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MALOCCLUSION AMONG ADOLESCENTS:

QUALITATIVE AND QUANTITATIVE STUDIES OF THE
IMPACT ON ORAL HEALTH AND DAILY LIFE

Jari Taghavi Bayat



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Malocclusion Among Adolescents: Qualitative and Quantitative Studies of the Impact on Oral Health and Daily Life

THESIS FOR DOCTORAL DEGREE (Ph.D.)

By

Jari Taghavi Bayat

Principal Supervisor:

Professor Jan Huggare
Karolinska Institutet
Department of Dental Medicine
Division of Orthodontics

Co-supervisors:

Associate Professor Nazar Akrami
Uppsala University
Department of Psychology

Professor Bengt Mohlin
University of Gothenburg
Sahlgrenska Academy
Institute of Odontology
Department of Orthodontics

Opponent:

Professor Susan J. Cunningham
University College London
Eastman Dental Institute
Department of Craniofacial Growth and Development
Unit of Orthodontics

Examination Board:

Associate Professor Rune Lindsten
University of Jönköping
The Institute for Postgraduate Dental Education
Division of Orthodontics

Professor Ulla Ek
Stockholm University
Department of Special Education

Associate Professor Inger Wårdh
Karolinska Institutet
Department of Dental Medicine
Division of Clinic Oral Physiology,
Geriatric Odontology and Prosthetic Dentistry

To my loved ones. Especially to my parents and Ellinor.

ABSTRACT

Though not considered pathological conditions, malocclusions and their impact have traditionally been assessed from a professional point of view. This could be due to their multifactorial aetiology and the great variation in their severity. Interceptive orthodontic treatments are undertaken during childhood often to reverse an unfavourable development, whereas corrective treatment is performed to adjust established deviations. Orthodontic treatment is, however, predominately optional and provided for the convenience of the individual. Therefore, it is important to involve the patients in the process of assessing treatment need. To do so, detailed knowledge of patient views of the condition and of its impact on their daily life are needed.

In Sweden, dental health care is free-of-charge for children and adolescents. However, due to limited public resources, subsidized orthodontic care is only offered to those with the greatest need. Thus, treatment priority determination is critical. Current modes for assessing treatment need and decision priority are based on normative occlusal indices, which do not account for patient values. In addition, findings of systematic reviews that use generic instrument to evaluate the impact of malocclusion on Quality of Life are inconclusive. These shortcomings reveal the limitations of these approaches. Thus, the aims of this thesis were to (i) examine the effect of malocclusions on the everyday lives of adolescents, (ii) explore the relationship between professionally assessed treatment need and patient demand for treatment, and (iii) develop a condition-specific instrument that would help improve treatment need evaluations.

The present thesis comprises three papers. *Paper I* was a qualitative investigation using grounded theory for data collection and analysis. It elucidated how malocclusions affect the daily lives of adolescents and how adolescents cope with malocclusion-related distress. *Paper II* was a cross-sectional, quantitative prediction study based on a subpopulation of Swedish adolescents and used survey and dental record data. In *Paper II*, path analysis explored the structural relationship between a set of self-assessed measures and treatment need and demand. *Paper III* was a methodological prediction study that used the same dataset as *Paper II*. Here, a prediction equation based on regression analysis was presented to test the validity of the measures in the newly developed Demand for Orthodontic Treatment Questionnaire (DOTQ).

The overall findings were that internal and external factors repeatedly remind adolescents with malocclusion of their condition. Consequently, adolescents develop strategies, such as “hiding one’s teeth” and “striving for a cure”, to handle the negative feelings associated with the condition. Self-assessed demand for treatment was significantly correlated with professionally assessed treatment need. Further, the DOTQ measures are reliable and inter-correlated. It was demonstrated that self-assessed demand for treatment is a strong predictor of professionally assessed treatment need. Finally, cross-validation confirmed the predictive validity of the DOTQ. Thus, the DOTQ seems to be a promising instrument for predicting orthodontic treatment need.

In clinical praxis, dental professionals who treat adolescents with malocclusions should be aware of various strategies that these patients use to deal with their condition, and which potentially lead to irrational behaviours. Patients often become frustrated when treatment need assessment becomes lengthy and delays treatment start. The perceived discrepancy between the professional focus on health aspects and the adolescent focus on aesthetics is unsatisfying in adolescent eyes. Thus, instruments able to evaluate patient perception would be helpful, and recommended, in assessments of orthodontic treatment need and treatment decision priority. Here, the DOTQ could become a useful consultation tool.

Populärvetenskaplig sammanfattning

Allt fler barn och ungdomar vill ha tandreglering för att komma tillrätta med sina felställda tänder och bettavvikelser. Graden och konsekvensen av bettavvikelser kan variera påtagligt. Tandreglering kan till exempel göras för att avbryta en ogynnsam bettutveckling eller för att rätta till bettavvikelser i det permanenta bettet. I Sverige erbjuds, i enlighet med Tandvårdslagen, avgiftsfri tandreglering till de barn och ungdomar som anses ha störst behov av behandling. Begränsade allmänna resurser gör att prioriteringar måste göras. Då bettavvikelser inte betraktas som sjukdomstillstånd, görs en majoritet av dessa behandlingar i huvudsak av estetiska och psyko-sociala skäl och för att underlätta livssituationen för den enskilde patienten. Inte minst därför är det av stor vikt att patientens åsikter tas i beaktande vid bedömning av behandlingsbehov. I den kliniska vardagen används i dagsläget instrument som främst utgår ifrån tandläkarens professionella perspektiv och omdöme. Syftet med denna avhandling var därför:

- ❖ Att kartlägga hur bettavvikelser påverkar ungdomars dagliga liv samt studera hur professionellt bedömt behandlingsbehov hänger samman med patientens behandlingsönskemål.
- ❖ Att utforma och utvärdera ett instrument för prediktering, bedömning och prioritering av behovet av tandreglering som tar hänsyn till ungdomars uppfattning om bettavvikelse samt hur det påverkar oral hälsa, funktion, självkänsla och livskvalitet.

Resultatet visar att ungdomar med bettavvikelser ofta blir påmind om detta, till följd av både extern och intern påverkan, som när de ser sig själva i spegeln, via medias inverkan eller till följd av kamraters påtryckningar. Många ungdomar utvecklar olika strategier för att kunna hantera sina tankar och känslor kopplade till sin bettavvikelse, såsom att hålla för munnen vid tal eller skratt, inte visa tänderna när de ler eller eftersträva tandreglering.

Avhandlingen visar också att skalor och instrument som baseras på självskattning med fördel kan användas som komplement till tandläkarens bedömning av bettavvikelser. Fynden visar att patienternas behandlingsönskemål hänger väl samman med den professionella bedömningen av behandlingsbehov.

Det utvecklade och standardiserade bedömningsformuläret DOTQ, med flertal skalor kopplade till självskattat behandlingsönskemål, kan användas för att förutsäga patienternas behov av tandreglering. Instrumentet skulle därmed också kunna användas som ett kompletterande verktyg i samband med bedömning och prioritering inför tandreglering.

LIST OF SCIENTIFIC PAPERS

This thesis is based upon the following articles, which are referred to in the text by their Roman numerals:

- I. **Taghavi Bayat, J.**, Hallberg, U., Lindblad, F., Huggare, J. and Mohlin, B. (2013) Daily life impact of malocclusion in Swedish adolescents: a grounded theory study. *Acta Odontologica Scandinavica*, 71, 792–798.

- II. **Taghavi Bayat, J.**, Huggare, J., Mohlin, B. and Akrami, N. (2016) Determinants of orthodontic treatment need and demand: a cross-sectional path analysis study. *European Journal of Orthodontics*. Advance online publication, doi: 10.1093/ejo/cjw020

- III. **Taghavi Bayat, J.**, Huggare, J., Mohlin, B. and Akrami, N. (2016) Predicting orthodontic treatment need: reliability and validity of the Demand for Orthodontic Treatment Questionnaire. *European Journal of Orthodontics*. Advance online publication, doi:10.1093/ejo/cjw056

TABLE OF CONTENT

1	Introduction	1
1.1	Orthodontics	1
1.2	Malocclusion	1
1.2.1	Aetiology	2
1.2.2	Prevalence	2
1.3	Dental care systems	3
1.4	Orthodontic treatment need.....	3
1.4.1	Aspects of oral health and function	3
1.4.2	Treatment need indices	4
1.5	Orthodontic treatment demand	7
1.5.1	Factors influencing demand.....	7
1.6	Health and quality of life.....	8
1.6.1	Health-related quality of life.....	8
1.6.2	Oral health-related quality of life.....	9
1.6.3	Malocclusion and instruments of OHRQoL in children	9
1.7	Self-esteem	11
1.8	Psychological testing	11
1.9	Qualitative versus quantitative research	12
1.10	Significance	13
2	Aims.....	15
3	Subjects and methods.....	16
3.1	Study setting	16
3.2	Design	16
3.3	Subjects.....	16
3.3.1	Study I	17
3.3.2	Studies II and III.....	17
3.4	Methods	18
3.4.1	Study I	18
3.4.2	Studies II and III.....	19
4	Results	25
4.1	Study I.....	25
4.2	Study II	27
4.3	Study III	28
5	Discussion.....	32
5.1	Main findings.....	32
5.2	Methodological considerations	33
5.2.1	Study I	33
5.2.2	Study II and III	35
5.3	General considerations	42
5.3.1	Incorporating patient perceptions	42
5.3.2	Challenges in adolescent self-reports	42

5.4	Future research	43
6	Conclusions	44
6.1	Clinical implications.....	45
6.2	Final remarks	45
7	Acknowledgements	46
8	References	49
9	Appendices	62
9.1	Appendix A.....	62
9.2	Appendix B.....	79
9.3	Appendix C.....	81
9.4	Appendix D.....	82
9.5	Appendix E.....	83

LIST OF ABBREVIATIONS

AC	Aesthetic Component of the IOTN (see below)
DHC	Dental Health Component of the IOTN (see below)
DOTQ	Demand for Orthodontic Treatment Questionnaire
HRQoL	Health-related Quality of Life
ICON	Index of Complexity, Outcome and Need
IOTN	Index of Orthodontic Treatment Need
OHRQoL	Oral Health-Related Quality of Life
QoL	Quality of Life
<i>R</i>	Multiple correlation coefficient
R^2	Explained variance (proportion of the variance)
SEM	Structural Equation Modelling
SMBI	Swedish Medical Board Index
TMD	Temporomandibular Disorders

1 INTRODUCTION

What is the professional concept of malocclusion and how do misaligned teeth affect young individuals in today's society? What motivates adolescents to seek treatment? What do they think? The following quote, by a participant in our first study, sums it up well:

It [orthodontic treatment] is something positive, a medicine against ugly teeth.

1.1 ORTHODONTICS

The term “orthodontics” comes from the Greek prefix *orthos* meaning “straight” or “correct” and the word *odous* or *odont* meaning “tooth”. Orthodontics is a discipline in dental medicine with an ancient history (1), involving the development and growth of the face, jaws, and bite (occlusion). The field includes diagnostics, preventive treatment, and treatment of congenital or acquired malocclusions. Orthodontic treatment can be divided into preventive, interceptive, and corrective. The main difference is that preventive and interceptive treatments are undertaken during childhood often to reverse an unfavourable development, whereas corrective treatment is performed to adjust established deviations. Thus, orthodontic treatment aims to correct incorrectly positioned teeth and to influence the jaws and their growth, in order to achieve aesthetic and well-functioning occlusion (2, 3).

1.2 MALOCCLUSION

Edward H Angle introduced the concept of malocclusion (4). The “ideal” or construct of “normal” occlusion is derived from the orthodontic profession. The current definition is based on the concept of *Six Keys to Normal (Optimal) Occlusion* (5). Deviations from an ideal occlusion are known as malocclusions. The prefix *mal-* (from Old French, from the Latin *male* from *malus*) means “bad” or “badly”. Thus, malocclusion is not a pathological condition or disease, but rather a deviation or variation from a constructed and accepted societal norm that can lead to impaired orofacial function and injuries in the local environment (2, 3, 6-16). Apart from this, malocclusions may give rise to concerns about dentofacial appearance and negatively affect patients' psychological well-being, self-esteem and self-image as well as influence their quality of life (17-22). The World Health Organization (WHO) guidelines for function, disability and health (23) state that not only biological consequences but also psychological and sociological effects of a condition or disability must be taken into account. Consequently, there is a suggestion to recognize malocclusion as a treatable chronic disability (24).

1.2.1 Aetiology

The aetiology of malocclusion and related abnormalities of the skeletal components of the face is complex and can vary. These conditions can arise due to (i) specific, isolated causes, (ii) genetic factors, (iii) environmental causes, or (iv) a combination of these (25, 26). Examples of specific causes can be disturbances in the embryological process due to mutations, leading to cleft lip or palate (CLP) or other craniofacial conditions (27, 28).

Malocclusions are predominantly genetically determined, and often influenced by environmental factors. For instance, skeletal and craniofacial dimensions are largely genetically determined, which can lead to anomalies such as mandibular prognathism or discrepancies due to long face patterns (25, 26). Environmental factors such as sucking habits and mouth breathing in the early years of life, due to allergies, hypertrophic adenoids, and/or enlarged tonsils, have been linked for instance to specific malocclusion traits like anterior open bites and posterior cross-bites (29, 30). Prolonged mouth breathing is also associated with posterior rotation of the mandible and large anterior face height (31, 32). Breathing problems during sleep may also negatively affect the occlusion (33-35). Thus, aetiology includes inherited predispositions, prenatal problems, systemic conditions that occur during growth, and aberrant orofacial function or habits as well as tooth loss due to trauma or acquired oral conditions, such as caries or periodontal disease. Because of these complex developmental patterns, malocclusion can be difficult to predict and prevent.

1.2.2 Prevalence

Given the multifactorial aetiology, malocclusion is common in a large proportion of children and adolescents. Prevalence and severity vary, however, and most frequency estimates of the different types of malocclusion derive primarily from studies done in northern European and North American countries (36-47). The variations in reported frequencies could be due to differences in the study populations, such as age and ethnicity, and diverging measurement methods. It is well known that the prevalence of the various types of malocclusion differ depending on period of life and dental stage (primary, mixed, or permanent dentitions). For instance, researchers following a Swedish subpopulation of children between the ages of 3 and 7 years noted a reduction - from 70% to 58% - in the prevalence of malocclusion (48). The prevalence of the different malocclusion types also vary in different parts of the world (41, 42, 45, 47). Class II malocclusions dominate in northern European populations, whereas Class III traits dominate in Eastern Asia and anterior open bite is more prevalent in some parts of Africa (26, 44, 49).

Most importantly, differences in criteria and cut-off points can affect prevalence figures substantially (see Treatment need indices).

1.3 DENTAL CARE SYSTEMS

Discussions of orthodontic care must take into account local settings; the national context; and the financial, insurance, and social security system in which care is provided. Health care in the Nordic countries is largely publicly funded and organised with the aim of ensuring each person equal access to health care services (50, 51). Europe has developed a variety of systems to organise and finance oral health and dental care, including the models used in the Nordic countries (52, 53). In Sweden, the Swedish Dental Act entitles children and adolescents to free-of-charge dental care for nearly all care until the year they turn 20 years of age; some counties provide dental care even longer (54). The care is provided by private or public clinics and is organised and financed by the county councils. This includes orthodontic care that is considered necessary to prevent occlusion-related developmental deviations or to restore good orofacial function and to achieve satisfactory aesthetics in manifested malocclusions. Because the prevalence of malocclusion is high and severity varies (37, 44, 47), and since public funding is limited, orthodontic care free-of-charge can only be offered to those with the greatest need (2). Assessment and prioritization of treatment need is thus of great importance.

