationship to be important. Smart-phone reminders could help improve the patient-orthodontist connection and enhanced informed consent. It has been reported that compliance is associated with good communication between the orthodontist and the patient (Nanda et al., 1992; Portnoy 1997; Sinha et al., 1996; Bos et al., 2005; Mehra et

al., 1998). Li et al. (2016) claimed using mobile phones as a means of communicating with patients resulted in better attendance, shorter treatment time and less breakages.

4. Monitoring hygiene supports

A fourth limitation of the study was the lack of data collected on oral hygiene support utilized by each child. Collection of this additional data would have overburdened the staff in the practices taking part and in future data such as this could also be collected via a mobile phone app. Also, parents may be able to provide this information in future studies through questionnaires or using a mobile phone app.

7.6.7. Future studies

Using a mobile phone reminder app

Li et al. (2016) performed a randomized controlled trial to determine the effectiveness of a messaging app called WeChat in improving patients' compliance and reducing the duration of treatment. Participants in the WeChat group received regular reminders and educational messages, while those in the control group received conventional management. Duration of treatment in the WeChat group was on average 7.3 weeks shorter than the control group, with 10 significant reductions seen in failed attendance, late attendance and bracket bond failure (Li et al., 2016). This app could track attendance, brushing and duration of treatment.

Scientific objective compliance index

The orthodontic patient's co-operation scale (OPCS) is a 10-item list of 5 positive and 5 negative statements used in many studies to measure patient compliance as it relates to keeping appointments, appliance wear and maintenance, oral hygiene, patient attitudes to treatment and parental interest in treatment. The scale was shown to have adequate internal consistency (Slakter et al., 1980). The OPCS could be used in future studies in a controlled environment such as UCC or QUB dental school and hospital.

A parent questionnaire

This could be used to determine the degree to which a parent is involved in their child's oral hygiene practices. Frequency of dental visits and paid/unpaid hygiene visits would

also be valuable questions. The purchase of hygiene aids and the use of these by the child should be included.

7.7. Conclusions

There was no difference between the average compliance exhibited by public (non-fee-paying) or private (fee-paying) patients over the course of fixed appliance treatment. However, the level of oral hygiene compliance was influenced by the household income. Females are more compliant than males in this Irish sample. Better oral hygiene compliance results in better treatment outcome as measured by the PAR index.

CHAPTER 8

SUMMARY CONCLUSIONS

8.1. Summary of Findings

All hypotheses have been analysed for an overall combined and separate public and private healthcare systems in an Irish sample. In the public healthcare system parents pay no fees and in the private system parents pay fees. The fee-paying parents either pay market value fees in privately owned practices or dental hospital subsidized fees.

The conclusions related to each of the aims of this project and the impact on the null hypothesis are listed below.

Aim 1: To investigate clinical and non-clinical factors influencing pre-treatment perceived need (which contributes to demand) for orthodontic fixed appliance treatment by both parent and child/adolescent in their decision to seek orthodontic care.

Conclusions: Parents and children were influenced by different factors in their perceived need for orthodontic treatment. Parent perceived need was influenced by the clinical factor IOTN AC. In the public system parental perceived need increased with increased clinical need but was highest for the lowest category of clinical need in the private system. The non-clinical factor gender affected parental perceived need differently between the healthcare systems. Parents had higher perceived need levels for females in the public system and for males in the private system. In the overall sample and in both private and public healthcare systems, the non-clinical factor that effected the child perceived need, was the influence by their peer group, particularly if they felt their teeth looked worse when compared with their peers.

Null hypotheses: Pre-treatment Patient Perceived Need is not significantly associated with age, gender, funding system, household income, IOTN DHC, IOTN AC, teasing and how they look compared to their peers.

The Null hypothesis is rejected for peers "How children feel they look compared to their peers"

Null hypothesis: Pre-treatment Parent Perceived Need is not significantly associated with age of the child, the gender of the child, funding system, household income, IOTN DHC and IOTN AC.

The Null hypothesis was rejected for IOTN AC.

Aim 2: To determine the amount a parent is willing to pay (WTP) pre- and post-treatment to obtain the benefit of straight teeth for their child. To investigate the clinical and non-clinical factors that influence willingness to pay by the parent pre-treatment. To determine if parents value fixed appliance more at the end of treatment.

Conclusions: The value placed on orthodontic treatment was significantly different between the public and private healthcare systems thereby suggesting a societal difference. The willingness to pay values were closely linked to societal market values in both systems, with the societal cost of orthodontic treatment being much lower in the jurisdiction of the public system (Northern Ireland) compared to the jurisdiction of the private system (the Republic of Ireland). The parental willingness to pay values increased with increased household income overall and in both healthcare systems separately. Clinical factors did not influence willingness to pay by the parents. The parents did not value fixed appliance orthodontic treatment more at the end of treatment than pre-treatment.

Null hypothesis: Pre-treatment Willingness to Pay is not significantly associated with the age of the child, the gender of the child, funding system, household income, IOTN AC, parent perceived need and teasing.

The Null hypothesis was rejected for household income.

Aim 3: To investigate factors that influence patient compliance (in terms of hygiene compliance) during treatment, measured 3 months from the start of treatment and the last 3 months of treatment.

Conclusions: Compliance levels were the same in both the public and private healthcare systems. Compliance was found to be slightly better in females and households with higher income. Better compliance produced better outcomes in the private system.

Null hypothesis: Compliance during treatment is not significantly associated with the age of the child, gender of the child, funding system, household income, IOTN AC and WTP.

The Null hypothesis is rejected for ‘gender’ and household income’.

8.2. Social impact of conclusions

There is no evidence from the results of this study that child perceived need is related to normative treatment need assessed either by IOTN DHC or IOTN AC. Therefore, is the use of this measure to qualify children <18 years, valid as a standalone instrument?. For the present study the levels of PN are the not significantly different at all levels of IOTN DHC and AC.

By making public orthodontic healthcare inclusive of all children, with the approach that all children receive orthodontic treatment paid for by their parents' taxes, the net of qualification is broadened to capture a greater diversity of reasons for perceived need. This includes perceived need that has roots in social, psychological, societal, comparative and holistic roots. Especially reducing peer group pressures that were shown to be the most significant factor in this study. This inclusivity would provide treatment to children at all levels of compliance, which would be at an acceptable level in a public healthcare setting, based on the present study results, and does not differ from private healthcare setting compliance. A good level of oral hygiene is needed pre-treatment together with informed consent, including education and monitoring during treatment.

Parents from both systems have high levels of perceived need and this is not associated with the malocclusion of the child based on IOTN DHC. Compliance is related to the income level of the household and therefore children from low income households would need more support during treatment with oral hygiene because the parents may not be able to provide appropriate material or professional supports.

Based on the results of this study there is no evidence why orthodontic treatment cannot be provided free for all children. There is evidence that parents on lower incomes value treatment less but this is not a reason to limit access to low income households. The lower valuations are directly related to a lower ability to pay. It appears that it is divorced from any genuine indication that parents on lower incomes value treatment less. They have very high levels of perceived need which for this study was based on the 'outcome' of straight teeth for their children.

This body of work would suggest that the IOTN DHC is not related to perceived need, compliance or willingness to pay. On that basis it may not be a fair and equitable method of limiting access to government funded orthodontic treatment.

CHAPTER 9

APPENDICES

9.1. Research Proposal Collaborative North/South

A longitudinal study of the benefit, outcome and cost of orthodontic treatment

Project details

A longitudinal study of the benefit, outcome and cost of orthodontic treatment

The pattern of orthodontic treatment provision in the North is different from that found in the South. In the North, orthodontic treatment is almost entirely publicly funded and delivered through the Hospital Dental Service, the Community Dental Service and the General Dental Service. In contrast, in the South only one third of orthodontic treatment is publicly funded and delivered through the Hospital Dental Service and the Community Dental Service. Two thirds of orthodontic patients in the South are treated in private practice and therefore fund their own treatment. This project will provide a unique opportunity to examine both delivery models to determine if lessons can be learnt from the contrasting systems. In the South access to publicly funded orthodontic care is restricted to those individuals with extremely severe malocclusions using pre-defined criteria. It has been proposed that a similar system should be introduced in the North. This project is therefore timely and will provide an opportunity to evaluate the benefits of such a system.

