ORAL HEALTH RELATED QUALITY OF LIFE OUTCOMES OF ORTHODONTICS IN CHILDREN

by

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Contemporary conceptual models of health emphasize the importance of patient-based outcomes and recognize the complexity involved in their assessment. Various health conditions, personal, social, and environmental factors, are all thought to contribute to individual’s quality of life. However, the impact of orthodontic treatment on Oral Health-related Quality of Life (OH-QOL) outcomes in children has not yet been systematically studied. Hence, this research was planned to assess the effect orthodontic treatment has on pediatric OH-QOL outcomes. Further, the important moderational role of children’s psychological assets on OH-QOL reports is explored.

Following completion of a preliminary study to confirm the psychometric properties of the Child Perception Questionnaire (CPQ11-14), the current two-phase study was undertaken. This consisted of a cross-sectional study examining the relationship among Self-Esteem (SE), malocclusion, and OH-QOL, and a longitudinal study examining the influence of orthodontics and children’s Psychological Wellbeing (PWB) on OH-QOL reports.

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The preliminary data confirmed that the CPQ11-14 is sensitive to change when used with children receiving orthodontic treatment. Our cross-sectional findings indicated that the impact of malocclusion on OH-QOL is substantial in children with low SE and identified SE as a salient determinant of OH-QOL in children seeking orthodontic treatment. Longitudinal data, on the other hand, detected significant improvement of OH-QOL outcomes after orthodontic treatment. As postulated, these improvements were most evident for the social and emotional domains of OH-QOL. However, covariate analysis emphasized the important role psychological factors play in moderating OH-QOL reports, as children with better PWB were more likely to report better OH-QOL regardless of their orthodontic treatment status.

These results substantiate the validity of contemporary models of patient-based outcomes linking biological, personal, social, and environmental factors. Researchers and clinicians are encouraged to adopt this forward thinking approach when dealing with children with oro-facial conditions. Further studies with larger samples and longer follow-ups would be of value to expand on these findings.
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LIST OF ABBREVIATIONS

Child-OIDP  Child-Oral Impact on Daily Performance
CHQ-CF87   The Child Health Questionnaire
CPQ11-4    The Child Perception Questionnaire
CS-OIDP    Condition Specific-Child Oral Impact on Daily Performance
DAI        The Dental Aesthetic Index
EWB        Emotional Wellbeing
FL         Functional Limitation
GTR        Global Transition Rating
H-QOL      Health-related Quality of Life
ICC        Intra-Class Correlation Coefficient
ICSII-OHRQOL The Second International Collaborative Study -Oral Health-Related Quality of Life Questionnaire
IOTN       The Index of Orthodontic Treatment Need
IOTN.AC    Aesthetic Component of the Index of Orthodontic Treatment Need
OASIS      The Oral Aesthetic Subjective Impact Scale
OH         Oral Health
OHIP       Oral Health Impact Profile
OH-QOL     Oral Health-related Quality of Life
OIDP       Oral Impact on Daily Performance
OQOL       Orthognathic Quality of Life Questionnaire
OS         Oral Symptoms
PAR        Peer Assessment Rating
PIDAQ      The Psychosocial Impact of Dental Aesthetics Questionnaire
PPQ        Parent/caregiver Perception Questionnaire
PWB        Psychological Wellbeing
QOL        Quality of Life
SE         Self-Esteem
SWB        Social Wellbeing
WHO        The World Health Organization
THESIS INTRODUCTION

The increased emphasis on inclusion of patient-centered outcome measures in clinical research studies by agencies such as the World Health Organization (WHO) is one of the many factors that has led to an increase in Quality of Life (QOL) research over the last 40 years. These advances were paralleled by developments of holistic conceptual models of patient outcomes, which integrate both biological and psychological aspects of health (1,2).

The field of orthodontics has, however, lagged behind. Whilst clinical outcomes of orthodontic treatment are well documented, relatively little is known about the psychological aspects. This is surprising considering that improvement in smile aesthetics and subsequent enhancement of psychosocial wellbeing is the most frequently cited reason for undergoing orthodontic treatment (3,4). For years, orthodontic clinicians have assumed that orthodontic anomalies can negatively impact the lives of people and that orthodontic treatment can enhance the lives and overall wellbeing of those people. However, research has not yet provided evidence to support these anecdotal claims, which lead some to speculate the existence of an element of “supplier-induced demand” (5).

The relatively few empirical attempts to consider the patient’s view in evaluating treatment results found no difference in children’s Self-Esteem (SE) or Psychological Wellbeing (PWB). This could be partly attributed to two main reasons. First, earlier empirical work was not paralleled by conceptual work clarifying the relationships between relevant psychosocial constructs. Conceptual frameworks are essential to determine what to measure and how it should be measured. Consequently, earlier studies
failed to measure what orthodontists perceived as an obvious benefit of orthodontic therapy (6-8).

Second, a critical analysis of the methodology employed in these studies reveals that, for the most part, orthodontic outcome studies designed and conducted prior to the new millennium, used SE as a primary outcome. However, results from child psychology studies question the validity of this measurement approach. For instance, in an extensive report on SE, Emler noted that appearance, in general, contributes only modestly to SE (9). Therefore, SE is not an appropriate end-point assessment tool when it comes to orthodontics in children. In fact, Cunningham identified the method of assessment of psychological health as an important reason for the conflicting evidence regarding the psychosocial benefits of orthodontics (10).

Currently, new measures have been developed to allow us to focus on outcomes that are more relevant to the child population; notably, Oral Health-related Quality of Life outcomes (OH-QOL) measures. OH-QOL is defined as an individual's assessment of how functional factors, psychological factors, social factors, and the experience of pain/discomfort in relation to oro-facial concerns affect his or her wellbeing (11). Thus defined, OH-QOL instruments are potentially promising research tools in orthodontics since improvement of QOL is a frequently stated reason for undertaking orthodontic treatment.

Results of OH-QOL studies could have significant implications for the orthodontic community. With the increased demands to justify the needs for and outcomes of treatment, an appropriately designed study could provide useful evidence for
parents, clinicians, public health agencies, and insurance companies to support the claimed benefits of orthodontic treatment.

Several cross-sectional studies have, indeed, supported the widely shared belief that an association exists between OH-QOL and orthodontics. However, most studies pointed out that the association between OH-QOL and normative measures of malocclusion are rather weak. Moreover, the longitudinal effects of orthodontic treatment on OH-QOL have not been determined. Hence, the intense debate about the relationships among malocclusions, orthodontic treatment, and OH-QOL remain unresolved. Further, the role of psychological factors which are deemed to be an important predictor of quality of life was often overlooked. Thus, longitudinal controlled evaluations are needed to assess causality and to account for relevant psychological constructs moderating OH-QOL reports in the population of children seeking orthodontic treatment.

As mentioned earlier, in addition to being either inadequately controlled or underpowered, earlier studies also lacked the theoretical grounding needed to accurately interpret their findings. Since this dissertation aims to tackle the above research weaknesses, a theoretical framework of patient-based outcomes, linking both clinical variables and characteristics of the individual to OH-QOL and general wellbeing (1), was adopted to help in answering the following questions: 1) Does orthodontics improve OH-QOL in children receiving treatment compared to those waiting for treatment? and 2) Do psychological factors influence OH-QOL outcomes in those children?.

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In Chapter 1, the epidemiology of malocclusion in children is reviewed. The large discrepancy between subjective and objective assessments of orthodontic treatment needs discussed in this chapter emphasizes the importance of supplementing clinical indicator with subjective measures whenever possible.

Chapter 2 provides operational definitions related to oral health and quality of life and introduces a bio-psychosocial model of patient-based health outcome measures. Since this model of disease and its consequences links the physical and the psychosocial wellbeing of the individual, it is used as a framework to discuss relevant clinical and non-clinical determinants of OH-QOL outcomes in children.

Chapter 3 provides an overview of the current status of patient-centered outcome research in orthodontics. Challenges and current developments are discussed in depth. Special attention is given to the assessment of change in children. This chapter also includes a summary of OH-QOL measures published prior to 2004. Their advantages and disadvantages are emphasized as they were considered in planning the study. In addition, a review of the evidence concerning the impact of orthodontic treatment on children's health status and wellbeing is provided. This review indicates that OH-QOL has not been studied in a systematic manner in relation to orthodontics. Further, earlier psychosocial studies in orthodontics are conceptually and methodologically examined.

Since the thesis reports on the effect of SE and PWB on pediatric OH-QOL outcome research, Chapter 4 provides a brief review of these constructs. The stability of SE and PWB is also discussed as portrayed in social and developmental psychology literature.
The knowledge gaps identified in the literature review are summarized in Chapter 5. Consequently, this chapter provides a rationale for undertaking this study and the objectives of the dissertation. Chapter 6 provides a description of the specific methods used. The relative merits of the measures employed are outlined as a basis for their selection.

Chapter 7 presents the results of this research. These consist of four manuscripts that address the main objectives of this dissertation. Manuscript I, “Is the child oral health quality of life questionnaire sensitive to change in the context of orthodontic treatment?”, describes the longitudinal psychometric properties of the Child Perception Questionnaire (CPQ11-14). This manuscript has been published in the *Journal of Public Health Dentistry* 2008 Fall; 68(4):246-8. Manuscript II, “Impact of self-esteem on the oral health-related quality of life of children with malocclusion” covers the main baseline findings. It has been published in the *American Journal of Orthodontics and Dentofacial Orthopedics* 2008; 134:484-9. Manuscripts III and IV present the longitudinal findings of this project. Manuscript III, “Does orthodontic treatment improve children’s oral health-related quality of life?” reports on OH-QOL gains following orthodontic treatment. It has been submitted to *Community Dentistry and Oral Epidemiology*, and is currently under revision. Manuscript IV, “Does psychological wellbeing influence oral health-related quality of life in children receiving orthodontic treatment?”, focuses on the role of PWB in moderating children’s response to OH-QOL questionnaires. It also examines the analytic implications of such results. This manuscript has been accepted for publication in the *American Journal of Orthodontics and Dentofacial Orthopedics*. 
The research findings and their implications are summarized and discussed in Chapter 8. Here are also presented the limitations of the study and suggestions for future research.
CHAPTER 1: EPIDEMIOLOGY OF MALOCCLUSION

Overview

Malocclusion exists on a continuum with no clear or simple division as to when treatment becomes desirable. Therefore, orthodontic treatment is different from most other medical interventions in that it does not cure or treat a condition; rather it aims to correct variations from an arbitrary norm (12).

Malocclusions can occur due to congenital and/or acquired aberrations in the size or the position of teeth and/or the supporting dentoalveolar structures. Classifications and indices of malocclusion are either qualitative (e.g., Angle's classification and British Standards Institute classification) or quantitative (e.g., Dental Aesthetic Index – DAI (13) and Index of Orthodontic Treatment Need – IOTN (14)).

Qualitative assessments are not usually suitable for use in epidemiological research. Therefore, prevalence figures for malocclusion are usually based on the normative need for orthodontic treatment. Quantitative assessments measure the clinical severity or complexity of the orthodontic condition. For instance, the IOTN establishes the prevalence of selected malocclusion traits such as dental crowding, maxillary median diastema (space between the upper central incisors), crossbite (facial or lingual displacement of posterior teeth), overjet (excessive protrusion of the upper incisors), and overbite (vertical overlap of the incisors).
Prevalence of Malocclusion

Approximately one-third of US and UK children have a clear normative need for orthodontic therapy (15-17). For instance, the U.K. Child Dental Health Survey in 1993 estimated that approximately 66% of 12-year-olds required some form of orthodontic treatment, and 33% required complex orthodontic treatment (14). Further, the 1994-1995 U.K. National Health Services Dental Survey found a definitive treatment need, in 25.6% of 14-year-olds sampled (18).

Similarly, the 1963-1965 and the 1969-1970 U.S. National Health and Nutrition Examination Survey indicated that approximately 14% of children aged 6-11 years and 30% of children aged 12-17 years had severe malocclusion (17). A later survey in 1988-1991 confirmed these findings (19).

The statistics are not that different for French Canadian children (20). Using the Grainger's Orthodontic Treatment Priority Index, 32% of the Quebec children surveyed were Angle's class II; 18% had an overjet of 5 mm and over; and 50% had one or more teeth in minor or major displacement.
Orthodontic Treatment Needs

Traditionally, orthodontic treatment needs and outcomes were assessed using normative measures of malocclusion. For instance, the IOTN is heavily used in the UK to prioritize treatment needs and guide the allocation of resources to support government programs. The DAI is another example of an index used worldwide to screen and identify persons eligible for subsidized or free care on the basis of their objective aesthetic needs. The proposed argument is that these instruments can serve as neutral, unbiased instruments to discuss treatment need with patients and as guides to allocate financial resources for orthodontic care. Although these clinical indicators are still of importance, they require supplementation with OH-QOL measures for two main reasons: first, the OH-QOL outcome does not necessarily correlate with objective findings, and patients’ ratings of outcome may not correlate with those of clinicians (21).

The studies conducted in Thailand to estimate orthodontic treatment need using both OH-QOL measures and normative indices demonstrate these concepts clearly. The results detected a marked difference between the standard normative and the sociodental orthodontic needs assessment approach, with the latter approach showing a 60% lower assessment of dental health care needs in 11- to 12-year-old Thai children (22, 23). In contrast, the subjective demands for orthodontic treatment in Europe and North America exceed professionally assessed needs (24, 25). The impact of idealized media images, especially where mass media is omnipresent, can significantly influence adolescents’ perception of their malocclusion, and hence, demands for orthodontic treatment (26). In fact, it has been suggested that social and cultural expectations regarding dental appearance have increased in the United States over the years (27). Clearly, professional
assessment of treatment needs does not necessarily reflect the impact of malocclusion on the daily life of children. Therefore, OH-QOL measures should be used in combination with normative indices in order to cover different dimensions of oral health.
CHAPTER 2: CONCEPTUAL BACKGROUND

Terminology: OH, QOL, H-QOL, and OH-QOL

In 1946, the World Health Organization broadened its definition of health to include physical, emotional, and social wellbeing (28). Subsequently, the Department of Health in England defined Oral Health (OH) as “the standard of oral and related tissue health that enables individuals to eat, speak, and socialize without active disease, discomfort, or embarrassment, and that contributes to general wellbeing” (29).