1.4 ORTHODONTIC TREATMENT NEED

Evaluations of need for treatment should be based on risk assessment regarding disturbances in oral health and function, aesthetic concerns, patient dissatisfaction and impact of the condition on patients' everyday life, both currently and in the future (14). Thus, deviations from an ideal occlusion do not *per se* necessitate treatment.

1.4.1 Aspects of oral health and function

Untreated malocclusions have been associated with negatively influencing dentofacial development and with tooth or soft-tissue injuries, increased risk of dental trauma, caries, periodontitis, speech difficulties, and impaired orofacial or masticatory function such as temporomandibular disorders (TMD) (2, 3, 6-16).

A systematic review of the Swedish Council on Technology Assessment in Health Care dealing with malocclusions and orthodontics from a health perspective (2) found scientific evidence for the following negative consequences of malocclusion:

1. Root resorption due to ectopically erupting teeth. For instance, there is a correlation between malpositioning of the maxillary canines and root resorption on the lateral incisors.
2. Dental trauma. In the absence of a lip coverage, there is a correlation between the incidence of trauma to the upper central incisors and large overjets. Larger overjets are linked to more severe injuries.

When it comes to TMD and untreated malocclusions, the systematic review showed that individuals with some specific malocclusions, such as cross-bite or large overjet, did have a slightly higher prevalence of TMD symptoms in studies with follow-ups of 2-5 years. However, when observation times were longer, no difference in frequency was found (2). In a systematic review from 2007, the authors concluded that: “Associations between specific types of malocclusions and development of significant signs and symptoms of TMD could not be verified” (15). In 2009 a systematic review presented medium- to high-level evidence of an association between posterior cross-bite and temporomandibular symptoms (16). Another, more recent systematic review concluded that unilateral cross-bites are associated with facial asymmetry (55).

Thus, according to available knowledge, the influence of malocclusion on periodontal health, speech, and chewing is minor, and it is questionable whether orthodontic treatment can be used to prevent TMD (2, 14, 15). On the other hand, preventive orthodontic treatment may be indicated to (i) reduce the negative influence on jaw growth and occlusal development of functional malocclusions, causing anterior or lateral forced bite, or (ii) ectopic tooth eruption (2, 14). Also, correction of large overjets at an early stage may reduce the risk of traumatic injuries (2, 3). After all, apart from malocclusions related to craniofacial developmental disorders, orthodontic treatment is mainly sought and undertaken to improve dental aesthetics and due to psychosocial reasons (2, 9, 14, 56-59).

1.4.2 Treatment need indices

The need for orthodontic treatment has traditionally been determined by orthodontic professionals, and is not seldom done so through the support of aesthetic and/or normative orthodontic treatment need indices. These indices usually grade the severity of aesthetic or morphological deviations of malocclusion (2). To perform its task, an index must be reliable

(allow reproducibility) and valid (measure what it aims to measure). It should also identify individuals in need of treatment (sensitivity) and those with no treatment need (specificity) (60). Treatment need indices categorize malocclusions in terms of occlusal traits and severity under the assumption that the greater the deviation from the constructed norm of an ideal occlusion, the greater the risk of future dissatisfaction, discomfort, pain, or injury. Scientific evidence for this assumption, however, is highly questionable (61, 62). Also, the most commonly used indices are not easily comparable and are unable to cover the entire spectrum of malocclusion traits (62).

Determining treatment need priority is necessary for effective resource use in orthodontic care. The main objective of these indices is to evaluate, and thereby facilitate treatment priority decisions (61-63). Considering available social resources and the numbers of children and adolescents who seek treatment, priority is aimed to be given to those with the highest need, based on index scores. This can vary in different times and societies, and depends of the prevalence of malocclusion, social norms, and available resources. The lowest score that is eligible for subsidized treatment is the cut-off point (61-63). The Nordic countries and countries such as England and the Netherlands that subsidise dental health services have commonly used indices to assess orthodontic treatment need when making treatment priority decisions in this area (62, 63). A multitude of indices have been developed for treatment need assessment. Some of these are presented in Table 1. This table also describes a few indices used to evaluate treatment outcomes since it has been suggested that these might function as indices of treatment need as well (64, 65).

Internationally, the Index of Orthodontic Treatment Need (IOTN), the Index of Complexity, Outcome and Need (ICON), and the Dental Aesthetic Index (DAI) are among the most frequently used indices for treatment need assessment (62). In Sweden, the Swedish Medical Board Index (SMBI) and the IOTN, which share some common ground, are the indices most commonly used for treatment need assessment and prioritization (2). Although these indices have served their function in the past, there is little evidence supporting the idea that individuals with greater scores, that is higher need as assessed by these indices, are more at risk when it comes to oral health, thus their predictive validity to detect health problems are questionable (2, 61, 62). Furthermore, it is up to debate whether they are able to serve their basic purpose of establishing relevant cut-off points for need for treatment (61).

Table 1. Examples of indices used for orthodontic treatment need assessment, and a few indices for treatment outcome.

Index	Year	Description	
Treatment Need			
Handicapping Labio-lingual Deviation Index (HLD)	1960	An epidemiological index. Mainly for public health purposes. Adjustable cut-off point.	(66)
Orthodontic Treatment Priority Index	1967	“For studying malocclusion in population groups.” Ten components weighted and summed leading to a value on a 10-point scale of severity.	(67)
Salzmann’s Handicapping Malocclusion Assessment Record	1968	For assessment of handicapping malocclusion, used to determine treatment priority decisions.	(68)
Summer’s occlusal index (OI)	1971	Mainly for epidemiologic purposes. Scores nine characteristics (dental age and various morphological factors). Includes classification of occlusion used to interpret the index scores.	(69)
Indication Index	1977	To evaluate demand for treatment. Focuses on current inconveniences concerning malocclusion.	(70)
Swedish Medical Board Index (SMBI)	1966; 1974; 1976	Normative. Non-parametric. Uses 4 categories of need: very great, great, obvious, and little need. A revised version added a fifth category (grade 0), describing no need.	(71-73)
Dental Aesthetic index (DAI)	1986	Based on an occlusal condition-related social acceptability scale. Initially designed for use in the permanent dentition. Contains scales for rating, and clinical and aesthetic components to produce a single score, reflecting malocclusion severity. Cut-off points are used to establish treatment need.	(74)
Norwegian orthodontic treatment index (NOTI)	1992	For evaluating treatment need. Normative. Non-parametric. Uses 4 categories of need: very great, great, obvious, and little/no need.	(75)
Standardized Continuum of Aesthetic Need (SCAN)	1987	An aesthetic scale, illustrating a series of photographs of 12-year-olds participating in a large multidisciplinary survey. The photographs are arranged in order of least to most attractive dentitions (grading 1-10).	(76)
Index of Orthodontic Treatment Need (IOTN)	1989	Based on the SMBI. Initially named the Index of Orthodontic Treatment Priority. Contains two components: the Dental Health Component (DHC) and the Aesthetic Component (AC). The DHC categorizes the unfavourable effects of a number of deviating occlusal traits in order of severity on a scale from 1-5. The AC is the reformed SCAN index, based on six laymen’s grading of photographs in terms of dental attractiveness in reverse order: 1-10	(39)
Orthodontic Indication Index	1995	“For priority planning of orthodontic care.” Further development of the Indication index by Lundström.	(77)
Index of Complexity, Outcome and Need (ICON)	2000	Evaluates treatment need and outcome, and the complexity of a malocclusion. The ICON is consensus based, reflecting the opinion of a panel of 97 orthodontists. Incorporates components from the AC of IOTN and the Peer Assessment Rating (PAR) index, seen below. Based on weighting and summation of various occlusal components, forming the final ICON score. Includes recommended cut-off points.	(78)
Treatment Outcome			
Little’s Irregularity Index	1975	Used to assess mandibular anterior irregularity, summing the amount of contact point displacements. Can be used for assessing pre-treatment status and post treatment changes.	(79)
Peer Assessment Rating index (PAR)	1992	Designed to evaluate treatment results, mainly on a group level. Based on the opinions of 74 dentists.	(80)
ICON	2000	See above.	(78)

Notably, even though orthodontic treatment is often motivated based on the potential improvement of social and psychological well-being (2, 57-59), using available indices patient perspectives are seldom included in orthodontic treatment need assessments (81, 82).

1.5 ORTHODONTIC TREATMENT DEMAND

Demand for orthodontic treatment can be defined as self-perceived need for treatment or subjective treatment need. There are indications that the rising demand for orthodontic treatment may be due in part to the current heightened emphasis on body image in today's culture, including the teeth and an attractive smile (58, 83). Apart from the previously mentioned quantitative studies on teen-age treatment-seeking to improve dental aesthetics for psychosocial reasons (9, 14, 57), several qualitative studies have established that adolescents and young adults who seek treatment are dissatisfied with the appearance of their teeth (56, 84), due to current societal norms and peer pressure. Thus, both cultural and social factors seem to influence perceived treatment need.

Aside from treating malocclusions that are potential oral health risks, it could be argued that the benefits of orthodontic treatment are mainly psychosocial (2, 57, 58, 85, 86), making it necessary to consider the patient perspective in treatment need assessments, and evaluating pretreatment concerns (87). However, a systematic review in 2014 revealed that patient perceptions, especially self-esteem, are rarely measured in orthodontic research (24). In-depth explorations of the psychosocial aspects of malocclusion, of potential correlations between malocclusion and self-esteem, of the impact of malocclusion on daily life, and of self-perceived need for treatment would thus be needed to improve future assessments of orthodontic treatment need.

1.5.1 Factors influencing demand

The following factors have been suggested to influence the demand for treatment: Gender, age, socio-economic background, self-esteem, norms of peer groups and also previous orthodontic treatment (88-94). Parental encouragement as well as the influence of dental professionals and patient self-perception are important motivating factors to undertake treatment (88, 95), thus, also influencing treatment demand.

1.6 HEALTH AND QUALITY OF LIFE

According to the WHO, health is “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” (96). Quality of life (QoL), on the other hand, refers also to life satisfaction, general well-being, and contentment with the various aspects of life. This broad term is applicable to both individuals as well as societies. The WHO defines QoL holistically as:

...an individual's perception of their position in life in the context of the culture and value system in which they live and in relation to their goals, expectations and standards and concerns (97).

It is a wide spanning concept comprising an individual's physical and psychological status, level of independence, relationships, all in relation to other relevant features of their environment. This description has been criticized since it invites a non-systematic mixture of facts, subjective values, and value systems; in different contexts, these create major challenges due to variations in meaning and interpretation of the term (98-100).

1.6.1 Health-related quality of life

Health-related quality of life (HRQoL) could be defined as an individual's, or a group's, perceived physical and psychological health and is used in relation to outcomes of health conditions and their treatment (101). HRQoL and QoL profiles are earning more and more attention as instruments for measuring various aspects of health care, due to the rising awareness that traditional clinical health measures lack the ability to capture the experiences and concerns of individuals affected by, or treated for, a certain condition (102). HRQoL instruments are used to improve interactions between patients and health care providers, to compare the impacts of various conditions, and to assist in priority setting in and organisation of health care services (103). HRQoL is usually assessed through self-report via a patient questionnaire – not a professional evaluation. A self-report usually includes the following domains: *(i)* somatic symptoms and their severity (such as pain and discomfort), *(ii)* psychological aspects (including emotion, cognition and general consciousness), and *(iii)* social components (such as of everyday life, family and work) (100).

1.6.2 Oral health-related quality of life

The impact of oral health on QoL can be exemplified by the findings in a study of homeless adults in Stockholm, in which the informants perceived oral health and dental treatment as “as a function to restore their human dignity and as a key to their holistic recovery” (104). When instruments that reflect the patient perspective were first introduced in dental medicine, they were denoted, for example, as “socio-dental indicators” and “subjective oral health measures”. Later, these terms were replaced with the concept of oral health-related quality of life (OHRQoL), which evolved over time to its present understanding (105). In 2007, Locker and Allen defined OHRQoL as:

... the impact of oral disorders on aspects of everyday life that are important to patients and persons, with those impacts being of sufficient magnitude, whether in terms of severity, frequency or duration, to affect an individual’s perception of their life overall (105).

In the last two decades, the number of instruments developed to evaluate the OHRQoL of patients with various oral conditions has increased dramatically (Table 2).

1.6.3 Malocclusion and instruments of OHRQoL in children

Several generic OHRQoL instruments for assessing the impact of oral conditions in children have been presented (106-108), see Table 2. Two systematic reviews of these instruments, however, highlight some uncertainty concerning the relation between malocclusion and its impact on adolescents QoL (21, 22). Because malocclusions seldom cause major pain or discomfort and do not qualify as pathological conditions, generic instruments (enabling inter-condition comparisons through for instance a health profile) should be replaced with condition-specific instruments (more sensitive and clinically relevant for a certain condition) when dealing with malocclusion. Recently, two such instruments designed for young people with malocclusion have been introduced; aiming to measure (i) the psychosocial impact of dental aesthetics (109, 110), and (ii) OHRQoL (111, 112).

Table 2. Examples of oral health-related quality of life instruments.

