

DOES ORTHODONTIC TREATMENT IN ADOLESCENTS AFFECT QUALITY OF  
LIFE?: A PRACTICE-BASED RESEARCH MODEL

A Thesis

by

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## ABSTRACT

To utilize Baylor's established practice-based research network (PBRN) to evaluate Oral Health Related Quality of Life (OHRQoL) of orthodontic patients 11-14 years of age.

145 adolescent patients (86 female, 59 male) from 16 private orthodontic practices were surveyed with the Orthodontic Quality of Life Assessment Survey (OQoLAS<sub>11-14</sub>) at two time-points 6-8 months apart. Participating orthodontists were asked to group patients into three groups based on the stage of treatment: Initial, Middle, and End of treatment groups. Using pretreatment intraoral photographs, pretreatment malocclusion was quantified using the Index of Complexity, Outcome, and Need (ICON). Changes in domain and total OHRQoL scores, as well as associations between OHRQoL and pretreatment malocclusion were evaluated statistically.

Between pre-treatment and 6-8 months into treatment, patients' perceptions of their health and satisfaction of their teeth and mouth improved significantly ( $p=0.048$  and  $p<0.001$ , respectively). During this same time period, patients' emotional well-being also improved significantly ( $p<0.001$ ). During the last 6-8 months of treatment functional limitations ( $p=0.001$ ), emotional well-being ( $p=0.022$ ), and social well-being ( $p=0.005$ ), as well as overall OHRQoL ( $p<0.001$ ) improved significantly. The end-of-treatment group showed a statistically significant ( $p=0.047$ ) association ( $r= -0.316$ ) between their pretreatment malocclusion and changes in the total scores over time.

Adolescent patients' self-reported perceptions of OHRQoL oral health and satisfaction improved significantly during the first 6-8 months after appliance placement. Adolescent patients showed improvements in their emotional well-being during the first 6-8 months of treatment. Functional limitations, emotional well-being, social well-being, and total OHRQoL improved during the last 6-8 months of treatment.

## DEDICATION

This thesis is dedicated to my parents, Roger and Jane, thank you for all of the support, unconditional love, and lessons you have given me throughout my life. You have both been shining examples of what hard work and a positive attitude can achieve.

To Daniela, thank you for making these last three years so enjoyable. You continue to motivate me to do better, and I cannot wait for all that the future holds for us.

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# CHAPTER I

## INTRODUCTION AND LITERATURE REVIEW

### Introduction

The term “quality of life” (QoL) is used in many settings and applications, and has evolved over the years to encompass many aspects of life. The origins of the term can be linked to 1939 and Edward Lee Thorndike’s research monograph, *Your City*, in which he attempted to look at the quality or “goodness” of American cities.[1] This idea of “goodness,” started a new way of thinking and assessing aspects of life that affect us as humans living in society. Webster’s New World Medical Dictionary defines quality of life as: “the patient’s ability to enjoy normal life activities.”[2] The World Health Organization (WHO) defines quality of life 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, standards, and concerns. It is a broad-ranging concept affected in a complex way by the person’s physical health, psychological state, level of dependence, social relationships, and their relationships to salient features of their environment.”[3] Although there have been many definitions proposed for QoL, none have been universally accepted. There is no-one definition of QoL because it depends on the context in which it is used. For example, the concept of quality of life used in the area of traumatic brain injuries will be very different from the one used in the field of orthodontics. Also, the quality of life for an adolescent patient will be different from the quality of life of a geriatric patient. QoL can

also be very different when moving from culture to culture, age group to age group, and individual to individual, which adds to the difficulty in universally defining the term.

Although there is no universal definition within the literature, there seems to be agreement on the multidimensional nature of the term. Numerous aspects or QoL domains have been used in previous studies. Fallowfield, bases QoL on satisfactory functioning in four domains: psychological, social, occupational, and physical.[4] Similarly, Marshman divided QoL into five domains: emotional, social, and psychological well-being and physical symptoms and functioning.[5] The lack of a universal definition has not stopped the pursuit of improving quality of life from expanding to almost every aspect of today's society. Attempts to improve quality of life assessments can be seen throughout history by individuals, companies, communities, governments, and countries. Holcombe explains that in developed countries the people have enough means to live contentedly, therefore public policy shifts from how to provide the necessities needed to survive (e.g., food, water, clothing, and shelter) to how to improve quality of life.[6] Most public policy has the stated goal of improving the quality of life, whether pertaining to health policies, housing and land policies, protection of the natural environment or natural resources. Improving quality of life in all aspects is of the utmost importance in society today.

### How is Quality of Life Measured?

Due to the lack of a consensus as to its definition and its multidimensional nature, QoL has proven to be difficult to measure and quantify. Numerous instruments have been used to measure QoL. Quality of life instruments can be generic, specific, and utilitarian.

Generic or general measures evaluate health related quality of life (HRQoL) of individuals with and without active disease.[7] A generic instrument could be as simple as a single question asking a person to rate his/her overall quality of life, or as complex as the Flanagan Quality of Life Scale, which rates a person's satisfaction in 15 domains of life.[8] The Medical Outcomes Study Short-Form 36 (MOS SF-36) is another example of a generic instrument, and was used to evaluate health outcomes among patients with chronic mental and physical conditions over a four year study period.[9] Generic measures can be applied to many groups of people, and therefore allow comparisons across different populations. The drawback to generic QoL scales is that they are imprecise and lack sophistication or specificity.

Specific QoL measures are typically used in the medical profession. They are designed explicitly for certain problems, conditions, populations, diseases or ailments. Specific measures can evaluate a patient's perceived health need or outcome of an intervention.[10] Specific measures fall into two categories: disease specific or dimension specific. The former measures the response to treatment for a certain disease condition (e.g., the QoL for a patient living with rectal cancer). Disease specific measures narrow the scope and directly address the impact of specific disease or intervention, and therefore are more sensitive to smaller, yet clinically significant, changes.[9] Dimension specific measures focus on a specific problem within a patient group (e.g., discomfort, muscle wasting, or flatulence). These measures are very helpful for observing specific problems that a certain intervention is trying to address.[11] A drawback of specific QoL measures is that they only pertain to restricted patient groups. Overall, specific QoL scales are very precise and detailed, yet they lack the external validity needed to extrapolate results to the general population.

Utility instruments were developed for individual decision making under circumstances of uncertainty.[12] Utilities are numerical values that correspond to the strength of an individual's preferences.[12-16] This method assigns numerical values on a scale from 0 (anchored as death) to 1 (anchored as complete health).[16] This is done to represent the overall health status of an individual. An example of this is the Health Utility Index,[17] where participants rate their own health status using a multi-attribute health status classification.[12] An advantage to using utility scores is that they account for time and risk preferences for different health states.[13] The disadvantages to using utility scores is that they can often times be imprecise, complex, and difficult to interpret. Utility measurements might not be sensitive enough to detect relatively small, yet clinically significant, changes in clinical status.[16]

Quality of life has typically been assessed through surveys or questionnaires. Surveys or questionnaires assessing QoL, or more specifically Health Related Quality of Life (HRQoL), can be administered as direct interviews, telephone interviews, self-completed questionnaires, and surrogate responders or proxies.[18] Direct interviews pose a problem because they often produce response bias, where the participants change their responses because they are concerned about the opinion of the interviewer. Telephone interviews can be costly in terms of both time and money. Grootendorst *et al.* concluded that the subjects themselves are best able to estimate their own HRQoL, and that self-completed surveys or questionnaires are the most popular method of administering HRQoL instruments.[19]

It is important to understand the terms typically used with QoL instruments. An item refers to a single question, such as 'How is your head feeling today?' The scale pertains to the possible responses to that question. Scales can be open-ended, which allow the subject to

fill in whatever he/she sees fit, or they can have a fixed set of responses, such as excellent, good, poor, and terrible. Global scales do not provide any demarcation criteria. Demarcation criteria can be added by giving the subjects instructions such as, terrible indicates constant head pain and no desire to move, while excellent indicates no head pain whatsoever. A domain is an area that identifies a particular focus of attention, such as functional capacity, and may comprise the response to a single item or responses to several related items.[20] A domain includes a collection of items used for obtaining the desired data.[20]

Certain empirical indicators are used to ensure that the instruments being developed are actually measuring QoL. Two important components that must be established for each instrument are validity and reliability. Validity ensures that the instrument measures what it is intended to measure. There are various methods available to assess the validity of a QoL instrument including face, construct, and content validity. Face validity takes a group of experts or the intended sampling population and asks whether the instrument “appears” to measure what it is intending to measure.[21-23] Content validity refers to whether the items in the instrument are appropriate to what the instrument is set up to measure.[21-23] This can be confirmed through an expert panel or group of subjects in a potential population providing feedback. Lastly, construct validity can be defined as, the extent to which a measurement corresponds to theoretical concepts (constructs) under study.[24] Does it measure the construct that it is supposed to measure? Construct validity is necessary to ensure that a measurement has the perceived overall validity needed, because without it, it is challenging to estimate and correct for random errors and method variance.[12]

Reliability is the second component that must always be established for QoL instruments. Reliability refers to the degree to which an instrument can produce the same

results when the measurement procedure is repeated.[11] Both internal and external reliability must have been established. Internal reliability deals with whether the questions used in an instrument have a strong link and are relevant to one another. The internal reliability, or consistency, is often calculated by a statistical test known as the Chronbach's alpha. The other form of reliability is external reliability, and is the degree to which an instrument varies from one application to another. The best way to test external reliability with questionnaires is the test-retest method,[23] in which subjects repeat the test after a period of time. If their answers to the test are similar, then the instrument is considered to have external reliability. The measure for the test-retest method is usually the intraclass correlation coefficient. Due to the lack of a universal definition of QoL, validity proves harder to measure for QoL instruments than reliability. Even so, methods have been developed to evaluate instruments for both validity and reliability.

Two years later, Juniper and Guyatt, tried a step-by-step approach to compose and assess HRQoL instruments.[25] Just like Slade and Spencer, they established domains and then created a large bank of preliminary statements. The statements were refined based on their face and content validity. An item impact study was then conducted. The respondents evaluated the relative importance of each statement, and then an item impact score for each statement was created by multiplying the mean response for each item by the mean item importance value given.[12] Only the items with item impact scores above the median were included in the final instrument.[25] Juniper and Guyatt's methodology has been used by many researchers to validate QoL instruments.

## Quality of Life Used in Healthcare and Dentistry

Because ailments impact the quality of life of people each day, treatments should improve this quality of life. Health plays a major role in determining overall quality of life and well-being, and the primary objective of any health care intervention is the enhancement of quality of life.[26] The impact that health and disease have on quality of life is known as health-related quality of life (HRQoL) and its importance is widely accepted in medicine.[10] HRQoL is the cornerstone of medical care, because some medical treatments can seriously impair, while others can greatly improve QoL. In 2012, healthcare spending in the United States was approximately \$2.8 trillion, representing almost 17% of the entire gross domestic product.[27] This puts the United States well ahead of every other country in the world in terms of healthcare spending. As the importance of HRQoL increases, so does the funding for medical treatment, and the number of HRQoL instruments used in healthcare. A number of medical specialties measure quality of life using the Short Form 36 (SF-36)[28], which measures health status on eight dimensions. Various other instruments have been used by various medical groups to assess HRQoL and determine the health status of their patients.