This broadened concept of health meant that biological measures of disease needed to be supplemented with subjective health measures evaluating the individual's perspective. Consequently, a plethora of terms and measures have appeared over the past 40 years. The term QOL was first used by Pigou in his book The Economics of Welfare (30) as a general description of a person’s sense of wellbeing. However, current definitions of QOL involve a combination of objectively and subjectively indicated wellbeing in multiple domains of life considered salient in one’s culture and time, while adhering to universal standards of human rights (31,32).

Quality of life first appeared in the medical literature in a 1966 study of hemodialysis patients (33). Currently, Health-related quality of life (H-QOL) refers to the physical, psychological, and social domains of health, seen as distinct areas that are influenced by a person's experiences, beliefs, expectations, and perceptions (34). H-QOL measures were designed to complement clinical indicators in population health needs assessment, individual health care, evaluation of health interventions, and policy programs. In essence, the H-QOL notion was developed to humanize health care (35).
Factors like chronic illness, new technology, cost containment, and interest in medical outcomes were major derivers of this H-QOL paradigm (35).

Not surprisingly, being a relatively young endeavor, there are many variations in the operational approach to OH-QOL. OH-QOL was initially defined by Kressin as “the impact of oral conditions on daily functioning” (36). A few years later, in a paper evaluating OH-QOL outcomes in elderly people, Locker et al. redefined OH-QOL as “the symptoms and functional and psychosocial impacts that emanate from oral diseases and disorders” (37). Then, Inglehart defined OH-QOL more specifically as “the absence of negative impacts of oral conditions on social life and a positive sense of dentofacial self-confidence” (11). In this definition, Inglehart embraced the central dimensions of OH-QOL proposed by Gift and Atchison (38). These suggest that OH-QOL be defined as a person's assessment of how the following factors affect his or her wellbeing: (a) functional factors; (b) psychological factors; (c) social factors; and (d) the experience of pain/discomfort. When these considerations center on oro-facial concerns, OH-QOL is assessed (Figure 1).

In theory, H-QOL measures combine information about health status and the value attached to that status by the individual (39,39-41). Since health conditions may affect the physical, psychological, and social functioning of the individual, these impacts may compromise the individual's QOL. However, the extent to which these experiences compromise the individual's QOL as assessed by H-QOL measures is still not clear.

Similarly, there seems to be an implicit assumption that since OH-QOL measures address aspects of daily life that are compromised by oral disorders, they must reflect how these disorders affect the QOL (42). Nonetheless, there remains a conceptual
ambiguity on how OH-QOL measures address the broader concept of QOL. QOL and
disease impact are theoretically distinct concepts, the former clearly being more general.
As such, they need to be labeled and measured separately from one another (31).
Therefore, while I chose to use Inglehart’s as a working definition of OH-QOL for the
purposes of this dissertation, it is important to note that available OH-QOL measures
document the frequency of the functional and psychosocial impacts resulting from oral
disorders, but they do not necessarily relate the meaning and significance of these
impacts to QOL (43).

Figure 1: The main components of OH-QOL

Reproduced from Oral health-related quality of life (2002), Page 3 (11)
The Bio-Psychosocial Model of Outcome Assessment as Applied to Orthodontics

Since the post-World War II definition of health was introduced, the assessment of therapeutic interventions continued to move away from the traditional bio-medical model of health, which views disease strictly as pathological processes affecting the body, towards a more holistic bio-psychosocial model of health, which views disease in terms of its impact on an individual's physical functioning and psychosocial wellbeing (44). The central concept in this salutogenic movement has to do with establishing and maintaining a harmonious balance among the body, mind, and spirit, as well as with the individuals’ social context and their environment. According to salutogenesis, maintaining this balance results in a good quality of life, despite unfavorable health conditions. Similarly, disturbance of such a balance can lead to poor quality of life (35).

One conceptual model that reflects this new paradigm of health has been described by Wilson and Cleary (1). This model, depicted in Figure 2, encompasses both biological and physiological variables at one end, and overall quality of life at the other end. In this model, symptoms of disease/disorder, functional, psychological, and social experiences related to that disease/disorder serve as a link between the two ends. More importantly, this model identifies the moderating role that personal and environmental characteristics have on this causal sequence. Thus specified, the Wilson-Cleary model makes explicit causal relationships between disease, health status, and H-QOL, while still acknowledging the holistic nature of QOL.

There is considerable evidence of the usefulness of this model in outcome assessment in dentistry (45,46). However, despite this evidence, the field of orthodontics has lagged behind in utilizing contemporary models of patient-based outcomes. A quick
survey of the literature reveals that outcome research in orthodontics focused primarily on normative assessment. Dental indices like the Peer Assessment Rating (PAR) and cephalometric radiographic analyses have been extensively used to evaluate the quality of orthodontic care and guide decisions on important issues like treatment alternatives and treatment timing.

Overall, little emphasis was given to OH-QOL outcomes in orthodontics. Only recently have a number of leading scientists in the field of orthodontic outcome research emphasized that the measurement of patient-based outcomes is central to the development of orthodontic oral health services (12,47-49). This research direction was, however, limited by the lack of instruments specifically designed to measure oral health impacts. As OH-QOL instruments became available, increasingly more studies were designed to include patient-reported outcomes of treatment.

Using the Wilson-Cleary model as a framework, the next section examines contemporary orthodontic literature to determine how both clinical and non-clinical factors influence OH-QOL in children. The literature is critically examined to highlight relevant conceptual gaps. However, as an overarching conclusion, studies have been, so far, focused on the linear pathway of the model (highlighted in gray in Figure 2). Very little consideration has been given to the moderating pathways created by individual and environmental factors (highlighted in white in Figure 2).
Figure 2: The Wilson-Cleary model of patient-centered outcomes

Reproduced from Wilson and Cleary (1995) (1)
Determinants of OH-QOL in Children

Clinical Determinants of OH-QOL in Children

Poor OH-QOL has been linked to several oro-facial conditions. In order of prevalence, dental caries, gingival and periodontal problems, malocclusion, hypodontia, and developmental malformations such as cleft lip and/or palate have all been studied in relation to OH-QOL in children. Other factors that contribute to the incidence of impacts in pre-adolescent children include sensitive teeth and oral ulcers. However, these impacts are usually associated with low levels of severity.

Dental caries. Dental caries is the most common chronic disease of childhood. The WHO has estimated that 60–90% of all school-age children are affected (50). However, despite the high prevalence of dental caries, it does not seem to affect Arabian children’s OH-QOL in its early stages (51). In contrast, others have shown the exact opposite; despite low levels of dental caries in Uganda, children experienced appreciable negative impacts on OH-QOL (52). These contradictory findings speak to the presence of other factors that influence the relationship between dental caries and OH-QOL reports, perhaps culture in this case.

Gingival and periodontal disease. Gingival problems are among the most important oral conditions affecting children's OH-QOL (22). More than 20% of Thai children surveyed reported that bleeding and swollen gums had impacts on their daily life. This could be related to natural processes like shedding primary teeth or space due to a non-erupted permanent tooth.
Malocclusion. While some researchers may not deem the effects as handicapping (53), the literature appears to support the notion that malocclusion does affect a person’s OH-QOL. Several studies reported on the impacts of malocclusion in children (54-58). For instance, the prevalence of oral impacts for children with definite need for orthodontic treatment was twice that for children with no or slight need for orthodontic treatment (54). Similarly, Australian children who had less acceptable occlusal traits reported poorer OH-QOL (59).

A study of 414 college students supports these findings; individuals with incisor crowding and anterior maxillary irregularity greater than two mm were at least twice as likely to experience an impact on “smiling, laughing, and showing teeth without embarrassment.” Further, individuals with overjet greater than five mm were almost four times more likely to experience impacts on their emotional state (60). In general, the impacts of self-perceived malocclusion primarily affected psychological and social everyday activities such as smiling, emotion, and social contact (54,56).

Altogether, there is definitely a trend for children with clinically identifiable malocclusions to report poorer OH-QOL compared to children with ideal occlusion. Of seven articles identified in a recent systematic review of malocclusion and children OH-QOL, six (22,52,56,58,61,62) found statistical associations and one did not (63). However, the associations between normative measures and OH-QOL scores are rather weak.

In fact, a study of British children with a need for treatment based on the examiner-assessed Aesthetic Component of the Index of Orthodontic Treatment Need (IOTN.AC) found that children with IOTN.AC of 6 or greater (indicating worse
malocclusion) did not have significantly higher CPQ11-14 scores (61). The authors noted that the association between OH-QOL and IOTN.AC was low and that they are two different attributes. Another British study of the same population used a different OH-QOL measure, the Child-Oral Impact on Daily Performance (Child-OIDP), and yet, found similar results (54). Although the prevalence of oral impacts increased from 16.8% for adolescents with no or slight need for orthodontic treatment to 31.7% for those with definite need for orthodontic treatment, there were inconsistencies between self-reports of OH-QOL and normative assessment of treatment needs. Interestingly, the same research group found that the OH-QOL scores were poorer when increased normative needs were associated with perceived treatment needs (the child felt their teeth needed straightening). Similarly, Mandall et al. found that the aesthetic impacts of malocclusion were not different between treated and untreated children; however, the untreated children who wished for orthodontic treatment perceived worse aesthetic impacts (64). Clearly, awareness of occlusal traits and satisfaction with one’s own occlusal condition varies among different individuals (65,66). It is also plausible that the desire for orthodontic treatment may differ according to the patient’s psychological status.

These weak associations can be explained by the fact that clinical indices, such as the IOTN (15), can emphasize malocclusions that may not be important to OH-QOL, such as posterior crossbites (63,67). These inconsistencies also highlight the shortcomings of using only clinical indices to estimate orthodontic treatment needs/outcomes and support the contemporary thinking on the consequences of disease, in that health and OH-QOL are not merely determined by the nature of the disease but also by other contextual factors.
**Hypodontia.** Until recently, only one study has evaluated the impacts of hypodontia (the congenital absence of teeth) on OH-QOL (68). All subjects studied reported considerable impact on OH-QOL. The majority experienced oral symptoms, functional limitations, as well as impacts on social and emotional wellbeing. The results confirm that chronic oral conditions can influence an individual's wellbeing by impacting on everyday physical, psychological, and social functioning (45). In this study, the number of missing permanent teeth was moderately correlated with OH-QOL. However, when retained primary teeth were taken into account, the number of missing teeth was highly correlated with OH-QOL, suggesting the importance of retaining primary teeth in children and adolescents with severe hypodontia. This study, however, did not examine the effect of other, potentially more important, variables such as the location of missing teeth. For instance, one could hypothesize that missing visible teeth would have more of an impact than missing teeth that could not be seen. Therefore, further studies are warranted to examine these findings.

**Cleft lip and/or palate.** Cleft lip and/or palate cases are more clinically severe and can affect facial appearance throughout life. Therefore, it has been assumed that they will have greater impacts on OH-QOL. However, Locker et al. found that the overall OH-QOL in those children was not different from children with dental decay (69). Actually, children with oro-facial conditions rated their OH better than the ones with dental decay. Although they may encounter more challenges in daily life such as mouth breathing, speech problems, missing school, being teased, and being asked questions about their condition, it seems that the majority of these children are well adjusted and able to cope with the adversities engendered by their condition. In fact, research indicates that many
persons with disabilities do experience good quality of life against all odds. This
discordance between patients’ perception of health and well-being on one hand, and their
objective health status on the other hand, is known as the “Disability Paradox” (35).

As Locker and Slade state, health and disease belong to different dimensions of
human experience; so, paradoxes occur when disease is assumed by researchers to cause
an impact (70). Such paradoxes highlight the importance of personal experience in
defining the self, one’s view of the world, social context, and social relationships (35).
Indeed, all contemporary models of disease and its consequences, such as that of Wilson
and Cleary, indicate that the relationships between biological variables and H-QOL
outcomes are not direct, but moderated by a variety of personal, social, and
environmental variables (1).

Non-clinical Determinants of OH-QOL in Children

*Personal factors.* According to the Wilson-Cleary model, personal, social, and
environmental factors may account for the weak relationships observed between OH-
QOL scores and clinical data. For instance, factors like age and gender can influence
QOL. It has been reported that females tend to be more concerned with dental aesthetics
than males (71-73). Nonetheless, this gender effect is usually most apparent during young
adulthood (18- to 29-year-old) (74), and therefore may not be relevant to the current
investigation. The effect of age on OH-QOL, on the other hand, has not been adequately
investigated. One study concluded that adolescents, despite having the most severe
malocclusions, were less affected by their occlusal status, compared to young adults (74).
As alluded to earlier, the moderational role of personality characteristics can be inferred from such studies highlighting the inconsistencies between normative and subjective outcomes. To recap, several studies indicated that the demand for orthodontic treatment does not seem to be directly related to measurable malocclusions (64,75,76). There are considerable variations in an individual’s ability to adapt to oro-facial abnormalities, while some remain quite unaffected, others have significant difficulties that can affect their QOL (77).

A recent systematic review of the relationship between clinical OH status and OH-QOL in children supports this moderational role of personal characteristics (67). The review further suggests that the weak relationships between children’s oral conditions and OH-QOL, can be explained by inter- and intra- personal variations (78,79).

Although personality characteristics, such as negative affectivity, were found to influence OH-QOL assessment in older men (80), orthognathic patients (81), and college students (82), the direct role of personal characteristics in moderating orthodontic treatment outcomes in children has not been well investigated. In fact, only a few studies make reference to personality attributes in relation to the outcomes of conventional orthodontics. For instance, a study of stereotypes of children with malocclusion concluded that the impact of social stereotypes on psychological wellbeing is likely to be modified by social interactions (83).

It was not until recently that the effect of personal traits on the perception of facial attractiveness was directly examined (Table 1). In a study of teenage Germans, a significant interaction effect was identified, which showed that the impact of dental aesthetics on social appearance concern was stronger in respondents with high private
and public self-consciousness than in low scoring subjects. This study suggests that
minor differences in dental aesthetics have a significant effect on perceived OH-QOL in
subjects with high self-consciousness (71). However, it must be acknowledged that these
findings relate to young adults and therefore cannot be extrapolated to adolescents; yet, it
certainly drives further research of adolescent orthodontic patients. Nonetheless, it is
interesting to note that three out of the four studies listed in Table 1 point to SE as a
potential moderator of the aesthetic impact of malocclusion.