The results of this study will also provide much needed objective evidence to guide policy in 3 key areas:
1. The Department of Health in the North is considering restricting orthodontic treatment to those children in the more severe categories of IOTN. Since no previous studies have included the patient's perspective on the need for or benefits derived from orthodontic treatment the present investigation will help to explore the appropriateness of restricting treatment provision using professional determinations of treatment need. This study will for the first time report on who receives orthodontic care North and South, their backgrounds, the costs to the patient and the Health Services and the benefits reported by patients. Models derived from these data will help policymakers assess the impact of restricting access to orthodontic care.
2. In the South much debate has taken place about the criteria needed to determine access to publicly funded orthodontic care. This study will provide robust data to guide policy on the appropriateness or otherwise of currently used thresholds.
3. Debate has also taken place about who should provide orthodontic care in the North and South of Ireland. This study will report on the costs and effectiveness of orthodontic treatment provision across a variety of settings (lower to high volume operators) delivered by practitioners with a range of postgraduate experience in orthodontics.

Method
This prospective investigation has been designed to record and study the changes that take place among a sample of patients receiving orthodontic treatment in the North and the South. The patients will be followed from before they commence treatment until one year after their orthodontic appliances are removed. A key component of the study will be the measurement of the psychosocial changes reported by the patients. To ensure that the results of this study accurately reflect the provision of orthodontic care North and South, steps will be taken to ensure that the sample of dentists and patients selected will reflect the general picture.

Research team training
As soon as the project commences, the research team (comprising the lead applicants, other associated parties and postgraduate students), will meet for a series of training sessions (3 one-day meetings). The purpose of this training will be to familiarise the research team with their individual roles within the project and to provide training in the outcome measures being assessed. Over the course of the project, a series of meetings will be held for all members of the research team to provide feedback on the progress of the research and to work as a team in reaching solutions for any difficulties that may arise. These meetings will be held at the Dental Schools in Belfast and Cork on alternate occasions. Two postgraduate students will be expected to gain PhD's from the work of the study, one of which will focus on the delivery of orthodontic care in the South and the other focusing on delivery of orthodontic care in the North.

The sample size
The sample size has been estimated using data from the previous study in the General Dental Services in England and Wales in 1993.[5] In this previous study a surrogate measure of psychosocial impairment was used, the 10-grade Aesthetic Component of IOTN. It was found that prior to any treatment 28% of the patients who received orthodontic treatment had a low aesthetic need for treatment (AC 1-4), 38% had a moderate aesthetic need (AC 5- 7), and 33% had a high aesthetic need for treatment (AC 9-10). Using these data it has been estimated that a sample of 400 patients will provide sufficiently precise data for the present study with approximately 130 patients in each of the 3 levels of aesthetic impairment (low, moderate, high).

The Dentists
Legally, any dental practitioner in the North or South can provide orthodontic treatment if they want to, but in practice, most orthodontic care is delivered by a relatively small proportion of dentists and orthodontists. The dentists will be grouped into 2 categories; moderate volume operators (50-200 cases per year), and high volume operators (200+ cases per year). Thirty dentists (15 from the North, 15 from the South) will be randomly selected from the moderate and high volume operators to reflect the normal orthodontic treatment delivery model (20 high volume operators and 10

2

moderate volume operators). The feasibility of this study from the perspective of the dentists and orthodontists, North and South, has already been explored and confirmed using informal contacts with key members of the profession.

Dentist/Receptionist Training

To ensure that the disruption to the daily routine of the dentist will be kept to within an acceptable limit, the data collector (postgraduate student/s) of the research team will play a major role in supporting the dentists and their receptionists. A variety of questionnaires will be administered during the course of this study and will be completed when the patient and their parents attend the dentist's surgery. After the dentist adjusts the patient's orthodontic appliances, the patient/parent will complete the questionnaires in the waiting area. The dental receptionist will ensure completion and collection of the questionnaires at the correct time points. The postgraduate students will liaise regularly with the dental receptionist to monitor each patient's progress.

Training evenings will be organised at the School of Dentistry, Belfast and Dental Hospital Cork for the participating dentists and their receptionists to familiarise them with the study protocol and the methodology. A similar training approach has been successfully employed previously by members of the research team in a randomised clinical trial among general dental practitioners in Northern Ireland.[14] Each dentist and receptionist will be reimbursed for their attendance at the postgraduate education allowance rate. They will also be reimbursed for the increase in appointment duration/workload, which will arise from participation in this project.

Patient selection

At the beginning of the study the dentists recruited will be asked to submit their waiting list for orthodontic treatment to the research team. The patients for whom they intend to commence orthodontic treatment in the next 3 months will be identified as will the expected duration of treatment. Only patients receiving substantive treatment where the expected duration of treatment is estimated to be greater than 12 months will be included in the study. Fifteen patients will then be randomly selected from the list submitted by each dentist. The research team will contact each patient, and where appropriate their parent or guardian, to seek their consent to include them in the investigation. If any patient/parent declines to participate another patient will be randomly selected from the dentist's waiting list until the target quota is reached for each dentist. During the study a variety of measurement techniques will be used in the following areas:

1. Professionally defined treatment need and treatment outcome. The pre- and post-treatment and out of retention record models will be rated using the Index of Orthodontic Treatment Need (IOTN) and the Peer Assessment Rating (PAR Index).[15]

2. Benefit from a psychosocial perspective. The data collector (i.e. postgraduate student in both centres) will complete a structured interview with each patient before treatment begins and at the end of the study period. Issues such as motivation to have treatment, expected outcome, and personal/family experience of orthodontic treatment will be explored.

Each patient will also be asked to complete 3 validated psychological measures before treatment begins and at 3-monthly intervals during active treatment and for one year after the end of active treatment:

a) A quality of life measure (Pediatric Quality of Life Inventory)[16] b) A general psychological measure (Adolescent Psychopathology Scale)[17] c) A self-esteem measure (Self-Esteem Index).[18]

3. Benefit from a contingent valuation perspective. A contingent valuation methodology using Willingness To Pay (WTP) will also be used to measure the benefits patients derive from treatment. The Health Economist member of the research team has used this method successfully in a similar study of the benefit derived from antimicrobial treatment of acne.[19] Questionnaires will be completed by the parent/guardian before treatment begins and at 3-monthly intervals during active treatment and for one year after the end of active treatment.

4. Cost. The cost analysis component of the study will include direct costs (cost of health care utilisation), indirect costs (e.g. patient and parent travel), as well as personal cost to the patient in terms of pain, social inconvenience and embarrassment. Questionnaires addressing these issues will be completed by the patient and their parent/guardian at 3-monthly intervals during active treatment and for one year after the end of active treatment.

5. Compliance. At 3-monthly intervals during the course of treatment and for one year after completion of treatment the dentist will rate the patient's compliance (below average, average, above average) in three key areas: oral hygiene, compliance with instructions on care/wearing of appliances, and attendance.

6. Treatment need and treatment outcome from the patient's perspective. With the assistance of the postgraduate students each patient will also complete questionnaires aimed to assess their perception of their treatment need, expectation of treatment outcome and their perception of the treatment result.

Outline of key stages:

Visit 1: The dentist obtains study models and frontal photograph of the anterior teeth in occlusion. Records forwarded to the relevant Dental School in North or South. Duplicate made, one set of models returned to the dentist.

Visit 2: Researcher/ postgraduate student attends dentist's surgery for data collection- interview, questionnaires.