While medicine has been at the forefront of quality of life research, dentistry has lagged behind. Instead of evaluating perceived functional status and psychological well-being as primary outcomes, dentistry has focused most of its research on clinician-based outcomes (e.g., determining whether the intervention greatly reduces demineralization lesions on the teeth).[29] Recently, there have been an increasing number of studies focusing on oral health-related quality of life (OHRQoL) in dentistry. This change in focus was partially due to changes in spending for dental services, which increased to \$110.9 billion



(3.0%) in 2012 .[27] The WHO has recognized OHRQoL as an important segment of the Global Oral Health Program.[30] Similarly, the Surgeon General identified OHRQoL as a health priority in 2000.[30]

In 2011, Sischo and Broder created a theoretical model of OHRQoL in which they linked health status (e.g., type/extent of defect), functional status (e.g., speech), oral-facial appearance, psychological status, OHRQoL, and overall QoL. The model recognizes the effects of environmental or contextual factors (e.g., sociocultural factors, education, family structure) and access to care on oral health perceptions and related QoL.[31]

Approximately 17 dental surveys have been developed to evaluate OHRQoL. The Oral Health Impact Profile (OHIP)[32] is perhaps the most commonly used index. The OHIP is based on Locker's conceptual model of oral health, which describes seven dimensions of OHRQoL: functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and social handicap.[33] The OHIP is a 49 item instrument designed to assess the effects of oral conditions on the well-being of individuals who are 60+ years of age.[32] In 1994, Slade and Spencer demonstrated the validity and reliability for the Oral Health Impact Profile.[32] They interviewed 64 dental patients, who provided 535 statements describing their oral disorders. Of the 535 statements, 49 were unique. These were then evaluated for their relative importance and assigned to one of seven conceptual domains by 328 people using Thurstone's method of paired comparisons. Slade and Spencer calculated internal and external reliability using Chronbach's alpha and intraclass correlation coefficients, respectively.[32] The OHIP was validated using longitudinal data from a specific cohort, where the instrument was tested on

its ability to detect previously observed associations with perceived need for a dental visit.[12]

A similar instrument developed by Atchison and Dolan to assess the oral health of older adults is The Geriatric Oral Health Assessment Index (GOHAI).[34] A pilot study tested 87 adults; a revised version was given to 1755 Medicare patients. The Dental Impact on Daily Living (DIDL)[35] instrument was developed in 1996 by Leao and Sheiham to evaluate five dimensions of OHRQoL. It was validated on 662 people between the ages of 35 to 44. The DIDL differs from the other instruments in that it evaluates the dental impacts on daily living. These instruments, and others like them, were developed to evaluate adults and how general dentistry affects their lives and well-being. All of the OHRQoL instruments used in dentistry have a specific number of questions addressing the negative impact of disease and ill health. [36, 37]

## Orthodontics and Quality of Life

### *Previously Used QoL Instruments in Orthodontics*

Initially, instruments used to evaluate OHRQoL in orthodontics were generic. They were instruments developed for general dentistry, such as the OHIP and GOAHI, along with the Oral Impacts of Daily Performance (OIDP) by Adulyanon and Sheiman[38] and Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ) by Klages *et al.* These generic instruments were limited in several ways.

One of the main issues with using generic dentistry instruments to measure orthodontic OHRQoL is content validity. In 1998, O'Brien *et al.* looked into the issue of using health-related quality of life measures from general dentistry in the field of orthodontics, and concluded that these instruments are not applicable to orthodontic patients, who are typically asymptomatic and concerned principally with aesthetics, rather than features such as pain and discomfort.[39] The second issue is that these surveys target different patient populations than typically seen in orthodontic practices. Adults are typically the population that has been used to validate these generic instruments. However, in a 2006 census report by the American Association of Orthodontists, it was reported that fifty-four percent of active patients in American orthodontists' practices were between the ages of 12 and 17.[40] Therefore, measuring OHRQoL of an adolescent with an instrument developed for adults will most likely lack the sensitivity needed to evaluate the impact of oral and orofacial conditions in an adolescent population, and in turn, affect the outcome measure. Besides their lack of sensitivity, adult measures are not suitable for children due to their length, content, language, and psychometric properties.[41]

The need to develop age-appropriate instruments was noted and quickly filled by the development of four child-centered OHRQoL surveys, of which only two have been subjected to psychometric validation,[5] the Child Oral Health Quality of Life (COHQoL),[42] and the Child-Oral Impacts of Daily Performance (Child-OIDP).[43]

The COHQoL instrument was developed in Canada to assess the OHRQoL of children 6-14 years of age, and consists of two questionnaires, including the Parental-Caregiver Perceptions Questionnaire (P-CPQ) and the Child Perceptions Questionnaire (CPQ) for children ages 6-7, 8-10, and 11-14 years. The CPQ is self-completed and has 36

items that assess four health domains: oral symptoms, functional limitations, emotional well-being, and social well-being. This instrument was designed to measure OHRQoL for children with a large spectrum of oral and orofacial conditions, such as caries, malocclusions, cleft lip/palate, and other craniofacial anomalies in a diverse population of kids.[5] Validation studies have been performed using the CPQ on populations in Canada[42], New Zealand[44], Uganda[45], Brazil[46], and the United Kingdom.[47]

Jokovic *et al.* tested a sample of 123 children to assess the validity of the CPQ, and re-tested a sample of 65 to establish its reliability. The CPQ<sub>11-14</sub> had a Cronbach's alpha statistic of 0.91 and an intraclass correlation coefficient of 0.90, showing that it was valid and reliable for assessing 11-14 year olds in Canada.[42] Foster *et al.* similarly evaluated 430 12-13 year old children in New Zealand. They showed that children with more severe malocclusion or caries rate had higher CPQ scores. There were statistically significant differences between mean CPQ<sub>11-14</sub> scores depending on malocclusion severity. The authors concluded that the CPQ<sub>11-14</sub> had adequate construct validity.[44]

In 2005 Robinson *et al.* evaluated a sample of 174 12 year old children from rural Uganda to assess the impacts of dental caries and fluorosis on OHRQoL. Construct validity for the instrument was assessed using global rating items compared to CPQ<sub>11-14</sub> scores, and a correlation of 0.31 was observed. Cronbach's alpha coefficient was 0.94. By re-testing 34 children the authors found an intraclass correlation coefficient of 0.94. The authors concluded that the CPQ<sub>11-14</sub> was a valid and reliable instrument for evaluating OHRQoL for this population.[45] In that same year, Marshman *et al.* evaluated a sample of 89 children from orthodontic and pediatric clinics in the United Kingdom. The authors found an overall correlation of 0.28 between the CPQ<sub>11-14</sub> scores and the global measures of oral health. The

instrument was found to have a good internal reliability based on a Cronbach's alpha coefficient of 0.83 and good external reliability based on an intraclass correlation coefficient of 0.83 as well. Marshman *et al.* concluded that the CPQ<sub>11-14</sub> had adequate construct validity.[47]

The authors from the previously mentioned studies all concluded that the CPQ<sub>11-14</sub> instrument had acceptable reliability and validity. However, the CPQ<sub>11-14</sub> has not been validated on patient populations in the United States. This becomes a problem, especially with children, because health and health-related quality of life are not solely determined by the nature of the disease. They also depend on personality attributes and the environment in which the patient lives.[5] Another drawback to the CPQ<sub>11-14</sub> is that it was developed to assess children with wide varieties of oral and orofacial conditions. This means that the instrument tends to be more generic, and might not be sensitive enough to correctly assess the effects of malocclusion. Using this instrument to assess a population made up solely of orthodontic patients may lead to unsubstantiated conclusions.

The Child-OIDP is another validated instrument designed to measure OHRQoL in children. The Child-OIDP is a modified version of the original adult OIDP. Changes were made to account for a child's language, intellect, and cognition. This instrument was first developed and validated on samples of Thai children. It was administered through interviews with 503 11-12 year old Thai children involved in the development process and 1,100 similar children involved in the validation study. The instrument includes eight categories/performances: eating, speaking, cleaning mouth, sleeping, emotion, smiling, study, and social contact. Pictures were used as visual aids. The authors reported a weighted kappa of 0.93, a Cronbach's alpha of 0.82, and corrected item-total correlations coefficients

ranging from 0.4-0.7.[43] A high prevalence of categories that were affected, known as impacts, although not deemed severe, were reported by the children. Oral impact with eating and brushing teeth was reported by ninety percent of the children interviewed.[43] In 2006, Yusuf *et al.* performed a validation/reliability study of the Child-ODP based on a sample of 228 10-11 year old children in the United Kingdom. The weighted kappa was 0.82, and Cronbach's alpha was 0.58. Significant associations between perceived oral treatment needs and perceived satisfaction with mouth and oral health status were demonstrated ( $p < 0.001$ ). The Child-ODP was found to be a valid and reliable instrument for children in the United Kingdom.[48] The Child-ODP has yet to be validated for orthodontic patient populations exclusively.

Although both the Child-OIDP and CPQ have been validated in many populations, neither has been validated on populations in the United States. This could be important because cultural norms vary between populations, and norms play a role in OHRQoL. The differences in cultural outlooks and expectations make it difficult to generalize findings to populations from different cultures. The characteristics of the adolescent target population being studied are also important. Adolescence is well established as an important period for physical, cognitive, and emotional development.[49, 50] Adolescent orthodontic patients are not only changing on a daily basis in regards to psychosocial awareness, but also experiencing rapid changes in facial and dental features.[10] In addition, many aspects of life, such as content of daily activities, understanding emotional states, perceptions of relationships, and communication skills all change and develop with age.[51, 52] Although both instruments have established age ranges for their target populations, these instruments are not specifically designed to evaluate adolescent orthodontic populations.

The fact that the CPQ and Child-ODP instruments were not developed for orthodontic populations exclusively is also a limitation, especially in terms of construct validity. These instruments both have sections that focus on pain, caries and dentofacial trauma. The CPQ's oral symptoms domain contains questions such as: *In the past 3 months, how often have you had... "Pain in your teeth, lips, jaws, or mouth", "Bleeding gums", "Sores in your mouth", and "Bad breath"*. The authors of the Child-ODP report various oral and dental problems that the child believes are the cause of their overall oral impacts. The more prevalent problems reported were sensitive teeth (27.9%), oral ulcers (25.8%), toothaches (25.1%), and exfoliating primary teeth (23.4%). Since orthodontics typically deals with aesthetics and asymptomatic patients, the psychosocial effect of malocclusion might not be detected without an orthodontics specific assessment.