Similarly, a comprehensive long-term study of British children identified baseline
SE as an important moderator of QOL (8). When SE at baseline was controlled for,
orthodontic treatment had little positive impact on psychological health and QOL in
adulthood. In fact, this same research group drew similar psychosocial conclusions from
a study investigating the effects of malocclusion in the early 1980s: “the individual’s
adjustment to his own imperfections in dental alignment is variable and there is no
evidence that children with visible irregularities will in general be emotionally
handicapped” (53) p.36. Some individuals are concerned about very minor malocclusions
and demand orthodontic intervention, whereas others accept major deviations from the
norm quite happily.

Since the desire for orthodontic treatment may differ according to the patient’s
psychological status, the influence of individual traits, such as SE and PWB, on OH-QOL
cannot be ignored. Longitudinal studies assessing this moderational role of psychological
traits on reported OH-QOL are necessary to better understand and interpret OH-QOL
measures in children.
**Social and environmental factors.** It has been also suggested that culture, education, ethnicity, and material deprivation can influence the extent of the impact of disease (63,68,79,84). Variables such as general health status, household income, and life stress have been shown to explain as much variance in the impact of oral disorders on adults as clinical indicators (70). Similar effects were reported for Canadian schoolchildren (62); children from low-income households had higher impacts on QOL than children from high-income households. Household income remained a predictor of OH-QOL scores after controlling for the potential confounding effects of oral diseases and disorders such as dental caries, dental injury, and malocclusion. Notably, the authors concluded that these disparities can be explained by differences in psychological assets and psychosocial resources, which reemphasize the importance of personal factors in moderating OH-QOL.

Further, evidence demonstrates that culture can influence a person’s definition of health, appraisals, and behavioral expressions (11). The effect of culture on OH-QOL reports can be extrapolated from a recent investigation of OH-QOL impacts experienced by Tanzanian schoolchildren. Despite the high prevalence of malocclusion in this sample, psychosocial impacts and dissatisfaction with appearance or function were not frequent, compared to similar studies conducted in Canada and New Zealand (85). It is plausible that individuals may evaluate aesthetics and/or function differently, depending on their cultural and/or social background (86). That being said, a recent master’s thesis concluded that having different value systems does not necessarily imply a difference in perceived OH-QOL (74).
These conflicting results highlight the complexity of studying social factors. In fact, when examining the causal pathways between social determinants and health, Newton and Bower advocate the use of a theoretical framework that reflects the complex relationship among material, psychosocial, and behavioral pathways (84). The evaluation of social and cultural factors, however, requires the use of heterogeneous samples with adequate variations in factors like cultural norms, cultural assimilation, education, and household income. Such an evaluation is not usually possible in clinical studies of orthodontics, where children typically belong to the same socio-economic class. Therefore, orthodontic researchers need to collaborate with social theorists in large-scale projects (84).
Table 1: Orthodontic studies evaluating personal determinants of OH-QOL

<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Location</th>
<th>Measure</th>
<th>SD</th>
<th>N</th>
<th>Main findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandall (2001)</td>
<td>UK</td>
<td>OASIS &amp; Piers Harris SE</td>
<td>CS</td>
<td>439</td>
<td>High child SE appears to be related to self-perceived malocclusion and its psycho-social impact (87).</td>
</tr>
<tr>
<td>Klages (2004)</td>
<td>Germany</td>
<td>“Dental self-confidence scale”, “social appearance concern” &amp; “appearance disapproval”</td>
<td>CS</td>
<td>148</td>
<td>Private self-consciousness was related to social appearance concern, while public self-consciousness was associated with both social appearance concern and appearance disapproval (71).</td>
</tr>
<tr>
<td>Marques (2006)</td>
<td>Brazil</td>
<td>OIDP &amp; the Global Negative Self-Evaluation Scale</td>
<td>CS</td>
<td>333</td>
<td>Low SE was an independent risk factor for an aesthetic impact (89).</td>
</tr>
</tbody>
</table>

SD: Study design, CS: Cross-sectional study
CHAPTER 3: QUALITY OF LIFE IN ORTHODONTICS

Overview

The notion that malocclusion is linked to QOL and wellbeing is largely derived from studies linking physical, social, and psychological distress to malocclusion (53,90).

Since the physical, social, and psychological aspects of malocclusion are key reasons why orthodontic care is sought, it can be argued that the best measure of the outcome from orthodontic treatment is improvement of physical, social, and psychological health (91-93). These aspects of health are encompassed by OH-QOL measures, which provide an insight into how individual’s OH status affects life quality and how oral health care brings about improvements to QOL (47,94).

However, in an extensive review of the literature, Zhang et al. note that much controversy exists about the impact of malocclusion and its treatment on QOL, and concluded that there is a need for a more comprehensive and rigorous assessment, employing standardized, valid, and reliable data collection instruments (93).
Challenges in Psychosocial Assessment in Orthodontics

Although OH-QOL assessment has recently penetrated into the orthodontic literature, longitudinal assessment of children’s OH-QOL has been hindered by several methodological issues. These challenges are here discussed by posing the following questions: “Who should be the informant?”; “Are 11- to 14-year-old children capable of providing valid QOL reports?”; and “Is it possible to measure change in OH-QOL as a result of orthodontic treatment in children?”.

Who Should be the Informant?

Until recently, children’s H-QOL was measured using parents as informants. This was mostly related to concerns about children’s cognitive capacities and communication skills that might compromise the validity and reliability of their QOL reports (41). On the other hand, concerns about the accuracy of parental assessments stimulated researchers to reconsider children reports (95,96). Studies that have used parallel reporting, using questionnaires designed to collect data from both the parent and the child, found parent-child agreement to be, at best, moderate (41,95,97). In fact, children with malocclusion consistently rated their OH-QOL worse than their caregivers’ ratings (98-101).

Further, the accuracy of proxy ratings is dependent on the specific domains of QOL considered (102). In general, there is greater agreement for observable functioning (e.g., physical QOL) than for non-observable functioning (e.g., emotional or social QOL). Pediatric OH-QOL measures, therefore, need to include child reports whenever possible. This is particularly important when the socio-emotional dimension of OH-QOL is of primary interest, as is the case in children undergoing orthodontic treatment.
Are 11- to 14-year-old Children Capable of Providing Valid OH-QOL Reports?

As mentioned earlier, there are concerns that children’s cognitive capacities and communication skills may compromise the validity and reliability of their QOL reports (41). However, the literature suggests that self-report of QOL and health status is feasible in 11- to 14-year-old children as age effects should no longer be significant. At this age, children have a good capacity to remember, retrieve, and apply information related to specific events and experiences (103,104). Their matured language skills and ease in independent reading allow for the comprehension of items and meet the demands of self-reported questionnaires (105).

Further, children at this stage, reflective of Piaget's stage of formal operations (106,107), have matured intellectual functioning and are capable of making the comparative judgments required for representations of health status and QOL. Their judgments regarding their general and specific abilities are, in fact, realistic (108,109). 11- to 14-year-old children view health as a multidimensional concept organized around constructs such as being functional, adhering to good lifestyle behaviors, and having a general sense of wellbeing and relationships with others. However, how these concepts are settled varies by age and by the kind of experiences to which children are exposed in their lives (110). In addition, they have a greater appreciation of illness, disease, and disability in that each can be understood based on causality and multi-system understanding (111-113). Despite the enormous psychosocial changes associated with childhood, French and Christie have shown that children begin to understand the effects of ill-health on social activities around 8 years of age (114). Therefore, most patients
undergoing orthodontic treatment are old enough to answer appropriately phrased questions regarding oral health and OH-QOL (115).

There are several developmental considerations, however, that need to be addressed when using child-reports of QOL. These include mental competence and verbal comprehension, understanding and use of time, and identifying QOL domains and markers that are appropriate to the child’s developmental stage and are relevant to children themselves (31,116). Thus, instrument developers need to recognize explicitly that children are developing beings; and use different item sets and response formats depending on the developmental level of the child (117).

In summary, the majority of research in medicine and dentistry supports the use of child self-reports. In fact, a systematic review of recently developed instruments like the Child Health Questionnaire (CHQ-CF87) (96) and the CPQ11-14 (118) has demonstrated that, with appropriate questionnaire techniques, it is possible to obtain valid and reliable OH-QOL information from children (119).
Is it Possible to Measure Change in OH-QOL in Children?

The meaning of OH can change over time. This change demonstrates the existence of response shift in relation to QOL (78). Response shift is defined as changing internal standards, values, and the conceptualization of QOL (120). This response shift, in general, complicates the assessment of change in QOL research. Response shift in children is compounded further by changes in cognitive understanding and psychosocial awareness (121). In fact, these developmental changes can make children “moving targets” (94).

These changes in a child's values, goals, and priorities concerning the relative importance of specific domains of health status are, therefore, more likely to be a critical cause of response shift in children than they are in adults. For example, some diabetic adolescents who have previously adapted well to the challenges of diabetes when they were younger, may now regard them as much more onerous, owing to age-related concerns about the impact of the treatment on peer activities. Children may change their appraisals of their condition as they adapt to that condition (122).

These changes in the basis that children use to evaluate oral health status and/or OH-QOL can cause particular problems in evaluating treatments in studies that involve repeated measurements (121,123). The causal direction of potential influences on children's health-related outcomes is very difficult to disentangle and is often misinterpreted. Thus, it can be difficult to isolate changes in OH-QOL that are solely brought about by interventions such as orthodontic treatment. Hence, having a control group of comparable age followed-up for an equivalent duration of time can help to take
these developmental changes into account and improve the interpretability of the results (124).

Assessment of Change in Children’s OH-QOL

Direct Measures of Change

Andrews and Withey believed that questions like “How do you feel about your life as a whole?” can represent a person’s quality of life (125). The most obvious advantage of such global questions is their brevity. It has been suggested that global questions pull together various components of health. As such they make the least demands on respondents' time. Hence, the use of global questions that directly assess change is advocated by some OH-QOL researchers, because they are simple, represent patients’ overall assessment of how their condition has changed over a specified timeframe, integrate patients’ values, and avoid the statistical issues associated with change scores (126,127).

These summary answers, however, do not provide information about aspects of health compromised by the disease/disorder. As a result, they cannot be used for clinical decision-making purposes such as treatment planning. Similarly, Global Transition Ratings (GTR) do not reveal the opposing trends in different dimensions of health, if they ever occur. This is something that is of obvious interest in the context of intervention studies.

More importantly, these retrospective judgments of change are subject to significant response shift and recall bias. As discussed earlier, response shift may reduce the confidence in the initial assessment (128) and, therefore, can undermine the validity
of direct change measures. According to Streiner and Norman, children may simply not remember their baseline state. When children are asked how they felt two or three years ago, they first reflect on their current state (how do I feel today?). This in turn triggers an “implicit theory of change” where children contemplate how they think the treatment influenced their lives. They then try to estimate what their initial state must have been. This theory of implicit change questions the robustness of GTR as direct measures of change (129).

Further, evidence indicates that participants may use different frames of reference in responding to global questions (79,130,131). While some place a value on physical health, others respond in terms of emotional functioning or health behavior. Also, there are respondents who make comparisons with others or refer to their own condition before becoming sick. Consequently, some questionnaires position the global questions at the beginning to prevent the respondents from being influenced by later items, while others place them at the end so that the earlier items serve as a frame for the areas of functioning that are of interest in the study. However, the true effect of positioning global questions remains unknown. Unlike adults, the criteria used by children to answer global questions have not been studied. It is not clear to what extent the terms health and wellbeing are distinguished by child respondents. It appears that health relates principally to physical problems, while wellbeing focuses primarily on mental problems (115). Therefore, considering the limitations above, global questions should be used to supplement, not to replace, QOL scales (127).
**Multiple Item Measures**

Classical measurement theory views the variability in the respondents' scores on a measure of a given concept as due to a combination of true variation in the concept across or within respondents, and error variation in the respondents' scores (129, 132). According to Streiner and Norman, random errors tend to cancel each other out if enough observations are made (129). Multiple item measures have the same effect of allowing random errors to average out (133, 134), since the scores on the individual items represent related observations. Therefore, the reliability of a measure for a given study population and study context can be improved by increasing the number of items and/or by increasing their inter-correlations.

For measures to identify within-individual changes that occur either naturally or as a result of clinical interventions, however, they should be sensitive to change. A wide range of statistical approaches are now available to assess the ability of OH-QOL measures to detect clinically significant changes and enhance the clinical application of these measures (135). In general, these statistical methods are based on two potential approaches, relating measurement sensitivity to meaningful clinical change, and evaluating the meaningfulness of change based on the perspectives of respondents (136). For instance, calculation of effect sizes can be used to determine the significance and magnitude of change. The scores on a questionnaire prior to and after an intervention are compared (132). Effect sizes can be calculated by dividing the mean of change scores by the standard deviation. Effect sizes of 0.2 are generally taken to be small, 0.5 to be moderate, and 0.8 or above to be large (137).
The CPQ11-14, the instrument chosen for this study, was constructed according to a process derived from the theory of measurement and scale development that represents the most systematic and sophisticated approach to the design of multi-item questionnaires (129,138). However, the ability of the CPQ11-14 to detect clinically relevant changes in children's outcomes is not yet fully explored (139).
How Has OH-QOL Been Assessed in Children Thus Far?

Adult OH-QOL Measures

Initially, OH-QOL was evaluated in orthodontics using measures that were originally developed in the field of dentistry. Adult instruments like the Oral Health Impact Profile (OHIP) (140) and the Oral Impacts of Daily Performance (OIDP) (36) have been used to assess the impacts of malocclusion in children. The Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ) (141) and the Orthognathic Quality of Life Questionnaire (OQOL) (32) were developed more recently for assessment of orthodontic and orthognathic aspects of quality of life. The PIDAQ and OQOL are potentially promising tools for research and clinical application in orthodontics. However, both instruments were designed for use in adults above 18 years old. As discussed earlier, in order for an OH-QOL measure to be appropriate for children, they should:

- Operationalize an accepted, clear, generic QOL definition.
- Include broadly encompassing QOL domains applicable to all children.
- Include both objective and subjective approaches.
- Have parallel forms for children and other informants.
- Weigh satisfaction on domains of perceived importance to the child.
- Demonstrate satisfactory psychometric characteristics.
- Provide norms for the general population in addition to any specific group of children it targets.
Recognize explicitly that children are developing beings (e.g., through the use of different item sets, response formats, or entirely different forms dependent upon the developmental level of the child) (31).