Instrument	Year	Description	
Generic (oral health-related)			
Social Impacts of Dental Disease (SIDD)	1986	Socio-dental indicator to measure the social impact of dental disease. Includes both clinical and socio-psychological aspects.	(113)
Geriatric Oral Health Assessment Index (GOHAI)	1990	Measures “patient-reported oral functional problems” and “psychosocial impacts associated with oral diseases”. To evaluate the effectiveness of dental treatment.	(114)
Dental Impact profile (DIP)	1993	Describes how quality of life is “detracted from or enhanced by, oral health and oral structures”.	(115)
Subjective Oral Health Status Indicators (SOHSI)	1994	A battery of “subjective oral health status indicators”. Developed for use in surveys of elderly adults.	(116)
Oral Health Impact Profile (OHIP)	1994	A “measure of self-perceived oral health”. To assess the impact of oral disorders on social life and the “dysfunction, discomfort and disability caused by these conditions”. Assesses treatment priorities, oral health behaviours and dental treatment.	(117)
Dental Impacts on Daily Living (DIDL)	1995	Measures five dimensions of QoL: comfort, appearance, pain, performance, and eating restriction. A scale for assessing dimension impact is included. Generates a total single score.	(118)
Oral Impacts on Daily Performance (OIDP)	1996	For use in combination with normative measures to assess dental needs of populations and facilitate dental service planning. Measures “behavioural impacts” of oral conditions and their compromising effect on physical, psychological and social abilities and performances.	(119)
Oral Health Quality of Life UK (OHRQoL-UK)	2001	Measures the perception of how oral health affects QoL. Takes account of both effect and impact of oral health. Includes an individualised weighting system.	(120)
Child Perception Questionnaire (CPQ 11-14)	2002	Measures the “functional and psychosocial outcomes of oral disorders”. Comprises four domains: oral symptoms, functional limitations, emotional well-being, and social well-being. Suitable for assessments at the group level.	(106)
Child Oral Health Quality of Life Questionnaire (COHQoL)	2004	Consists of “a battery of measures for children and their parents”, including the CPQ. Developed in several stages.	(121)
Child Oral Impacts on Daily Performance (Child-OIDP)	2004	Child version of the OIDP. Assess impact in eight areas: eating, speaking, cleaning, sleeping, emotion, smiling, study and social contacts.	(107)
Child Oral Health Impact Profile (COHIP)	2006	COHIP has dimensions common to many adult and other OHRQoL measures developed for children. Includes Oral Symptoms, Functional Well-being, Social-Emotional Well-being, School Environment and Self-Image.	(108)
Condition-specific (malocclusion-related)			
Orthognathic Quality of Life Questionnaire (OQLQ)	2000	Measures effects of dentofacial deformities on QoL in patients seeking orthognathic surgery. Consists of four domains: oral function, facial aesthetics, awareness of dentofacial aesthetics and social aspects.	(122,
	2002		123)
Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ)	2006	A psychometric instrument. Investigates the relationship between dental aesthetics and OHRQoL. Consists of four measures: dental self-confidence, social impact, psychological impact, and aesthetic concern. Later tested “across age-groups”.	(109,
	2015		110)
Malocclusion Impact Questionnaire (MIQ)	2016	Measures “the actual and perceived issues, problems, limitations, restrictions and adaptation strategies specific to adolescents with malocclusion”. Comprises 17 one-dimensional items.	(111, 112)

1.7 SELF-ESTEEM

Self-esteem is a term with a multitude of definitions. The construct of self-esteem plays an important role in the social sciences and in everyday life (124). In social psychology, three conceptually different, yet correlated, definitions are used. In one definition, self-esteem is used to denote how individuals feel about themselves in general terms, and is referred to as *global self-esteem*, or trait self-esteem. The term *global* is used because it is relatively stable through time and circumstances and has been proven to be rather stable through adulthood (125). However, there are different approaches to global self-esteem. A cognitive approach assumed that a decision lays behind individuals' ideas about their own worth (126, 127). Other definitions of global self-esteem are emotionally derived, suggesting that it is people's feelings of affection for themselves that define self-esteem (128-130).

A second definition, *state self-esteem*, denotes feelings of self-worth (131-133); it describes self-evaluative emotions and reactions to different situations (134) such as feeling proud or ashamed of oneself. A third definition concerns individuals' evaluations of their abilities, personal characteristics, or physical attributes. The term *self-confidence* is often used here and is sometimes equated with self-esteem. Several scales for assessing self-esteem actually include subscales that measure self-confidence (135, 136). It has also been demonstrated that individuals with high self-esteem evaluate themselves in a more positive manner and have higher feelings of self-worth than those with low self-esteem (130). Testing different models, researchers have shown that self-evaluations and self-esteem appear to regulate separate aspects of psychological life (137). Thus, to believe that one is good at things is not equivalent to having high self-esteem. Self-esteem has been defined as "a capacity to construe events in ways that promote, maintain, and protect feelings of self-worth" (128).

1.8 PSYCHOLOGICAL TESTING

Psychological tests require involvement and action on the part of the subject. The behaviour of the individual is used to measure specific attributes or predict a certain outcome. Thus, such a test is not a measurement of all possible behaviours. These characteristics are common to all psychological tests, they are: (i) a sample of behavior, (ii) acquired under standardized conditions, and (iii) determined according to rules or procedures for converting the information to scores or quantitative information (138). Most psychological tests can be arranged into *performance testing*, *observations of behaviours*, and *self-reports*.

A self-report is any test, asking individuals to report their symptoms, feelings, behaviours, opinions, attitudes, interests, or for example, psychological state of mind. For instance, self-report measures are often used in self-esteem research (124). Data can be collected manually or in electronic format, but also through interviews.

Self-reports are easily obtained, and they are often used since they may reveal valuable and sometimes diagnostic information about individuals. Furthermore, they can be used in clinical situations, by asking specific questions (anamnesis), in order to formulate a diagnosis. However, bias must be considered, since self-reports are based on individual recollections and experiences. For instance, individuals are predisposed to report experiences that are considered more socially acceptable. Thus, it is often recommended that self-report data be used in combination with other data (138).

1.9 QUALITATIVE VERSUS QUANTITATIVE RESEARCH

Quantitative research is often associated with the deductive approach, that is hypothesis-driven, based on existing theory tested against observations (empirical). Qualitative methods on the other hand, are associated with inductive methods, where research begins with observations, often in order to find patterns, generate hypotheses, concepts or models; or contribute to new theory (139, 140).

In quantitative research, statistical estimation and inference are often deducted from a smaller generalizable sample in relation to a larger “true” population of interest relevant for the research question. The qualitative approach, however, aims to understand specific situations, happenings, or populations through narrative description and constant comparison (139-143). Consequently, quantitative methods are used to demonstrate causal relationships under standardized and often controlled conditions, while qualitative methods are useful for generating a deeper understanding of specific, natural, and uncontrolled phenomena. Table 3 describes some main features of the two research approaches.

Table 3. Examples of concepts traditionally associated with quantitative and qualitative research methods.

	Quantitative	Qualitative
Research question	Often pre-specified, result-oriented	Open/Open-ended, focusing on the process
Research field	Medicine, economics, psychology, etc.	Sociology, nursing, psychology, etc.
Reasoning	Deductive, based on objectivity and causation	Inductive, based on subjectivity and meaning
Analysis	Numerical, statistical inference	Narrative, constant comparison

These research techniques are also possible to combine. For instance in health research, to combine these approaches can be advantageous in instrument development (105, 144). Using qualitative methods to first explore a sparsely studied phenomenon, researchers can gain valuable insights that enable instrument development at a later stage with quantitative methods. Combining these approaches may help identify relevant phenomena; for example, in a comparison of two seemingly equally effective surgical methods (as evaluated quantitatively), descriptions of the side-effects or the post-surgical experience of the patients (as evaluated qualitatively) may uncover some important differences. The qualitative approach is able to capture patient experiences, which adds valuable knowledge that may affect recommendations for treatment modalities (145). Recently, published studies in the fields of medicine and health care have begun looking more closely at the value of the mixed method approach (146, 147).

1.10 SIGNIFICANCE

Available indices for orthodontic treatment need assessments, mainly reflect experts concerns and values (61, 62, 82). Studies have demonstrated differences between treatment need assessment by professionals and patient perception of their malocclusions (81, 148).

Likewise, many oral health related quality of life instruments have been criticized for being expert-centered (105). In health care, qualitative interviews are considered to be the main mechanism through which the views of patients can be captured. Gayatt and co-workers also state that instruments targeting QoL issues should be “derived from in-depth interviews with those who will ultimately be expected to complete the questionnaire” (149). Locker and Allen adds that it is important to include patient values, in order for an instrument of health to qualify as a HRQoL instrument (105).

In the past decades, the orthodontic field has increasingly explored the importance of QoL (150, 151). Inconsistent findings in evaluating the impact of malocclusion using generic OHRQoL instruments (21, 22), suggest that instruments aiming to measure the impact of malocclusion need to be condition-specific to serve their function. Thus, to address the shortcomings in the assessment of orthodontic treatment need, and to learn more about the impact of malocclusion on the daily lives of adolescents following the recommendations of QoL researchers, a new approach based on a combination of qualitative and quantitative inquiries seems crucial.

2 AIMS

The overall aim of this thesis was to examine the effect of malocclusion on the everyday life of adolescents and to explore the relationship between professionally assessed treatment need and patient demand for treatment, and to develop a condition-specific instrument predicting treatment need through self-assessed treatment demand of adolescents.

The specific aims were:

- Study I** To explore how malocclusions affect the daily life of adolescents and how adolescents cope with malocclusion-related distress.
- Study II** To study the relationship between a number of measures linked to treatment demand, and how these are related to professionally assessed treatment need. To propose a model for predicting orthodontic treatment need and demand.
- Study III** To identify key measures in predicting orthodontic treatment need, and to propose a condition-specific instrument to improve orthodontic treatment need assessments.

3 SUBJECTS AND METHODS

3.1 STUDY SETTING

All studies were conducted in the city of Uppsala, Sweden. All participating adolescents were entitled to regular dental care, publicly financed and arranged through Uppsala County Council according to the Swedish Dental Act (54).

3.2 DESIGN

Study I was a, in-depth, qualitative interview investigation, employing classic grounded theory (GT) for data collection and analysis. Study II was a prediction study with explorative elements; path analysis was used to propose and test a model. Study III, a cross-sectional methodological prediction study, tested and validated a proposed condition-specific self-assessment instrument using regression analyses and a prediction equation. Studies II and III were quantitative studies on the same population sample. The data in these studies were derived from the results of a comprehensive malocclusion-related questionnaire (Appendix A) and dental records on orthodontic treatment need. Figure 1 presents an overview of the included studies.

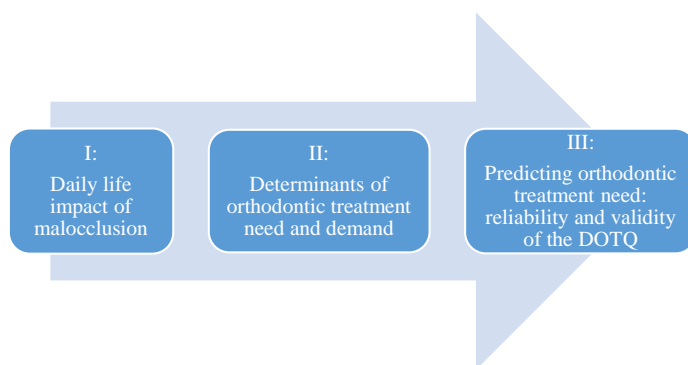


Figure 1. Flow chart of the three studies in the present thesis.

3.3 SUBJECTS

All participants and their parents received written information about the studies. In Study I, participants and their parents also signed informed-consent forms. In Studies II and III, the act of filling out the questionnaire and returning it was considered approval from the participant; as the written instructions informed the participant of this. All studies were approved by the Research Ethical Committee in Stockholm, Sweden. Reference numbers 2009/5:4 and 2014/2084-32.

3.3.1 Study I

Twelve adolescents aged 13 and 14 years (seven girls) were strategically selected based on age, gender, and place of residence from waiting lists for assessment of orthodontic treatment need in two Public Dental Service clinics. The lists comprised patients with a considerable deviation from the normal occlusion; referred for specialist consultation by general practitioners according to Uppsala County Council guidelines, which are based on the DHC of the IOTN (39) (Appendix B). The procedure of informant selection aimed to create gender-specific but otherwise heterogeneous groups regarding place of residence and age. The aim was to enable discussion and to achieve variation in experience among the informants, regardless of malocclusion type which was not recorded since sampling would continue until saturation was reached.

3.3.2 Studies II and III

The study sample was compiled from the Uppsala City population registry. The sample comprised 150 Swedish adolescents aged 13 years. Evry Sweden AB, a consulting company, randomly recruited the sample. Written information about the study was sent to 240 participants, asking them to participate by filling out and returning the enclosed questionnaire or completing an online questionnaire on the SurveyMonkey platform. The respondents were requested not to ask their parents for help but to fill in the questionnaire by themselves. At approximately 4 weeks with one reminder at 2 weeks, 92 responses (38.3%) had been received. So another 100 adolescents were randomly selected for participation. After a new reminder at 2 weeks, the total number of returned questionnaires reached 162 (51% online). Due to incomplete ($n = 7$) or late incoming responses ($n = 5$) the final data set comprised 150 participants.

The number of participants necessary to reach a statistical power of 0.80 and a probability of Type I error (α) of 0.05 by assuming a true correlation of 0.20 (being the average effect size in social psychological research), was calculated. Thus, a sample size of 150 individuals was required (152). It was also considered that the point of stability of a correlation is reportedly reached at a sample size of about 150 (153).

3.3.2.1 Dental records

To retrieve information on orthodontic treatment need, the general dental records of the participants were screened retrospectively ($N = 157$). The database that was set up included professional evaluations and notes on occlusal status, treatment need assessment, and IOTN-DHC scores. If the DHC component was missing, a consulting orthodontist and qualified user

of IOTN (JTB) interpreted the descriptions of occlusal status and diagnosis recorded by the orthodontic specialists and converted the data into corresponding DHC grades. In the original sample ($N = 157$) this was performed in 28 out of 46 patients with established treatment need. This procedure was repeated to verify intra-examiner reliability. The distribution of the final 150 participants by IOTN-DHC severity was Grade 1: $n = 74$; Grade 2: $n = 17$; Grade 3: $n = 17$; Grade 4: $n = 32$; and Grade 5: $n = 10$.

3.4 METHODS

3.4.1 Study I

The qualitative methodology of classic GT, was used for data collection and analysis in Study I (154). GT is an inductive methodology and described as a general method (it uses qualitative as well as quantitative data) for systematically generating theory, concepts, or models through systematic research. GT is especially useful for studying social processes for which few theories exist (154). Its theoretical background is in symbolic interactionism, implying that meaning is constructed and altered as a product of interactions between persons (155). The research procedures of GT leads to the emergence of conceptual categories that are related to one another and theoretically explains the actions that continually solve the “main concern” of the participants in the area studied. The principles include *theoretical sampling*, *saturation*, *constant comparisons*, and *theoretical sensitivity*. Theoretical sampling refers to a sampling process that is continued until no additional information arises from new data, which is referred to as reaching saturation. Differences and similarities in emerging codes and categories are constantly compared during the process of analyses. Theoretical sensitivity refers to the use of personal and professional experience to view data from new aspects and different angles (156).

Using a theme guide (Appendix C), open, tape-recorded in-depth interviews were performed using procedures of Focus Group Discussions (FGD) (157, 158). Each session lasted about 30 minutes. According classic GT methodology, the FGDs were carried out successively, and analysed, until saturation was reached. One interviewer (JTB), accompanied by one observer (a last year dental students familiar with GT methodology), conducted the interviews in a conference room at a general Public Dental Service clinic. In total, five ‘mini’ FGDs in gender specific groups (three with girls and two with boys) were conducted. The participants were asked to discuss freely, and given the opportunity to raise issues or questions of their own. Follow-up questions were asked if relevant. The interviews were transcribed verbatim and analysed according to open, selective coding routes (154): line-by-line reading of the data with analysis of what was being expressed and its meaning. Thus, the substance of the data

was apprehended and segmented into *substantive codes*, labelled concretely, and put into summarizing categories. Thereafter, the categories were labelled, assigned elevated and more abstract labels than the original codes belonging to each category. In the process of selective coding, a core category was identified. The core category must be related to all the categories and their sub-categories, and describe the core content of the matter being studied.

Throughout analysis, ideas and notions were noted in memos, together with preliminary assumptions and theoretical reflections (154). Data collection and analyses were conducted simultaneously in collaboration with an experienced GT social science researcher.