In 2008, Stewart *et al.* recognized the need for an age-specific, orthodontics-specific instrument. They developed the Orthodontic Quality of Life Assessment Survey for 11-14 Year Old Children (OQoLAS<sub>11-14</sub>).[12] The authors sampled 203 adolescents between 11-14 years of age and tested the OQoLAS<sub>11-14</sub> for face, content, and construct validity, as well as internal and external reliability (a subgroup of 29 adolescent patients evaluated over a two week period). They were able to demonstrate adequate validity (Cronbach's alpha coefficient of 0.91) and reliability [intraclass correlation coefficient of 0.95 (95% C.I. = 0.91-0.97)] for this instrument. The authors concluded that the OQoLAS<sub>11-14</sub> was appropriate to evaluate the impact of malocclusion on the quality of life in 11-14 year old adolescent orthodontic patients.[12] This instrument fills the large void in the orthodontic literature with regards to evaluating the OHRQoL of adolescent orthodontic patients.

### *What Do We Know?*

There is a great deal of controversy and debate in the orthodontic literature regarding quality of life. The controversy focuses on two questions: 1.) Does malocclusion affect a person's QoL? and 2.) Does orthodontic treatment improve the QoL of patients? It has long been thought that orthodontic treatment improves patients' self-esteem, well-being, and oral health, but it has not been well established based on strong evidence. There is literature that shows reductions in QoL for patients suffering from hypodontia, abnormalities in facial appearance, orofacial pain, as well as developmental anomalies such as cleft lip/palate.[53] There is also literature showing that malocclusions and dentofacial anomalies can produce physical, social, and psychological stress. [54, 55] Work, school, social interactions, psychological status, sleep, diet, and nutrition have all been shown to be affected by impaired oral and craniofacial health.[56] Malocclusion, however, is not handicapping. Malocclusion in adolescent patients has less of an effect on social dimensions, and more on function, physical, and psychological dimensions.[57] In 1980, Shaw *et al.* evaluated how malocclusions can affect the health of the masticatory system, and concluded that there is variation in how an individual adjusts to his/her own imperfections in dental alignment, and there is no evidence that children with visible irregularities will be emotionally handicapped.[55] These conclusions, although present in the literature, were again made without strong evidence.

The smile is the second most observed facial characteristic relating to physical attractiveness,[58] which hints that there might be an association between oral health and quality of life. This belief is shared by the orthodontic community, orthodontists, and



patients. Adolescent patients and their parents expect that orthodontics will improve oral functioning, health, esthetics, and also enhance self-esteem and social life.[59-61] Dissatisfaction with their dental appearance raises expectations for self-image enhancement, including social self-confidence and general appearance.[62] There are multiple studies demonstrating that people living with severe malocclusions are more likely to be teased and have difficult times interacting socially.[63-65] Children who require more complex orthodontic treatment, when compared with children with no need for orthodontic treatment, suffer more in terms of negative psychosocial impact and lower QoL.[66] In addition, adolescents with more severe malocclusions and worse OHRQoL seek orthodontic treatment more frequently than those with less severe disorders.[67] These social problems do improve following orthodontic and orthognathic treatment. Much of this improvement is due to esthetic changes that occur during orthodontic treatment. Various studies have demonstrated that normative esthetic impairment, an objective need for treatment based on occlusal indices, has a significant negative impact on OHRQoL,[68-73] and that improved dental esthetics has a direct effect on OHRQoL in young adults.[68, 74-76] In a 2014 systematic review, Dimberg *et al.* looked at the existing literature surrounding the impact of malocclusion on quality of life in adolescent orthodontic patients. They included six studies cross-sectional studies in their review. Four of the studies used the CPQ<sub>11-14</sub>, one the OHIP, and another the OIDP as measures of OHRQoL. The authors concluded malocclusions have negative effects on OHRQoL, most predominantly in the emotional and social well-being domains.[77]

Stroud noted that if orthodontics truly improves a patient's quality of life in multiple dimensions (functionally, physically, occupationally, socially, and psychologically), then

there are numerous possibilities and outcomes for the orthodontic community. Psychometric QoL evaluations of patients can aid the orthodontist in diagnosis, treatment planning, and interacting with the specific personality of each patient. With a society that is becoming more and more adamant in justifying the needs and outcomes of treatment, information regarding orthodontics impact on quality of life may be very useful to parents and insurance companies.[57] If patients are happier socially, occupationally, physically, and psychologically, it is reasonable to assume that they will be better contributing more to society.

Unfortunately, the foregoing views are not supported by the research. It has been shown that the perception of malocclusion differs between orthodontists and patients, and further, that the severity of malocclusion is not always reflected in the self-perceived ORHQoL of that patient.[71, 74, 78-80] This indicates that some patients with severe malocclusions report little negative impact on quality of life, others with very minor discrepancies report large negative impacts on quality of life.

Others have found that orthodontic treatment has little effect on a patient's quality of life. In 2007, Kenealy *et al.* published a 20-year longitudinal study of 1018 adolescents 11 to 12 years of age, that sought to determine whether orthodontic treatment was effective, and what the effects of malocclusion on OHRQoL were. Their results went against the notion that children with poor dental health and malocclusion 'suffer' psychologically.[81] They concluded that orthodontic treatment during childhood/adolescence had very little impact on quality of life of adults. Even adults who were identified as needing orthodontic intervention as children, and never received treatment, were shown to have had no psychological difficulties in adulthood. The study also found that self-esteem increases over a 20-year

period, but the increase had nothing to do with whether orthodontic treatment was needed during childhood/adolescence.

Similarly, in 2009, Taylor *et al.* sampled 293 subjects between the ages of 11-14 with three QoL instruments: the Youth Quality of Life to assess general QoL, the Children's Oral Health-Related Quality of Life to assess OHRQoL, and the Treatment Expectations and Experiences to ascertain the patients' expectations for changes in their lives.[69] Assessments of occlusion and dental aesthetics were done using the Index of Complexity, Outcome, and Need. Subjects were divided into three groups: precomprehensive orthodontic, postinterceptive orthodontic, and nonorthodontic comparison. The authors found little effect of malocclusion on QoL, and no differences between the three groups in general QoL and OHRQoL scores. The authors concluded that malocclusion and orthodontic treatment have no effect on general or OHRQoL.

As such, the relationships between malocclusion, orthodontics, and quality of life still remain inconclusive. It is evident that the evidence thus far in regards to orthodontic QoL requires further study to help validate or disprove the perceptions of the orthodontic community.

In 2014, Kang and Kang evaluated whether malocclusion or orthodontic treatment affects OHRQoL in adults. They did not follow the patients from beginning to end of treatment, instead they divided their sample of 860 adults into four groups: normal occlusion, malocclusion, fixed treatment, and retention.[82] OHRQoL was evaluated using two measures, the short form Oral Health Impact Profile (OHIP) and the Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ). The authors found that the malocclusion and fixed treatment groups had significantly ( $p < 0.001$ ) higher OHIP-14 scores than the normal

occlusion and retention groups. The malocclusion group also had the highest PIDAQ scores, while the normal occlusion and retention groups had the lowest. The authors also found that women had higher OIDP-14 and PIDAQ scores. They concluded that malocclusion has a negative impact on OHRQoL in adults, but that this can be improved with orthodontic treatment.

### *Quality of Life Changes During Orthodontic Treatment*

While there are studies evaluating the impact of malocclusion and orthodontics on quality of life, very few have evaluated quality of life changes *during* orthodontic treatment. It has been shown that patients wearing full-bonded orthodontic appliances may have difficulty when eating, speaking, and smiling.[83, 84] Patients who miss appointments are more likely to complain about pain and discomfort, which leads to a poorer attitude during treatment, less compliance and an overall decrease in the sense of treatment satisfaction. Sergl *et al.* noted that patients with higher expectations tend to complain less about orthodontic pain and discomfort.[85]

Palomares *et al.* sampled 100 Brazilian adults who were in the retention phase of orthodontic treatment for more than six months and compared their Oral Health Impact Profile (OHIP) scores to 100 non-treated adults seeking orthodontic treatment.[68] They found the mean OHIP scores for the non-treated group were 5.3 times higher than the treated subjects. The authors concluded that young Brazilian adults treated orthodontically and in retention had significantly better OHRQoL scores than non-treated adults. Although these results are promising, there was no OHRQoL baseline taken pre-treatment for these subjects.

In 2013, Abreu *et al.* evaluated 96 preadolescent patients prior to appliance placement and one month into treatment using the Child Perceptions Questionnaire (CPQ<sub>11-14</sub>).[42] They found an improvement in overall OHRQoL,[86] which was mainly due to an increase in the emotional well-being domain. This increase in emotional well-being during the first month of orthodontic treatment seems counterintuitive, but Abreu *et al.* and Zhang *et al.* in earlier studies, concluded that this paradoxical increase in emotional well-being was due to the emotional benefits of orthodontic therapy (i.e. the preadolescent patients finally accepted their malocclusion and were finally dealing with it).[86, 87]

Stroud, in her master's thesis, used the Oral Health Impact Profile (OHIP) to evaluate the psychosocial effects of orthodontic treatment.[57] She divided up a sample of 120 adolescent patients with Class I molar classification and moderate crowding into three groups based on stage of orthodontic treatment (beginning, middle, and end). Stroud concluded that although patients become less self-conscious, tense, and uncomfortable at the beginning and middle of treatment, the biggest improvements occur at the end of treatment. The psychosocial changes at the end of treatment were more highly significant, and these improvements in psychosocial functioning and self-concept lead to a better quality of life.[57]

In a systematic review done by Zhou *et al.* in 2014, the authors searched four electronic databases for articles involving orthodontic treatment and QoL published between January 1960 and December 2013. They reviewed 204 articles and found 11 that met their inclusion criteria. Of the 11 articles included, four QoL instruments were used, the OHIP, OIDP, CPQ, and OHQoL-UK. The OHIP and CPQ were the two most commonly used instruments. The authors stated that the level of evidence was relatively high.[88] In their

discussion the authors noted that in most of the studies the patients reported compromised overall OHRQoL for the first month after appliance placement. Overall, the studies found that patient's OHRQoL improved during treatment, between the completion of treatment and the pre-treatment scores as well as between the completion of treatment and the mid-treatment scores. Only one study reported worse OHRQoL scores for treated patients than untreated normal occlusion subjects.

### Practice-based Research

Practice-based research networks (PBRNs) have been used in most areas of health care, and provide a much more efficient means of collecting data compared to the traditional university settings. A division of the United States Department of Health and Human Services known as the Agency for Healthcare Research and Quality (AHRQ) defines PBRNs as “a group of ambulatory practices devoted principally to the primary care of patients, and affiliated in their mission to investigate questions related to community-based practice and to improve the quality of primary care.” (AHRQ website) PBRNs provide a critical link between clinical and health service researchers and practicing clinicians. PBRNs were first brought from Europe to the United States in the 1970's, with the goal of providing more “real world” insights into clinical practices that were lost or difficult to translate from the traditional research performed in academic settings.[89] These networks provide an organizational framework and support that make it easier to evolve from the laboratory setting to a community-based setting, and allow the results to be quickly applicable for the primary care provider.