Therefore, the validity of these measures for children has been questioned given their conceptual basis, item content and wording, recall periods, and response formats (94,142,143). In fact, some of these measures require advanced reading and language skills, and high levels of abstract thinking that render them unsuitable for children. For example, the OHIP ask questions like:" Because of problems with your teeth, mouth or dentures ... have you been less tolerant of your spouse or family? ... have you suffered financial loss?". Clearly, such questions are irrelevant to children. Moreover, adult measures ignore aspects of daily life that are important for children such as school activities and peer relationships. Therefore, the majority of these measures are not applicable to the child orthodontic patient (12). This is really important considering that 54% of patients currently receiving orthodontic care in the United States are between the ages of 12 and 17 (144).

**Child OH-QOL Measures**

In an attempt to address the shortcomings above, several OH-QOL measures were developed specifically for use in children to fill this urgent need. These are:

- The Second International Collaborative Study-Oral Health-Related Quality of Life Questionnaire for Children (ICSII-OHRQOL)
- Michigan Oral Health-Related Quality of Life Scale-Child Version
- Oral Aesthetic Subjective Impact Scale (OASIS)
• Child Oral Health Quality Of Life Questionnaire (Child OH-QOL Questionnaire)

• Child-Oral Impacts of Daily Performance (Child-OIDP)

Preliminary evaluation of the ICSII-OHRQOL showed its potential validity in children (143). However, to the best of our knowledge, this validation was not pursued any further. The Michigan Oral Health-Related Quality of Life Scale-Child Version was designed for use in a younger age group to assess the impacts of early childhood caries and it is therefore irrelevant to orthodontic patients. The OASIS was one of the early attempts to assess the aesthetic impacts of malocclusion on subjective quality of life (64). It consists of five questions to measure the amount of concern that children feel because of the arrangement of their teeth. Respondents are asked to indicate, on a seven-point Likert scale, their concern about tooth appearance, nice comments about teeth, unpleasant comments about teeth, teasing about teeth, avoidance of smiling, and covering the mouth. However, OASIS was originally designed to reflect orthodontic treatment need, and it has not been so far applied as an outcome measure. OASIS is composed of only five items; it seems that the developers have given little consideration to the multidimensional aspect of OH-QOL. Further, its technical properties are not known as it was not tested in different groups apart from the original 14- to 15-year-old children it was developed in.

Thus, it is fair to conclude that at present, there are two adequately validated OH-QOL measures that could be potentially useful in the context of orthodontic treatment of children, the Child-OIDP (145) and the CPQ11–14 component of the child OH-QOL Questionnaire (146). The properties of both measures are contrasted in Table 2 and a detailed description is provided.
Table 2: Development and age adaptations of the Child-OIDP and the CPQ11-14

<table>
<thead>
<tr>
<th>Age adaptation feature</th>
<th>Child-OIDP</th>
<th>CPQ11-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age versions available (Years)</td>
<td>11-12</td>
<td>11-14</td>
</tr>
<tr>
<td>Direct application or modification of an adult measure</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Child specific development</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Children involved in item generation and reduction</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Items from children</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Domains from children</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Wording addressed</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Response Burden</td>
<td>8</td>
<td>37</td>
</tr>
<tr>
<td>Response options addressed</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Recall time addressed</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Attribution addressed</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Negative wording addressed</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>

The Child-OIDP. The original Oral Impact on Daily Performance (OIDP) index was developed from a theoretical model of oral health proposed by Locker (147) as adapted from the WHO Classification of Impairments, Disabilities, and Handicaps (148). The Child-OIDP was developed from the original OIDP index using input from children and pediatric dentists, and pays attention particularly to the language used, performances included, number of questions, and the response format. The Child-OIDP is administered
as an interview. The recall period of 6 months for the OIDP was shortened to 3 months for the child version (145).

The Child-OIDP assesses the oral impacts on 11- to 12-year-old children’s daily life in relation to eight daily performances, namely, eating, speaking, cleaning mouth, sleeping, smiling, studying, emotion, and social contact. It records the frequency of the impact (on a scale from 1–3) and its severity (on a scale from 1–3). If no impact is reported, then a zero score is assigned. The impact per daily performance is then estimated by multiplying the corresponding frequency and severity scores. The overall Child-OIDP score is the sum of the eight performance scores (ranging from 0–72) multiplied by 100 and divided by 72 (145).

The CPQ11–14. This is one of the recent child OH-QOL instruments. This questionnaire, developed by Jokovic and colleagues (118), forms one part of the generic self-completed child OH-QOL questionnaire, incorporating a Parental/Caregiver Perceptions Questionnaire (PPQ), the Family Impact Scale, and three age-specific questionnaires for children. The CPQ11-14 was developed for use with 11 to 14-year-olds with a wide range of dental, oral, and oro-facial disorders. It is composed of 37 questions encompassing four domains: six questions assessing Oral Symptoms (OS), nine questions assessing Functional Limitations (FL), nine questions related to Emotional Wellbeing (EWB), and 13 questions evaluating Social Wellbeing (SWB). CPQ11-14 Score ranges from zero to 80. A high score indicates worse OH-QOL.

All questions ask about the frequency of events in the preceding three months in relation to the condition of the child’s lips, teeth, and jaws. The CPQ11-14 was developed using the item-impact method proposed by Guyatt and Juniper (149). The
development process involved several critical stages (Figure 3). After developing a preliminary list of items by interviewing parents and experts dealing with children affected by oro/craniofacial conditions; the initial item list was reduced using the item-impact method. This method is based on the frequency and the perceived importance of the items selected by that population. Since the ultimate goal was to develop an evaluative measure, the high prevalence items were selected to promote responsiveness. Finally, the reduced questionnaire was tested for validity and reliability.

Figure 3: Diagrammatic representation of the CPQ11-14 developmental process
Reproduced from Jokovic (2003). Page 97 (118)

Initial testing of the questionnaire has shown that the CPQ11-14 possesses good discriminative ability, with the highest scores being noted for the oro-facial group and the lowest for the pedodontic group, the orthodontic group lying in between (146,150). The instrument has been, so far, tested in Canada, New Zealand, Uganda, Saudi Arabia, Brazil, and the United Kingdom and found to be a valid and reliable in children with malocclusion (51,52,63,151,152). It consistently demonstrated good test-retest reliability.
and internal consistency in each of these countries. Altogether, these results show that 11- to 14-year-old children are able to give acceptable accounts of OH-QOL (115). Non-English versions of the CPQ11-14 are now available (51,153) and attempts to develop a short form for use in clinical trials and public health survey are also underway (152,154).

Further, Foster Page et al., investigated the ability of the CPQ11-14 to discriminate between the various levels of malocclusion severity (152). They hypothesized that children with more severe malocclusions should have higher overall CPQ11-14 scores. The study evaluated 430 children in New Zealand, and revealed that there was a statistically significant distinct gradient in mean CPQ11-14 score by malocclusion severity. These differences were, however, clearer for the emotional and social wellbeing sub-scales. A similar gradient in CPQ11-14 scores was observed across categories of the PAR index in a study of Canadian children (151).

Increasingly, studies are being undertaken to evaluate the CPQ11-14 in different orthodontic contexts (Table 3). These results support the use of CPQ11-14 for future orthodontic studies and demonstrate its excellent cross-sectional psychometric properties. Nonetheless, the longitudinal psychometric properties of the CPQ11-14 have not been assessed thus far. Therefore, a preliminary study was undertaken, by this author and a colleague, to confirm its longitudinal psychometric properties. (155).

In summary, while the CPQ11-14 was primarily intended for use as an outcome measure in clinical trials and evaluation studies, the Child-OIDP was designed specifically to be used in population based surveys to assist dental service planning. Further, the psychometric properties of the CPQ11-14 are currently well-established for 11- to 14-year-old children; an age group that comprises a good percentage of the patients
currently seeking orthodontic treatment. Therefore, the use of the CPQ11-14 has become popular in orthodontics. In fact, leading OH-QOL researchers consider it as the questionnaire of choice in future orthodontic QOL research (10).
<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Location</th>
<th>SD</th>
<th>N</th>
<th>Main findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jokovic (2002)</td>
<td>Canada</td>
<td>CS</td>
<td>123</td>
<td>CPQ11-14 has good discriminative ability and test-retest reliability (146).</td>
</tr>
<tr>
<td>Jokovic (2005)</td>
<td>Canada</td>
<td>CS</td>
<td>123</td>
<td>Children are able to give acceptable accounts of oro/craniofacial impact (115).</td>
</tr>
<tr>
<td>Marshman (2005)</td>
<td>UK</td>
<td>CS</td>
<td>89</td>
<td>CPQ11-14 exhibits acceptable reliability and validity (63).</td>
</tr>
<tr>
<td>Foster Page (2005)</td>
<td>New Zealand</td>
<td>CS</td>
<td>430</td>
<td>There was a distinct gradient in mean CPQ11-14 scores by malocclusion severity (58).</td>
</tr>
<tr>
<td>O’Brien K. (2006)</td>
<td>UK</td>
<td>CS</td>
<td>325</td>
<td>CPQ11-14 is likely to be a useful measure for orthodontic trials in the UK (57)</td>
</tr>
<tr>
<td>O’Brien C (2007)</td>
<td>UK</td>
<td>CS</td>
<td>116</td>
<td>CPQ11-14 did not differentiate between the crowding, hypodontia, or an increased overjet, but there was a statistically significant difference between the malocclusion and control total CPQ11-14 scores. These differences were significant for the EWB and SWB domains, and non-significant for the OS and FL domains (56).</td>
</tr>
<tr>
<td>Locker (2007)</td>
<td>Canada</td>
<td>CS</td>
<td>141</td>
<td>There was a clear gradient in CPQ11-14 scores categories of the PAR index. The gradient across the DAI categories was less clear. The results provide evidence of the validity of the CPQ11-14 when used to evaluate orthodontic treatment (151).</td>
</tr>
<tr>
<td>Do (2008)</td>
<td>Australia</td>
<td>CS</td>
<td>1401</td>
<td>The CPQ11-14 showed acceptable construct validity against global ratings of oral health and overall wellbeing. Children who had more caries or less acceptable occlusal traits reported worse OH-QOL (59).</td>
</tr>
<tr>
<td>Agou (2008)</td>
<td>Canada</td>
<td>LG</td>
<td>45</td>
<td>The results provide preliminary evidence of the sensitivity to change of the CPQ11-14 when used with children receiving orthodontic treatment (156).</td>
</tr>
</tbody>
</table>

**SD**: Study design, **CS**: Cross-sectional study, **LG**: Longitudinal study
Does Orthodontic Treatment Improve OH-QOL?

Although many studies have examined the relationship between malocclusion and
OH-QOL in children (Table 4), very few studies have directly compared OH-QOL
outcomes between children who received orthodontic treatment to those who did not.
Only recently have de Oliveira and Sheiham studied the impact of orthodontic treatment
on OH-QOL in Brazilian adolescents (72). The findings showed that those who had
completed treatment were 1.85 times less likely to have OH-QOL impacts than those
currently undergoing treatment, and 1.43 times less likely than those who had not had
treatment. These findings were corroborated by a recent case-control study of the same
population (157).

The majority of these studies highlight the importance of the emotional and social
dimensions of OH-QOL in children when assessing orthodontic treatment outcomes.
Nonetheless, given the cross-sectional study designs, an association rather than evidence
of causation was observed. Therefore, further studies are warranted to confirm or refute
these findings.

As mentioned earlier, according to the operational definition of OH-QOL
employed in this dissertation, OH-QOL consists of four major domains (Figure 1). These
are: oral symptoms, functional limitations, social wellbeing, and emotional wellbeing.
Therefore, in order to examine the relationship between orthodontics and the various OH-
QOL domains, the literature is surveyed by posing the following questions: Does
orthodontic treatment improve oral symptoms?; Does orthodontic treatment improve oral
function?; Does orthodontic treatment improve social wellbeing?; and Does orthodontic treatment improve emotional and psychological wellbeing?
<table>
<thead>
<tr>
<th>Author (Y)</th>
<th>Location</th>
<th>Measure</th>
<th>SD</th>
<th>N</th>
<th>Main findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandall (2000)</td>
<td>UK</td>
<td>OASIS</td>
<td>CS</td>
<td>334</td>
<td>OASIS scores were similar between treated and untreated children, but untreated children who wished for orthodontic treatment had worse scores (64).</td>
</tr>
<tr>
<td>de Oliveira (2003, 2004)</td>
<td>Brazil</td>
<td>OIDP &amp; OHIP-14</td>
<td>CS</td>
<td>1675</td>
<td>Adolescents who had completed orthodontic treatment had fewer oral health-related impacts compared to those currently under treatment or those who never had any treatment. Current methods of assessing orthodontic need should be complemented by OH-QOL measures (72,158)</td>
</tr>
<tr>
<td>Gherunpong (2004)</td>
<td>Thailand</td>
<td>Child-OIDP</td>
<td>CS</td>
<td>1126</td>
<td>The severity of oral impacts was mainly related to difficulty eating and smiling. Toothache, oral ulcers, and natural processes contributed largely to the incidence of oral impacts (145).</td>
</tr>
<tr>
<td>Kok (2004)</td>
<td>UK</td>
<td>CPQ11-14</td>
<td>CS</td>
<td>174</td>
<td>Children with a normative need for treatment did not have significantly higher CPQ11-14 scores. (61).</td>
</tr>
<tr>
<td>Jokovic (2005)</td>
<td>Canada</td>
<td>CPQ11-14</td>
<td>CS</td>
<td>123</td>
<td>The impact of child oral and oro-facial conditions on functional and psychosocial wellbeing is substantial (115).</td>
</tr>
<tr>
<td>Gherunpong (2006) Tsakos (2006)</td>
<td>Thailand</td>
<td>Child-OIDP</td>
<td>CS</td>
<td>1034</td>
<td>There was a marked difference between the standard normative and the sociodental orthodontic needs assessment approach, with the latter approach showing a 60% lower assessment of dental health care needs in Thai 11- to 12-year-old children (23,159,160).</td>
</tr>
<tr>
<td>O’Brien K (2006)</td>
<td>UK</td>
<td>CPQ11-14</td>
<td>CS</td>
<td>325</td>
<td>CPQ11-14 scores were increased for girls, increased treatment needs (IOTN), and when the child felt their teeth needed straightening (57).</td>
</tr>
<tr>
<td>O’Brien C. (2007)</td>
<td>UK</td>
<td>CPQ11-14</td>
<td>CS</td>
<td>116</td>
<td>Malocclusion has a negative impact on the OH-QOL of adolescents. The OS and FL subscales of the current questionnaire are not relevant to orthodontic patients (56).</td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Dental Measure</td>
<td>Study Design</td>
<td>Impact</td>
<td></td>
</tr>
<tr>
<td>------------------------------</td>
<td>---------</td>
<td>----------------</td>
<td>--------------</td>
<td>----------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Johal (2007)</td>
<td>UK</td>
<td>CPQ&lt;sup&gt;11-14&lt;/sup&gt;</td>
<td>CS 90</td>
<td>Increased overjet or spacing does have a significant negative impact on the child’s quality of life compared to controls, but no differences between the overjet and spaced group (55).</td>
<td></td>
</tr>
<tr>
<td>Zhang (2007)</td>
<td>China</td>
<td>CPQ&lt;sup&gt;11-14&lt;/sup&gt;</td>
<td>CS 217</td>
<td>The impact on QOL after insertion of fixed orthodontic appliances was considerately less than what child patients expected (161).</td>
<td></td>
</tr>
<tr>
<td>Bernabe (2007)</td>
<td>Peru</td>
<td>Child-OIDP</td>
<td>CS 805</td>
<td>Impacts of self-perceived malocclusion primarily affected psychological and social everyday activities such as smiling, emotion and, social contact (162).</td>
<td></td>
</tr>
<tr>
<td>Traebert (2007)</td>
<td>Brazil</td>
<td>OIDP</td>
<td>CS 414</td>
<td>Some types of malocclusions have an impact on quality of life, especially in terms of satisfaction with appearance (60).</td>
<td></td>
</tr>
<tr>
<td>de Oliveira (2008)</td>
<td>UK</td>
<td>CPQ&lt;sup&gt;11-14&lt;/sup&gt;</td>
<td>CS 187</td>
<td>OH-QOL measures explained the prediction of perceived need for braces. Importantly, children with an impact were denied orthodontic treatment (163).</td>
<td></td>
</tr>
<tr>
<td>Mtaya (2008)</td>
<td>Tanzania</td>
<td>OIDP</td>
<td>CS 1601</td>
<td>Compared to the high prevalence of malocclusion, psychosocial impacts and dissatisfaction with appearance or function was not frequent among Tanzanian schoolchildren (85).</td>
<td></td>
</tr>
<tr>
<td>Bernabe (2008)</td>
<td>UK</td>
<td>Child-OIDP</td>
<td>CS 200</td>
<td>The prevalence of OIDP attributed to any oral condition was 26.5% whereas the prevalence of OIDP attributed to malocclusion was 21.5%. The prevalence of such impacts increased from 16.8% for adolescents with no/slight need for orthodontic treatment, to 31.7% for those with definite need for orthodontic treatment (54).</td>
<td></td>
</tr>
<tr>
<td>Bernabe (2008)</td>
<td>Brazil</td>
<td>Child-OIDP</td>
<td>CS 157</td>
<td>One in four Brazilian adolescents undergoing orthodontic treatment reported side effects, specific impacts on daily living, related to wearing orthodontic appliances (164).</td>
<td></td>
</tr>
</tbody>
</table>
Brazilian adolescents with a history of orthodontic treatment were less likely to have physical, psychological, and social impacts on their daily performances associated with malocclusion than those with no history of orthodontics (157).