3.4.2 Studies II and III

3.4.2.1 Common features

A comprehensive questionnaire was developed based on Study I findings of the impact of malocclusion on daily life of adolescents, and findings of previous studies (17, 18, 106, 159-162). Questionnaire development included theoretical processing and language adaptation to suit the age group and to avoid the risk of leading or biased questions. The original lengthy questionnaire consisted of 12 measures and more than 100 items in total. The measures aimed to assess various domains related to malocclusion, self-esteem, treatment need and demand. A five-point Likert scale with the endpoints 0 (*Do not agree at all*) and 4 (*Agree fully*) allowed participants to respond to each statement. The questionnaire also included background and control questions, and a few open-ended questions to collect views and feedback. The design adhered to available knowledge on survey methods and questionnaire construction (138, 163, 164). A panel consisting of one child psychiatrist, one psychologist, and three orthodontists reviewed the questionnaire before it was used in the survey. Two pilot studies for language comprehension and item relevance were also done. The first pilot study included six adolescents (aged 13-15 years); two of these (aged 13) were also interviewed and asked to comment each questionnaire item further, including marking its relevance. The second pilot study involved nine subjects, including a panel of experts ($n = 4$), dental staff at an orthodontic clinic ($n = 3$) and adults who have had orthodontic treatment in their youth ($n = 2$, age = 30 plus). The questionnaire was then re-evaluated and minor adjustments were made. Appendix A shows the original questionnaire in Swedish language.

Participants filled out the questionnaire online or on paper. The paper responses were then transferred digitally and a database was created, which was processed in *Statistica* (version 13).

The database contained a variety of condition-related self-assessed measures that included *self-esteem* (Dental Self-Esteem, but also Global Self-Esteem), *aspects of malocclusion* (e.g. Perceived Malocclusion and Perceived Functional Limitation), and *Treatment Demand*. Items being reversed coded were recoded. Then an index was created by averaging the responses across all items within each measure. The DHC of the IOTN was used to represent professionally assessed treatment need (Appendix B). DHC results were matched against the findings from analyses of the measures.

The data in Studies II and III originate from the same data set. But, the methodology, set of variables used, and main focus of the analyses differ substantially between the studies, as described below. Studies II and III tested and improved the measures and their items in a cumulative manner. Appendix D illustrates the development of the Demand for Orthodontic Treatment Questionnaire (DOTQ).

3.4.2.2 *Study II-specific*

The overall methodology of this study was based on theoretical reasoning and a semi-explorative approach dealing with the structural relationship between a number of measures and a variable (DHC) based on dental record findings. Before using the measures ($N = 7$) these were evaluated theoretically. Here are the descriptions of the used measures:

Dental Self-Esteem. Measured by 8 items (3 reverse coded). Higher scores indicate higher dental self-esteem. Item example: “I am proud of (the appearance of) my teeth”.

Global Self-Esteem. Measured by 12 items (4 reverse coded). Higher scores indicate higher global self-esteem. The items were modified to fit the age group (165). Item example: “Sometimes I feel like I am not good enough” (reversed coded).

Social Influence. Measured by 12 items (3 reverse coded). Included items measuring different aspects of influence (e.g., media, peers). Higher scores indicate higher burden due to negative social influence. Item example: “I am worried that people will comment on my teeth”.

Perceived Malocclusion. Measured by 8 items (1 reverse coded). Tapping a range of occlusal status. Higher scores indicate higher perceived malocclusion. Item example: “I have crooked teeth”.

Perceived Functional Limitation. Measured by 9 items, tapping various aspects of oral functional limitations. Higher scores indicate higher perceived functional limitation. Item example: “I bite myself in the palate (gum tissue) when I bite together”.

Prioritizing Healthy and Straight Teeth. Measured by 4 items (1 reverse coded). One of these items was later removed due to unclear wording and inconsistency. Higher scores indicate that healthy and straight teeth have a higher priority than white teeth. Item example: “Having white teeth is more important to me than having straight teeth” (reverse coded).

Treatment Demand. Measured by 11 items (1 reverse coded). Assessed demand for orthodontic treatment. Higher scores indicated higher treatment demand. Item example: “I have longed for braces for a long time”.

Statistical analysis

A series of basic statistical analyses, including mean score and standard deviation calculations, were done to examine the properties of the measures and their interrelations (Table 5). Reliability (internal consistency) was assessed by Cronbach’s alpha. Pearson product-moment correlations were calculated looking at the relations between the measures. The correlations among all measures are presented in Table 6. This was followed by the main analysis, *path analysis*, performed with insights from the correlation analysis and theoretical elaborations derived from findings in previous research (56, 166).

To study the relations between the measures and examine whether they could predict Treatment Need and Treatment Demand, path analysis was done using the latent variable modelling program *Mplus* (167). *Mplus* is a form of structural equation modelling (SEM) that uses the relations between latent variables.

Path analysis can be used in place of regression analysis, where only a single dependent variable is used, to simultaneously model the relations among different variables based on more than one dependent variable. Model testing in path analysis is straightforward: a theoretical model is proposed (Figure 2) and then tested.

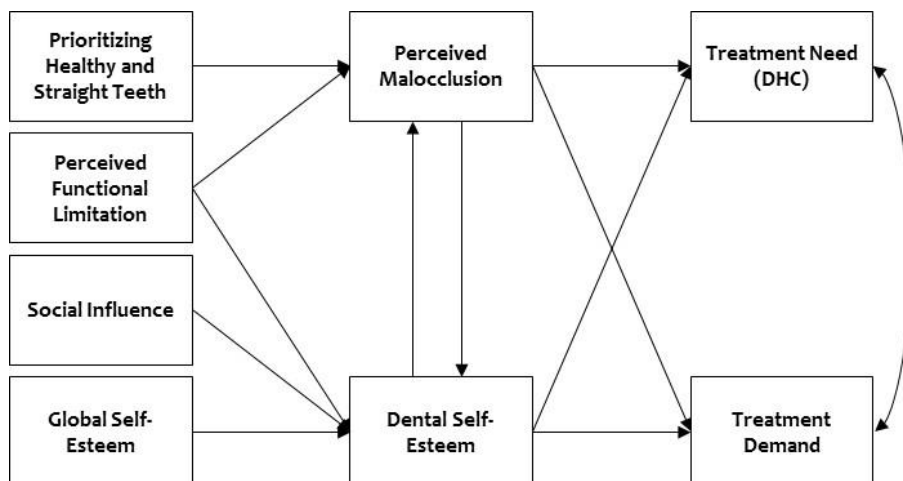


Figure 2. Theoretical path model explaining orthodontic treatment need and demand.

A variety of indicators are used to display the fit between the theoretical model and the data-generated models. The indicators and their interpretation are as follows:

The chi-square test (χ^2), is an overall test of difference between observed and expected relations. A value closer to zero denotes a better fit. Since χ^2 is dependent on sample size, supplementary indicators of fit are recommended (168). The root mean square error of approximation (RMSEA), measures the discrepancy between observed and hypothesized relations in degrees of freedom. A value near or lower than 0.05 suggests a satisfactory fit, and reported with 90% confidence interval. The standardized root mean square residual (SRMR) is the square root of the discrepancy between the data and the theoretical model. Ranging from 0 to 1, a value of ≤ 0.08 indicates an acceptable fit. The comparative fit index (CFI), is a relative measure of fit enabling comparison between two theoretical models. The values range from 0 to 1; the larger the value, the better the fit. A CFI value ≥ 0.90 is usually needed to indicate an acceptable fit (169).

3.4.2.3 Study III-specific

In this study all original 12 measures (Appendix A) were analysed in more depth to improve and shorten the questionnaire and to achieve consistent, reliable and coherent sets of items within each measure. Through new theoretical analysis and re-evaluation of the wording and language, additional item-reduction based on reliability analyses, examination of correlations among items, factor analysis and cross-validation testing allowed modification and improvement of the instrument. Table 4 describes the measures included in Study III.

Table 4. Description of measures included in Study III.

Measures	No. of Items ¹	Description	Item example
Psychological and Social			
Dental Self-Esteem	8 (3)	Describes the degree of self-esteem in connection with dentition. Higher scores indicate higher dental self-esteem.	<i>I feel proud of the way my teeth look.</i>
Global Self-Esteem	10 (4)	Items on global self-esteem modified to fit the age group (165). Higher scores indicate higher global self-esteem.	<i>I am satisfied with being who I am.</i>
Social Influence	9 (2)	Describes different aspects of social influence. Higher scores indicate higher (negative) psycho-social impact.	<i>Sometimes I get teased because of how my teeth are arranged.</i>
Need for Dental Comparison	5 (2)	Describes the urge to compare the appearance of one's teeth with others. Higher scores indicate higher need to compare.	<i>I am envious of those who have nice teeth.</i>
Dental Fixation	8 (2)	Describes the degree of fixation with one's teeth and dental arrangement. Higher values indicate higher fixation.	<i>I find it difficult to avoid thinking about my teeth.</i>
Malocclusion related			
Perceived Malocclusion	6 (1)	Subjective perception of the respondent's occlusion or malocclusion. Higher scores indicate higher perceived malocclusion.	<i>My front teeth stick out.</i>
Perceived Functional Limitation	7 (0)	Refers to various aspects of functional limitation connected to occlusion and/or mastication. Higher scores indicate higher perceived functional limitation.	<i>When I bite, I bite myself in the roof of my mouth.</i>
Prioritizing Healthy & Straight teeth	3 (1)	Higher values indicate that healthy and straight teeth have higher priority than white teeth.	<i>It is more important to have healthy teeth than white teeth.</i>
Coping with Malocclusion	7 (1)	Describes coping with malocclusion-related distress. Higher scores reveal higher coping activity.	<i>I avoid smiling when I am being photographed.</i>
Treatment Demand			
Treatment Demand	7 (0)	Measures demand for orthodontic treatment. Higher scores indicate higher demand for treatment.	<i>I have wanted to have braces for a long time.</i>

¹() = Number of reverse coded items.

Analytical and statistical strategy

Simultaneous analyses of the psychometric properties of the measures were conducted to achieve high measure reliability and uniform dimensionality.

Reliability (internal consistency) analyses consisted of review of Cronbach's alpha and correlations between the items. To make the measures more consistent the lower limit of Cronbach's alpha reliability was set to 0.70 and the lower limit of item-total correlation to 0.30 (dealing with how a specific item correlates with other items within the measure).

Items not reaching these limits and thus correlating poorly with other items within the measure, were excluded. If a measure would not reach the reliability bar, the item(s) with the lowest item-total correlation was excluded to improve reliability. Thus, omission was weighted against reliability changes within each subscale.

Table 7 presents the results of the analyses above, the outcome of the factor analyses regarding dimensionality, together with basic statistics for the measures.

To test predictive validity, a number of multiple regression analyses were performed. The first multiple regression analysis was conducted to identify the extent to which Treatment Need (based on DHC) is predicted by a set of self-assessed measures. The measures used, together with the variable Gender, were included as previous research has found them to be important for predicting treatment need (21, 93, 94, 112, 161, 171). Then, another multiple regression analysis was performed to identify the extent to which all variables explain Treatment Need, and in particular assess the overlap between self-assessment data and professional assessment.

To test the instrument's ability to predict Treatment Need (the validity of the prediction), the dataset was randomly split into two sets (except for DHC). Participants from each DHC category (1 to 5) were then randomly assigned to one of two groups (Subgroup 1 or Subgroup 2) using *www.random.org*, in order to evenly distribute informants with different DHC scores across the two groups. The second multiple regression analysis was performed for Subgroups 1 and 2, used the entire set of variables, including Gender and Treatment Demand as independent variables and Treatment Need (DHC) as the dependent variable, to predict DHC in one group, then using the prediction equation to calculate the predicted DHC scores of the second group. The second multiple regression analysis was repeated, reversing the groups. The predicted DHC for each group was then correlated with the original DHC scores from the dental records. The predictive power of the DOTQ, is revealed by the extent of the correlation between predicted and actual DHC (from the dental records). The validity of the prediction is revealed by the match between the correlations in the two groups.

4 RESULTS

4.1 STUDY I

A core category was identified and labelled “*Repeatedly reminded of the Malocclusion*”. It illustrates how malocclusion had become an important issue for the adolescents, and that the dissatisfaction it led to was often on their minds:

. . . I think about it quite often, when laughing and then // when filming [being video recorded] and stuff like that, when one receives the [recorded] video, then the teeth usually are shown, then I think of it. And then, in the morning when I brush my teeth, and in the evenings, then I am also thinking about it.

The results showed that many of the adolescents frequently compared their teeth with others and with media ideals, consciously or not. The majority of the adolescents were aware of the impact that the media has on today’s society. The concerns of being judged by others, affected the self-esteem of some and there seemed to be an association between being self-critical and being noticeably affected by peer assessments:

. . . Well if it bothers you [to have irregular teeth], then it’s in a way because of very low self-esteem. But I don’t know if it affects me that much. It’s like everything else. It’s like . . . one may have ugly hands, one may have ugly toes, and one may have ugly . . . everything. Well . . . it all depends on one’s point of view. [Continues] I believe they are ugly [talking about own teeth] but they have been uglier. Although . . . I don’t think of it all the time.

The data revealed that negative experiences during early childhood tended to remain in their minds and gradually developed into a recurrent feature of everyday life, affecting self-confidence:

. . . my teeth are ugly. And so. I think that . . . teeth are not any fun. Since . . . when I was younger I was excluded and teased because of my teeth. So now . . . it isn’t funny.

To handle malocclusion-related concerns the adolescents evolved different coping strategies. One strategy was try hiding their teeth, for example by avoiding smiling or holding a hand in front of their mouth when socializing, or avoiding being on in photos:

. . . In all my school photos, I have not smiled at all, as a matter of fact. No, I just close my mouth . . .

Another strategy was seeking orthodontic treatment. Treatment itself could be considered a sacrifice in order to achieve a goal of straight, nice teeth and a nice smile, which they expected would solve many of their social issues:

. . . It [orthodontic treatment] is something positive, a medicine against ugly teeth!

Figure 3 presents five categories related to the core category. These refer to recurrent emotional and cognitive patterns that describe different aspects and ways by which the informants dealt with the main concern, which some of the quotations above illustrate.

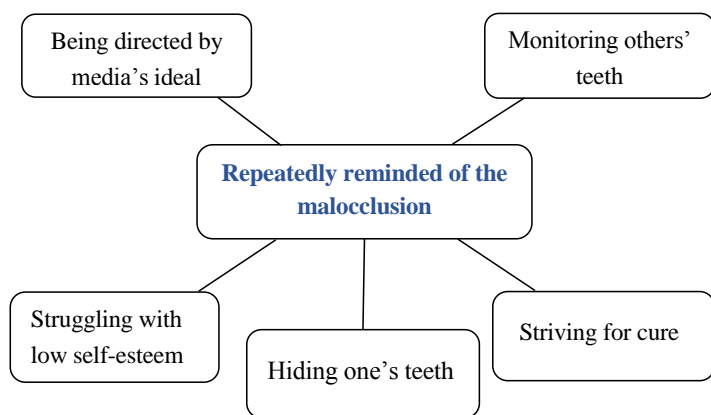


Figure 3. Grounded theory model describing the core category and five related categories.

The results indicate that malocclusion concerns frequently reinforced low self-esteem. For the young people with malocclusion, feeling socially comfortable without needing to focus on their teeth was important. Low self-esteem could be associated with visible malposition of teeth, according to the participants. The adolescents used various coping strategies, such as hiding the teeth and/or seeking treatment, to deal with these concerns. Media influence seemed to reinforce low self-esteem. Finally, the adolescents found it frustrating having to wait for orthodontic treatment (due to prolonged treatment need assessment processes).