Visit 3: One year after active treatment, study models and duplicates, interview with researcher, questionnaires.

Data analysis

At the end of the study each dentist will be asked to submit the pre- and post-treatment study models of 5 patients treated at the same time as the target sample but not included in the main study. Comparison with the study patients will determine if treatment bias existed for those patients included in the main study. Appropriate parametric and non-parametric statistics will be used to analyse the data generated. Among others, the following key analyses will be completed:

Before treatment need - the relationship between professionally defined need and patient defined need will be assessed using the initial IOTN and PAR ratings and the structured interview (visit 2); the validated psychosocial measures (visit 2); the self-rating of dental aesthetics (visit 2); the dental photograph (visit 2); the anxiety levels recorded using the validated questionnaire (visit 2).

Expected/ actual outcome - the relationship between patient expected outcome and actual outcome will be assessed using the PAR scores from the final study models and the initial and final structured interview (visit 3).

Residual need/outcome - the relationship between professionally defined residual need and patient defined residual need will be assessed using the final IOTN and PAR ratings and the structured interview (visit 3); the self-rating of dental aesthetics (visit 3); the dental photograph (visit 3); including analysis of the influence of anxiety levels.

Benefits of treatment - professionally defined and patient reported benefits will be assessed by comparing the final IOTN and PAR ratings from the study models (including the change in IOTN and PAR ratings during treatment) and the after treatment structured interview; the psychosocial changes recorded by validated questionnaires at 3-monthly intervals; the contingent valuation results (willingness to pay) recorded at 3-monthly intervals; the relationship between demographic factors (socioeconomic status and gender) and benefits will be explored.

Patient experience and compliance- the relationship between patient experience, compliance and benefits (professionally defined and patient reported) will be assessed using the data recorded for indirect costs (social inconvenience, pain and discomfort, and embarrassment) and the IOTN and P AR ratings; the after treatment structured interview; the psychosocial changes recorded by validated questionnaires at 3-monthly intervals; the contingent valuation results (WTP) recorded at 3-monthly intervals; the patient compliance ratings recorded by the dentist; the anxiety levels recorded by the validated questionnaire.

Cost/ effectiveness - the direct costs of treatment will be compared with professionally defined outcomes (IOTN and PAR), patient reported benefits (final structured interview and validated psychological questionnaires), and contingent valuation data. Outcomes and costs will be assessed across the range of socioeconomic groups to determine if differences exist. The costs and effectiveness of orthodontic treatment provision will be explored among lower and high volume operators and in relation to the level of postgraduate orthodontic training.

Dissemination Of Results

The results of this study will be disseminated in the form of a report to key policymakers in both the North and South of Ireland. Presentations will also be given at key national and international dental and orthodontic conferences. Papers reporting the outcome of the study will be submitted to international journals.

Timetable	Activity
1-3 months	Recruitment of dentists and orthodontists (15 North, 15 South) and postgraduate students (1 North, 1 South) Training session for research team (3 one-day meetings) Training session for dentists and their receptionist. Selection of patients.
3-21 months	Data input and analysis will take place continually from this stage onwards. Completion of active orthodontic treatment - patients normally attend the dentist at 4-6 weekly intervals during active treatment. Dentist will chart patient compliance at 3-monthly intervals. Patient will complete validated psychological measures at 3-monthly intervals. Patient/ parent will complete contingent valuation form and cost questionnaire at 3-monthly intervals.
21-33 months	Includes 8-month retention period. Dentist will assess patient compliance at 3-monthly intervals. Patient will complete validated psychosocial measures at 3-monthly intervals. Patient/ parent will complete contingent valuation form at 3-monthly intervals. Final visit - one year after completion of active treatment the dentist will take study models 21-33 months (contd.) and the postgraduate students will complete a structured interview and evaluation of residual treatment need and treatment outcome from the patient's perspective.
33 – 36 months	Final data analysis. Dissemination of results, publication of papers.

9.2. Ethical Approval

Queen's University Belfast

Research Ethics Committee
Room 1009
Education Centre
Royal Group of Hospitals
Belfast BT12 6BA
Northern Ireland
Tel (028) 9024 0503 Ext 2649

24 April 2002

Dr Donald Burden
Division of Orthodontics
School of Dentistry
Queens University Belfast
Grosvenor Road
Belfast
BT12 6BP

Dear Dr Burden

RESEARCH ETHICS COMMITTEE

Application No: 116/02

Title of Project: A longitudinal study of the benefit, outcome and cost of orthodontic treatment.

The above project was considered by the Research Ethics Committee at a meeting held on Tuesday 23 April 2002. The Committee consulted the full protocol, considered the application form and the consent/patient information sheet and decided to give approval to your project on ethical grounds.

If the study is being carried out in a hospital, this approval is conditional on informing the Hospital Administration, making a note in the patients' chart that he/she has participated in the study and if it is a drug study the Chief Pharmacist of the hospital.

Approval of the above study is conditional on your full participation with an audit of the research process. To comply with this condition it is necessary for the investigators to transmit the following information to the Research Ethics Committee within 48 hours of recruitment of patients at our email address: Researchethics@qub.ac.uk

Project application No:
Patient Hospital No:
Date of Consent:
Hospital Ward (if inpatient):

Yours sincerely

Dr T J McMurray
CHAIRMAN, RESEARCH ETHICS COMMITTEE
FACULTY OF MEDICINE

UCC
Tel: 353-21-4901255/4345599
Fax: 353-21-4343211
Coláiste na hOllscoile Corcaigh, Éire
University College Cork, Ireland

COISTE EITICE UM THAIGHDE CLINICIÚIL
Clinical Research Ethics Committee
2200 Cork Airport Business Park
Kinsale Road
Cork
Tel: 021-4321563
Email: l.drinan@ucc.ie

27th October 2004

Professor Martin J Kinirons
Head of Department
Oral Health Services Research Centre
University Dental School and Hospital
Wilton
Cork

Re: A longitudinal study of the benefit, outcome and cost of orthodontic treatment.

Dear Professor Kinirons

The Clinical Research Ethics Committee of the Cork Teaching Hospitals reviewed your correspondence at its recent meeting held on 5th of October 2004.

The Committee approved finalised questionnaires and noted and filed:

- Patient Information expanded
- Study models and photos retained with treatment records.

Yours sincerely

Dr Michael Hyland
Chairman
Clinical Research Ethics Committee
of the Cork Teaching Hospitals

9.3. Informed Consent

INFORMATION FORM (for patients)

The Department of Orthodontics at the School of Dentistry, Queen's University Belfast is conducting a study at the dental practice you are attending today. We are interested in finding out more about the benefits of orthodontic treatment and what people think about their dental appearance. We would like to invite you to take part in this research.

If you agree to take part you will be asked to complete a number of questionnaires and to take part in an interview where you will be asked some questions about yourself. Your permission will also be sought to speak with your parent/ guardian about you.

A number of the questionnaires must be completed at three-monthly intervals but this can be done during your appointments at this dental practice.

Your responses will be treated as strictly confidential. We may publish a summary of everybody's responses or present such a summary at a scientific meeting, but your identity and your responses would be totally confidential.

If you decide not to take part it will not affect the treatment you receive in any way and no-one will ask you why you do not want to take part.

If you are under-16 we will also ask your parent/ guardian for their permission for you to take part in this study. Please talk this over with your parent/ guardian before you decide whether or not to take part.

<u>If you agree to take part please sign the attached consent form.</u>

CONSENT FORM

I agree to participate in a study being conducted at the dental practice named below. The purpose of the study is to examine the benefits of orthodontic treatment. I have read and understand the information form. I understand that I will be asked to complete a series of questionnaires and take part in an interview. My parent/ guardian will also be asked some questions about me. I understand that refusal to take part will not affect the care that I receive.

However, I wish to take part in this study.