<table>
<thead>
<tr>
<th>Author</th>
<th>Country</th>
<th>Study Design</th>
<th>Case-Control</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bernabe (2008)</td>
<td>Brazil</td>
<td>Cross-sectional study</td>
<td>Case-control</td>
<td>279</td>
</tr>
</tbody>
</table>

**SD**: Study design, **CS**: Cross-sectional study, **CC**: Case-control study
Does Orthodontic Treatment Improve Oral Symptoms?

Pain is a common symptom that can impact on QOL (165). Malocclusion by itself does not cause oro-facial pain; however, it can give rise to pain indirectly by leading to either temporomandibular disorder, dental, or gingival trauma (166-170). Nevertheless, the relationship between malocclusion and temporomandibular disorder is not confirmed (171-173), and there is no convincing evidence that orthodontic treatment could cause or treat temporomandibular disorder (168,171,172,174).

Similarly, the literature is conflicting regarding the association between malocclusion and dental trauma. A meta-analysis of the relationship between overjet size and dental trauma suggests that children with an overjet greater than 3 mm are twice as much at risk of injury to the incisors compared to children with an overjet of less than 3 mm (175). In contrast, several studies have reported no significant relationship between dental trauma and overjet (176,177).

The relationship between gingival trauma and malocclusion is also controversial (178). The current consensus is that malocclusion is a cofactor that may accelerate the rate of development of an existing periodontal disease, but it does not initiate it on its own (179,180). However, large overjets, deep overbites, and severe Class II, division 2 malocclusions have been associated with increased periodontal disease prevalence (166). In fact, one randomized controlled study suggested that early correction of protruding upper incisors may have some effect on the incidence of both dental and gingival trauma (169).
**Does Orthodontic Treatment Improve Oral Function?**

Improvement of speech and masticatory efficiency are perhaps the most commonly claimed functional benefits of orthodontic treatment. However, the evidence for these claims remains largely anecdotal.

Some studies reported on differences between subjects with malocclusion and those with normal occlusion in masticatory ability and chewing efficiency (181,182). One study even suggested that more severe malocclusions may affect dietary habits such as choice of food and nutritional status (183). However, most studies found either no, or very weak, associations between malocclusion and masticatory function (184,185). Similarly, orthodontic treatment did not improve chewing efficiency in growing patients (186), but it did improve the masticatory ability of orthognathic patients (187,188).

Speech disorders are another potential consequence of malocclusion. A significant but weak association between speech disorder and malocclusion has been demonstrated in a number of studies (189-191). For example, pronunciation problems for sibilants like /s/, /z/, /j/, and /ch/ have been associated with occlusal traits like large overjet and deep bite (192-195). However, the complexity of speech production makes it difficult to draw a conclusive cause-and-effect relationship (196). Studies have shown that patients with malocclusion can compensate for their malocclusion, regardless of its severity, and produce normal speech (189,197-199).

**Does Orthodontic Treatment Improve Social Wellbeing?**

Dental aesthetics is an important aspect of facial appearance (191,200,201), which is in turn an important element of social attractiveness (200-202). In fact, several reviews have identified facial appearance as an important determinant of interpersonal popularity,
evaluation of one's personality, social behavior, and intellectual expression (203,204). Some even argue that the dentofacial appearance of children can impact teachers’ judgment of students’ intelligence and academic potentials (203). For instance, some studies have suggested that children with incisor crowding and median diastemas were judged to be less attractive, less intelligent, and from a lower social class (200). These assumptions are, however, undermined by studies that reported no differences in the rating of attractive or unattractive schoolchildren based on facial appearance (205). In addition, the judgment an individual makes concerning the personality of others under experimental settings, are usually made in the absence of other real life information regarding these individuals (206).

Bullying is another social impact commonly attributed to malocclusion (207). Psychological theorists believe that bullying victims are often socially isolated, and suffer from psychological problems including anxiety and depression (208). In fact, name calling and teasing in childhood can leave lasting impressions extending into adulthood (188,209). However, due to improper study designs or inappropriate assessment techniques, there is little evidence of improvement in the social wellbeing of children following orthodontic treatment (207).

Nonetheless, current research shows that OH-QOL measures are potentially promising tools to demonstrate the importance of psychological and social components of oral health on children's lives (56,72,157).

**Does Orthodontic Treatment Improve Emotional and Psychological Wellbeing?**

Many claim that certain malocclusions, especially conspicuous occlusal and space anomalies, may adversely affect SE and/or PWB, and that treating it would likely result
in enhancement of SE and/or PWB (82,88,210-214). While some studies support this assumption in adults (24,215,216) and orthognathic surgical patients (21,217-222), the research is less clear-cut for children and adolescents.

Some studies did, indeed, establish connections between orthodontic treatment and enhanced SE (75,88,223,224). People who are satisfied with their facial appearance, and presumably their dental appearance, seem to be more self-confident and have higher SE than those who are dissatisfied with their facial appearance (200,215). In fact, severe malocclusions were associated with feelings of uselessness, shamefulness, and inferiority (188,209,225). Most of these studies, however, were cross-sectional in nature (75,88,223,224), underpowered (75), or inadequately controlled (75,88,215,223,224).

Controlled evaluations, on the other hand, have often failed to document a cause-and-effect relationship between SE and orthodontics (Table 5). For instance, a prospective longitudinal evaluation of 224 eleven to 15-year-old Norwegian children revealed that improvement in SE was not correlated with orthodontic treatment changes (6). Similar results were reported for British and American children who participated in randomized controlled trials examining the psychosocial effects of early orthodontic treatment (226,227). It seems that while dental-specific evaluations appear to be influenced by treatment, the more general psychosocial responses such as subjects' SE are not (7).

Perhaps the most striking results were those reported by Cardiff researchers. In this 20-year follow-up study, the authors noted that the lack of orthodontic treatment when there was need did not lead to psychological difficulties in later life (8,228). The study’s overall conclusion was that while participants' SE increased over the 20-year
period, in general, it was not as a result of receiving braces, and it did not relate to whether an orthodontic treatment need existed in 1981.

In summary, although the psychosocial component is a dominant factor in determining the demands for orthodontic treatment (229), experimental data have repeatedly shown that treatment does not increase children’s global SE or PWB. These results do not necessarily negate the widespread belief among clinicians that orthodontic treatment has considerable psychosocial benefits; rather, they question the way we have been measuring these benefits thus far. They also shed light on the way we view SE and PWB as endpoint outcomes in orthodontic psychosocial research, and warrant a review of how these concepts are defined and measured in the child psychology literature.
Table 5: Studies evaluating the effect of orthodontics on children’s SE/self-concept

<table>
<thead>
<tr>
<th>Author* (Year)</th>
<th>Study design</th>
<th>N</th>
<th>Psychosocial Instrument</th>
<th>Indication of SE improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rutzen (1973)</td>
<td>Cross-sectional study</td>
<td>252</td>
<td>Rosenberg SE Scale (230)</td>
<td>No</td>
</tr>
<tr>
<td>Klima (1979)</td>
<td>Cross-sectional study</td>
<td>173</td>
<td>Secord Self-concept (231)</td>
<td>No</td>
</tr>
<tr>
<td>O’Regan (1991)</td>
<td>Cross-sectional study</td>
<td>218</td>
<td>Piers-Harris Self-concept Scale (232)</td>
<td>No</td>
</tr>
<tr>
<td>Korabik (1994)</td>
<td>Prospective longitudinal study</td>
<td>58</td>
<td>Piers-Harris Self-concept Scale (233)</td>
<td>No</td>
</tr>
<tr>
<td>Albino (1994)</td>
<td>Randomized Controlled Trial</td>
<td>76</td>
<td>Coopersmith SE Inventory Rosenberg Self Image (7)</td>
<td>No</td>
</tr>
<tr>
<td>Dann (1995)</td>
<td>Randomized Controlled Trial</td>
<td>101</td>
<td>Piers-Harris Self-concept Scale (226)</td>
<td>No</td>
</tr>
<tr>
<td>Birkeland (2000)</td>
<td>Prospective longitudinal study</td>
<td>208</td>
<td>Global Negative Self-Evaluation Scale (6)</td>
<td>No</td>
</tr>
<tr>
<td>O’Brien (2003-2005)</td>
<td>Randomized Controlled Trial</td>
<td>176</td>
<td>Piers-Harris Self-Concept Scale (210,227)</td>
<td>Short-term: Yes Long-term: No</td>
</tr>
<tr>
<td>Shaw (1986-2007)</td>
<td>Prospective longitudinal study</td>
<td>337</td>
<td>Rosenberg SE Scale Centre for epidemiological studies depression scale Perceived stress scale (8,228,234)</td>
<td>No</td>
</tr>
</tbody>
</table>

*Studies examining orthognathic patients are not included
SELF-ESTEEM AND PSYCHOLOGICAL WELLBEING IN CHILDREN

Self-Esteem

Conceptual Background

SE continues to be one of the most widely researched concepts in social and developmental psychology (235-238). Generally conceptualized as a part of the self-concept, to some, SE is one of the most important parts of the self-concept. For a period of time, so much attention was given to SE that it seemed to be synonymous with self-concept in the literature on the self (239,240). This focus on SE has largely been due to the association of high SE with a number of positive outcomes (235,241). For instance, the belief is widespread that raising a child or an adolescent’s SE would be beneficial for both the individual and society as a whole.

Self-concept is a broad-ranging concept relating to personal self-concept (facts or one's own opinions about oneself), social self-concept (one's perceptions about how one is regarded by others), and self-ideals (what or how one would like to be) (242). On the other hand, SE refers most generally to an individual's overall positive evaluation of the self (239,243-245).

SE is composed of two distinct dimensions, competence and worth (243,244). The competence dimension (efficacy-based SE) refers to the degree to which people see themselves as capable and efficacious. The worth dimension (worth-based SE) refers to the degree to which individuals feel they are persons of value. Blascovich and Tomaka described SE as an encompassing self evaluation influenced by many variables including abilities, traits, behaviors, clinical conditions, and coping abilities (246). However, using
factor analysis, Fleming and Watts observed three essential components of SE in adolescents: social confidence, school abilities, and self regard (247).

Further, Emler’s extensive report on SE states that appearance, in contrast to parental influence for instance, does not contribute significantly to variations in SE (9). Although Festinger’s social comparison theory implies that individuals have a tendency to compare themselves with others, which can cause feelings of inadequacy or failure (26), research suggests that adolescents simply tend to delete roles in which their performances are less satisfactory. For example, Harter found in studies of adolescents that poor self-evaluations in domains such as attractiveness or athletic skills are associated with low self-esteem only in children who rate those domains as important; high self-esteem children tend to devalue the importance of domains in which they believe they are not doing well (108). Hence, it is unlikely that impaired perception of oro-facial appearance as a result of malocclusion would translate into diminished SE.

Research on SE has generally proceeded on the presumption of one of three conceptualizations. First, SE has been investigated as an outcome. Scholars taking that approach have focused on processes that produce or inhibit SE (108,248-250). Second, SE has been investigated as a self-motive, noting the tendency for people to behave in ways that maintain or increase positive evaluations of the self (251,252). Finally, SE has been investigated as a buffer for the self, moderating various life encounters and providing protection from experiences that are harmful (253-256).

There is considerable evidence that supports this role of SE as a personal resource that may moderate the effects of conditions or events (257,258). Numerous psychological studies, including Harter’s popular thesis of SE, suggest that SE facilitates coping with
less favorable conditions (109,259-262). One dimension of the self may compensate for the loss or chaos in another, so that a relatively balanced self is maintained where good quality of life may result (35).