These findings also indicate a possible discrepancy in attitude toward malocclusion between professionals on the one hand, who focus on the oral health aspects of the condition, and adolescents on the other hand, who were concerned about aesthetics.

4.2 STUDY II

The response rate in Studies II and III was 48% (51% online), that is 162 respondents, before excluding incomplete responses ($n = 7$) and late arrival replies after set deadline ($n = 5$). The final data set consisted of 150 participants, of which 56 % were girls. Cross-referencing to dental record data revealed that 28 % of the respondents had a treatment need corresponding to DHC grades of 4 and 5. The analyses and results of Studies II and III are based on these data.

The results showed that the measures used in Study II were both reliable and inter-correlated. Table 5 presents basic statistics for the subscales and the dental record variable. The analyses of the measures in this study showed that these were both reliable and inter-correlated, as presented in Table 6.

Table 5. Basic Statistics for the questionnaire-based measures and the dental record based variable¹.

Measure	<i>M</i>	<i>SD</i>	No. of items	α	Inter-item <i>r</i>
Psychological and Social					
Dental Self-Esteem	2.32	0.93	8	0.85	0.44
Global Self-Esteem	3.04	0.73	12	0.87	0.40
Social Influence	0.99	0.72	12	0.81	0.28
Malocclusion related					
Perceived Malocclusion	0.89	0.77	8	0.76	0.28
Perceived Functional Limitation	0.44	0.49	9	0.74	0.27
Prioritizing Healthy & Straight teeth	2.95	0.89	3	0.68	0.42
Treatment Demand and Need					
Treatment Demand	1.52	1.08	11	0.89	0.45
Treatment Need ¹	2.25	1.42	-	-	-

M = mean, *SD* = standard deviation, α = internal consistency reliability, Inter-item *r* = average correlation among the items within each measure. *N* varies between 148 and 150 as a function of outliers. Response range for all scale scores ranged from 0 to 4, except for Treatment Need which ranged from 1 to 5 (DHC-IOTN grade).

Table 6. Intra correlations between measures.

Measure	Pearson product-moment correlation coefficient (<i>r</i>)							
	1	2	3	4	5	6	7	8
1. Dental Self-Esteem	-							
2. Global Self-Esteem	0.39*	-						
3. Social Influence	-0.63*	-0.41*	-					
4. Perceived Malocclusion	-0.50*	-0.21*	0.29*	-				
5. Perceived Functional Limitation	-0.18*	-0.38*	0.29*	0.46*	-			
6. Prioritizing Healthy and Straight Teeth	0.12	0.33*	-0.19*	-0.03	-0.08	-		
7. Treatment Demand	-0.44*	-0.08	0.27*	0.55*	0.25*	0.09	-	
8. Treatment Need (DHC)	-0.26*	0.06	0.00	0.47*	0.17*	0.07	0.64*	-

DHC = the Dental Health Component of the IOTN

* $p < .05$.

Path analysis revealed that the proposed model (i) had good fit to the data and, more importantly, (ii) provided a test of the unique effect of all included measures on Treatment Need and Treatment Demand, revealing a high correlation between the two ($r = 0.64$).

The path model explained 33% of the variance in Treatment Demand and 22% of the variance in Treatment Need (Figure 4).

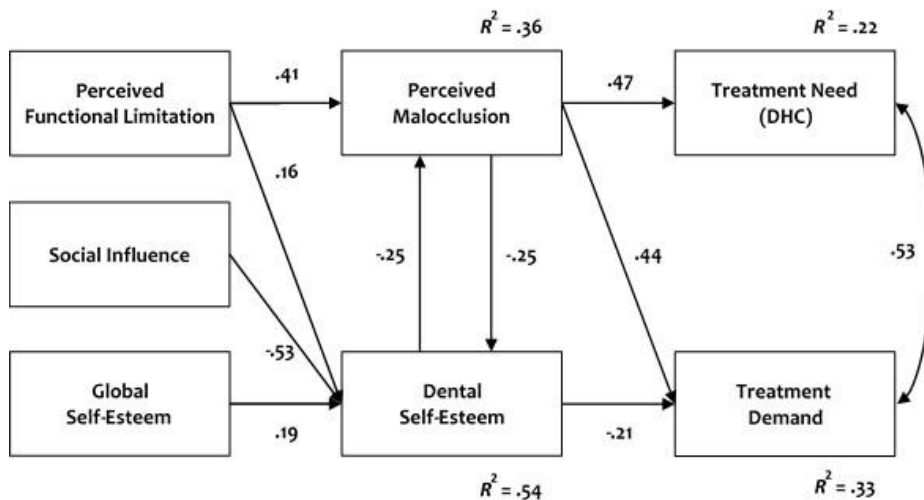


Figure 4. Path model explaining orthodontic treatment need and demand. DHC = the Dental Health Component of the IOTN. All standardized coefficients are significant ($p < .05$, all p-values are two-tailed).

4.3 STUDY III

Overall, the findings revealed that the extensive re-analysis and processing of the original measures and their items improved and shortened the instrument with consistent, reliable and coherent sets of items within each measure. As Table 7 shows, the DOTQ-measures were proven to be reliable and highly inter-correlated.

The results also indicate a high correlation between Treatment Demand and several other measures (Table 8). Notably, these correlations did not diverge from corresponding correlations in Study II (Table 6).

Table 7. Basic statistics and results of reliability and factor analyses for the self-assessed measures.

Measure	<i>M</i>	<i>SD</i>	α	Inter-item <i>r</i>	Explained variance (%)	Factors
Psychological and Social						
Dental Self-Esteem	2.32	0.93	0.85	0.44	50	1
Global Self-Esteem	3.15	0.74	0.88	0.45	50	1
Social Influence	0.95	0.76	0.79	0.32	63	3
Need for Dental Comparison	1.55	1.06	0.77	0.42	53	1
Dental Fixation	1.25	0.96	0.85	0.42	58	1
Malocclusion related						
Perceived Malocclusion	0.95	0.93	0.80	0.41	51	1
Perceived Functional Limitation	0.39	0.49	0.71	0.27	52	2
Prioritizing Healthy & Straight teeth	2.95	0.89	0.68	0.42	61	1
Coping with Malocclusion	0.96	0.96	0.84	0.50	58	1
Treatment Demand						
Treatment Demand	1.45	1.23	0.90	0.57	62	1

M = mean; *SD* = standard deviation; α = internal consistency reliability; inter-item *r* = average correlation among the items within each measure; explained variance (%) = variance in the items explained by the factor; factors = number of factors with an eigenvalue above 1.0. Response range for all scale scores ranged from 0 to 4.

Table 8. Correlations between measures.

Variable	Pearson Product-Moment Correlation											
	1	2	3	4	5	6	7	8	9	10	11	
1. Dental Self-Esteem												
2. Global Self-Esteem	0.38*											
3. Social Influence	-0.65*	-0.41*										
4. Need for Dental Comparison	-0.67*	-0.43*	0.70*									
5. Dental Fixation	-0.61*	-0.37*	0.75*	0.74*								
6. Perceived Malocclusion	-0.48*	-0.17*	0.25*	0.28*	0.24*							
7. Perceived Functional Limitation	-0.20*	-0.34*	0.32*	0.23*	0.31*	0.45*						
8. Prioritizing Healthy & Straight teeth	0.13	0.31*	-0.19*	-0.20*	-0.20*	-0.04	-0.10					
9. Coping with Malocclusion	-0.65*	-0.44*	0.64*	0.60*	0.65*	0.29*	0.37*	-0.16				
10. Treatment Demand	-0.48*	-0.10	0.29*	0.37*	0.36*	0.54*	0.27*	0.10	0.34*			
11. Gender (Girl = 0, Boy =1)	0.16	0.14	-0.22*	-0.28*	-0.26*	0.03	0.03	-0.04	-0.18*	-0.16		
12 DHC	-0.27*	0.07	0.00	0.11	0.08	0.49*	0.16	0.07	0.14	0.61*	0.02	

DHC = the Dental Health Component of the IOTN

N varies between 148 and 150 as a function of missing values.

* $p < 0.05$ (two-tailed).

Employing the whole set of variables (including Gender and Treatment Demand as independent and Treatment Need as dependent variables), the first regression analyses revealed that the set of independent variables together explained 56 % ($R = 0.75, P < 0.01$) of the variance in the DHC for Subgroup 1, and 49 % ($R = 0.70, P < 0.01$) for Subgroup 2.

The results of the following analyses showed that the measures can predict treatment need, as indicated by the DHC. The validity of the prediction, concerning assessed and predicted treatment need was high and significant correlation ($P < 0.01$) was found between the subgroups ($r = 0.59$ and $0.49, N = 75$ for each group), which confirms the validity of the prediction.

Validity was confirmed as analyses of the entire sample demonstrated that the measures explained a large proportion of the variance in the prediction. The findings revealed that the independent variables, the measures, explained 47 % ($R = 0.69, P < 0.01$) of the variance in Treatment Need (DHC). The unstandardized regression coefficients for this model are presented in Table 9.

Table 9. Summary of multiple regression analyses for the total sample with the Dental Health Component of the IOTN (DHC) as the dependent variable and the measures in the Demand for Orthodontic Treatment Questionnaire (DOTQ) as independent variables.

Variable	Beta	t	p
Constant	0.67	0.76	0.45
Psychological and Social			
Dental Self-Esteem	-0.06	-0.32	0.75
Global Self-Esteem	0.35	2.30	0.02
Social Influence	-0.20	-0.94	0.35
Need for Dental Comparison	-0.03	-0.19	0.85
Dental Fixation	-0.17	-1.01	0.32
Malocclusion related			
Perceived Malocclusion	0.40	3.02	0.00
Perceived Functional Limitation	-0.13	-0.54	0.59
Prioritizing Healthy & Straight teeth	-0.13	-1.23	0.22
Coping with Malocclusion	0.13	0.87	0.38
Treatment Demand			
Treatment Demand	0.62	6.63	0.00
Gender			
Girl = 0, Boy = 1	0.06	0.29	0.77

β = Unstandardized regression coefficient, measuring how strongly each independent variable, predictor, influences the dependent variable. Negative β = negative relationship.

The coefficients above can be used to calculate predicted DHC for each individual by the following formula: Constant (see above) + [the individual's score on each measure (results from Questionnaire) \times Unstandardized β coefficient for respective measure] = Predicted treatment need.

Notably, a step by step analysis of this model demonstrated that only Treatment Demand (36.3 %), Global Self-Esteem (4.1 %), Perceived Malocclusion (3.9 %), and Social Influence (1.6 %) contributed significantly to the prediction of Treatment Need, thus, revealing Treatment Demand as the most powerful predictor.

The linear relation between predicted treatment need and professionally assessed treatment need is depicted in Figure 5.

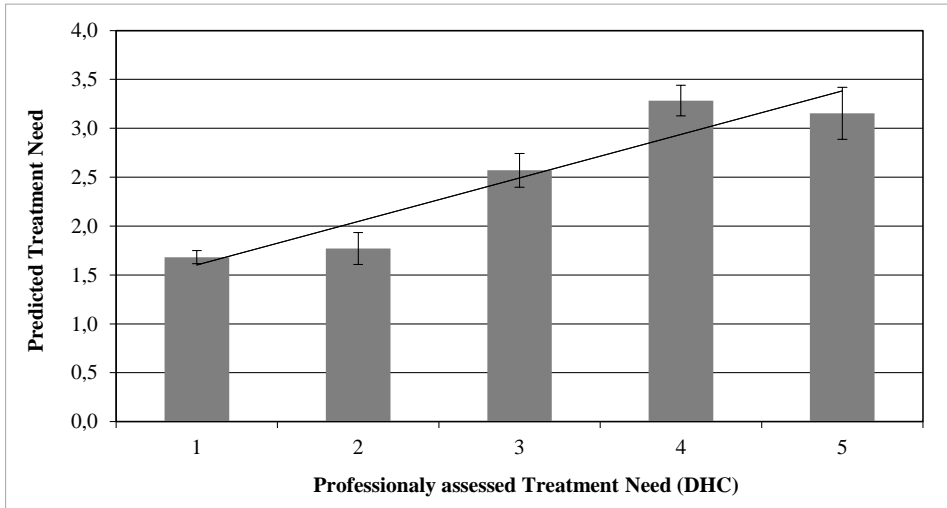


Figure 5. Mean scores of predicted treatment need as a function of professionally assessed treatment need. Bars indicate standard error of the mean and the trend line indicates the relation between assessed and predicted treatment need ($R = 0.69$).

To sum up, results indicate that the DOTQ is reliable, valid, and capable of predicting treatment need as assessed by the DHC. The methodology and prediction equation presented shows that the accuracy of the prediction is rather high. See Appendix E for the DOTQ.

5 DISCUSSION

This thesis presents three unique and coherent studies. Through an original outline, using an initial inductive methodology followed by novel quantitative prediction method approaches, adolescents' perception of malocclusion and its influence on aspects of oral health and function, patient-concerns and impact of the condition on patients' everyday life, has been investigated. The advantages of these studies lie in their overall approach as well as in the methodologies that open up further lines of investigation. Paper I is one of the few existing qualitative studies that have been conducted on malocclusions (172); to our knowledge, it is the first on children and adolescents with malocclusion that explores the impact of the condition on their Daily life. Study II used a semi-explorative approach to explain how key psychological and social measures (variables) linked to perceived malocclusion and treatment demand may be related to each other and to treatment need. Study II also explored how these predictors perform in combination, and whether they are able to predict treatment need and demand. Study III, proposed and tested the new DOTQ, designed to measure patient demand for treatment, using cross-validation in a unique equation model to calculate the findings.

5.1 MAIN FINDINGS

1. Malocclusion has an undeniable impact on adolescents, who were repeatedly reminded of their condition through ideal imaging in the media and either concerns about the views of their friends or outright peer pressure.
2. Due to social impact, adolescents with malocclusion developed avoidance strategies, for instance, by hiding their teeth behind their hands, avoiding smiling, or seeking treatment, in order to improve their situation. The attendant impacts of malocclusion include negative feelings associated with the condition and low self-esteem.
3. Studies of the structural relationship between a set of measures and IOTN-DHC-assessed treatment need, revealed a high correlation between professionally assessed need and self-reported treatment demand.
4. The path model explained the effect of each included measure on Treatment Need and Treatment Demand, which accounted for a large proportion of the variance in the two.
5. The condition-specific Demand for Orthodontic Treatment Questionnaire (DOTQ) that the present thesis developed demonstrated reliable and intercorrelated measures.

6. The DOTQ measures explained, to a large extent, the variance in treatment need among adolescents with malocclusion. Four measures contributed significantly to this prediction: *Treatment Demand*, *Global Self-Esteem*, *Perceived Malocclusion* and *Social Influence*, with the first mentioned being the most powerful predictor.
7. Cross-validation confirmed the predictive power of the DOTQ, revealing that the instrument can predict treatment need as assessed by professionals.