Name of Dental Practice: _____

Signature of patient: _____ Date: _____

Signature of parent: _____ Date: _____
(if patient is under-16)

Witnessed: _____ Date: _____

9.4. The Sample Representation RoI Public System

APPENDIX 4

Prevalence/Resource Calculation* - Health Boards

	EHB.	NEHB	NWHB	WHB	MWHB	SHB	SEHB	MHB
1998:								
12 yr. olds	20461	5719	3831	6231	5467	9199	6691	3821
Eligible 50%	10230	2858	1916	3115	2733	4599	3345	1910
Uptake	6820	1905	1277	2077	1822	3066	2230	1273
Cons/ Specialists	17.0	4.8	3.2	5.2	4.6	7.7	5.6	3.28
2000								
12 yr. olds	19350	5234	3603	5852	5012	8403	6376	3481
Eligible 50%	9675	2617	1801	2926	2506	4201	3188	1740
Uptake	6450	1744	1201	1950	1670	2801	2125	1160
Cons/ Specialist	16.2	4.4	3.0	4.9	4.2	7.0	5.3	2.9
2002								
12 yr. olds	19059	4924	3277	5269	4864	8259	6171	3370
Eligible 50%	9529	2462	1638	2635	2432	4129	3085	1635
Uptake 2/3	6353	1641	1092	1756	1621	2753	2057	1123
Cons/ Specialists	15.88	4.1	2.7	4.4	4.1	6.9	5.1	2.8
2004								
12 yr. olds	19014	4727	3138	5019	4571	7802	5958	3153
Eligible	9507	2363	1569	2509	2285	3901	2979	1576
Uptake	6338	1575	1046	1673	1524	2601	1986	1051
Cons/ Specialists	15.8	3.9	2.6	4.2	3.8	6.5	5.0	2.6
2006								
12 yr. olds	17819	4268	2861	4536	4260	7161	5305	2801
Eligible	8909	2134	1430	2268	2130	3580	2652	1400
Uptake	5939	1423	960	1512	1420	2387	1768	934
Cons/ Specialists	14.8	3.6	2.4	3.8	3.6	6.0	4.4	2.3
2008								
12 yr. olds	17968	4152	2773	4459	4257	7105	5230	2910
Eligible	8984	2076	1386	2229	2128	3552	2615	1450
Uptake	5986	1384	924	1486	1419	2335	1743	970
Cons/ Specialists	15.0	3.5	2.3	3.7	3.5	5.8	4.4	2.4

*Based on population projection.
See details of Calculation Model at Chapter 2.

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9.5. The Questionnaires of the Collaborative Study

instrument completed by patients entering the study prior to banding

/_____/Hospital/29/9/04)

Child Orthodontic Questionnaire

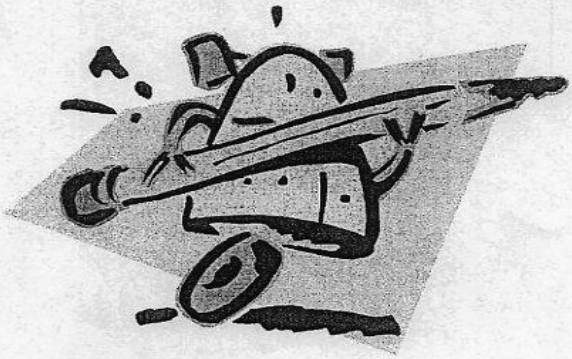
Hello,

Thanks for helping us with our study!

We are doing this study to understand better what young people think about their teeth.

PLEASE REMEMBER:

- Don't write your name on the questionnaire
- This is not a test and there are no right or wrong answers
- Answer as honestly as you can
- Put a tick (√) in the box beside the answer that is best for you
- Please ignore the numbers next to the boxes



1

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First, a few questions about you:

1. Are you a boy or girl:
Boy [ ](1)
Girl [ ](2)

2. How old are you?
Under 11 years old [ ](1)
11 years old [ ](2)
12 [ ](3)
13 [ ](4)
14 [ ](5)
15 [ ](6)
16 [ ](7)
17 [ ](8)
18 [ ](9)
over 18 years old [ ](10)

3. What year are you in school? _____

4. How many brothers and sisters do you have? _____

5. Where do you come in your family?:
Oldest [ ](1)
Middle [ ](2)
Youngest [ ](3)
Only child [ ](4)
Other [ ](5)

Now a few questions about school:

6. Do you like going to school?
Yes [ ](1)
No [ ](2)

7. What do you like about going to school? _____

8. What do you not like about going to school? _____

9. Do you usually have someone to sit with and talk to during lunch-time at school?
Yes [ ](1)
No [ ](2)

10. If "No", does this bother you?
Yes [ ](1)
No [ ](2)

11. Why or why not?_____

A few questions about your friends:

12. Do you have many friends?
Yes [ ](1)
No [ ](2)

13. Do you ever wish you had more friends?
Yes [ ](1)
No [ ](2)
Why?_____

14. Do you have a boyfriend/girlfriend?
Yes [ ](1)
No [ ](2)

15. If "No", would you like to have one?
Yes [ ](1)
No [ ](2)

16. Does it bother you that you don't have one?_____

Some questions about other people:

17. Do you know of anyone else who has braces on their teeth?
Yes [ ](1)
No [ ](2)

18. If "Yes", how many people do you know who have braces?
1-5 people [ ](1)
5-10 people [ ](2)
more than 10 [ ](3)

19. Did you know any of these people before they got their braces?
Yes [ ](1)
No [ ](2)

20. If "Yes", how did their teeth look before they got their braces?
I thought their teeth looked very good [ ](1)
I thought their teeth looked good [ ](2)
I thought their teeth looked OK [ ](3)
I thought their teeth looked bad [ ](4)
I thought their teeth looked very bad [ ](5)

21. Do you think people with straight teeth are more popular with others than people with crooked teeth?

Yes [ ](1)
No [ ](2)

Questions about your teeth:

22. On average, how often do you brush your teeth?

Never [ ](1)
once a week [ ](2)
2-4 times per week [ ](3)
Once a day [ ](4)
Twice a day or more [ ](5)

23. Do you ever have to be reminded to brush your teeth?

Yes [ ](1)
No [ ](2)

24. On average, how often do you floss your teeth?

I don't floss my teeth [ ](1)
Once a week [ ](2)
2-4 times per week [ ](3)
Once a day [ ](4)
Twice a day or more [ ](5)

25. Do you ever have to be reminded to floss your teeth?

Yes [ ](1)
No [ ](2)
I don't floss [ ](3)

26. Have you ever used anything on your teeth other than regular toothpaste?

Yes [ ](1)
No [ ](2)

27. If "Yes", what have you used on your teeth?

Mouthwash [ ](1)
Whitening toothpaste [ ](2)
Bleaches to make your teeth white [ ](3)

Some questions about how your teeth look:

28. When you think about your teeth, would you say that they:

Look very nice [ ](1)
Look nice [ ](2)
Look OK [ ](3)
Look bad [ ](4)
Look very bad [ ](5)

29. Would you say that other people think your teeth look nice?

Yes [ ](1)
No [ ](2)
Don't know [ ](3)

30. How do you think your teeth look compared with other people you know?

My teeth look better [ ](1)
My teeth look the same [ ](2)
My teeth look worse [ ](3)

31. Have you ever felt shy or embarrassed because of how your teeth look?

Yes [ ](1)
No [ ](2)

32. Have you ever been worried about what other people think of your teeth?

Yes [ ](1)
No [ ](2)

33. Have you ever been teased or given a nickname because of the way your teeth look?

Yes [ ](1)
No [ ](2)

Questions about your family:

34. Has anyone in your family ever had braces?

Yes [ ](1)
No [ ](2)

35. If so, who had the braces?

Mother/father [ ](1)
older brother/sister [ ](2)
younger brother/sister [ ](3)

36. Would you like to talk with your orthodontist about getting your braces?

Yes [ ](1)
No [ ](2)

37. Do you have your own ideas about what you want your teeth to look like afterwards?

Yes [ ](1)
No [ ](2)

38. If "Yes", what do you want your teeth to look like after you are finished wearing your braces? _____

39. Who decided that you needed to get braces?

It was my decision	[ ](1)
It was my parents' decision	[ ](2)
My parents and I decided together	[ ](3)

Questions about what you think:

40. Do you think you need braces?

Yes	[ ](1)
No	[ ](2)
Unsure	[ ](3)

41. Why or why not do you think you need braces?

_____

42. How important is it for you to have straight teeth?

very important	[ ](1)
important	[ ](2)
no difference	[ ](3)
unimportant	[ ](4)
very unimportant	[ ](5)

43. Do you think getting braces will make your teeth healthier and stop cavities in the future?

Yes	[ ](1)
No	[ ](2)

44. Do you think straight teeth are important in keeping your mouth healthy?

Yes	[ ](1)
No	[ ](2)

45. When you are done wearing braces and your teeth are straight, do you think having straight teeth will make any difference to you?