It is therefore fair to conclude that SE is not an ideal outcome measure to assess the psychosocial benefits of orthodontic treatment. In fact, speculations about the moderational role of SE in orthodontics find roots in studies as early as the 1970s. In a five-year follow-up study of the social importance of orthodontic rehabilitation, Rutzen states that there were no differences in SE between persons with treated and untreated malocclusion because the untreated persons compensate in their role performance (230).

**Stability of SE**

SE, like other dimensions of personality, is a function of interacting biological, developmental, and social processes across the life course. However, most definitions of SE suggest that it is a stable and enduring characteristic (246). Rosenberg (1995), for example, described SE as "the evaluation which an individual makes and customarily maintains with regard to himself/herself; it expresses an attitude of approval or disapproval (239)."

Whether or not SE is truly stable is an important question that has received considerable attention in experimental psychology (263). Although the occurrence of short-term fluctuations in SE has been convincingly demonstrated (264), there is overwhelming empirical evidence indicating an appreciable stability in global SE (238,265). Individuals who are higher (or lower) relative to their peers in global SE at one time point also tend to be higher (or lower) in SE relative to their peers at a future time point (266).
That being said, adolescence is generally regarded as a period of considerable biological, social, psychological, and developmental change. Therefore, there is some debate concerning the proportion of adolescents who are troubled by these changes and the proportion who go through this stage without tumult (267,268). In theory, the significant changes associated with adolescence are likely to be reflected by shifts in a person’s SE. During this developmental period, SE is dominated by inner thoughts, feelings, attitudes, desires, beliefs, fears, and expectations (245,269-271). As early adolescents gradually move into late adolescence, they liberate from parents, parent-adolescent conflict heightens, peer association intensifies, and concerns turn to dating and sexual activity (272). In fact, Rosenberg and several others noted that these processes may generate more disturbances to SE at ages 12 and 13 than at any other point in the life cycle (245).

It is important to note, however, that SE solidifies during adolescence and becomes less susceptible to evaluations by others. Ellis et al. found that roughly midway through adolescence, individuals shifted from evaluating themselves primarily on external standards of achievement to rating themselves primarily on internal standards of personal happiness (273). Hence, as adolescents continue to mature and adjust to new social roles, physical characteristics, and cognitive abilities, they redefine their self-theories. Self-cognitions are reorganized and reintegrated, self-consciousness diminishes, stability of self is restored, and levels of SE rise steadily as individuals move through this period of development (267,268,274-278).

In fact, empirical research on changes in SE during adolescence has yielded fairly consistent results. Engel (279), Monge (280), and Piers and Harris (281) have reported
that SE is stable from approximately 13 through 18 years of age. The few studies (282) which found changes in SE across the adolescent years were dismissed by many theorists (280,283), as these studies did not account for the multidimensional structure of SE.

To sum, despite short-term fluctuations that may occur during adolescence, SE is, for the most part, a relatively steady trait. As individuals grow, SE becomes more stable, resistant to change, and uninfluenced by the short-term evaluations of peers (284). These conclusions coupled with the empirical evidence undermining the importance of appearance to maintain high levels of SE in children, explain why earlier orthodontic studies did not demonstrate increases in SE following treatment.
Psychological Wellbeing

Conceptual Background

Over the past 30 years or so, there have been various attempts by psychologists to define PWB and explain its causes and consequences. In social psychology, wellbeing refers to general happiness and overall satisfaction with life (285). In the health industry, however, the term is used as kind of a catch-all phrase meaning contentment, satisfaction with all elements of life, self-actualization, peace, and happiness. According to Campbell, PWB resides within the experience of the individual (286). It is a person’s evaluative reaction to his/her life, either in terms of life satisfaction (cognitive evaluations) or affect (ongoing emotional reaction).

SE has been reported to be one of the strongest predictors of wellbeing (287-289). For instance, Diener’s review of wellbeing cites 11 studies demonstrating positive associations between SE and PWB (290). Similarly, Rosenberg found that those low in SE tend to be more self-conscious, depressed, and isolated than those with high self-esteem (291). Further, Campbell et al. compared satisfaction in different domains with overall life satisfaction, and found that among all the variables studied, the highest correlation with life satisfaction was satisfaction with the self ($r=0.55$, $p<0.001$) (292).

The conceptualization of PWB revolves around two distinct, but complementary, philosophies: hedonism and eudemonism. In hedonism (293), wellbeing consists of pleasure or happiness, while in eudemonism, wellbeing lies in the actualization of human potentials (294); a feeling of having achieved something with one's life.

The hedonic position has dominated psychological research for many years. Many researchers accept the use of subjective wellbeing as an operational definition of
hedonism and wellbeing while still endorsing a eudaimonic view of what fosters subjective wellbeing. Although subjective wellbeing is perhaps a noisy and imperfect metric for happiness, it is a useful, effective, and a scientific measure provided that its limitations are acknowledged. According to Diener, the assessment of subjective wellbeing, consists of life satisfaction, the presence of positive mood, and the absence of negative mood (295,296).

**Stability of PWB**

Twin studies have demonstrated that PWB is considerably stable over time (297). Albeit relationships with parents, peers, and school performance have been found in various studies to be important to children’s PWB (298), PWB is largely determined by genetics and inherent personality characteristics (297). Objective physical attractiveness (299) and physical health (300), on the other hand, correlated with wellbeing at very low levels.

Because of this trait-like feature of subjective wellbeing, many researchers were able to demonstrate that characteristically happy people tend to interpret the same life events and encounters more favorably than unhappy people (301). Lyubomirsky and Tucker, for example, showed that individuals with high subjective wellbeing tended to cast events and situations in a more positive light, to be less responsive to negative feedback, and to ignore opportunities that are not available to them (302). Thus, people high in subjective wellbeing may have attributional styles that are more self-enhancing and enabling, which in turn could contribute to the relative stability of their happiness.

The hedonic treadmill theory is a widely accepted model of PWB, according to this theory, good and bad events temporarily affect well-being, but people quickly adapt
back to hedonic neutrality. The term “hedonic treadmill”, therefore, stand for the hypothesis that trying to improve one’s wellbeing is futile, and that wellbeing is instead determined by a combination of genes and random factors (303).

This theory, however, was recently revisited using data from recent empirical work. In a 2006 article, Diener et al. indicate that individuals may have different set points and that a single person may have multiple happiness set points where different components of wellbeing, such as pleasant emotions, unpleasant emotions, and life satisfaction, can operate in different directions. These revisions to the hedonic treadmill theory imply that wellbeing can change under some condition for some people in reaction to some external event (303).

Nevertheless, Diener et al. stress that while these revisions provide psychologists and policy makers with a possibility for changing individuals’ wellbeing, the processes of adaptation must still be carefully considered when evaluating interventions aiming at enhancing PWB (303). This is particularly important considering that experimental intervention studies are in the initial stages and that no experiments have directly tested whether an average person can be made reliably happier in the long-term by some intervention. The effect of the intervention could be transitory; although people might initially react positively to interventions, they may adapt over time and return to their baseline wellbeing.
CHAPTER 5: STATEMENT OF THE PROBLEM

Several key themes were identified in this overview of the psychosocial literature in orthodontics. In summary, although children represent more than half the patient population currently receiving orthodontic treatment in North America, the evidence supporting the strongly held beliefs among the orthodontic community regarding the psychosocial benefits of orthodontic care in children is, at best, conflicting. These benefits were commonly assessed using SE as a “yard stick”. However, results from long-term psychological studies question the conceptual appropriateness of this measurement approach in children. Furthermore, the diverse interpretations as to what social and psychological oral health mean, as well as the lack of rigorous standardized approaches to assess these constructs, make it difficult to compare the impact of orthodontic treatment across studies.

Fortunately, with the emergence of OH-QOL measures, significant advances have been made in the assessment of the social and psychological consequences of oral health (304). OH-QOL measures have the potential to provide a greater understanding of the consequences of untreated malocclusion and the benefits of orthodontic care.

Research on the use of these measures among children is promising (146). There is a boom in studies examining the association between orthodontics and OH-QOL. The number of studies listing “OH-QOL” as a key word in the orthodontic literature in the MEDLINE database has increased from only eight studies in the early nineties (1991-1996), to just less than 30 papers during the subsequent five years (1997-2002), to over 100 articles published in the last five years (2003-2008). These numbers clearly indicate that orthodontic researchers are moving away from the traditional clinician-centered
model towards the modern patient-centered model of assessment. These new research movements are, in fact, both important and timely considering the significant debates regarding the psychosocial benefits of orthodontic treatment.

Nonetheless, the associations between OH-QOL and orthodontic treatment have not been examined longitudinally. Hence, there is an urgent need for a longitudinal evaluation of the effects of malocclusion and its treatment on OH-QOL. However, since longitudinal assessments of children are complicated by a variety of factors, the inclusion of a control group is essential considering the rapid, multi-faceted, and rather unpredictable developmental changes children undergo during this period.

Moreover, most studies indicated that the association between OH-QOL and normative measures of malocclusion are rather weak. According to contemporary models of the consequences of disease, H-QOL and, by extension, OH-QOL are not merely determined by the clinical condition but also by the characteristics of the individual.

We decided, therefore, to examine the effect of individual characteristics, namely; SE and PWB, in moderating OH-QOL reports of participating children. This involves a two-phase study, a cross-sectional phase examining the relationship among SE, malocclusion, and CPQ11-14 reports, and a longitudinal study examining the influence of children’s PWB and orthodontic treatment on CPQ11-14 reports. Only one psychological factor was reported on each phase of the study (SE at baseline and PWB at follow-up) because of the expected high correlation between SE and PWB. If both constructs were concurrently assessed as independent variables using regression models, this may lead to imprecise estimates of regression coefficients, slight fluctuations in correlation or number
of cases may lead to large differences in regression coefficients. In addition, this may increases the standard error of coefficients, thus reducing tests of significance (305,306).

In summary, the main objectives of this dissertation are twofold; first, to determine changes in OH-QOL in children receiving orthodontic treatment compared to those waiting for treatment; and second, to examine the moderational role of SE and PWB on OH-QOL outcomes in these children. More specifically, this research project was planned to address the following questions:

- Is the CPQ11-14 sensitive to change in the context of orthodontic treatment?
- Does SE impact OH-QOL reports in children with malocclusion?
- Does orthodontic treatment improve children’s OH-QOL?
- Does PWB influence OH-QOL in children receiving orthodontic treatment?
CHAPTER 6: MATERIALS AND METHODS

Ethical Considerations

Study Approval

All aspects of the research project were approved by the Research Committee, Faculty of Dentistry, University of Toronto; the Scientific Review Committee, University of Toronto; and the Research Ethics Board, University of Toronto.

Confidentiality

Confidentiality was assured to patients in the consent letter. All data collected would remain strictly confidential. No names or addresses would be released to the Community Dental Health Services Research Unit, or to any family member or treating staff member. Subjects’ dental records were accessed only to obtain clinical and demographic information needed for interpretation of the results. Questionnaire responses would be coded and stored in a locked filing cabinet in a secure location at the Faculty of Dentistry. Only researchers involved in this project have access to this material. As per the Tri-council Policy on Ethics guidelines, research data will be retained for at least five years following completion of the study.

Informed Consent Process

A member of the research team verbally explained the details of the study to prospective participants and their parents. The parents were also given a written information sheet to clarify the aim, characteristics, and importance of the study, and to ask for their participation. Parent’s consent and child’s assent were obtained to allow for child’s participation. Negative consent was accepted without any prejudice being
attached to the children who chose not to participate. The same process of obtaining consents from control subjects was undertaken. However, minor changes to the wording of information sheets, consent, and assent forms were made to reflect that children were waiting for treatment.

**Methodology**

**Study Design**

Treatment outcomes are ideally assessed using randomized controlled trials. However, randomized controlled trials are not feasible in orthodontics for a number of important reasons. These were discussed in detail in the *Journal of Evidence Based Dentistry* in a paper titled “Are random controlled trials appropriate for orthodontics?” (307). Perhaps the most relevant of these reasons are the ethical constraints of randomization in orthodontics. Mew suggests that a prospective consecutive trial might be the best and most feasible alternative in orthodontics (307).

Therefore, this three-year prospective consecutive cohort study was planned to evaluate OH-QOL among children seeking orthodontic treatment. All subjects were assessed twice: at baseline after consenting for participation in the study and two months after finishing orthodontic therapy for the treatment group or after an equivalent duration of time for controls awaiting treatment. A checklist developed by Wallander *et al.* to guide the implementation of H-QOL measures in intervention studies was adapted to aid in designing the present study (31).
**Sampling Design**

A convenience consecutive sampling design was employed. This design minimizes volunteerism and other selection biases by consecutively selecting every accessible person who meets the entry criteria. Overly specified inclusion criteria were avoided to enhance generalizability of the results.

**Selection Criteria**

Treatment subjects were recruited from the graduate orthodontic clinic at the University of Toronto during their initial assessment visit. Control subjects, on the other hand, were recruited from the graduate orthodontic wait-list after their initial screening visit. All children aged 11 to 14 years (birth years from 1990-1994), who were in good general health and capable of reading at first-grade level English were included. Children with cleft lip and/or palate or other gross cranio-facial disproportions requiring combined orthodontic and surgical treatment were excluded.

**Sample Size**

We estimated that a 5% difference between groups would be clinically important. This is a rough estimation of the minimal clinically important difference since evidence is lacking in this area. Thus, the mean difference at follow-up would be four (corresponding to a mean score of 24.3 in the treatment group vs. 20.3 in the comparison group) and the common within-group standard deviation is 14.5. The sample size needed for this study to achieve an 80% power to yield a statistically significant result at $\alpha$ level of 0.05 is approximately 60 per group. Justification of the proposed sample size was based on CPQ11-14 scores in children awaiting orthodontic treatment (118). Assuming a response rate of approximately 60%, more subjects were recruited. The number of subjects
recruited at baseline was 199. The total number of subjects at follow-up was 118 (Appendix A). Hence, the overall response rate was 59.29%.

Recruitment

The goals of the recruitment procedure were to obtain a sample that represents the target population and meet the sample size requirement of the study. The sample recruited for this dissertation was independent from that used in the validity study. Children were recruited from the Orthodontic Clinic, Faculty of Dentistry, University of Toronto. Data were collected as part of the usual screening procedure implemented to assign patients for treatment. Eligible subjects were asked to participate in the study at the assessment visit, after being triaged to the graduate orthodontic clinic. Subjects were assured that their participation would not influence the outcome of their treatment/assessment. Recruitment was terminated when the target sample size was reached. Two dentally-trained research assistants, who were not involved in the treatment, approached all subjects using a standardized approach. All measurements were standardized.