5.2 METHODOLOGICAL CONSIDERATIONS

To ensure that the instrument to be developed was patient-centered, and reflected aspects of daily life important to adolescents with malocclusion, this thesis began with a GT investigation. It used an open and broad research approach. In line with the Gill and Feinstein recommendations (101), and which Locker and Allen referred to almost a decade ago after inspecting existing OHRQoL instruments from a methodological viewpoint (105).

5.2.1 Study I

The inductive methodology of GT allows systematic generation of theory. Other main advantages include its intuitive appeal, conceptualization potential, and enabling of extensive data generation. Glaser and Strauss defined GT as “systematic generating of theory from data that itself is systematically obtained from social research” (154), which in Glaser’s words, surpasses all descriptive methods (173). The systematic approach to data collection and analyses, facilitates comparisons and generalizations of GT research results (142). The constant comparative rationality provide GT with a rigor that is in contrast to other qualitative approaches (174).

Limitations of GT include the potential for methodological errors, the risk of developing assumptions, and the risk of preconceptions; there is also a debate on whether the method allows generalizability. This last is considered to be a complicated issue, since the main goal of qualitative research is to provide contextualized understanding of the human experience (175). Another possible drawback is that classic GT discourages researchers from doing literature reviews before starting a study, but instead to wait until after completing analysis, in order to not contaminate research findings (154).

Following Glaser’s and Strauss’ “The discovery of grounded theory (154), various conceptual phalanges emerged that led to differences in the practice and outcome of GT: besides *classic* or *Glaserian* GT (173), *reformulated* (142) and *constructivist* (174) approaches developed.

But despite these forms, the main characteristics of the theory remained unchanged (176). It is important to bear in mind that a theory offers an explanation of a phenomenon, rather than the truth.

Study I used classic GT, which instructed the researcher to approach the data objectively and discover theory from the facts. A further reason this thesis chose classic GT was because the outcome could be presented as either a hypothesis to be further tested, or as a theory that explained what had been studied. This method left the path of further processing of the findings in future studies open.

Use of the focus group approach (FGD) was motivated by its long tradition in qualitative research. In contrast to other interview techniques, the FGD has the advantage of being able to identify new aspects of the topic of interest (157). It has been stated that FGDs are a good alternative to individual interviews concerning adolescents and similar topics (56), especially since young teenage boys might find it difficult to express themselves during in-depth interviews (177). Thus, FGDs are likely to serve as discussion promoters. There are, however, several general limitations, (i) the wording or construction of the theme guide could potentially lead to response bias, (ii) the participants may introduce bias in their responses (157), and (iii) the views of less outspoken individuals could be overshadowed if more verbal individuals are allowed to dominate the sessions. Though, the constant comparative method of GT minimises these risks of information biases due to the principles of analysis.

Because the interviewer was an orthodontist, subconscious preconceptions could in theory influence the process of information collection and analysis, so an observer sat in on the interviews, and a theme guide was developed and followed (Appendix C). Furthermore, the participants were given the opportunity to discuss freely and to raise issues or questions. More importantly, analysis was done in collaboration with an experienced researcher skilled in GT methodology and with a background in the social sciences, which is a strength that contributes to the soundness of the findings.

Participants were recruited until saturation was judged to have been reached; this resulted in 12 participants. Central in this context is the amount of generated data and more important, the emergence of new information from these data. Thus, not number of participants *per se*.

Traditionally, focus groups consist of eight to ten participants (157, 158). However, depending on the purpose, opinions on the ideal number of informants in each group vary. Mini-focus groups involving only three to six informants are thought to promote greater in-

depth interviews, by offering a more intimate atmosphere, which is preferred when discussing concerns of a more personal nature (157, 158).

5.2.2 Study II and III

5.2.2.1 Common aspects

The respondents comprised a subpopulation of Swedish adolescents aged 13 years. These individuals were selected from the population registry, mainly to (i) achieve a fairly normally distributed study population, allowing for control of sensitivity and specificity in the material, and (ii) to reduce the risk of response bias via contamination from parental or dental professional influence. Response bias is when responses do not reflect the true thoughts, feelings, or behaviour of the participants (178). The risk of this was expected to be reduced since most of the individuals would normally have no need of orthodontic treatment; also, minimising the risk of participants wishing to please the clinician/examiner with their answers.

However, age group and method of subject recruitment could raise concerns, for example, in representativeness and generalizability. Other issues, in theory, could be lack of detailed background information (e.g. socio-economic background and ethnicity). Especially, since a stratified recruitment method, often recommended to avoid selection bias (178), was not used and the background questions in the survey deliberately only concerned gender, date of birth, and dental appointments in the last 3 months.

Demography

Responding to these issues in reverse order, we did not consider the background questions to be an issue looking at the overall demography of the region where these studies were conducted. For instance, in 2014 only 7% of the children between ages 6 and 12 years were born outside of Sweden, according to Statistics Sweden (179). The same figure for 13-17-year-old adolescents was 11 %. Furthermore, just over 12% of the children came from families where both parents were born abroad. Reflecting on demographics and the dynamics in changes of cultural backgrounds, a 2007 Swedish study concluded that, despite these changes, variations in malocclusion frequencies and treatment need among children are of minor degree and overall need for orthodontic treatment remains unchanged (44). A 2010 study evaluating the association between self-perceived orthodontic treatment need and malocclusion in 12-13-year-old adolescents of Swedish and immigrant background found self-perceived need for treatment to be higher among children of Swedish background compared to others (180). Finally, possible variations in terms of socioeconomic aspects are

considered to be relatively small. For instance, the overall figures in 2014 for children of unemployed parents in Uppsala were below 5% (179).

Recruitment method

The recruitment method we used, questionnaire surveys, is common in psychology and the social sciences. There are several advantages to using surveys as a method of gathering information on populations in a country such as Sweden, which has well-organized and easily accessible population registries. The main advantages are cost effectiveness and time savings. The response rate to questionnaires, however, is usually lower than in the case of interviews conducted by telephone and could be an issue. Research shows a steady decline in survey response rates in recent decades (181), both for traditional as well as for web-based versions.

Response rate

A power analysis found that a minimum of 150 participants would be needed in order to generate statistically significant results. So, based on the assumption that approximately 60–65% would consent to participate in the survey, we first wrote to 240 individuals. Because we did not reach 150 participants, despite actions taken to reduce non-response (e.g. by incorporating an introductory letter), we asked an additional 100 adolescents to participate. One important factor contributing to the low response rate could be the length of the original questionnaire used (182). It is important to explore whether the response rate affected the representativeness of the sample population, and thus the generalizability of the findings. An approximation can be made by looking at the characteristics of the final sample where no obvious skewedness, indicative of selection-bias, was detected regarding distribution of individuals with treatment need. Just above half of the respondents were girls. Nearly 1/3 of the respondents had a treatment need corresponding to DHC grades 4 and 5, not deviating from prevalence rates reported in Sweden and other European countries (2, 39, 40, 43, 44, 46). Stratified randomized selection, could have been used to ensure inclusion of specific occlusal traits. This could have been valuable if such data was needed for further analyses.

Age of participants

We included 13-year-olds to balance the need for informants of a certain maturity level versus the fact that many older adolescents considered for treatment might have already begun or received treatment (fixed appliance treatment is often begun between the ages of 12 and 14 years). Research has indicated that children typically need to have reached at least 13 years of age before being able to discuss aesthetics in relation to orthodontics in an adequate manner; studies have shown that 11–12 year-olds still have difficulties describing their own dental occlusion (88, 183). Age also seems to influence the perception of malocclusion and

treatment need (93, 94, 184). Based on existing knowledge, it could further be assumed that the influence of the measure Perceived Functional Limitation would increase if the measure was tested in 17-18-year-olds (185). Furthermore, age-specific questionnaires have been recommended for children of different ages (e.g. 6-7, 8-10, and 11-14 years) since it seems that each of these age-groups are similar in cognitive ability, but that ability differs between groups (106). Thus, the reliability and validity of our findings need to be tested in other age-groups.

Dental record data

Data collection on professionally assessed treatment need, from dental records, was done in order to match the findings from the questionnaire with the assessments of orthodontists. These data could have been collected differently, for instance by clinically examining the participants, and/or taking impressions and photographs of their occlusion. However, this might have reduced the number of willing participants, given the greater effort required, and had been time-consuming and difficult to perform in busy general Public Dental Service clinics. To make the research practicable without compromising quality, we decided to collect data on orthodontic treatment need retrospectively, from each participant's dental records. In this stage of the assessment process, the clinicians' assessments are based on clinical evaluation and intra-oral radiographs, and possibly panoramic radiographs. Thus, this procedure had some advantages, one being that the data had already been collected in a clinical setting. Hence, the professionals were naturally blinded to the "test". Also, the method was deemed sufficiently accurate and easy to perform, given that patient records at all general Public Dental Service clinics are accessible through the same database. The IOTN was chosen since Uppsala County Council has designated the index for use in determining treatment priority and free-of-charge orthodontic treatment. Assessments are routinely performed by calibrated professionals in the Uppsala Public Dental Service on behalf of the County Council.

It should be mentioned that approximately 8 % of the children living in Uppsala attend private clinics, according to the Libretto Dental Systems. Thus, making their journals inaccessible from the Public Dental Services database, if they have not been assessed for orthodontic treatment need. This was however not an issue in this study sample. Also, this approach did not allow comparisons of respondents with non-respondents, since non-respondents did not agree to participate, thus we could not access their records. However, the distribution of DHC grades in the respondent group showed no major detectable deviations compared to existing distribution data from earlier studies.

It is, however, impossible to rule out an influence of these methodological considerations and limitations on the findings. It is also important to keep in mind that societies, time factors, and social context differ and are constantly changing. Thus, longitudinal follow-ups to reproduce and confirm these findings are needed.

5.2.2.2 *Study II-specific*

Path analysis was used as the modelling and analysis method in Study II. Path analysis is a powerful method to simultaneously study, or model, the relations among different variables. Modelling is straight forward. A theoretical, or input, path model is first constructed, where the relationships between all the independent variables are specified, as well as the directions between them; this yields a model based on hypothesized relationships through which independent variables produce both direct and indirect effects on a dependent variable. After statistical analysis, an output path model is conducted based on the data. A variety of indicators express the fit between the theoretical model and the data-generated model (168). Path analysis enables estimation of the magnitude as well as the significance of the relationships between the variables. Even though path analysis is useful for evaluating causal hypotheses, it lacks the capacity to detect direction of causality.

Study II presents and tests a unique model, displaying how key psychological and social measures (such as Global, Dental Self-Esteem, and Social Influence), and a number of self-assessed malocclusion-related measures (such as Perceived Malocclusion and Functional Limitation) are linked. The model also describes how these predictors of Treatment Need and Treatment Demand affect each other. Further, we studied whether any of the measures contribute uniquely to explaining Treatment Demand and if and how they are related to professionally assessed Treatment Need. Thus, Study II represents an important piece of the puzzle concerning which factors affect treatment demand and the interlinkages between these factors as well as with professionally assessed treatment need.

While this has not been done before, even though the path model exhibited good fit to data, it should be emphasized that the results of Study II are the outcome of a semi-explorative approach with many variables. Longitudinal studies are needed to investigate directions of causality, as well as the role of possible mediators (e.g. confounders) and factors outside the model that we did not have information about in our study. For instance, the relation between Perceived Malocclusion and Treatment Need and Treatment Demand could be related to the access to dental care free-of-charge. Future studies are needed to verify the validity of

the model and test it across age-groups since the significance of the various measures might differ in older age-groups.

5.2.2.3 *Study III-specific*

The following considerations and possible limitations need to be discussed. Theoretical analysis and re-evaluation of the wording and language of the original 12 measures was done to avoid risk of leading or biased questions, and ensure that the items within a measure covered the aspects they were intended to, otherwise they were omitted. This was done since the theory behind the measures and items constitutes an important framework (105). Further, items were also removed if the wording seemed inadequate or difficult to interpret, for instance by usage of the ambiguous words 'if' or 'not'. This was done to avoid the risk of negative influences of divergent items on the measure (138).

Psychometric properties

To achieve high reliability and uniform dimensionality, the psychometric properties of the measures were analysed simultaneously. In the reliability analyses, the lower limit of Cronbach's alpha reliability was set to 0.70 and the lower limit of item-total correlation to 0.30 to make the measure more consistent. Since the appropriate degree of reliability and correlation depends on the aim, and considering the substantial number of items and measures included, these limits are to be seen as set by an acceptable margin (138).

The reliability of the scale scores was good, with one exception: Prioritizing Healthy and Straight Teeth. Although it didn't quite reach the bar, the measure was kept for further analyses given that α was not far from the limit, and since it was the smallest of all the measures in the instrument (only three items). Also, since there are indications that dissatisfaction with dental aesthetics could be as much attributed to tooth colouring as to visible anterior teeth irregularities, it seemed reasonable to keep this measure (166, 180).

Exploratory factor analyses evaluated the dimensionality of each scale, using a method that allowed possible factors to correlate (170), since the theoretical framework and construction of some of the measures aimed to capture more than one dimension within the construct. Factor analyses showed that all measures consisted of a single factor, accounting for the major part of the variation in participants' responses, with a couple of exceptions. These were, (i) Social Influence, in which a three-factor solution was detected (moderately correlated to each other), (ii) Perceived Functional Limitation, in which two factors were found (highly correlated). These exceptions were allowed since the factors covered various

aspects of the construct, as intended. For instance, Perceived Functional Limitation aimed to measure *different* aspects of limited oral function (e.g. muscle-, jaw function-, and malocclusion-related difficulties locally in the oral environment).

Predictive validity

The regression analyses and prediction equation confirmed the predictive power of the DOTQ and the validity of the suggested approach for making similar predictions based on cross-validity testing. The first multiple regression analysis identified the degree to which the set of self-assessed measures predict Treatment Need. We used these measures, including the variable Gender, because their predictive influence regarding treatment need are well-known (21, 93, 94, 112, 161, 171). The second multiple regression analysis identified the extent to which the entire set of the variables, including Gender and Treatment Demand, explained professionally assessed Treatment Need. The idea behind this was to assess the overlap between self-assessment data and professional assessment.

Testing the validity of the prediction, randomly splitting the data set into two sets, and then randomly assigning participants from each DHC category (1 to 5) to one of the two groups (Subgroup 1 and Subgroup 2) were important for achieve an evenly distributed number of informants with different DHC scores in both groups, given the limited number of participants with high DHC values.

The second multiple regression analysis proved that this methodology: *(i) predicting* Treatment Need (DHC) in Subgroup 1, *(ii)* using the prediction equation to calculate *predicted* need (DHC scores) in Subgroup 2, and finally *(iii)* correlating predicted scores with the original treatment need values collected from dental records, is able to indicate the predictive power of the DOTQ, and confirm the validity of the prediction.

By using the prediction equation, the predicted treatment need for an individual can be calculated, making it useful in a clinical setting.

The results showed that the measures used are reliable and able to predict treatment need, as quantified by the DHC. The high correlation between predicted treatment need and professionally assessed DHC supports the validity of the prediction. This validity was further underlined at the sample level, where the analysis showed that the measures explained a large proportion of the variance in the prediction.