Yes	[ ](1)
No	[ ](2)

46. If "Yes", how will having straight teeth make your life different?

_____

47. Would you like to say anything else about getting your braces?

_____

48. How nice do you think your teeth look now?

_____

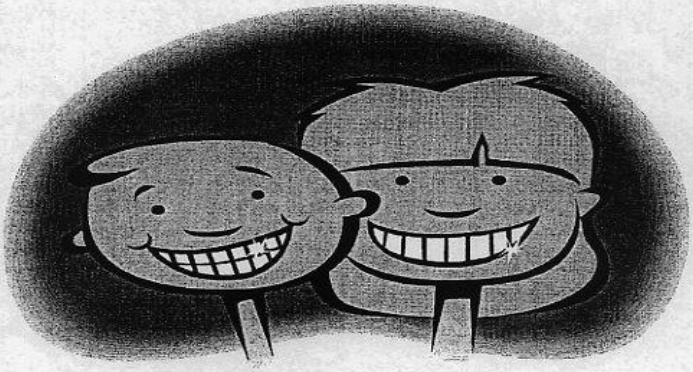
Look very nice Look very bad

49. How important is it for you to have straight teeth?

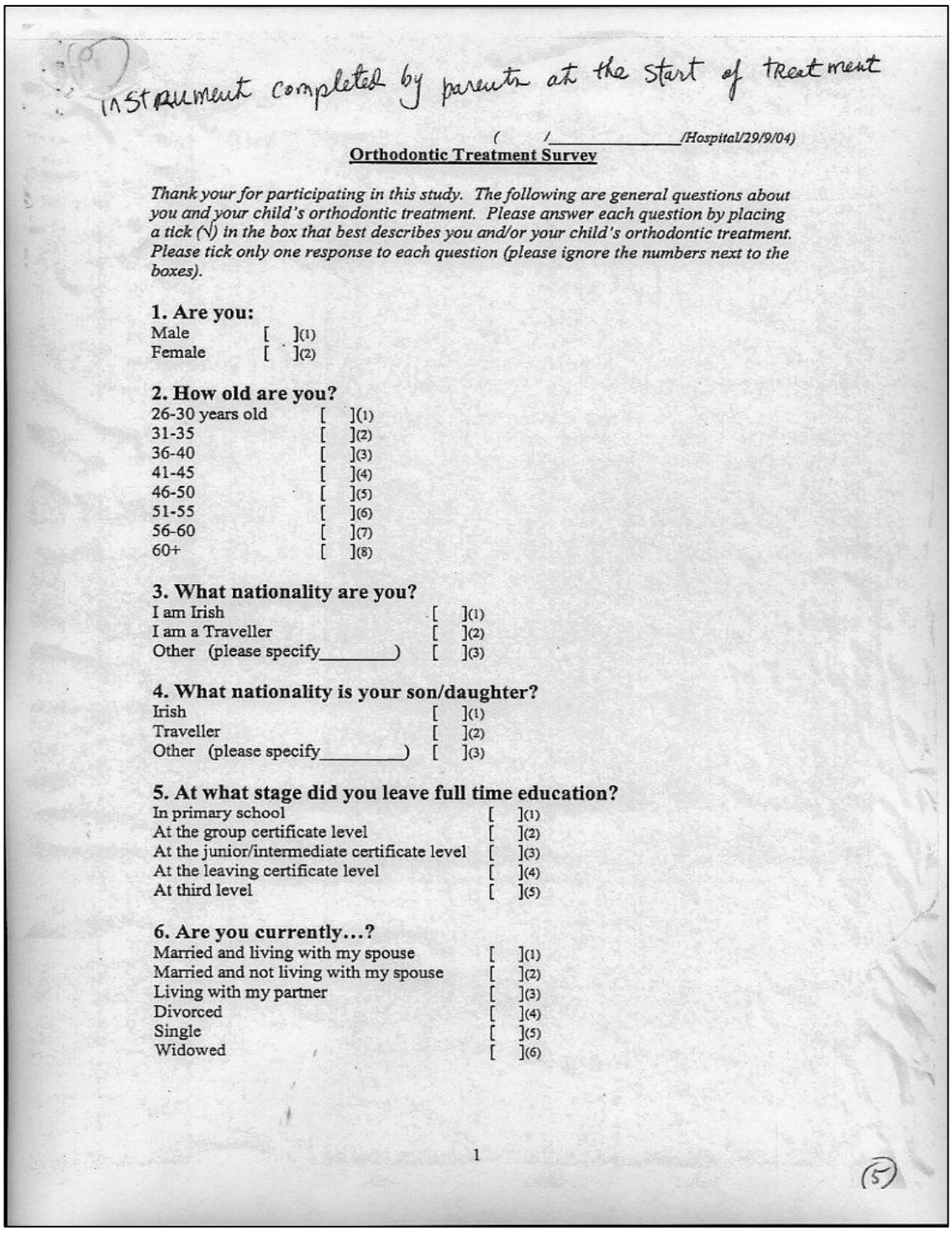
_____

Very important very unimportant

There, it is finished – Thank you for your help!



Parent questionnaire



Instrument completed by parents at the start of treatment

(/ /Hospital/29/9/04)

Orthodontic Treatment Survey

Thank your for participating in this study. The following are general questions about you and your child's orthodontic treatment. Please answer each question by placing a tick (√) in the box that best describes you and/or your child's orthodontic treatment. Please tick only one response to each question (please ignore the numbers next to the boxes).

1. Are you:

Male [ ](1)
Female [ ](2)

2. How old are you?

26-30 years old [ ](1)
31-35 [ ](2)
36-40 [ ](3)
41-45 [ ](4)
46-50 [ ](5)
51-55 [ ](6)
56-60 [ ](7)
60+ [ ](8)

3. What nationality are you?

I am Irish [ ](1)
I am a Traveller [ ](2)
Other (please specify_____) [ ](3)

4. What nationality is your son/daughter?

Irish [ ](1)
Traveller [ ](2)
Other (please specify_____) [ ](3)

5. At what stage did you leave full time education?

In primary school [ ](1)
At the group certificate level [ ](2)
At the junior/intermediate certificate level [ ](3)
At the leaving certificate level [ ](4)
At third level [ ](5)

6. Are you currently…?

Married and living with my spouse [ ](1)
Married and not living with my spouse [ ](2)
Living with my partner [ ](3)
Divorced [ ](4)
Single [ ](5)
Widowed [ ](6)

1

(5)

7. At present are you...?

A homemaker	[ ](1)
Employed full time	[ ](2)
Employed part time	[ ](3)
Unemployed seeking work	[ ](4)
Unemployed not seeking work	[ ](5)
Self employed	[ ](6)
Engaged in full or part time education	[ ](7)