Data Collection Procedure

All subjects completed the questionnaire unassisted by parents or researchers, following explanation of the study purposes and questionnaire format, and obtainment of parental consents and children assents (Appendix B). Tracking information including mailing address and telephone numbers were recorded. Study casts were prepared using alginate impressions and wax bite registrations. These casts were used to assess clinical changes using the DAI and PAR indices at T1 and T2 time-points. The need for T2 PAR and DAI assessment of control subjects was re-assessed after obtaining data from the first
15 cases. Since the scores in the wait-list group did not change, there was no need for further occlusal assessment of control subjects.

Comprehensive orthodontic treatment of all treatment subjects was undertaken by instructor-supervised graduate students. T2 Time point represents the assessment of subjects two months after the completion of treatment for the treatment subjects, or after an equivalent duration for control subjects. A yoked control design was employed to ensure the comparability of follow-up duration. This design was first described by Church in the early 60’s (308). It simply indicates that each time follow-up data are collected from a treatment subject, a follow-up questionnaire is sent to a control subject. This should approximate the overall T1-T2 time interval for treatment and control groups.

Since implementing repeat mailing strategies and/or telephone reminders may improve response to postal questionnaires in health care research (309), a systematic series of repeated contact attempts was implemented to minimize loss of control subjects and incomplete follow-ups (310). First follow-up questionnaires were sent with a pre-paid envelope and a hand-signed personalized letter (Appendix B-4). A reminder letter and a second questionnaire were sent to non-respondents after 2 weeks. Non-responders were then telephoned two weeks later. Data collection was terminated and a complete database was compiled for data analysis in December of 2008.

T2 data included the same measures administered at T1. In addition to the two global questions assessing satisfaction with dental aesthetics and function administered at T1, four global transition ratings were included in the CPQ11-14 follow-up questionnaires. These rated changes in the child's perception of oral health status, related
overall wellbeing, the way their teeth look, and the way their teeth come together, on a seven-point scale ("Worsened a lot"; "Worsened somewhat"; "Worsened a little"; "Stayed the same"; "Improved a little"; "Improved somewhat"; "Improved a lot compared to the first time they filled the questionnaire") (Appendices D and E). The repeated administration of the questionnaires to both groups allowed direct comparison between scores at baseline and follow-up.

**Quality Control and Data Management**

An electronic operational folder was developed to document recruitment, measurement procedures, variables definition, database creation, data management, analysis, and missing data. Data-entry control checks to identify and correct errors were scheduled. A list of eligible, approached, accepted, rejected, and completed subjects was created. Reasons for rejections to participate or loss at follow-up were recorded (Appendix A). Any changes in original data were documented. Finally, regular back up and creation of separate data sets for analysis, archiving, and storing original data were implemented.

**Budget**

The Community Dental Health Services Research Unit funded this study. An estimated sample size of 100 in each group was used to calculate costs. Each study model cost CDN$25 per control subject. Printing and mailing follow-up questionnaires cost approximately CDN$500. PAR ratings cost approximately CDN$2000. Therefore, the total budget needed was approximately CDN$5000.
Analytic Approach

Data analysis was carried out using SPSS (Statistical Package for Social Sciences) version 12. Statistical analysis is detailed in each of the papers presented in Chapter 7 of this dissertation.

Measures

Subjects’ OH-QOL was assessed using the CPQ11-14 while their SE and PWB was assessed using the CHQ-CF87. The DAI was used to determine the severity of malocclusion and the PAR was used to evaluate normative outcomes of orthodontic treatment. The following measures represent the major variables of the study. Each will be discussed with respect to scale description, validity and reliability, and strengths and weaknesses.

- Self-reported measures
  - The Child Perception Questionnaire (CPQ11-14)
  - The Child Health Questionnaire (CHQ-CF87)

- Normative measures
  - The Dental Aesthetic Index (DAI)
  - The Richmond Peer Assessment Rating (PAR)

The Child Perceptions Questionnaire (CPQ11-14)

Description of the scale. This study uses the CPQ11-14 as a measure of OH-QOL (Appendix C) (118). The measure was described in depth in Chapter 3 of this dissertation.
**Validity and Reliability.** The instrument has been tested and validated in clinical populations similar to that of the current investigation (Table 3). Thus, the psychometric properties of the CPQ11-14 have been well established.

**Strengths and Weaknesses.** The CPQ11-14 is the first standardized self-report child OH-QOL measure that accounts for developmental differences (118). Its longitudinal psychometric properties have been recently evaluated and found to be acceptable in the context of orthodontic treatment (151,156).

**The Child Health Questionnaire (CHQ-CF87)**

**Description of the scale.** The CHQ-CF87 is a generic pediatric H-QOL instrument (96) that was developed according to the 1946 WHO multidimensional definition of health (28). This self-report child-format questionnaire consists of 87 items designed to tap into the physical and psychosocial experiences of children aged 11- to 17-years. As noted earlier, only two of the CHQ-CF87 subscales were used in this study: the SE (14 items) and the PWB (16 items) subscales. This helped reduce the child response-burden while still measuring psychological attributes relevant to the scope of this study.

The SE subscale of the CHQ-CF87 (Appendix F) recognizes that SE is an important multidimensional concept that emerges during pre-adolescent development and continues to be shaped and redefined through adulthood (311). Child and parents interviews were used to develop the SE scale of the CHQ-CF87. The CHQ-CF87 includes items assessing satisfaction with school and athletic ability, looks or appearance, ability to get along with others and family, and life overall. Thus, the following components of SE are assessed: social confidence, school abilities, and self regard (247). Responses were measured along a five-level response continuum that ranges from "very
satisfied" to "very unsatisfied". Low SE score indicates significant dissatisfaction with abilities, looks, family/peer relationships and life overall.

The PWB scale (Appendix G) originated from a scale developed by Dupuy (312). It measures the frequency of both negative and positive experiences. There are items to capture anxiety, depression and happiness. Frequency was captured using a five-level continuum that ranges from "all of the time" to "none of the time".

**Validity and Reliability.** The CHQ-CF87 has undergone extensive psychometric evaluation and been shown to be a reliable and valid measure in healthy schoolchildren. The CHQ-CF87 has demonstrated good test-retest reliability and internal consistency. (96,313-320).

**Strengths and Weaknesses.** The majority of child and adolescent SE and PWB measures that were available prior to the CHQ-CF87 lacked sufficient evidence concerning their validity and interpretation of scores relative to a normative sample, or required the use of a trained interviewer (321,322). The CHQ-CF87 addresses these caveats. It is appropriate for use as a self-completion measure for children aged 11 years upwards. Several reviews recommend the use of the CHQ-CF87 to assess children’s H-QOL (323-326). The length of the instrument, however, limits its application. Therefore, we decided to administer only the two sub-scales that are relevant to the context of the present study; SE and PWB.

**The Dental Aesthetic Index (DAI)**

**Description of the index.** The DAI indicates the severity of malocclusion by fitting a score on a continuum of dental aesthetics on the social acceptability scale of occlusal conditions. Hence, the DAI can serve as an orthodontic treatment need index,
because it can indicate, for any set of occlusal measurements, the amount of deviation from social norms for aesthetic dental appearance (13).

A DAI score is produced using a number of objective physical measurements of occlusal traits associated with dental aesthetics as perceived by the public. Ten simple intraoral measurements of occlusal traits are recorded and multiplied by a pre-determined weight. The products are summed and a constant is added. This calculation procedure identifies deviant occlusal traits and links clinical and aesthetic components mathematically to produce a single score (Appendix H). The sum obtained is the DAI score for the person being assessed. An example of the equation for a DAI score is as follows:

\[
\text{DAI score} = 6 \times (\text{missing visible teeth}) + 1 \times (\text{crowding}) + 1 \times (\text{spacing}) + 3 \times (\text{diastema}) + 1 \times (\text{largest upper anterior irregularity}) + 1 \times (\text{largest lower anterior irregularity}) + 2 \times (\text{anterior maxillary overjet}) + 4 \times (\text{anterior mandibular overjet}) + 4 \times (\text{vertical anterior openbite}) + 3 \times (\text{anterior-posterior molar relation}) + 13.
\]

The score can be placed on the social acceptability scale of occlusal conditions to determine the percentile score for that person on a dental aesthetic continuum from 0 (most socially acceptable) to 100 (least socially acceptable), thus establishing societal norms for dental aesthetics (Figure 4) (327). The social acceptability scale of occlusal conditions is based on lay populations’ aggregate judgments of the social acceptability of two different sample sets of 100 occlusal configurations. The DAI is the standard double cross-validated regression equation that links objective measurements of occlusal morphology with societal norms for socially acceptable dental appearance. The
theoretical concept underlying the DAI predicts that the more a person's dental appearance deviates from excellent, the more likely it is that the person will experience social handicaps, and therefore he/she needs orthodontic treatment (328).

**Figure 4:** Distribution of standard DAI scores and their cumulative percentages
(Reproduced from the DAI manual-1986: Page 11)

**Validity and Reliability:** Studies in the United States, as well as internationally, show the validity and reliability of the DAI for prospective orthodontic patients. DAI scores were significantly associated with student and parents' perceptions of orthodontic
treatment need (13,328) and were a good predictor of future fixed orthodontic treatment (185,329,330). Further, agreement between orthodontists' decisions and the DAI scores in a sample of 1337 dental models was approximately 90% (327).

**Strengths and Weaknesses.** The DAI was chosen for this study because it mathematically links the perceptions of aesthetics with anatomic trait measurements. Not only this obviates the need for two separate instruments that cannot be combined as in the Index of Complexity, Outcome, and Need (4) or the IOTN (329), but it also makes DAI scores the closest to correspond to consumers’ assessment of perceived orthodontic treatment need. Further, this index is relatively easy to use by trained dental auxiliaries (331). A DAI score can be obtained clinically or from a study model, without using radiographs. Therefore, it is not surprising that the DAI has been adopted by the WHO as a cross-cultural index. Nonetheless, like other occlusal indices, the DAI does not account for facial aesthetics.

**Richmond Peer Assessment Rating (PAR)**

**Description of the index.** The PAR was introduced by Richmond to objectively assess the professional outcomes of orthodontic treatment (332,333). It is a commonly used, reliable, and reproducible index that is well known on national and international levels. The index assigns a score to a particular malocclusion trait and multiplies this score by a weighting. The weighting factors were established by a British panel of 74 dentists (332,333). The sum of scores represents the extent of departure from ideal occlusion. The index takes into account maxillary and mandibular anterior crowding or spacing, buccal segment relationships (anterio-posterior, transverse, and vertical direction), overjet, anterior crossbites, overbite, and midline deviations (Appendix I). The
ways with which the PAR index could be used to determine treatment effectiveness are twofold: a reduction in the overall PAR score and percentage reduction in the PAR score. Comparing treatment results, the PAR index would categorize the change as either "Worse- No different", "Improved," or "Greatly improved". Richmond suggested that a "high standard orthodontic treatment" should indicate an overall reduction of at least 70% in the PAR score (332-334).

Validity and Reliability. The PAR has been extensively used to assess effects of treatment (335-337). It has consistently demonstrated excellent reliability and superb agreements with orthodontists’ opinions of treatment outcomes (338-341).

Strengths and Weaknesses. Although the PAR offers uniformity and standardization in assessing the objective outcomes of orthodontic treatment, it does not consider the aesthetic value directly. Dental aesthetics is assessed only by considering anterior alignment (340). Therefore, the PAR has several shortcomings. For example, no account is taken of features such as facial profile, occlusal function, or iatrogenic damage resulting from treatment. Its assessment is relatively crude and does not consider tooth inclination, angulations, posterior arch alignment, or arch width (339). Moreover, it can be very difficult to use in mixed dentition cases (342). Most importantly, PAR scores represent only one aspect of orthodontic treatment outcome as it does not include the patient’s perspective (343).
CHAPTER 7: RESULTS

The results from this study are presented in four manuscripts that comprise this chapter. Each of these manuscripts addresses one objective of the dissertation.

Manuscript I, “Is the child OH-QOL questionnaire sensitive to change in the context of orthodontic treatment?”, describes the longitudinal psychometric properties of the CPQ11-14. This manuscript has been published in the *Journal of Public Health Dentistry* 2008 Fall; 68(4):246-8.


Manuscript III, “Does orthodontic treatment improve children’s oral health-related quality of life?”, presents the longitudinal comparison of OH-QOL reports in children who received orthodontic treatment and children who did not. It has been submitted to *Community Dentistry and Oral Epidemiology*, and is currently under revision.

Manuscript IV, “Does psychological wellbeing influence oral health-related quality of life in children receiving orthodontic treatment?”, addresses the role of psychological factors in moderating children’s response to OH-QOL questionnaires. It also examines the analytic implications of such results. It has been accepted for publication in the *American Journal of Orthodontics and Dentofacial Orthopedics*. As indicated earlier, only one psychological factor was reported on each phase of the study (SE at baseline and PWB at follow-up) because of the high correlation between the two constructs ($r=0.63; p<0.001$).
Manuscript I: Is the Child Oral Health Quality of Life Questionnaire Sensitive to Change in the Context of Orthodontic Treatment? A Brief Communication
Is the Child Oral Health Quality of Life Questionnaire Sensitive to Change in the Context of Orthodontic Treatment? A Brief Communication

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Abstract

Objective: This study aimed to assess the ability of the Child Oral Health Quality of Life Questionnaire (COHQoL) to detect change following provision of orthodontic treatment. Methods: Children were recruited from an orthodontic clinic just prior to starting orthodontic treatment. They completed a copy of the Child Perception Questionnaire, while their parents completed a copy of the Parents Perception Questionnaire and the Family Impact Scale. Normative outcomes were assessed using the Dental Aesthetic Index (DAI) and the Peer Assessment Rating (PAR) index. Change scores and effect sizes were calculated for all scales. Results: Complete data were collected for 45 children and 26 parents. The mean age was 12.6 years (standard deviation = 1.4). There were significant pre-/posttreatment changes in DAI and PAR scores and significant changes in scores on all three questionnaires (P < 0.05). Effect sizes for the latter were moderate. Global transition judgments also confirmed pre-/posttreatment improvements in oral health and well-being. Conclusion: The results provide preliminary evidence of the sensitivity to change of the COHQoL questionnaires when used with children receiving orthodontic treatment. However, the study needs to be repeated in different treatment settings and with a larger sample size in order to confirm the utility of the measure.