After establishing the validity of the prediction, the following multiple regression based on the entire sample was done to (i) establish a prediction using a larger sample (higher power) and (ii) to find out which measures reinforce the prediction. The results showed that the independent variables to a large extent explained the variance in Treatment Need (DHC). Confirming cross-validity, the following *step-wise solution* of this model revealed that only four measures – Treatment Demand, Global Self-Esteem, Perceived Malocclusion, and Social Influence – contributed significantly to the prediction of DHC-assessed treatment need. Notably, Treatment Demand was the most important predictor.

The result also showed a high correlation between Treatment Demand and number of other measures, which could indicate that this measure incorporates individuals' own perceptions with the perceptions of others, making this finding relevant in a social context. The findings also reveal a linear correlation between predicted professionally assessed and self-reported demand. Interestingly, the predicted mean values are closely positioned regarding the true DHC grading of the sample population, demonstrating the strength of the DOTQ.

This study has some possible technical limitations. Given that relatively few individuals with DHC grade 5 were included in the sample ($N = 10$), the measure seems unable to make a clear distinction between DHC grades 4 and 5. This seems to be true for DHC grades 1 and 2 as well, although not as clearly. Since both grades 4 and 5 indicate treatment need (in contrast to DHC 1 and 2), a synthesis of the two would indeed increase the power of the instrument. However, this needs to be tested empirically in a larger sample before any conclusions can be drawn. The study sample included a number of individuals ($N = 22$) who had already received orthodontic treatment, which could possibly have affected the results. Thus, we excluded these, repeated the regression analysis, and found a similar outcome. This showed little or no impact on the overall findings; the independent variables still explained the variance of Treatment Need as measured by DHC to a large extent.

So the result indicate that the DOTQ is reliable, valid, and capable of predicting treatment need as assessed by the DHC. The methodology and prediction equation presented in this thesis shows that the prediction accuracy is high.

Appendix E presents the DOTQ (back-translated into Swedish with English proofreading, also reviewed by a bilingual 13-year-old for suitability of language level). The English versions of the items presented in Studies II and III differ slightly. The items in Study II were not back-translated. The items in Study III were back-translated, as explained above. If the DOTQ is to be used in English language settings, the translation must be first verified.

5.3 GENERAL CONSIDERATIONS

5.3.1 Incorporating patient perceptions

Attempts have been made to combine normative indices, such as the IOTN, with generic OHRQoL instruments for children, but without the desired effect (82). Given that malocclusion seldom cause major pain or discomfort, generic OHRQoL instruments should be replaced with condition-specific instruments. Two condition-specific instruments were recently introduced for use with adolescents: the Psychosocial Impact of Dental Aesthetics (PIDAQ) and the Malocclusion Impact Questionnaire (MIQ) (110, 112). The first aims to facilitate clinical decision-making and to assess psychosocial outcomes of orthodontic treatment, while the goal of the second is to “measure the oral health-related quality of life of young people with malocclusion”.

The demand for orthodontic treatment is increasing, most likely as a result of a heightened awareness and emphasis on appearance, including dental aesthetics (58, 83). This trend is not in the least a consequence of societal norms and the beauty ideals portrayed in the media (56, 84). Dealing with malocclusions, instruments need to be condition-specific to serve their function. A paradigm shift in assessment and decision priority strategies for selecting which patients will receive orthodontic treatment is critical. More attention should be paid to the daily impact of malocclusions. Clinical evaluations should be combined with validated instruments that explore patient demand for treatment.

5.3.2 Challenges in adolescent self-reports

Research that involves children and abstract discussions, such as about aesthetics in relation to orthodontics, has its own challenges. Children under the age of 13 find it difficult to describe their own dental occlusion (88, 183); age also appears to influence the perception of malocclusion (93, 94, 184). Researchers have found that a child’s concept of self and, for instance QoL, change with age and is a normal part of development (186). Beginning in the teen age years, psychosocial awareness increases and physical appearance often becomes a crucial theme. Adolescents become more concerned about how others view them as the importance of peer acceptance grows (187). This coincides in time with notable developmental changes in the orofacial region.

When filling out a questionnaire, adolescents must understand the questions and be able to relate to them. Repeated measurements can be a challenge due to developmental changes over time. Thus, the meaning and relevance of items can vary to a child over time. Most children eligible for orthodontic treatment, however, are often 12-14 years of age and

considered mature enough to reflect over and answer well-constructed questions related to self-esteem, health, and health-related impacts of conditions.

5.4 FUTURE RESEARCH

Based on these findings, the present thesis argues that a shift in method of assessing orthodontic treatment need is necessary – from normative, expert-centred indices to assessment strategies that focus on the overall consequences of malocclusion for the individual. Aspects such as perceived functional limitations, self-esteem, and psycho-social impact could then be measured and allowed to supplement professional evaluations of the physical consequences of malocclusions. It would also facilitate treatment need evaluations in so called “borderline” cases, as studies have shown that use of normative indices can lead to an indiscriminate selection due to inter-examiner incongruence (188, 189).

In order to continue on this path, current condition-specific instruments need to be further tested (longitudinally) and more widely used. Adapting available IT solutions, such as by transferring or developing instruments as mobile applications, would probably facilitate this process (190). So, whether constructed to measure the impact of dental aesthetics, the impact of malocclusion, or the demand for treatment, these newly presented instruments have one thing in common: to bring patients and their experiences to the forefront.

Concerning the DOTQ, further research should test the instrument in clinical settings and compare outcomes with the results of the current process of selecting adolescents for subsidized orthodontic treatment in different parts of Sweden. To test the generalizability and upgrade the instrument, further investigations could for example include:

- Additional tests regarding (i) age and geographic setting, (ii) other priority assessment indices and if possible malocclusion-related conditions.
- Examination of instrument accuracy and predictive power in clinical settings and in different professional categories (e.g. dentists and specialists).
- Reframing, adding, and/or removing items to improve the robustness and specificity of the instrument (e.g. by adding items on social desirability and investigating whether proxy items like parents and peers would improve performance).
- Formulation of a short-form and indexing to facilitate clinical use.
- Comprehensive longitudinal testing.
- Making the instrument available online and for interactive use.

6 CONCLUSIONS

Malocclusions may have considerable impact on the daily lives of adolescents, due to patient-perceived psychosocial aspects of the condition. This research has shown that adolescents with malocclusion are often repeatedly reminded of their condition (due to internal and external factors), with negative feelings associated with the condition and possibly low self-esteem. These concerns coincide in time with notable physical and cognitive changes, and with increased psychosocial awareness. Adolescents are also affected by idealized images portrayed in the media and concerned about the views of their peers. These concerns related to the condition can lead to avoidance strategies such as hiding one's teeth or seeking treatment. There also seems to be a discrepancy in attitude between the professional focus on the oral health aspects of malocclusions and the adolescent focus on aesthetic aspects. Further, self-assessed measures can be used to study the structural relationship between treatment need and demand. The malocclusion-related self-assessment measures presented in this thesis are reliable and inter-correlated. The unique path model that this thesis proposes displays the effect of each included measure on Treatment Need and Treatment Demand, explaining a large proportion of the variance in treatment demand and professionally assessed treatment need. This opens up for further prediction studies modelling the relationship between important variables. Results of the path model study show a high correlation between professionally assessed need and self-reported demand for treatment. The findings suggest that rather accurate predictions can be made using self-assessment measures. This adds another dimension to processes for assessing treatment need, and hopefully increases the proportions of the right patients being selected for subsidized orthodontic treatment.

Finally, the novel developed DOTQ represents a patient-based outcome instrument for assessing Demand for Orthodontic Treatment in young people with malocclusions. The measures of the DOTQ were proven to be reliable and highly inter-correlated. The prediction equation presented for cross-validation functioned as intended. A highly significant correlation between assessed and predicted treatment need for the subgroups confirms the validity of the prediction. The measures explained a large portion of the variance in Treatment Need. Four measures contributed significantly to the prediction, with Treatment Demand being the most powerful predictor. Cross-validation confirms the predictive validity of the measure and its capacity to predict treatment need assessments by professionals. Consequently, the DOTQ seems to be a promising instrument in allowing adequate expression of how individual patients determine their own demand for orthodontic treatment.

6.1 CLINICAL IMPLICATIONS

1. Adolescents deal with their condition by developing coping strategies, which potentially lead to irrational behaviors that clinicians ought to be aware of when interacting with adolescents with malocclusions.
2. Tedious treatment need assessment processes, which delays the decision for orthodontic treatment, is frustrating for adolescents.
3. Adolescents with malocclusions dislike what they view as a discrepancy between the attitudes of professionals who focus on oral health aspects and their own emphasis on aesthetic aspects.
4. The high correlation between professionally assessed need and self-reported demand for treatment highlights the importance of considering patient perceived needs.
5. Instruments that intercept the opinions of patients are recommended when assessing orthodontic treatment need.
6. DOTQ can, by revealing the magnitude of treatment demand, support dentists in deciding which patients to refer for specialist consultation, and supplement the specialist opinion regarding orthodontic treatment need.

6.2 FINAL REMARKS

The best solution for targeting those who would benefit most from orthodontic care is to base treatment need assessments on a holistic conception of the consequences of malocclusion. Validated clinical indices that assist professionals in treatment priority decisions may be advantageously combined with validated instruments that explore patient demand for treatment.

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9 APPENDICES

9.1 APPENDIX A

Välkommen!

Den här studien genomförs med hjälp av en enkät som består av flera delar. De flesta frågor handlar om tänder och hur vi påverkas av dem. Det tar ca 20-30 min att svara på frågorna och vi ber dig att vara ensam när du gör det och att du gör allt i en sittning (dvs utan att avbryta eller börja om). Dina svar kommer aldrig att visas ihop med någon information som gör att andra kan spåra svaren till just dig. Du kan även avbryta studien när som helst om du inte längre känner för att svara på frågorna.

Som tack för att du har deltagit och svarat på frågorna kommer vi att skicka en biobiljett till dig när vi har mottagit dina svar.

Om du har några frågor om studien är du välkommen att maila oss på följande adress: jari.taghavi@ki.se

1. Ange koden som finns på enkäten som du har fått per post! Vänligen var noga med att skriva rätt kod.

Här kommer några bakgrundsfrågor om dig. Var vänlig fyll i uppgifterna noggrant.

2. Är du:

- Flicka
- Pojke

3. Vilket år är du född?

4. Vilken månad är du född?

5. Har du besökt tandvården de senaste 3 månaderna?

- Ja
- Nej

6. Om du svarade Ja på frågan ovan, ange orsak.

7. Nedan ser du ett antal påståenden och ett par frågor om tändernas ställning. Ange hur varje påstående stämmer in på dig och svara på frågorna som följer. Läs varje påstående noga och markera det alternativ som passar din situation på bästa sätt.

	0 = Stämmer inte alls	1	2	3	4 = Stämmer helt
Mina tänder står rakt.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Det händer att jag biter mig i gommen/tandköttet.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag har tänder som står snett.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag har glugg mellan mina tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag har utstående framtänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Det är trångt (för mina tänder).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag har svårt att bita ihop med framtänderna.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mina tänder passar inte ihop när jag biter samman.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

8. Är det något med dina tänder som stör dig? Skriv i så fall vad.

9. Vilket av ovanstående stör dig mest (ange nummer på påståendet).

10. Här kommer ett antal påståenden om bettet och bettfunktionen (dvs hur det fungerar att äta och tugga mm). Läs varje påstående noga och markera det alternativ som passar din situation på bästa sätt.

	0 = Aldrig	1	2	3	4 = Ofta
Min käke låser sig när jag gappar.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag har svårt att bita av med framtänderna.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag har svårt att sluta mina läppar.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag känner trötthet/smärta i tuggmusklerna.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag får ont i käkarna när jag gappar stort.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag har svårt att gapa stort.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag hör ofta knäppningar från mina käkleder (området framför örat).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag biter mig i gommen när jag biter ihop.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag har svårt att tugga.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

11. Nedan ser du några påståenden om tänder utseende och tandhälsa. Läs varje påstående noga och markera det alternativ som passar dig bäst.

	0 = Stämmer inte alls	1	2	3	4 = Stämmer helt
Att ha vita tänder är viktigare för mig än att ha raka tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Det är viktigare att ha friska tänder än vita tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Att ha tänder som står rakt är viktigare för mig än att ha vita tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
För mig är det viktigare att tänderna är friska än att de står rakt.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

12. Här kommer några påståenden om tänder och sociala situationer/sammanhang. Läs varje påstående noga och markera det alternativ som passar dig bäst.

	0 = Stämmer inte alls	1	2	3	4 = Stämmer helt
Jag har en känsla av att folk ibland stirrar på mina tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag bryr mig inte om vad andra tycker om mina tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag tänker inte på hur mina tänder ser ut när jag är med andra.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Det händer att jag känner mig "utanför" på grund av hur mina tänder står.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag känner att det finns en förväntan i samhället att alla ska ha raka tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Det händer att jag blir retad för hur mina tänder står.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Att ha tänder som står rakt och prydligt skulle göra det lättare att umgås med andra.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag brukar tänka på mina tänder när jag ser kändisar med fina tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag är orolig för att andra ska kommentera mina tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag gillar inte när folk säger något om mina tänder, även om det är på skoj.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Att se reklambilder med vackra tänder stör mig inte alls.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Att se folk med fina tänder får mig att tänka på mina tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

13. Här kommer några fler påståenden om tänder, hur de ser ut, och hur de påverkar en. Läs varje påstående noga och markera det alternativ som passar dig bäst.

	0 = Stämmer inte alls	1	2	3	4 = Stämmer helt
Jag är nöjd med hur mina tänder ser ut.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag blir ledsen när jag tänker på hur mina tänder ser ut (t.ex. färg, form, eller storlek).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag känner mig stolt över hur mina tänder ser ut.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag får ofta höra att jag har fina tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mina tänder får mig att känna mig glad.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag blir ledsen när jag tänker på hur mina tänder står.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag känner mig mindre snygg på grund av hur mina tänder står.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag visar gärna mina tänder när jag ler.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

14. Här kommer några påståenden om hur du ser på dig själv. Läs varje påstående noga och markera det alternativ som passar dig bäst.

	0 = Stämmer inte alls	1	2	3	4 = Stämmer helt
Jag är rätt lycklig.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag känner mig ofta sårad.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ibland känner jag mig så ledsen att jag inte orkar bry mig om någonting.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag känner att jag inte är en populär person.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Överlag känner jag mig någorlunda nöjd med mig själv.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag bekymrar mig sällan för vad andra människor ska tänka om mig.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag tycker ibland att jag inte duger till.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag tror att de flesta gillar några sidor av min personlighet.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag är en person som man kan tycka om.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag är nöjd med att vara just den jag är.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag känner mig aldrig underlägsen folk jag känner.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag känner mig positiv till livet i största allmänhet.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

15. Här kommer ett antal påståenden om tänder och om hur du ser på dina tänder. Läs varje påstående noga och markera det alternativ som passar dig bäst.