8. What job have you done for the longest period of time?

_____

9. What job has your spouse/partner done for the longest period of time? _____

10. Do you have:

A medical card	[ ](1)
Private health insurance	[ ](2)
Both	[ ](3)
Neither	[ ](4)

11. On average, how often does your son/daughter go to the dentist?

Never	[ ](1)
Once every three years	[ ](2)
Once every two years	[ ](3)
Once or twice a year	[ ](4)
More than twice a year	[ ](5)

12. On average, how often do you go to the dentist?

Never	[ ](1)
Once every three years	[ ](2)
Once every two years	[ ](3)
Once or twice a year	[ ](4)
More than twice a year	[ ](5)

13. On average, how often does your partner/spouse go to the dentist?

Never	[ ](1)
Once every three years	[ ](2)
Once every two years	[ ](3)
Once or twice a year	[ ](4)
More than twice a year	[ ](5)

14. What was the main reason you decided to get braces for your son/daughter?

Dentist/orthodontist recommendation	[ ](1)
Personal experience of having had braces	[ ](2)
My other children have had braces	[ ](3)
My son/daughter asked for braces	[ ](4)
I wanted it for my son/daughter	[ ](5)

15. Why did you choose to receive your son's/daughter's treatment through the dental hospital?

It is affordable	[ ](1)
It is in a convenient location	[ ](2)
It offers better treatment delivery	[ ](3)
I already knew the orthodontist	[ ](4)
Other (please explain_____)	[ ](5)

16. Leaving aside the actual cost of treatment, if you were told your son's/daughter's treatment would cost ____ Euro, would you be willing to pay that for the treatment?

Yes [ ](1)
No [ ](2)

17. Amount: _____

18. Again, leaving aside the actual cost of treatment, and assuming payments would be spread out over the treatment, what is the maximum amount you would be willing to pay in total for your son's/daughter's treatment?

Euro_____

19. Did you have to take time off work to come here today?

Yes [ ](1)
No [ ](2)

20. If "Yes", did you take…:

Less than half a day	[ ](1)
Half a day	[ ](2)
A full day	[ ](3)

21. How much time will it take you to travel to and from your appointment today (ie, roundtrip)?

_____ mins/ hours (RT)

22. How many miles will it take you to travel to and from your appointment today (ie, roundtrip)?

_____ miles (RT)

23. Did you drive to your appointment today, or did you take a bus or taxi?

Drove [ ](1)
Bus/taxi [ ](2)

24. Did your visit here today entail any additional expense? For example did you have to pay for parking or a child minder?

Yes [ ](1)
No [ ](2)

If Yes, approximately how much did you pay? _____Euro

25. Do you feel your son's/daughter's orthodontic treatment represents good value for money?

Yes [ ](1)
No [ ](2)

26. How would you rate your ability to pay for your son's/daughter's treatment?

I am easily able to pay [ ](1)
I am able to pay [ ](2)
I am somewhat able to pay [ ](3)
It will be difficult to pay [ ](4)
It will be very difficult to pay [ ](5)

27. Do you think people considering hospital orthodontic treatment should be means tested prior to treatment?

Yes [ ](1)
No [ ](2)

28. Do you feel orthodontic treatment should be:

Free for everyone, regardless of need or income [ ](1)
Free for only people with low income (regardless of need) [ ](2)
Free for severe cases only (regardless of income) [ ](3)
Everyone should pay something, regardless of need or income [ ](4)

29. Please indicate your current income:
(*If there is more than one income in your household please indicate the combined income total and the number of people who contribute to that total:*

Income:		Number of people contributing to that total
Less than 10,000	( )	____
11,000- 20,000	( )	____
21,000- 30,000	( )	____
31,000- 40,000	( )	____
41,000- 50,000	( )	____
51,000- 60,000	( )	____
61,000 - 70,000	( )	____
71, 000 - 80,000	( )	____
81,000 - 90,000	( )	____
91,000 - 100,000	( )	____
Greater than 100,000	( )	____

30. Do you have any other comments you would like to add regarding any aspect of your son's/daughter's treatment?

_____

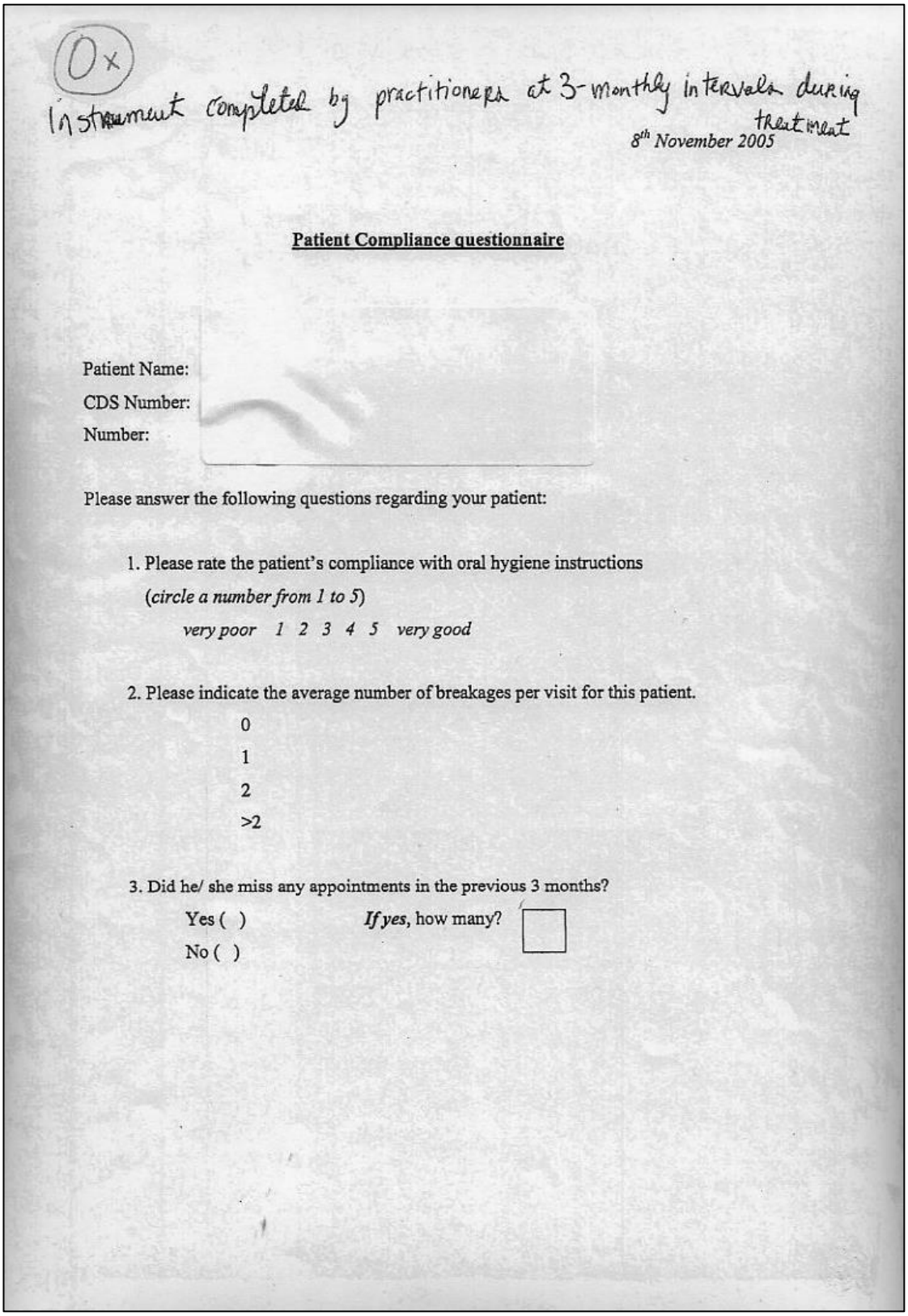
31. How important is it to you that your son/daughter have straight teeth?