There is a fundamental difference between research, which is defined as “a systematic search for facts,”[90] and quality improvement in healthcare, which the American College of medical quality defines as, “an interdisciplinary process designed to raise the standards of the delivery of preventive, diagnostic, therapeutic, and rehabilitative measures in order to maintain, restore, and improve health outcomes of individuals and populations.” Both of these processes are crucial for improving healthcare as a whole, but traditionally they are two separate courses of action; research involves detection and breakthrough, while quality improvement emphasizes application. For the longest time, clinicians have complained that the results presented in the journals are not directly applicable to their clinical practices because the relevant research findings must be adapted to fit everyday practice, which vary due to financial realities, practice styles and configurations, and unique patient populations and communities.[91-93] The creation of PBRNs was initiated because research findings were slow to be brought into clinical practice.[94] It takes approximately 17 years to turn 14% of original research findings into changes in care that benefit patients and lead to improvement in their care.[95]

PBRNs were first created and implemented in areas of medicine, and the number of PBRNs continues to grow every year. The AHRQ reported that in 2000 the United States had approximately 24 primary care PBRNs. Since then the AHRQ has directly funded over 68 PBRNs and provided assistance to many more. In 2011, the AHRQ reported over 130 primary care PBRNs operating in the United States with participants in every state. They identified more than 67,000 clinicians in over 16,500 locations serving over 52.7 million patients. It is evident that this recent, enormous growth in PBRNs will continue as more

clinicians become aware of them and see how relevant and important the results are to their own clinical practices.

### *Practice-based Research in Dentistry*

Dentistry has not been oblivious to the success medicine has achieved by implementing PBRNs. A PBRN in dentistry is a group of practitioners that work either in private practice or community clinic settings and use part of their patient population for research. The National Institute of Dental Craniofacial Research saw the need for PBRNs in dentistry and in March 2005 began funding three seven-year grants to establish PBRNs, totaling \$75 million. The three networks formed were the Practitioners Engaged in Applied Research and Learning (PEARL) Network (administered by the New York University College of Dentistry), the Dental Practice-Based Research Network (DPBRN) (administered by the University of Alabama at Birmingham, and the Northwest PRECEDENT (administered by the University of Washington) (NIDCR website). The three networks each conducted multiple short-term clinical studies, comparing different dental materials, procedures, and diagnostic approaches on different patient populations and clinical settings. These networks have conducted Health Insurance Portability and Accountability Act (HIPAA) compliant anonymous chart reviews, evaluated treatment trends, and determined prevalence of less common oral conditions.

Other PBRNs in association with universities have also been established. For example, the South Texas Oral Health Network (STOHN) was established in 2008 from funding by the National Institutes of Health, and is affiliated with the University of Texas



Health Science Center in San Antonio. STOHN's infrastructure is a good example of how a university can provide an organizational infrastructure for dental practitioners and faculty to coordinate research studies.[89]

Besides affiliations with universities, dental PBRNs have been created within the network of group practices. The HealthPartners (HP) of Minneapolis and the Kaiser Permanente Northwest/Permanente Dental Associates (PDA) located in Portland, Oregon, are two examples of this. The HP Dental group is part of a larger multispecialty comprehensive healthcare group that treats about 100,000 patients (56 dentists, 16 locations). The PDA dental care program treats about 180,000 patients (110 dentists, 14 locations). Both of these groups have participated in practice-based research projects, including both individual and in collaborations with other networks.[96]

There currently exist only three PRBNs dedicated to orthodontic research in the United States. The first was formed in 2006 in the department of orthodontics at the University of Texas Health Science Center at San Antonio. This PRBN has only published one retrospective study evaluating bond failure differences between direct and indirect bonding of orthodontic brackets in 11 private practices.[97] Although only 11 private practices were involved, the records of 1368 patients were examined after only 10 days of observation in each office. A total of 29,963 teeth were examined for differences in bond failures! Such a large sample would have taken much longer to obtain without the use of a PBRN. The second orthodontic PBRN was recently formed by the New York University College of Dentistry, and is called the Consortium for Translational Orthodontic Research. This network evaluated accelerated tooth movement in its initial project.

The third orthodontic PBRN, The Baylor Alumni PBRN, was developed by Brown during his master's thesis in 2013. He evaluated white spot lesions in private practices.[98] Brown *et al.* sent out an initial survey to the Baylor orthodontic alumni inquiring about their willingness to participate in a PBRN. The response rate, after contacting the non-responders, was 49% (n=116), 89.5% of whom said they would be willing to participate in the PBRN. Of that group who said they were willing to participate, only 42.5% followed through with the white spot lesion project. These results and the response from the participating doctors were promising, and future studies should utilize similar alumni networks. 57% of the participating orthodontists responded that they would be willing to participate in a future study. There still is a huge need for orthodontic practice-based research and the organizational networks that coordinate these projects.

There are many barriers that have been identified in the creation and maintenance of a PBRN, with the most common barrier being the belief that the research is too much of a burden with no significant benefit for the participating doctor and/or patient. Other barriers that have been identified include: time constraints, insufficient staff and training, excessive eligibility requirements, fear of negatively impacting the doctor-patient rapport, and discomfort with the informed consent process.[99, 100] In order to overcome these barriers, clinicians need to be made aware of the enormous benefits to practice-based research and the sense of community that the networks provides to the participating doctors.[100] Systems need to be created to decrease the burden on both the patient and clinician, and sufficient training and support need to be provided to make clinicians feel comfortable with contributing.[100]

The utilization of an existing alumni network to create an orthodontic PBRN reduces or eliminates many of the barriers previously mentioned. Pre-existing contact lists, email list serves, newsletters, google documents, and meetings make it much easier for the network's coordinator to contact a large number of clinicians and notify them efficiently regarding previous study results and future research opportunities. The alumni association also has a sense of camaraderie, and these pre-existing relationships can be utilized for participation.

Orthodontics and other dental specialties are constantly looking for evidence-based research that can be implemented immediately into private practice. Most orthodontic research takes place in a university clinic setting. By doing so, the researchers face the problem of external validity. The patient population in dental school clinics is not the same as in private practice. A practice-based research model solves this problem by collecting research data from various practicing orthodontists. Another big advantage in using a PBRN is the ability to collect large sample sizes very efficiently.[101] Baylor's alumni PBRN was recently developed and utilized, providing important real-life results. The alumni and other local orthodontists agree that a PBR network is important for research and those that contributed said that they would do the same again for other projects. This proposed study is a perfect opportunity to employ the previously developed PBR network.

### Proposed Study

The specialty of orthodontics today is concerned with treating patients with various skeletal and/or dental malocclusions and growth patterns. Through the use of appliances and growth modification, orthodontists improve tooth alignment, function, and esthetics. These

dental and facial changes should improve OHRQoL. In addition to the changes that occur between the start and finish of orthodontic treatment, it is also to measure OHRQoL at various times throughout their orthodontic journey in order to better assist the orthodontist in knowing when the critical periods of treatment are (i.e., when motivation and cooperation wax and wane). As such, the proposed study asked members of the Baylor Alumni PBRN to provide patients that fall into 3 groups based on treatment timing (initial, middle, and end-of-treatment). Patients were surveyed with the OQoLAS<sub>11-14</sub> at one time-point and then again 6-8 months after. The purpose of this study was to utilize the Baylor Alumni PBRN to evaluate whether malocclusion and orthodontic treatment affect adolescent orthodontic patients' OHRQoL using the OQoLAS<sub>11-14</sub>.

## CHAPTER II

### DOES ORTHODONTIC TREATMENT IN ADOLESCENTS AFFECT QUALITY OF LIFE?: A PRACTICE-BASED RESEARCH MODEL

#### Overview

To utilize Baylor's established practice-based research network (PBRN) to evaluate first the relationship between malocclusion and Oral Health Related Quality of Life (OHRQoL) using the Orthodontic Quality of Life Assessment Survey for 11-14 year olds (OQoLAS<sub>11-14</sub>). Second, evaluate the differences in OHRQoL in adolescent patients at different stages in orthodontic treatment.

145 adolescent patients (86 female, 59 male) from 16 private orthodontic practices were surveyed with the OQoLAS<sub>11-14</sub> at two time-points 6-8 months apart. Participating doctors were asked to group patients into three groups based on time in treatment: Initial, Middle, and End of treatment groups. Using pretreatment intraoral photographs, pretreatment malocclusion was quantified using the Index of Complexity, Outcome, and Need (ICON). Changes in domain and total OHRQoL scores, as well as associations between OHRQoL and pretreatment malocclusion were evaluated statistically.

Between pre-treatment and 6-8 months into treatment, patients' perceptions of their health and satisfaction of their teeth and mouth improved significantly ( $p=0.048$  and  $p<0.001$  respectively). Within the first 6-8 months of treatment patients' emotional well-being improved significantly ( $p<0.001$ ). During the last 6-8 months of treatment functional limitations ( $p=0.001$ ), emotional well-being ( $p=0.022$ ), and social well-being ( $p=0.005$ ), as

well as overall OHRQoL ( $p < 0.001$ ) improved significantly. The end-of-treatment group showed a statistically significant ( $p = 0.047$ ) association ( $r = -0.316$ ) between their pretreatment malocclusion and changes in the total scores over time.

Adolescent patients' self-reported perceptions of oral health and satisfaction improved significantly during the first 6-8 months after appliance placement. Adolescent patients showed improvements in their emotional well-being during the first 6-8 months of treatment. Functional limitations, emotional well-being, social well-being, and total OHRQoL improved during the last 6-8 months of treatment.

## Introduction

The term “quality of life” (QoL) is used in many settings and applications, and has evolved over the years to encompass many aspects of life. The World Health Organization (WHO) defines quality of life 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, standards, and concerns. It is a broad-ranging concept affected in a complex way by the person’s physical health, psychological state, level of dependence, social relationships, and their relationships to salient features of their environment.”[3] In 2003, the WHO went even further and named oral health related quality of life (OHRQoL) an important part of the global health program. With the recent emphasis on patient-centered outcomes and research in the field dentistry, there has been of large OHRQoL instruments that have been developed and are now being used in the current literature. There currently exist approximately 17 dental surveys to evaluate OHRQoL.

The Oral Health Impact Profile (OHIP)[32] is perhaps the most commonly used index. The OHIP, and many other OHRQoL instruments have been validated on adult populations and include questions regarding oral pain and symptoms (typically dental pain due to caries). Because such questions do not pertain, these instruments are far too generic to measure OHRQoL in adolescent orthodontic patients.

One of the main problems is that most existing surveys target different patient populations than typically seen in orthodontic practices. In a 2006 census report by the American Association of Orthodontists, it was shown that fifty-four percent of active patients in American orthodontists' practices were between the ages of 12 and 17.[40] Therefore, measuring OHRQoL of an adolescent with an instrument developed for adults will most likely lack the sensitivity needed to evaluate the impact of oral and orofacial conditions in an adolescent population, and in turn, affect the outcome measure. Besides their lack of sensitivity, adult measures may not be suitable for children due to their length, content, language, and psychometric properties.[41]

The other issue with using generic dental instruments to measure orthodontic OHRQoL is content validity. In 1998, O'Brien *et al.* looked into the issue of using health-related quality of life measures from general dentistry in the field of orthodontics, and concluded that these generic instruments are not applicable to orthodontic patients, who are typically asymptomatic and concerned principally with aesthetics, rather than features such as pain and discomfort.[39] Even popular, age-appropriate instruments like the Child Perceptions Questionnaire (CPQ)[42] contain questions regarding oral pain and symptoms.