	0 = Stämmer inte alls	1	2	3	4 = Stämmer helt
Jag brukar inte titta på mina tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag har svårt att undvika att tänka på mina tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Att ha sneda tänder är fult.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag brukar tänka på mina tänder när jag är ute på nätet (t.ex. sociala medier, webbkameran).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag tänker ofta på mina tänders ställning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag tänker inte på mina tänder när jag står framför en spegel.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag tänker inte så ofta på hur mina tänder ser ut.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Raka och fina tänder är viktigt för utseendet.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hur ens tänder ser ut påverkar hur man blir bemött.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag blir påmind om mina tänders ställning när jag blir fotograferad/filmad.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag bedömer folk delvis utifrån hur deras tänder ser ut.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag blir påmind om mina tänders ställning när jag ler.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

16. Här kommer några påståenden om tänder samt om hur du ser på andras tänder. Läs varje påstående noga och markera det alternativ som passar dig bäst.

	0 = Stämmer inte alls	1	2	3	4 = Stämmer helt
Jag är avundsjuk på dom som har fina tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag brukar tänka på hur andras tänder ser ut.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag bryr mig inte om någon har finare tänder än jag.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag tycker att andra har finare tänder än jag.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag jämför sällan mina tänder med andras.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

17. Nedan ser du ett antal påståenden om tänder och hur tänder kan påverka i olika sammanhang. Läs varje påstående noga och markera det alternativ som passar dig bäst.

	0 = Stämmer inte alls	1	2	3	4 = Stämmer helt
Jag undviker situationer där mina tänder kan synas.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag försöker att inte tänka på mina tänder hela tiden.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag undviker att le när jag fotograferas.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag försöker att inte oroa mig för hur mina tänder står.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag säger till mig själv att mina tänder står tillräckligt bra.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
När jag är med andra undviker jag att visa mina tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag försöker tänka att alla inte har perfekta tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag tror att det till slut kommer att ordna sig med mina tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag har inga problem med att prata om mina tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Det händer att jag håller för min mun för att dölja mina tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag försöker att undvika le på grund av mina tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

18. Nu kommer några påståenden om tandställning. Ta ställning till om du tror att påståendet är sant eller falskt. Läs varje påstående noga och markera det alternativ som du tror är rätt.

	Sant	Falskt
Den som har tandställning bör inte äta godis och läsk.	<input type="radio"/>	<input type="radio"/>
Det tar längre tid att borsta tänderna när man har tandställning.	<input type="radio"/>	<input type="radio"/>
När tandställningen tas bort kan tänderna gå tillbaka.	<input type="radio"/>	<input type="radio"/>
Det kan till en början göra ont att ha tandställning.	<input type="radio"/>	<input type="radio"/>
Det går inte att ha tandställning i vuxen ålder.	<input type="radio"/>	<input type="radio"/>
Tandställning ökar risken för att få hål i tänderna.	<input type="radio"/>	<input type="radio"/>

19. Nu kommer några påståenden om attityder till tandställning. Läs varje påstående noga och markera det alternativ som passar dig bäst.

	0 = Stämmer inte alls	1	2	3	4 = Stämmer helt
Mina kompisar tycker att jag ska ha tandställning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag kan tänka mig att ha tandställning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mina föräldrar tycker att jag ska ha tandställning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag blir ledsen om jag inte får tandställning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag tycker det är viktigt att få tandställning innan jag blir för gammal.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag har länge velat ha tandställning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag tycker inte att det är värt att vänta länge för att få tandställning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Det skulle kännas jobbigt att behöva vänta på att få tandställning om jag hade velat ha det.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag vill ha tandställning trots att det till en början kan göra ont.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag är beredd att ha tandställning även om jag måste ha en tråd klistrad på insidan av framtänderna i flera år efteråt.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Min tandläkare tycker att jag ska ha tandställning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag vill inte ha tandställning om jag måste dra ut tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

20. Här kommer ytterligare några påståenden om attityder till tandställning. Läs varje påstående noga och markera det alternativ som passar dig bäst.

	0 = Stämmer inte alls	1	2	3	4 = Stämmer helt
Jag tror att tandställning försvårar tandborstningen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag kan bara tänka mig att ha tandställning som inte syns.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Det skulle kännas pinsamt att ha tandställning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Det är värt att ha tandställning i flera år för att få fina tänder.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag tycker att det är snyggt med tandställning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jag kan inte tänka mig att ha tandställning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

21. Till sist kommer några få frågor om dig och tandställning. Läs varje fråga noga och markera det alternativ som stämmer in på dig.

	Ja	Nej
Har du diskuterat tandställning med din tandläkare?	<input type="radio"/>	<input type="radio"/>
Har du fått ett beslut om att få tandställning?	<input type="radio"/>	<input type="radio"/>
Har du tandställning nu?	<input type="radio"/>	<input type="radio"/>
Har du redan haft tandställning?	<input type="radio"/>	<input type="radio"/>

22. Beskriv hur dina tänder skiljer sig från hur du skulle vilja att de såg ut.

Nu är du klar med enkäten och vi vill tacka dig för din medverkan! En biobiljett kommer med posten så snart vi har fått dina svar. Har du några synpunkter på hur det var att besvara enkäten är du välkommen att göra det här nedan.

Vill du veta mer eller om du har några övriga frågor är du varmt välkommen att kontakta oss via nedanstående mail:

jari.taghavi@ki.se

23. Har du synpunkter, tankar eller funderingar kring formuläret kan du skriva dessa här:

9.2 APPENDIX B

The Dental Health Component (DHC) of the Index of Orthodontic Treatment Need (IOTN)

DHC uses the acronym MOCDO. The most severe feature of the malocclusion is graded. MOCDO: Missing teeth; Overjets; Cross-bites; Displacement of contact points; Overbites.

Grade	Level of treatment need
5	Very great
4	Great
3	Moderate
2	Little
1	No need

Suffix	Description of deviating occlusal characteristics - some examples
a	Overjet – measured from the most prominent part of the prominent incisor
b	Reverse overjet with no masticatory or speech problems
c	Cross-bite
d	Displacement of contact points, in relation to the dental arch, largest displacement recorded (not including spacing inline of the arch)
e	Open bite
f	Deep bite
h	Hypodontia

The Dental Health Component composition

Grade	Letter	Description
5	a	Increased overjet greater than 9 mm
	h	Extensive hypodontia with restorative implications; more than 1 tooth missing in any quadrant requiring pre-restorative orthodontics
	i	Impeded eruption of teeth (except 3rd molars) due to crowding, displacement, presence of supernumerary teeth, retained deciduous teeth, and due to any pathology
	m	Reverse overjet greater 3.5 mm with reported masticatory and speech difficulties
	p	Defects of cleft lip and palate
	s	Submerged deciduous teeth
4	a	Increased overjet > 6mm, but less than or equal to 9 mm
	b	Reverse overjet greater than 3.5 mm with no masticatory or speech difficulties
	c	Anterior or posterior cross-bites with more than 2 mm discrepancy between the retruded contact position and intercuspal position
	d	Severe displacements of teeth greater than 4 mm
	e	Extreme lateral or anterior open bites greater than 4 mm
	f	Increased and complete overbite with gingival or palatal trauma
	g	Less extensive hypodontia requiring pre-restorative orthodontics or orthodontic space closure to obviate the need for a prosthesis
	h	Posterior lingual cross-bite with no functional occlusal contact in one or more buccal segments

Grade	Letter	Description
	i	Reverse overjet greater than 1 mm, but less than 3.5 mm with recorded masticatory and speech difficulties
	j	Partially erupted teeth, tipped and impacted against adjacent teeth
	k	Existing supernumerary teeth
3	a	Increased overjet greater than 3.5 mm, but equal to or less than 6 mm with incompetent lips
	b	Reverse overjet greater than 1 mm, but equal to or less than 3.5 mm
	c	Anterior or posterior cross-bites with greater than 1 mm, but equal to or less than 2 mm discrepancy between the retruded contact position and intercuspal position
	d	Displacement of teeth greater than 2 mm, but equal to or less than 4 mm
	e	Lateral or anterior open bite greater than 2 mm, but equal to or less than 4 mm
	f	Increased and incomplete overbite without gingival or palatal trauma
2	a	Increased overjet greater 3.5 mm, but equal to or less than 6 mm with competent lips
	b	Reverse overjet greater than 0 mm, but equal to or less than 1 mm
	c	Anterior or posterior cross-bite with equal to or less than 1 mm discrepancy between retruded contact position and intercuspal position
	d	Displacement of teeth greater than 1 mm, but equal to or less than 2 mm
	e	Anterior or posterior open bite greater than 1 mm, but equal to or less than 2 mm
	f	Increased overbite greater than or equal with 3.5 mm without gingival contact
	g	Pre- or postnormal occlusions with no other anomalies. Includes up to half a unit discrepancy
1		Extremely minor malocclusions, including displacements less than 1 mm

9.3 APPENDIX C

Theme guide (Study I)

The original theme guide included the following issues:

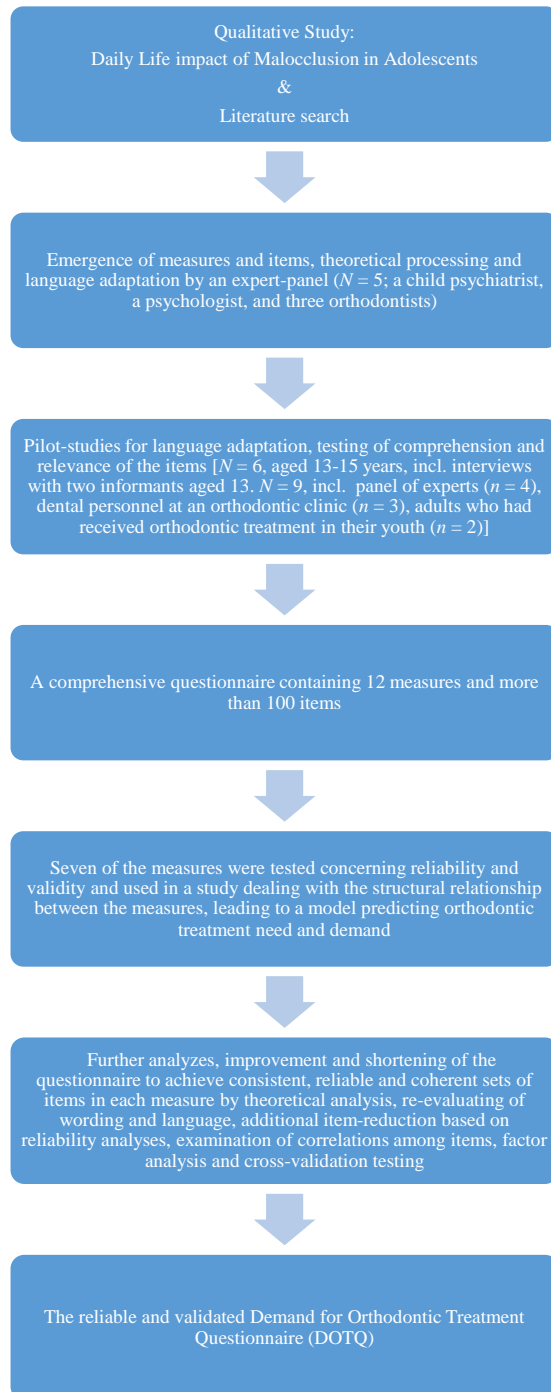
- Thoughts about teeth in general
- Thoughts about one's own teeth and their appearance
- If and how teeth could affect oneself
- Ideas and wishes regarding the looks of the teeth and reflections on what affected these views
- Issues of concern regarding teeth in relation to dental medicine professionals, friends and family
- Opinions about orthodontic treatment

As the interviews were performed simultaneously to the analysing process, according to the classic GT, the guide was revised if necessary prior to the upcoming interview bringing up the following themes:

- The role of media
- The influence of peers
- Difficulties in social settings
- Influence on self-esteem

9.4 APPENDIX D

Development of the Demand for Orthodontic Treatment Questionnaire (DOTQ)



9.5 APPENDIX E

Measures and items of the DOTQ

Dental Self-Esteem

1. I am happy with the way my teeth look.
2. I feel sad when I think about what my teeth look like (for instance their color, shape, or size).*
3. I feel proud of the way my teeth look.
4. I am often told that I have nice teeth.
5. My teeth make me feel happy.
6. I feel sad when I think about how my teeth are arranged.*
7. I feel less attractive because of how my teeth are arranged.*
8. I like to show my teeth when I smile.

Global Self-Esteem

1. I am quite happy.
2. I often feel hurt.*
3. Sometimes I feel so sad that I cannot be bothered to care about anything.*
4. I feel that I'm not a popular person.*
5. Overall, I feel reasonably happy with myself.
6. I sometimes feel that I am not good enough.*
7. I think most people like aspects of my personality.
8. I am a person that others can like.
9. I am satisfied with being who I am.
10. I feel positive about life in general.

Social Influence

1. I sometimes feel that people are staring at my teeth.
2. I don't care about what others think of my teeth.*
3. I feel that people expect everyone to have straight teeth.
4. Sometimes I get teased because of how my teeth are arranged.
5. Having nice straight teeth would mean it would be easier to socialize with others.
6. I tend to think about my own teeth when I see celebrities with nice teeth.
7. I am worried that people will comment about my teeth.
8. I don't like it when people comment on my teeth, even if it's in fun.
9. Seeing advertisements with people with beautiful teeth does not bother me at all.*

Need for Dental Comparison

1. I am envious of those who have nice teeth.
2. I often think about what other people's teeth look like.
3. I don't care if someone has nicer teeth than I have.*
4. I think that other people have nicer teeth than I have.
5. I don't often compare my teeth with other people's.*

Dental Fixation

1. I usually don't look at my teeth.*
2. I find it difficult to avoid thinking about my teeth.
3. I usually think about my teeth when I'm out on the internet (using social media, web camera).
4. I often think about the arrangement appearance of my teeth.
5. I don't think so often about how my teeth look. *
6. How your teeth look affects how people treat you.
7. I am reminded of how my teeth are arranged when I get photographed / filmed.
8. I am reminded of what my teeth look like when I smile.

Perceived Malocclusion

1. My teeth are straight.*
2. I have crooked teeth.
3. My front teeth stick out.
4. My teeth are crowded.
5. I find it hard to bite with my front teeth.
6. My teeth do not meet properly when I bite.

Perceived Functional Limitation

1. My jaw locks when I open my mouth wide.
2. I have problems biting with my front teeth.
3. I find it hard to close my lips.
4. My jaw muscles feel tired.
5. My jaws hurt when I open my mouth wide.
6. I have problems opening my mouth wide.
7. When I bite, I bite myself in the roof of my mouth.

Prioritizing Healthy and Straight teeth

1. Having white teeth is more important to me than having straight teeth.*
2. It is more important to have healthy teeth than white teeth.
3. Having straight teeth is more important to me than having white teeth.

Coping with Malocclusion

1. I avoid situations where my teeth can be seen.
2. I try not to think about my teeth all the time.
3. I avoid smiling when I am being photographed.
4. When I am with others, I avoid showing my teeth.
5. I have no problems talking about my teeth.*
6. I sometimes keep my hand in front of my mouth to hide my teeth.
7. I try to avoid smiling because of my teeth.

Treatment Demand

1. My friends think I should have braces.
2. I can imagine myself with braces.
3. I will be sad if I don't get braces.
4. I think it's important to get braces before I get too old.
5. I have wanted to have braces for a long time.
6. I want to have braces even though it may hurt at first.
7. I am willing to have braces even though I have to have a wire attached to the inside of my front teeth for years.

* = Reverse coded item