_____

Very important very unimportant

Thank you very much for taking the time to complete this questionnaire. All responses will be treated in the strictest confidence.

Completed by the orthodontist providing the active fixed appliance treatment



0x

Instrument completed by practitioners at 3-monthly intervals during treatment

8th November 2005

Patient Compliance questionnaire

Patient Name:

CDS Number:

Number:

Please answer the following questions regarding your patient:

1. Please rate the patient's compliance with oral hygiene instructions

(*circle a number from 1 to 5*)

very poor 1 2 3 4 5 *very good*

2. Please indicate the average number of breakages per visit for this patient.

0

1

2

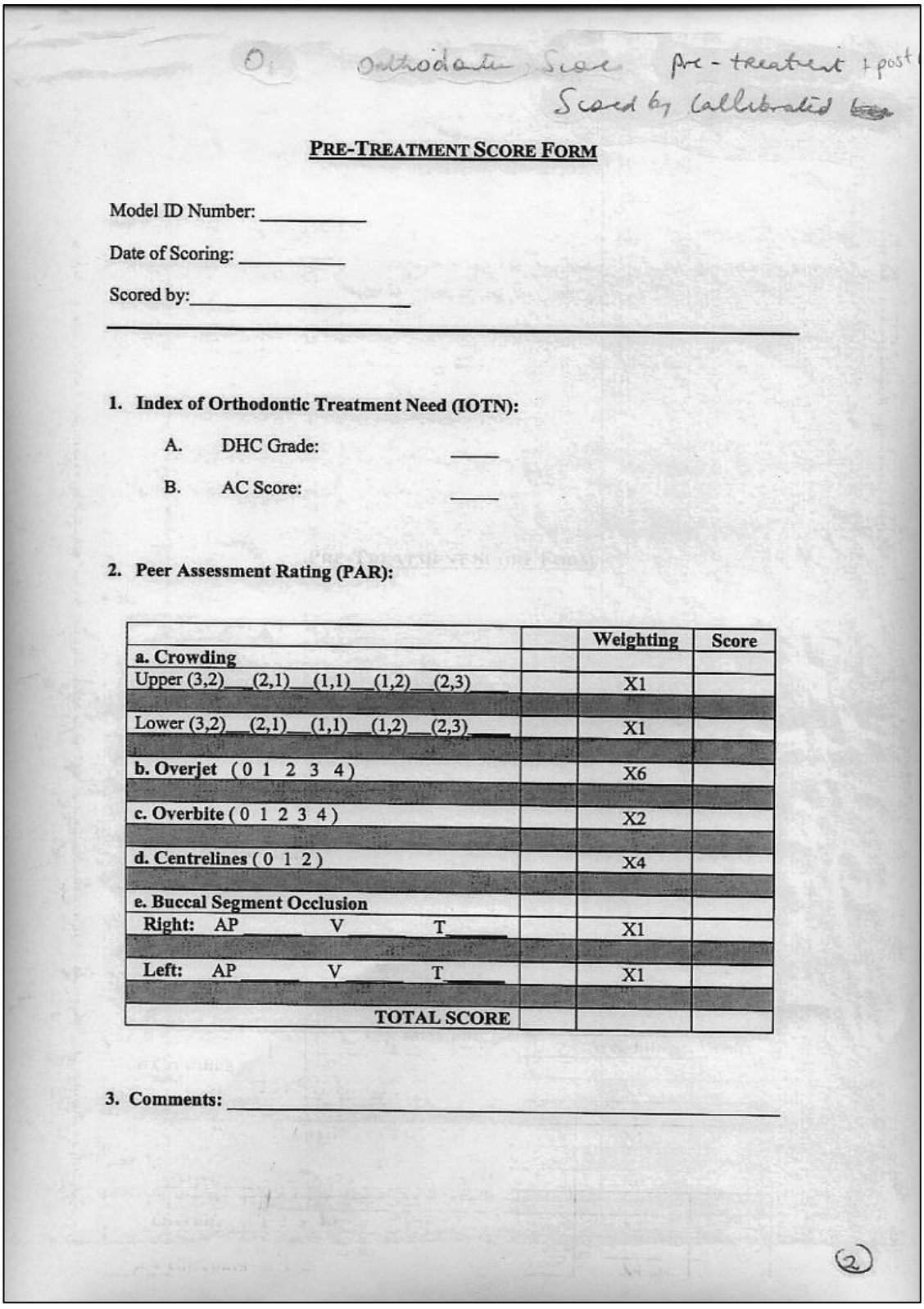
>2

3. Did he/ she miss any appointments in the previous 3 months?

Yes ( ) *If yes*, how many? ☐

No ( )

9.6. Peer Assessment Rating Form



Orthodontic Score Pre-treatment + post
Scored by Calibrated

PRE-TREATMENT SCORE FORM

Model ID Number: _____

Date of Scoring: _____

Scored by: _____

1. Index of Orthodontic Treatment Need (IOTN):

A. DHC Grade: ____

B. AC Score: ____

2. Peer Assessment Rating (PAR):

		Weighting	Score
a. Crowding			
Upper (3,2) (2,1) (1,1) (1,2) (2,3)		X1	
Lower (3,2) (2,1) (1,1) (1,2) (2,3)		X1	
b. Overjet (0 1 2 3 4)		X6	
c. Overbite (0 1 2 3 4)		X2	
d. Centrelines (0 1 2)		X4	
e. Buccal Segment Occlusion			
Right: AP ____ V ____ T ____		X1	
Left: AP ____ V ____ T ____		X1	
TOTAL SCORE			

3. Comments: _____

(2)