In 2008, Stewart *et al.* recognized the need for an age-specific, orthodontics-specific instrument. They developed the Orthodontic Quality of Life Assessment Survey for 11-14

Year Old Children (OQoLAS<sub>11-14</sub>).[12] The authors sampled 203 adolescents between 11-14 years of age and tested the OQoLAS<sub>11-14</sub> for face, content, and construct validity, as well as internal and external reliability (a subgroup of 29 adolescent patients evaluated over a two week period). They were able to demonstrate adequate validity (Cronbach's alpha coefficient of 0.91) and reliability [intraclass correlation coefficient of 0.95 (95% C.I. = 0.91-0.97)] for this instrument. The authors concluded that the OQoLAS<sub>11-14</sub> was appropriate to evaluate the impact of malocclusion on the quality of life in 11-14 year old adolescent orthodontic patients.[12] This instrument fills the large void in the orthodontic literature with regards to evaluating the OHRQoL of adolescent orthodontic patients.

In a 2014 systematic review, Dimberg *et al.* looked at the existing literature surrounding the impact of malocclusion on quality of life in adolescent orthodontic patients. Based on six studies cross-sectional the authors concluded that malocclusions have negative effects on OHRQoL, most predominantly in the emotional and social well-being domains.[77]

In another systematic based 11 articles, four QoL different instruments were used, including the OHIP, OIDP, CPQ, and OHQoL-UK. [88] The authors noted that in most of the studies the patients reported compromised overall OHRQoL for the first month after appliance placement, and that patient's OHRQoL improved during treatment, as well as between the completion of treatment and the mid-treatment scores. However, five of the 11 studies were cross-sectional, sampling patients once, with many of those surveyed not undergoing orthodontic treatment. Most of the six longitudinal studies only surveyed patients during the first 6 months of treatment. Only Feu *et al.*'s study surveyed orthodontic patients over a two year period at three time-points.[102]



Lastly, all of the studies in the current literature are done in university clinic settings. Practice-based research networks (PBRNs) are groups of private and community-based practices all devoted to investigating questions and achieving “real world” results. These networks provide an organizational framework and support that make it easier to evolve from the laboratory setting to a community-based setting, and allow the results to be quickly applicable for the primary care provider.

There currently exist no studies which use an orthodontic, age-specific OHRQoL instrument in a practice-based research setting to evaluate whether orthodontic treatment in adolescents improves OHRQoL at various stages during the treatment. The purpose of the present study is to utilize Baylor’s established practice-based research network (PBRN) to evaluate first the relationship between malocclusion and Oral Health Related Quality of Life (OHRQoL) using the Orthodontic Quality of Life Assessment Survey for 11-14 year olds (OQoLAS<sub>11-14</sub>). Second, evaluate the differences in OHRQoL in adolescent patients at different stages in orthodontic treatment.

## Materials and Methods

Participating doctors in this study were recruited by email, phone, and face-to-face interactions. Responding to either emails or telephone calls, 47 alumni of Texas A&M University Baylor College of Dentistry orthodontic department agreed to participate in the study. An email was sent thanking them for their participation in our practice-based research network, and detailing the study, its timeline, and necessary materials that would be

collected. Packets were mailed to participating doctors with all the necessary information and materials for the study, including:

- Copies of the parental information letters which explained the study briefly
- Copies of the parental consent forms
- Copies of the minor assent forms
- Two copies of the OQOLAS<sub>11-14</sub> for each patient to be taken at T1 and T2
- A 2GB Transcend® thumb drive pre-set with folders labeled with each patient's unique code to upload pre-treatment intraoral digital photographs
- Two copies of the patient tracking sheet, each with unique patient and practice codes, and a place for the doctor to record the patient's full name next to the code
- A mailing checklist stating which materials needed to be sent at certain times
- Two self-addressed manila envelopes labeled #1 or #2 with pre-paid postage

Only sixteen of the 47 orthodontists who initially agreed to participate sent in materials, resulting in a response rate of 34%. The 31 non-participating doctors that were spoken to and surveyed gave 38 responses or "reasons for not participating". The responses included: 12 out 38 were "too busy", 6 out of 38 were "doctor forgot", 6 out of 38 were "staff

forgot”, 7 out of 38 were “not enough patients that meet criteria”, one out of 38 was “the project asked for too much information”, one doctor was holding onto his T1 survey and other information to send once he had T2’s collected, and 5 out of 38 responses were categorized as “other” (see Figure 2). The “other” responses included family member illness, wrong mailing address, confusion about how to contact principle investigator, and one doctor is no longer practicing.

### *Patient Recruitment and Grouping*

Participating doctors were asked to recruit patients from their private practices that met our previously established selection criteria:

#### Inclusion Criteria:

- Adolescent patients between 11-14 years of age
- Class I occlusion
- Roughly equal numbers of patients treated with extractions and nonextraction
- Consent forms signed by parent

#### Exclusion Criteria:

- Patients with craniofacial syndromes
- Patients with impacted canines
- Orthodontists treating with segmental mechanics
- Participants not fluent and literate in English

- Participants unable to complete the survey in its entirety without any assistance because of physical or psychological problems
- Poor quality intraoral photographs

The orthodontists were asked to select patients based on their stage of orthodontic treatment at the first assessment (T1). (see Figure 1). The initial treatment (IniTx) patients included those who had not yet started treatment. The mid-treatment (MidTx) patients were approximately 1 year into treatment, and end-of-treatment (EndTx) patients were within 6-8 months of completing orthodontic treatment.

The study was approved by the Texas A&M University Baylor College of Dentistry (IRB2013-0659-EXP-BCD). Written parental consent and child assent was obtained from all participating subjects. Each participating practice was asked to provide approximately 11 patients (5 from the IniTx, 3 from the MidTx and 3 from the EndTx groups). A unique code was assigned to each patient, which specified their group assignment and the orthodontic practice where they were being treated. The pre-treatment intraoral digital photographs were then uploaded using the patient's unique code to the provided 2GB Transcend thumb drive. One participating doctor did not upload the photographs to the thumb drive, but instead printed the intraoral photographs on high-quality photo paper and sent them with envelope #1.

### *OQOLAS<sub>11-14</sub>*

The Orthodontic Quality of Life Assessment Survey for 11-14 year old (OQOLAS<sub>11-14</sub>) was used to measure of patient QoL in 11-14 year old children.[12] It consists of a questionnaire that includes 34 questions relating to three domains, functional limitations, emotional well-being, and social well-being. Each question contained five possible responses: “Not At All” = 1, “Very Little” = 2, “Some” = 3, “A lot” = 4, and “Everyday/Almost Everyday” = 5. The individual scores for each question, the cumulative scores for each of the three domains, and an overall total score were calculated. With the OQOLAS<sub>11-14</sub>, higher scores indicate lower quality of life. Five additional questions were asked at the beginning of the survey. The first two questions asked the patient’s gender and his/her current age. The next three questions evaluated the subject’s perception of his/her oral health (“The health of your teeth and mouth is?”), how the subject’s teeth and mouth impact his/her life (“How much does the condition of your teeth or mouth affect your life overall?”), and how satisfied the subject was with his/her oral condition (“How pleased are you with your teeth and mouth?”) The first question had five possible responses ranging from “Poor to Excellent,” and the last two questions had five possible responses as well ranging from “Not at all” to “Very much”. The entire survey takes about 4-7 minutes to complete.

Participating practices were asked to administer the OQOLAS<sub>11-14</sub> to all groups at T1 and 6-8 months later at T2, ensuring that the T2 survey of the EndTx group was shortly after treatment had been completed. Monthly reminder emails were sent to the participants. Materials in envelope #1, which included a patient tracking sheet #1, parental consent forms,

minor assent forms, OQOLAS<sub>11-14</sub> taken at T1, and thumb drive were received from April 2014-July 2014. All T2 surveys were mailed back in envelope #2 and were received between 11/14-2/15.

### *ICON Scoring*

The patient's pre-treatment dental and orofacial status was evaluated using the Index of Complexity, Outcome, and Need (ICON).[103] It was assessed using pre-treatment intraoral photographs, including upper and lower occlusal views, right and left posterior buccal views, a frontal view, and a right side overjet photograph. The photographs were scored with the ICON, which takes into consideration five occlusal traits: dental aesthetics (which uses the IOTN aesthetic component)[12], crossbite, anterior vertical relationship, upper arch crowding/spacing, and buccal segment antero-posterior relationships (Appendix Table 1). Each trait was then weighted (Appendix Table 2) in order to calculate overall weighted score. Overall weighted scores were used to assess the complexity of the patient's malocclusion pre-treatment.

### *Statistical Analysis*

The data was evaluated and because it not normally distributed, quartiles were used for descriptive statistics, and nonparametric Wilcoxon signed ranks tests were to determine differences between time-points T1-T2. Spearman rank-order correlations were used to evaluate the relationships between the OQOLAS<sub>11-14</sub> and the ICON scores. Data processing

and statistical analysis was carried out using the Statistical Package for Social Sciences Program (SPSS version 22.0). A one-way ANOVA was used to evaluate the ages of our groups and a Bonferroni correction was used to compare the groups. A statistical p value was set at 0.05 to denote statistical significance.

## Results

### *Sample Characteristics*

Out of the 16 participating practices, 145 adolescent orthodontic patients were surveyed with the OQOLAS<sub>11-14</sub>. Of the 145 subjects, 59 were males and 86 were females, with a mean age of 12.8 years (see Table 1). The IniTx group had 59 patients (27 male, 32 female, mean age of 12.6 +/- 1.02 years), the MidTx group had 40 subjects (14 male, 26 female, mean age of 13.2 +/- 0.90 years), the EndTx group had 46 subjects (18 male, 28 female, mean age of 12.9 +/- 0.87 years).

### *OQOLAS<sub>11-14</sub>*

There was a significant 0.6 years ( $p=0.007$ ) age difference between the initial treatment group and the middle of treatment group. There were no statistically significant age differences between the initial treatment group and the end-of-treatment group, or between the middle of treatment group and end-of-treatment group. There were no significant group differences in malocclusion (ICON scores).

Between pre-treatment and 6-8 months into treatment, the patients' responses to the question asking, "The health of your teeth and mouth is:" showed statistically significant ( $p=0.048$ ) improvements, from "Good" to "Very good" (see Figure 3). The responses to the oral satisfaction question asking: "How pleased are you with your teeth and mouth?" improved ( $p<0.001$ ) from "Some" to "A lot". Over the same time period, the oral impact question showed no changes. The middle and end-of-treatment groups, showed no significant changes over time for any of the three global ratings (see Figure 4 and 5).

The functional limitations and social well-being domains, as well as the total scores of the IniTx group worsened between pre-treatment and 6-8 months into treatment, but none of the changes were statistically significant (see Table 2). In contrast, their emotional well-being domain improved significantly ( $p<0.001$ ). Of the seven questions that made up the emotional well-being domain, five showed statistically significant improvements between pre-treatment and 6-8 months into treatment. All five pertained to the patient's emotions regarding his/her mouth, or whether he/she was shy, embarrassed, unsure, or worried about his/her mouth's health or appearance. The two questions showing the greatest improvements between pre-treatment and 6-8 months into treatment were "Have you felt unsure of yourself because of your teeth or mouth?" ( $p=0.001$ ) and "Have you felt shy or embarrassed because of your teeth or mouth?" ( $p=0.003$ ). Both questions improved from "Very little" to "Not at all".

The middle treatment group showed improvements in the functional limitations, emotional well-being domains, and total scores, but the changes were not statistically significant (Table 3). The social well-being domain remained unchanged between 12 months into treatment and 18-20 months into treatment.



The end-of-treatment group showed statistically significant improvements in the functional limitations, emotional well-being, and social well-being domains, as well as in the total scores (Table 4). Three of the 12 questions comprising the functional limitations domain showed statistically significant ( $p < 0.05$ ) improvements over time. All three questions related to difficulties associated with eating foods: “Do you take longer than others to eat a meal?” “Is it difficult to bite into foods like apples or corn on the cob?” and “Have you had trouble chewing tough meats like steak and beef jerky?”

Four of the seven emotional well-being questions showed statistically significant ( $p < 0.05$ ) improvements in the end-of-treatment group. When asked, “Have you felt unsure of yourself because of your teeth or mouth?” “Have you felt shy or embarrassed because of your teeth or mouth?” “Have you been concerned what other people think about your teeth or mouth?” and “Have you worried that you are different than other people because of your teeth or mouth?” the patients consistently reported significant ( $p < 0.05$ ) improvements.

Of the 10 questions comprising the social well-being domain, only two showed statistically significant improvement between T1 and T2. Because of their teeth or mouth, the patients in the end-of-treatment group were more likely to smile or laugh when they were around their peers ( $p = 0.007$ ) and they were less likely to feel uncomfortable eating in front of others ( $p = 0.14$ ).

The end-of-treatment group also showed a statistically significant ( $p = 0.047$ ) association between their pretreatment malocclusion and changes in the total scores over time (Table 5). This association was negative ( $r = -0.316$ ), indicating that the patients with the higher ICON scores prior to treatment showed greater improvements in total QoL score

during the last 6-8 months of treatment. There were no other statistically significant associations between changes in QoL and ICON scores.

## Discussion

Adolescent patients' self-reported perceptions of oral health and satisfaction improved significantly during the first 6-8 months after appliance placement. When asked to rate the health of their teeth and mouth, and how satisfied they were with their teeth and mouth, the patients' responses improved from "Good" to "Very good". This improvement could be attributed to the confidence and trust that patients put in the orthodontist overseeing their treatment. For many years, they had typically been seen by a general dentist every 6-12 months, and after starting orthodontic treatment, they were being seen every 6-10 weeks. This means that their teeth and mouth were checked regularly. Under orthodontic supervision, patients are educated about their orofacial conditions, and given tools and guidance to improve the overall health of their teeth and mouth (e.g., proper techniques to brush and floss, adjunctive hygiene aids, how to use an appliance to correct a condition, etc). Previous studies have shown that patients and parents expect orthodontics to improve function, health, esthetics, social well-being, and self-esteem.[59-61] Therefore, improvements in perceptions of oral health and satisfaction during the first 6-8 months of treatment might be explained by the confidence the patients have that their conditions are being monitored, treated, and improved during the regular visits to the orthodontist. Also, their teeth have become straighter, having worked out much of their rotational and alignment discrepancies. Initial leveling and aligning phase takes about 6 +/- 2 months.[104] The

esthetic improvements associated with leveling and aligning of teeth could also be a factor in the improvements in oral health and satisfaction.

Adolescent patients also showed improvements in their emotional well-being during the first 6-8 months of treatment. Similarly, Stroud found a significant improvement in the psychological discomfort domain of the OHIP during the 6 months of treatment, which is comparable to the emotional well-being domain in the OQoLAS<sub>11-14</sub>.<sup>[57]</sup> Improvements in emotional well-being could be attributed to the completion of the initial leveling and aligning phase of treatment. The improvements could also be due to the fact that the patients had long felt a certain way about their mouth and teeth, but for the first time they are now under the care of a professional who they trust will help fix their problems. As such, they no longer need to feel unsure, embarrassed, and/or shy about their teeth and mouth, or feel that they are different or not as healthy as others, because they have been educated about their orofacial condition, told that their problems are more common than they thought, and are being treated in an environment where those around them are either involved in delivering care or are themselves being treated. Previous studies have shown similar improvements in emotional well-being during the first months of orthodontic treatment, which they attributed to the emotional benefits of orthodontic therapy.<sup>[86, 87]</sup>

Interestingly, functional limitations and social well-being worsened - albeit not significantly, between pre-treatment and 6-8 months into treatment. The majority of functional limitations domain questions in the OQoLAS<sub>11-14</sub> ask the patients if they take longer to eat meals, have difficulties eating certain foods, and/or if food gets stuck in their teeth. Activities involved with eating might be expected to become more difficult after appliances are placed. Similarly, the worsening of the social well-being during the initial 8

months of treatment might be expected because the questions asked pertain to whether the patients have been teased, or gotten into arguments because of their teeth or mouth. Patients with orthodontic appliances in place might be expected to be teased by family members or children at school more than they were before the appliances were bonded. Patients and parents also seem to argue more about oral hygiene, appliance activations, and patient cooperation once appliances are placed and treatment has started.[105] A recent systematic review reported a decrease in overall OHRQoL during the first month after appliance placement[88], which was thought to be due to the patients still adapting to the appliances.

The middle of treatment group (MidTx) showed a tendency towards improvements in the quality of life measures, but none of the changes were statistically significant. Stroud found that patients became less tense and uncomfortable, and avoided smiling less during the middle of treatment.[57] The present study might have shown this same result if more patients had been surveyed. Improvement would have been expected in all domains and total scores.

Functional limitations improved during the last 6-8 months of treatment. The improvements were all related to eating ability. They indicated that they were able to eat faster, and that they had less difficulty in biting into or chewing certain foods. Studies have shown that patients wearing full-bonded appliances have more difficulty eating.[83, 84] Stroud found that patients has less difficulty chewing foods, avoided eating certain foods less, and had less food caught in their teeth after appliance removal.[57]

Emotional well-being also improved during the last 6-8 months of treatment. After treatment, the patients felt less unsure, shy, embarrassed or worried about the health or appearance of their teeth or mouth. They were also less worried about what others thought of

their teeth or mouth. Six to eight months prior to debond, the patients' teeth have typically been leveled and aligned, which to many of them, means their braces should come off. But the orthodontist is still correcting discrepancies in order to lock in the bite. The patients' lack of understanding of this process could lead to feelings of irritation and insecurity. After the full-bonded appliances are removed, it is reasonable to assume that the patients feel more empowered and sure about their health and appearance of their smiles. They would not be as worried or embarrassed about their now corrected orofacial conditions. Stroud showed a statistically significant improvement in psychological disability at the end of treatment.[57]

Social well-being improved during the final 6-8 months of orthodontic treatment. Again, the questions that make up this domain provide an explanation as to why significant improvements occurred when the appliances were removed. Most important, the patients felt more comfortable smiling and laughing and eating in front of their peers. After debond, patients are typically proud of their new smiles and appearances and feel more compelled to show them off. Due to the previously mentioned difficulties with smiling and eating for patients in full braces, again one can assume that they are much more likely to smile and feel comfortable eating around peers after debond. Lastly, there is a question in the social-well being domain that asks "How often do people ask you questions about your teeth or mouth?" While in treatment, patients are asked questions about their teeth, whether it is by parents asking about brushing or elastic wear, peers asking when they will be done with braces, or assistants or orthodontists while at adjustment visits. The sheer number of questions asked about the patient's teeth or mouth is significantly reduced once braces are removed. All of these reasons help explain why the social well-being improved during the last 6-8 months of

treatment. Stroud did not show any statistically significant improvements in the social disability domain in the final 6-8 months of treatment.[57]

The improvements in functional limitations, emotional and social well-being domains, and the total scores in the EndTx group seen in this study are consistent with previous studies. Stroud saw the biggest improvements in psychosocial functioning and self-concept at the end of treatment and concluded that these improvements lead to a better quality of life.[57] Based on 11 articles that provided strong evidence, it was concluded that patients' OHRQoL improved after completion of treatment compared to pre-treatment and mid-treatment scores.[88]

While the EndTx group showed a significant association between pretreatment malocclusions and changes in QoL scores over time, the initial and middle of treatment groups did not. Patients with the higher pre-treatment ICON scores might be expected to show the greatest improvements in total QoL scores during the last 6-8 months of treatment. A potential explanation for this is that patients with more severe malocclusions tend to have better compliance throughout treatment.[106] The lack of association for the initial treatment and middle of treatment group may be due to the subjective nature of the ICON. The ICON scores are calculated by evaluating five occlusal traits, one of which is aesthetic component. The IOTN aesthetic component consists of a series of 10 intraoral photographs, to which the patients were matched. Identifying the photograph that most closely resembles the aesthetics of the case being scored is difficult and subjective. In addition, the aesthetic component is multiplied by a factor of 7, the highest weighting factor out of all five occlusal traits evaluated by the ICON, and one subjective deviation in IOTN aesthetic component can lead to a large change in the total ICON score. These reasons can lead to a big variation in ICON

scores and this potentially is why we did not find associations between pre-treatment malocclusion and QoL scores.

The World Health Organization has recommended that quality of life measures be included in clinical studies,[107] and this has led to the increase in OHRQoL studies that have appeared in the orthodontic literature over the last ten years. OHRQoL is a very important aspect of clinical and patient outcomes in orthodontics, and can give insight as to what orthodontists can do to improve patient needs, care, and outcomes.[107] Zhou *et al.* recommend in their 2014 systematic review that the orthodontic community choose a single OHRQoL instrument to use across the board in order to standardize the OHRQoL conversation in orthodontics and allow for meta-analysis.[88] For reasons detailed previously, the need for using an orthodontic specific, adolescent specific measure is of great importance, and the OQoLAS<sub>11-14</sub> provides this, and is currently the only one of its kind. The orthodontic community could adopt the OQoLAS<sub>11-14</sub> as the single orthodontic OHRQoL measure. Long-term follow-up studies with large sample sizes using the OQoLAS<sub>11-14</sub> from pre-treatment through end of treatment are needed. Follow-up studies sampling patients with worse malocclusions (higher ICON scores) are also needed, and could possibly show even greater improvements in OHRQoL. The implementation of the OQoLAS<sub>11-14</sub>, which takes only 4-7 minutes to complete, into clinical and private practice settings is fairly simple, and would be greatly beneficial to the orthodontic community.

CHAPTER III  
CONCLUSIONS

- Adolescent patients' self-reported perceptions of oral health and satisfaction improved significantly during the first 6-8 months after appliance placement.
- Adolescent patients showed improvements in their emotional well-being during the first 6-8 months of treatment.
- Functional limitations improved during the last 6-8 months of treatment.
- Emotional well-being improved during the last 6-8 months of treatment.
- Social well-being improved during the final 6-8 months of orthodontic treatment.
- OHRQoL is improved during the last 6-8 months of treatment.