9.7. Index of Orthodontic Treatment Need

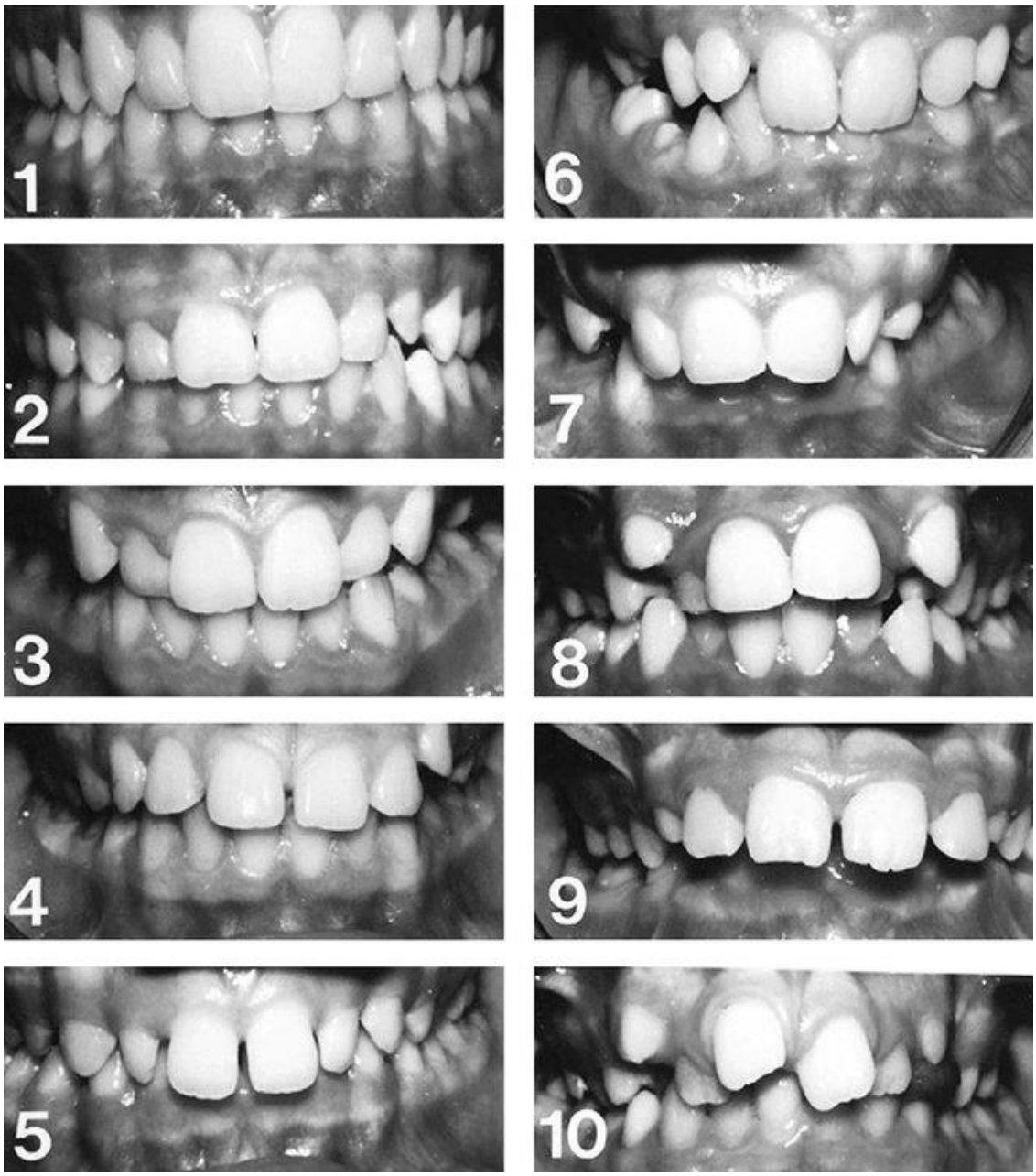


Figure 58. The Aesthetic Component of the IOTN. The Aesthetic Component was originally described as " SCAN ", Evans R and Shaw WC (1987). A preliminary evaluation of an illustrated scale for rating dental attractiveness European Journal of Orthodontics 9:314–18. By kind permission of Oxford University Press.

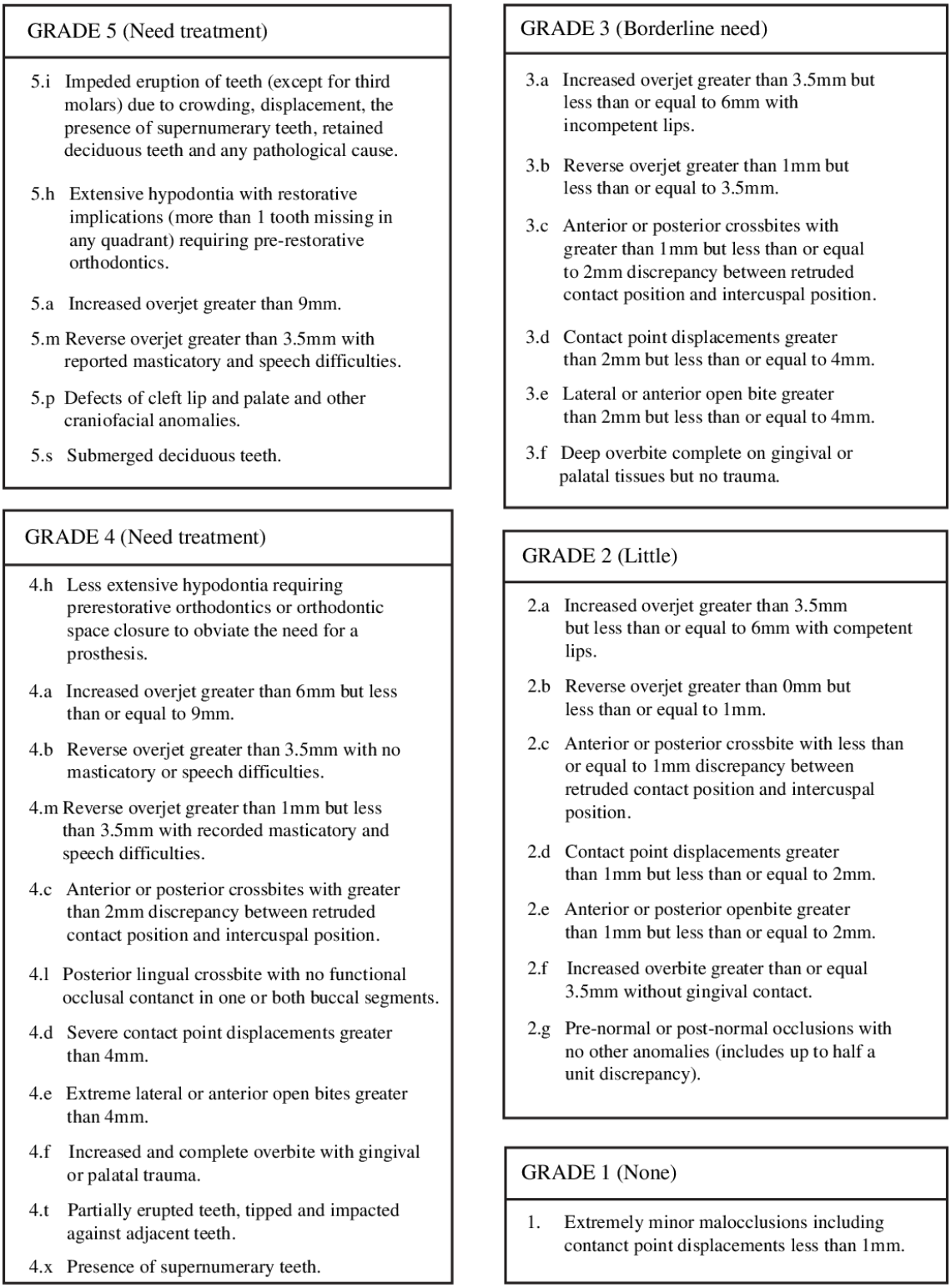


Figure 59. The Dental Health Component of the Index of Orthodontic Treatment Need. Reproduced from Brook P H, Show W C 1989 The development of an index of treatment priority. European Journal of Orthodontics 11: 309 – 320, with permission from Oxford University Press.

9.8. Raw data for compliance at T1 and T2

Table 81 demonstrates the levels of oral hygiene over the course of fixed appliance treatment using the average of compliance for T1 and T2 (patient compliance OH).

Table 81: The frequency of levels of patient compliance (OH) for the overall, public and private healthcare funding systems at time-points T1 and T2.

	Time-point T1 oral hygiene compliance measured three months from the start if fixed appliance treatment			Time-point T2 measurement of oral hygiene compliance for the last three months of fixed appliance treatment		
	Healthcare funding system					
Level of Compliance	Overall	Public system	Private System	Overall	Public System	Private System
	Frequency counts (n) and percentages (%) for each level of patient compliance (OH)					
1-2	44(13.7)	20(13.8)	24(13.6)	28(10.8)	15(14.3)	13(8.4)
3	89(27.6)	26(17.9)	63(35.6)	61(23.6)	23(21.9)	38(24.7)
4-5	189(58.7)	99(68.3)	90(50.8)	170(65.7)	67(63.8)	103(66.9)
Total	322(100)	145(100)	177(100)	259(100)	105(100)	154(100)

Table 81 shows at T1, that for below average compliance (level 1-2), the public and private healthcare systems had similar percentages of patients (13.8% and 13.6%). The majority of patients (68.3%) in the public system had above average hygiene (level 4-5). The majority of patients within the private system (50.8%) also had hygiene levels of (4-5) but the percentage was lower than for the public system. Approximately a third of patients in the private system had average hygiene levels (35.6%) whereas only (17.9%) of public patients were in this category at T1. In the overall sample the greatest number of patient had hygiene levels of (4-5) and this increased from T1 to T2.

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