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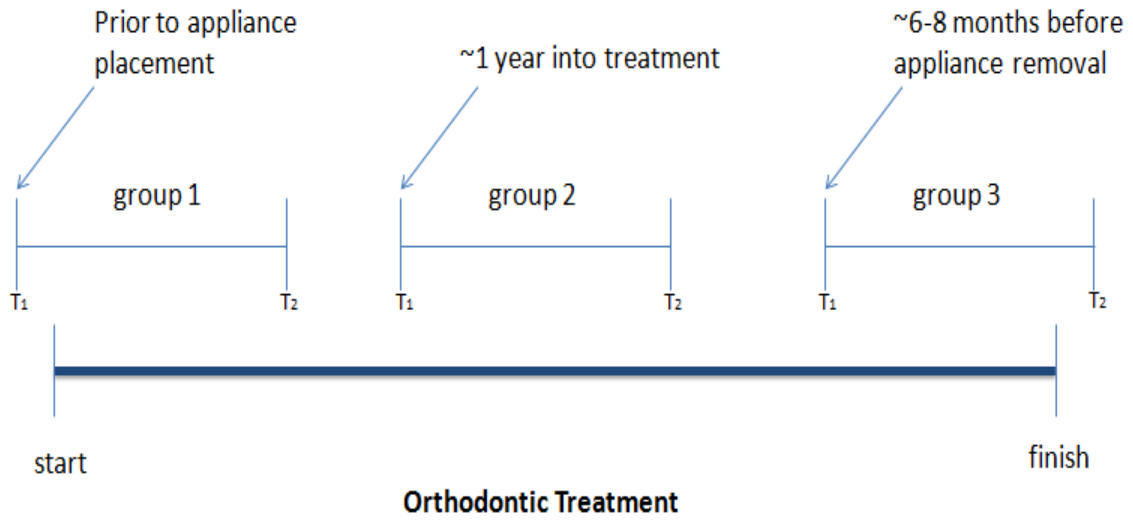
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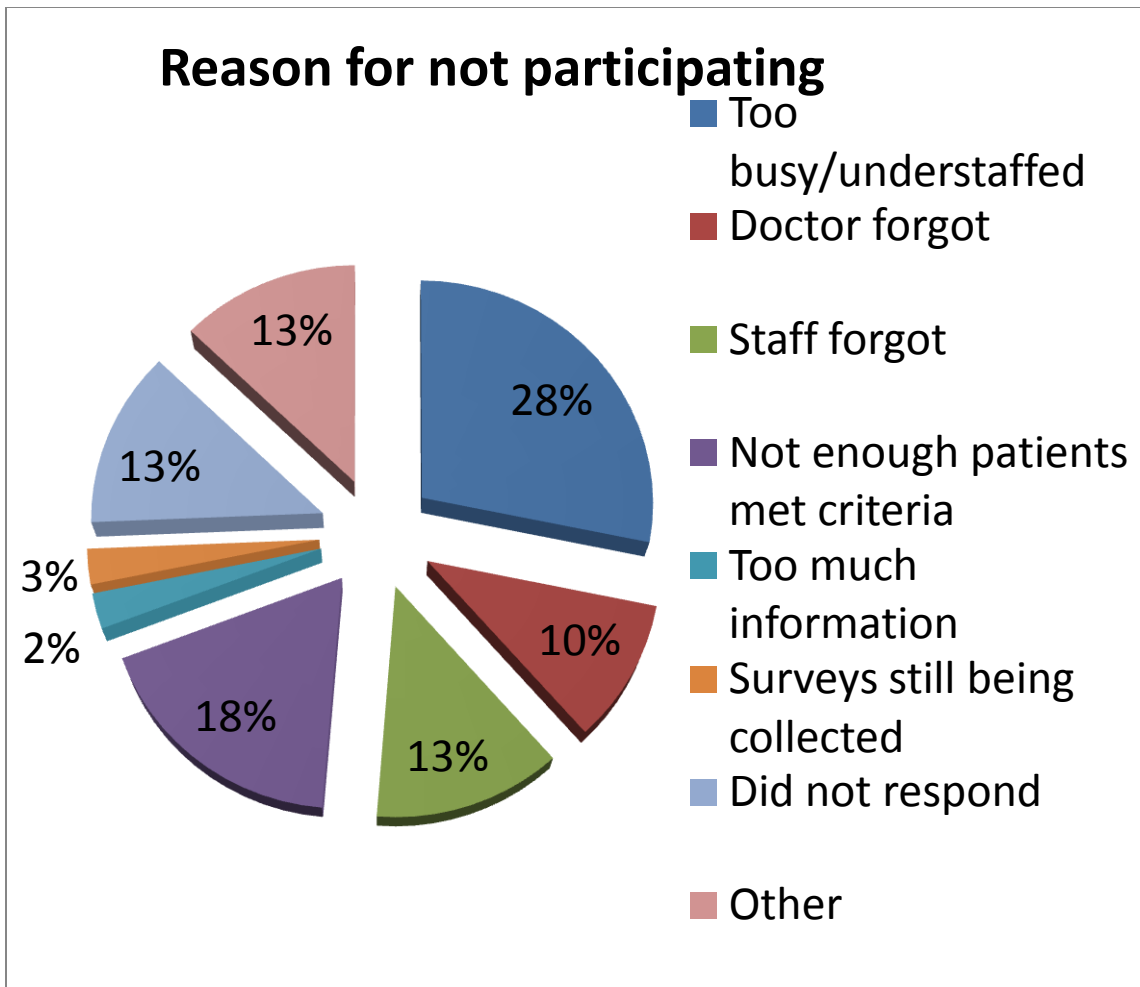
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APPENDIX FIGURES AND TABLES

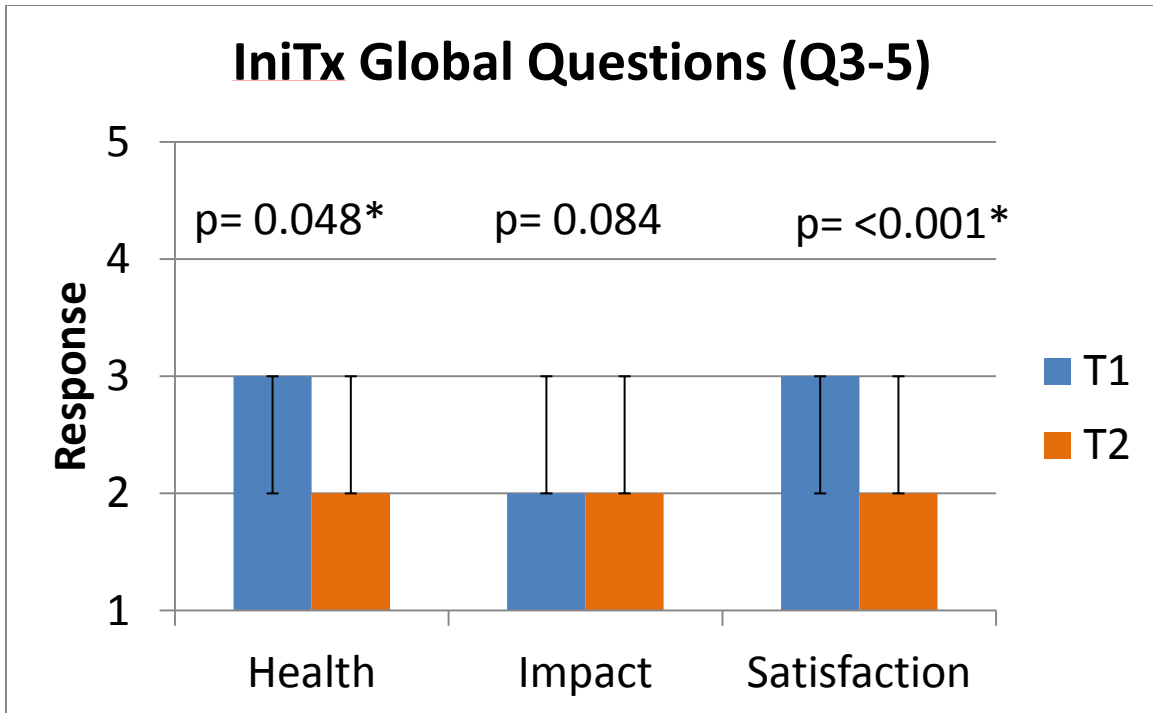


Time between T1 and T2:  
6-8 months for all groups

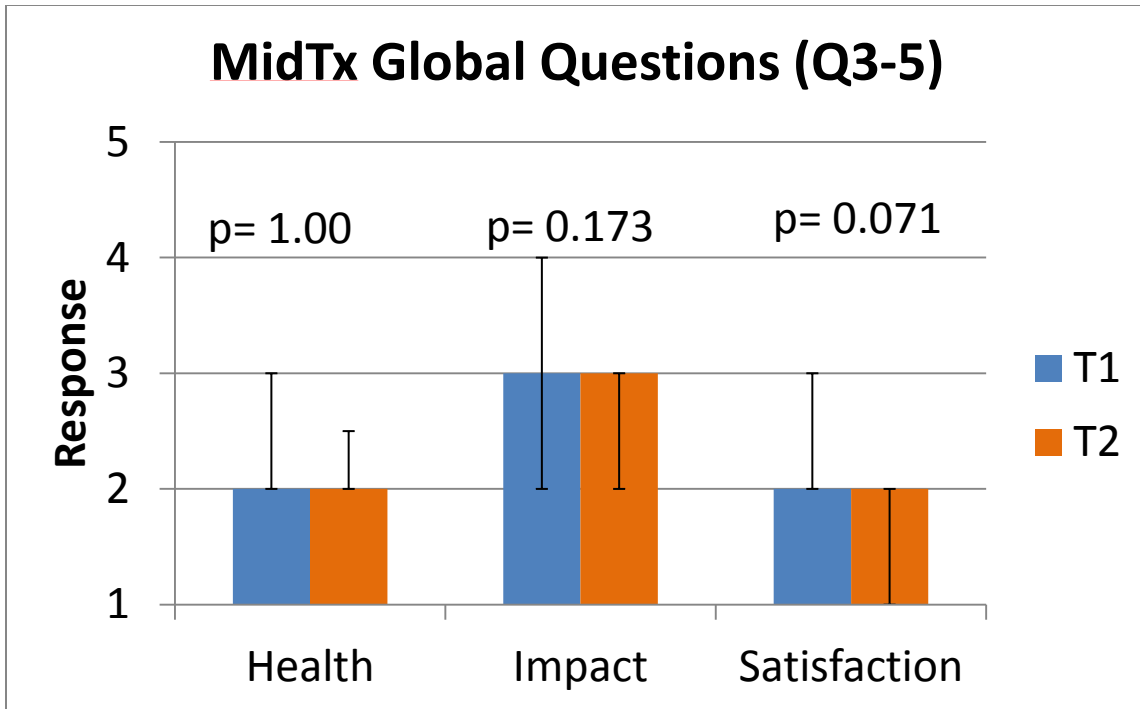
**Figure 1** Initial (IniTx), middle (MidTx), and end-of-treatment (EndTx) groups, and survey time-points (T1 and T2) on an orthodontic treatment timeline



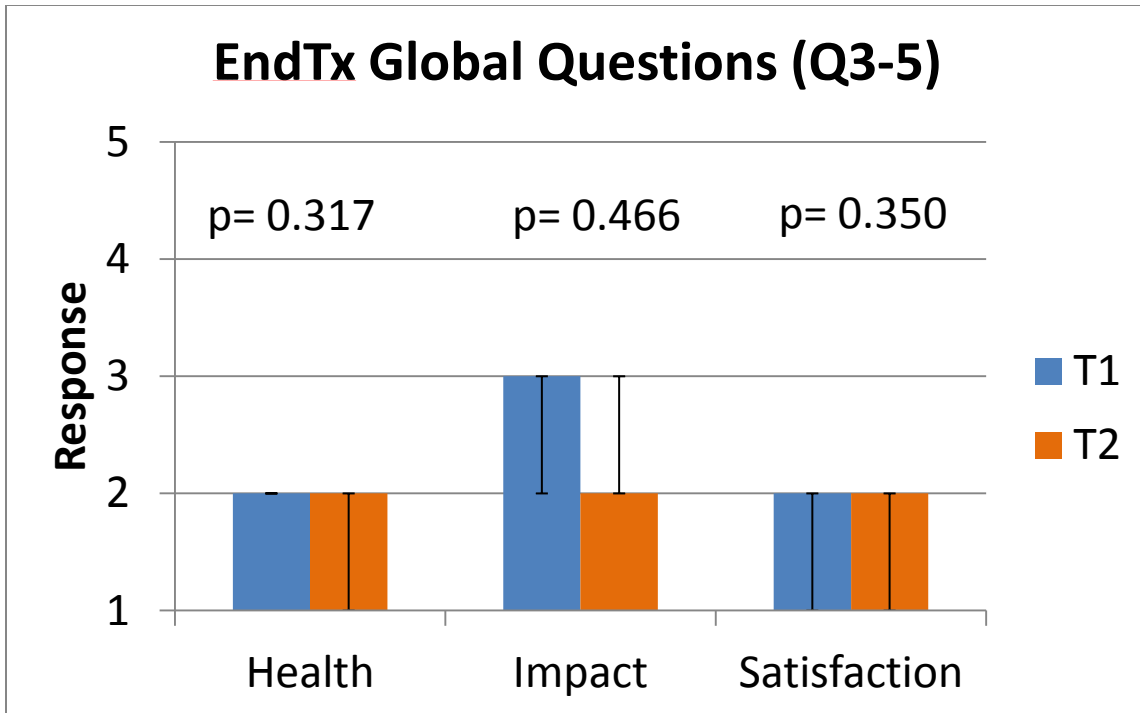
**Figure 2** Non-responders survey



**Figure 3** Initial treatment group global question response changes (higher numbers indicating lower quality of life) between pre-treatment (T1) and 6-8 months into treatment (T2)



**Figure 4** Middle of treatment group global question response changes (higher numbers indicating lower quality of life) between 12 months into treatment (T1) and 18-20 months into treatment (T2)



**Figure 5** End-of-treatment group global question response changes (higher numbers indicating lower quality of life) between 6-8 months before debond (T1) and after debond (T2)

**Table 1** Total number, sex distribution and average ages of the initial (IniTx), middle (MidTx), and end-of-treatment (EndTx) groups

Groups	N	♂	♀	Avg. Age (years) +/- SD
IniTx	59	27	32	12.6 +/- 1.02
MidTx	40	14	26	13.2 +/- 0.90
EndTx	46	18	28	12.9 +/- 0.87
Total	145	59	86	12.8

**Table 2** Medians and interquartile ranges for T1 (pre-treatment) and T2 (6-8 months into treatment), as well as changes from T1-T2, and associated probabilities for the initial treatment (IniTx) group

	T1			T2			Changes T2-T1			Probability
	25	50	75	25	50	75	25	50	75	
Functional limitations	17.00	20.00	24.00	18.25	22.00	27.00	-3.00	1.00	4.25	0.278
Emotional well-being	8.00	10.00	16.00	7.00	9.00	12.00	-5.00	-2.00	0.00	<0.001*
Social well-being	10.00	11.00	13.00	10.00	12.00	14.00	-1.00	0.00	1.00	0.308
Total score	37.00	42.00	49.00	37.00	44.00	53.00	-5.75	-0.50	4.00	0.468



**Table 3** Medians and interquartile ranges for T1 (~12 months into treatment) and T2 (~18-20 months into treatment), as well as changes from T1-T2, and associated probabilities for the middle of treatment (MidTx) group

	T1			T2			Changes T2-T1			Probability
	25	50	75	25	50	75	25	50	75	
Functional limitations	19.00	21.00	24.00	17.50	21.00	23.50	-3.75	-0.50	2.00	0.375
Emotional well-being	8.00	9.00	11.00	7.00	8.00	11.50	-2.50	-1.00	0.00	0.087
Social well-being	11.00	13.00	15.00	11.00	12.00	14.00	-2.50	0.00	1.00	0.141
Total score	39.00	44.00	49.00	36.50	43.00	48.00	-9.75	-1.50	2.00	0.123

**Table 4** Medians and interquartile values for T1 (~6-8 months before debond) and T2 (post-debond), as well as changes from T1-T2, and associated probabilities for the end-of-treatment (EndTx) group

	T1			T2			Changes T2-T1			Probability
	25	50	75	25	50	75	25	50	75	
Functional limitations	18.00	23.00	28.00	18.00	21.00	24.00	-5.25	-2.00	1.00	0.001*
Emotional well-being	7.00	9.00	11.25	7.00	8.00	10.00	-2.00	-0.50	0.25	0.022*
Social well-being	11.00	13.00	15.00	10.50	12.00	13.00	-3.00	-1.00	0.00	0.005*
Total score	39.0	44.0	54.0	37.00	41.00	46.00	-9.00	-4.00	0.00	<0.001*

**Table 5** Associations between the pretreatment ICON and QoL changes that occurred during the initial (IniTx), middle of treatment (MidTx), and end-of-treatment (EndTx) groups

	Functional limitations		Emotional well-being		Social well-being		Total score	
	R	Prob	R	Prob	R	Prob	R	Prob
IniTx	-0.012	0.934	-0.097	0.498	0.038	0.789	0.004	0.977
MidTx	0.008	0.961	-0.202	0.231	-0.216	0.200	-0.141	0.412
EndTx	-0.197	0.217	-0.301	0.055	-0.191	0.237	-0.316*	0.047*

## Orthodontic Quality of Life Assessment Survey

11-14 years

**1. Are you a boy or a girl?**

- Boy
- Girl

**2. What is your current age?** \_\_\_\_\_

CURRENT AGE

**3. The health of your teeth and mouth is:**

- Excellent
- Very good
- Good
- Fair
- Poor

**4. How much does the condition of your teeth or mouth affect your life overall?**

- Not at all
- Very little
- Some
- A lot
- Very much

**5. How pleased are you with your teeth and mouth?**

- Not at all
- Very little
- Some
- A lot
- Very much

<i>QUESTIONS</i>	<i>NOT AT ALL</i>	<i>VERY LITTLE</i>	<i>SOME</i>	<i>A LOT</i>	<i>EVERYDAY/ ALMOST EVERYDAY</i>
<b>6. How often have you noticed yourself breathing through your mouth?</b>	○	○	○	○	○
<b>7. Have you had trouble sleeping due to problems with your teeth or mouth?</b>	○	○	○	○	○
<b>8. Have you had difficulty saying words that start with a “t” or “d” like “teeth” or “doctor”?</b>	○	○	○	○	○
<b>9. Do you have difficulty pronouncing words like “church” or “threw”?</b>	○	○	○	○	○

<i>QUESTIONS</i>	<i>NOT AT ALL</i>	<i>VERY LITTLE</i>	<i>SOME</i>	<i>A LOT</i>	<i>EVERYDAY/ ALMOST EVERYDAY</i>
10. Does food get stuck in the roof of your mouth?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. Do you take longer than others to eat a meal?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. Is it difficult to bite into foods like apples or corn on the cob?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13. Have you had trouble chewing tough meats like steak and beef jerky?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. Do you limit the foods you eat due to problems with your teeth and mouth?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15. How often do you have difficulties eating foods you would like to eat?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16. How often do you have difficulties drinking with a straw?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17. Have you felt irritable or frustrated because of your teeth or mouth?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18. Have you felt unsure of yourself because of your teeth or mouth?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19. Have you felt shy or embarrassed because of your teeth or mouth?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20. Have you been concerned what other people think about your teeth or mouth?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
21. Have you worried that you are not as good-looking as others because of your teeth or mouth?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

<b>22. Have you worried that you are not as healthy as others because of your teeth or mouth?</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>23. Have you worried that you are different than other people because of your teeth or mouth?</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>24. Have you ever not wanted to speak or read out loud in class because of your teeth or mouth?</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>25. Have you avoided taking part in activities like sports, clubs, drama, music, school trips because of your teeth and mouth?</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>26. Have you ever avoided talking to your peers because of your teeth or mouth?</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>27. Do you ever avoid smiling or laughing when around your peers because of your teeth or mouth?</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>28. How often do you feel uncomfortable eating in front of others because of your teeth or mouth?</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>29. How often do you avoid spending time with other youth because of your teeth and mouth?</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>30. Have you ever argued with your peers or family because of your teeth or mouth?</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>31. Does anyone ever tease or call you names because of your teeth or mouth?</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>32. Have other youth ever excluded you because of your teeth or mouth?</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

<b>33. How often do people ask you questions about your teeth or mouth?</b>	○	○	○	○	○
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### ICON SCORING (Occlusal Traits)

	Score	0	1	2	3	4	5
Aesthetic	1-10 as judged using IOTN AC						
Upper arch crowding	Score only the highest trait either spacing or crowding	Less than 2mm	2.1-5mm	5.1-9mm	9.1-13mm	13.1-17mm	>17mm or impacted teeth
Upper arch spacing		Up to 2mm	2.1-5mm	5.1-9mm	>9mm		
Crossbite	Transverse relationship of cusp or worse	No crossbite	Crossbite present				
Incisor open bite	Score only the highest trait either open bite or overbite	Complete bite	Less than 1mm	1.1-2mm	2.1-4mm	>4mm	
Incisor overbite	Lower incisor coverage	Up to 1/3 tooth	1/3-2/3 coverage	2/3 up to full covered	Fully covered		
Buccal segment anteroposterior	Left or right added together	Cusp to embrasure relationship only. Class I, II, or III	Any cusp relation up to but not including	Cusp to cusp relationship			

			cuspid to cuspid				
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**ICON Scoring (Weighting of Occlusal Traits)**

Occlusal Trait	ICON weighting
IOTN Aesthetic Component	7
Crossbite	5
Anterior Vertical Relationship	4
Upper Arch Crowding/Spacing	5
Buccal Segment Antero-posterior Relationship	3