Key Words: children, malocclusion, oral-related quality of life, validity, responsiveness

Introduction

The process of developing and evaluating oral health-related quality of life measures involves an ongoing assessment of the performance of the measure in different populations and various contexts. This is particularly important with respect to generic measures which were developed to be used as outcome indicators in surveys and clinical trials. The Child Oral Health Quality of Life Questionnaire (COHQoL) is a generic instrument designed to assess the adverse impacts of oral conditions on children aged 11-14 years (1-3). It consists of questionnaires for children [Child Perception Questionnaire (CPQ11-14)] and parents [Parents Perception Questionnaire (PPQ)], and a Family Impact Scale (FIS) also completed by parents. The cross-sectional construct validity and test–retest reliability of the questionnaires have been established (4). The sensitivity of the CPQ11-14 to variations in orthodontic status has also been demonstrated (5). However, a key property of any measure used to evaluate a therapeutic intervention is sensitivity to change. To date, no studies have assessed the utility of the COHQoL as an evaluative measure.

Consequently, we undertook a study of 11- to 14-year-old children with malocclusions who received orthodontic therapy to determine if the CPQ11-14, PPQ, and FIS were able to detect pre-/posttreatment changes in the oral health quality of life of these children. In assessing sensitivity to change, there are three issues that need to be considered, namely responsiveness, longitudinal construct validity, and the minimal important difference (4,5).

Methods

Study Design. This study utilized a single group before-and-after design to assess changes in oral health-related quality of life following orthodontic treatment.

Study Subjects. Participants were 11- to 14-year-old children with clinically identified malocclusions as defined by the Dental Aesthetic Index (DAI) (6) and the Peer Assessment Rating (PAR) (7). The children were consecutively recruited during their first orthodontic screening visit at the Faculty of Dentistry, University of Toronto. To be eligible, a child had to be fluent in English and be in good general health. Children with severe dento-facial deformities were excluded. Parents’ consent and children’s assent were obtained, and the University Research Ethics Board approved all study procedures. Comprehensive orthodontic treatment of an average duration of 28 months was provided to all subjects. Follow-up data were collected at the first recall appointment after treatment was completed. If the parent/caregiver failed to attend the recall appointment, the questionnaire was mailed to their home address with a self-addressed envelope. A second copy was mailed if the follow-up questionnaire had not been returned within 1 month.
Data Collection. Data were obtained using the CPQ11-14 (1), PPQ (2), and FIS (2). The following subscale scores were created for the CPQ11-14 and PPQ by summing the responses to items organized into conceptually distinct subscales: oral symptoms (OSs), functional limitations (FLs), emotional well-being (EWB), and social well-being (SWB). Included in the follow-up CPQ11-14 and PPQ questionnaires were single-item global transition ratings pertaining to change in subjects’ perception of dental appearance and occlusion, oral health, and overall well-being as a result of orthodontic treatment. These were scored on a 7-point scale ranging from “improved a lot” to “worsened a lot.”

Pre- and posttreatment study models were taken to assess the child’s occlusion using the DAI and PAR. The ratings were undertaken by three calibrated examiners. Intra-examiner reliability for the DAI raters was high with intraclass correlation coefficients (ICCs) of 0.98, 0.91, and 0.98, respectively. The ICC for inter-examiner reliability was 0.80. For the PAR raters, ICCs for intra-examiner reliability were all 0.99 and for inter-examiner reliability the ICC was 0.95.

Data Analysis. Change scores for the overall CPQ11-14, PPQ, and FIS were computed by subtracting post-treatment scores from pretreatment scores. Paired t-tests were used to test the statistical significance of the changes. Change scores were also calculated for the DAI and PAR and evaluated using paired t-tests. The P value for all tests was set at \( P < 0.05 \). The responsiveness of the questionnaire and clinical measures was determined by the calculation of effect sizes. Effect size (\( d \)) statistics were calculated by dividing the mean of the change scores by the standard deviation (SD) of the pretreatment scores, in order to give a dimensionless measure of the effect. Effect size statistics of <0.2 indicate a small clinically meaningful magnitude of change, 0.2-0.7 a moderate change, and >0.7 a large change (8). Assessment of longitudinal construct validity and calculation of the minimal important differences were limited by a lack of variation in responses to the global transition ratings.

Results

Sample Characteristics. Complete baseline and follow-up data were available for 45 children and 26 parents. The mean age of those children was 12.6 years (SD = 1.4) and almost 60 percent were girls.

The mean DAI and PAR scores at baseline and follow-up are presented in Table 1. As expected, significant declines were observed with effect sizes exceeding 2.0 (\( P < 0.001 \)). Data on the pre-orthodontic intervention and post-orthodontic intervention COHQoL scores with effect sizes are also presented in Table 1. With the exception of the FL and SWB subscales of the PPQ, all scales and subscales demonstrated significant reductions following orthodontic treatment (\( P < 0.05 \)). This reduction was associated with effect sizes reflecting moderate changes. By subscale, the largest change score was observed for the EWB subscale of the CPQ11-14, and the OS subscale of the P-CPQ.

Table 2 shows the distribution of responses to the global transition items for children and parents. For all items, the majority reported that they improved a lot or improved somewhat. Longitudinal construct validity is indicated if those reporting improvement on the global transition ratings have positive change scores, those reporting deterioration have negative change scores, and those who report no change have scores close to zero. The skewed distribution and small cell sizes precluded such assessment. Similarly, the method recommended by Juniper et al. (9) for calculating minimal important differences could not be employed. However, those children who reported that their overall well-being had improved somewhat had mean CPQ change scores of 6.6, and those who reported improving a little had mean change scores of 5.0. Although based on small numbers of subjects, these provide a preliminary estimate of the minimal important difference for the CPQ11-14.

Table 1: Comparison of the Child Oral Health Quality of Life Questionnaire (COHQoL) Overall, Domain Scores, and Clinical Measures Before and After Orthodontic Treatment

<table>
<thead>
<tr>
<th>COHQoL scores: pre-/posttreatment</th>
<th>Pretreatment</th>
<th>Posttreatment</th>
<th>P value*</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPQ11-14</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oral symptoms</td>
<td>12.0</td>
<td>10.3</td>
<td>&lt;0.001</td>
<td>0.55</td>
</tr>
<tr>
<td>Functional limitation</td>
<td>14.8</td>
<td>13.1</td>
<td>&lt;0.05</td>
<td>0.45</td>
</tr>
<tr>
<td>Emotional well-being</td>
<td>15.0</td>
<td>11.4</td>
<td>&lt;0.001</td>
<td>0.60</td>
</tr>
<tr>
<td>Social well-being</td>
<td>18.9</td>
<td>16.0</td>
<td>&lt;0.01</td>
<td>0.44</td>
</tr>
<tr>
<td>PPQ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oral symptoms</td>
<td>12.2</td>
<td>9.9</td>
<td>&lt;0.01</td>
<td>0.56</td>
</tr>
<tr>
<td>Functional limitation</td>
<td>11.5</td>
<td>11.7</td>
<td>NS</td>
<td>–</td>
</tr>
<tr>
<td>Emotional well-being</td>
<td>14.2</td>
<td>10.3</td>
<td>&lt;0.01</td>
<td>0.51</td>
</tr>
<tr>
<td>Social well-being</td>
<td>15.9</td>
<td>14.5</td>
<td>NS</td>
<td>0.20</td>
</tr>
<tr>
<td>Family Impact Scale</td>
<td>20.7</td>
<td>17.6</td>
<td>&lt;0.01</td>
<td>0.42</td>
</tr>
<tr>
<td>Clinical measures: pre-/posttreatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAI</td>
<td>36.6</td>
<td>18.2</td>
<td>&lt;0.001</td>
<td>2.1</td>
</tr>
<tr>
<td>PAR</td>
<td>30.4</td>
<td>4.2</td>
<td>&lt;0.001</td>
<td>2.2</td>
</tr>
</tbody>
</table>

* Paired t-test.
Sample sizes: child \( n = 45 \); parents \( n = 26 \).
Effect sizes: pretreatment score–posttreatment score/standard deviation of baseline score.
CPQ11-14, Child Perception Questionnaire; PPQ, Parents Perception Questionnaire; DAI, Dental Aesthetic Index; PAR, Peer Assessment Rating; NS, not significant.
Table 2
**Distribution of Children and Parents’ Responses (%) to Global Questions About the Extent to Which Appearance, Occlusion, Oral Health, and Life Overall Were Affected by Orthodontic Treatment**

<table>
<thead>
<tr>
<th>Global transition ratings</th>
<th>Appearance</th>
<th>Occlusion</th>
<th>Oral health</th>
<th>Life effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved a lot</td>
<td>86.7</td>
<td>97.2</td>
<td>86.7</td>
<td>88.9</td>
</tr>
<tr>
<td>Improved somewhat</td>
<td>5.6</td>
<td>0</td>
<td>11.1</td>
<td>11.1</td>
</tr>
<tr>
<td>Improved a little</td>
<td>2.8</td>
<td>2.8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Stayed the same</td>
<td>0</td>
<td>0</td>
<td>2.2</td>
<td>0</td>
</tr>
<tr>
<td>Worsened a little</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Worsened somewhat</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Worsened a lot</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Discussion**

This study aimed to document changes in the oral health-related quality of life of children having orthodontic treatment, and, in doing so, to examine the evaluative properties of the COHQoL questionnaires. The provision of orthodontic treatment was associated with substantial and statistically significant improvements in scores on the CPQ11-14, PPQ, and FIS (Table 1). Hence, the COHQoL was found to be sensitive to change in the context of orthodontic treatment for children with malocclusion.

Responsiveness and longitudinal construct validity are important characteristics of oral health-related quality of life instruments which are to be used as evaluative measures. Effect sizes were used in this study to compare the relative responsiveness to change resulting from orthodontic interventions using both subjective and clinical measures. The data in Table 1 provide evidence that responsiveness was acceptable for all three scales of the COHQoL with moderate effect sizes observed. These effect sizes were comparable to those reported for other widely used instruments such as the OHIP-14 (10). The changes in COHQoL scores were paralleled by substantial decreases in the scores on the two normative indices employed. Some minor concerns remain because of the clustered distribution of responses to the global transition ratings, shown in Table 2. This precluded assessment of longitudinal construct validity and the proper calculation of the minimal important difference. However, the fact that the majority of children reported considerable improvement as a result of treatment supports the validity of the measure as an indicator of change.

Ideally, this study should have included a comparison group which did not receive treatment. This would have allowed comparison of changes in scores over time between a treated group and one who had not received treatment. However, our objective was not to evaluate the benefit to be derived from orthodontic treatment; rather, it was to assess the sensitivity to change of a measure. A study is underway to compare change scores of a treated and an untreated group of children with malocclusions which can address the issue of treatment efficacy. Its larger sample size will also allow the sensitivity to change of the COHQoL to be explored more fully. Nevertheless, the results reported here suggest that the COHQoL is a suitable measure to use when the aim is to assess changes in child oral health-related quality of life. The effect sizes we report and the preliminary estimate of the minimal important difference can also provide the basis for sample size calculations for treatment efficacy studies.

The children in this study are among those with the worst malocclusions in their age group. This means that the sensitivity of the instruments to more subtle differences and changes in child oral health requires further investigation. Future work with the COHQoL measures should determine whether there are differences in quality of life outcomes associated with different orthodontic intervention strategies such as multiple extractions versus functional appliance therapy.

**References**

Manuscript II: Impact of Self-Esteem on the Oral Health-related Quality of Life of Children with Malocclusion
Impact of self-esteem on the oral-health-related quality of life of children with malocclusion

Shoroog Agou,^a^ David Locker,^b^ David L. Streiner,^c^ and Bryan Tompson^d^ 

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Introduction: The purpose of this study was to examine the relationship between self-esteem and oral-health-related quality of life (OHRQoL) in a sample of children seeking orthodontic treatment in Toronto, Ontario, Canada.

Methods: This was a cross-sectional study of children aged 11 to 14 years, evaluating the associations among the child perception questionnaire (CPQ11-14), the self-esteem subscale of the child health questionnaire, and the dental aesthetic index (DAI).

Results: The CPQ11-14 scores were significantly related to the self-esteem scores and the DAI ratings. Regression analysis showed that self-esteem contributed significantly to the variance in CPQ11-14 scores. However, the amount of variance explained by normative measures of malocclusion was relatively small.

Conclusions: The impact of malocclusion on quality of life is substantial in children with low self-esteem. Compared with normative measures of malocclusion, self-esteem is a more salient determinant of OHRQoL in children seeking orthodontic treatment. Longitudinal data will be of value to confirm this finding. (Am J Orthod Dentofacial Orthop 2008; 134:484-9)

The child perception questionnaire (CPQ11-14) is a generic oral-health-related quality of life (OHRQoL) instrument designed to assess the adverse impacts of oral conditions in children aged 11 to 14 years. The CPQ11-14 is becoming an increasingly popular tool in orthodontic outcome research, because of its demonstrable psychometric properties. However, when its performance was assessed against clinical indicators, modest associations were often observed.

The inconsistencies between clinical indicators and reported OHRQoL agree with anecdotal clinical experience. Some children have remarkable levels of concern for the most minor anomalies, and, paradoxically, others are tolerant of severe occlusal problems. More adolescents with good occlusion who feel dissatisfied with their teeth have been reported. Moreover, patients’ concerns regarding orthodontic treatment do not always agree with professional evaluations. Accordingly, it is reasonable to assume that the relationship between reported OHRQoL and malocclusion is most likely mediated by other factors. Studies in the medical literature have stressed the importance of innate psychological attributes, such as self-esteem (SE), in predicting the effect of health conditions on the quality of life. Spilker advocated controlling for psychological parameters whenever quality of life is used as a primary outcome. Few studies have examined parallel associations in children seeking orthodontic treatment. In a study of Brazilian schoolchildren, those with low SE were found to be more sensitive to the esthetic effects of malocclusion. Similarly, a study of potential orthodontic patients in Nigeria found that children with high SE most frequently did not express orthodontic concerns.

Although many cross-sectional studies reported significant associations between malocclusion and SE in adolescents, longitudinal evaluations often failed to document a clear-cut cause-and-effect relationship. The findings of these studies should shed light on the way we view SE as an end point outcome in orthodontic psychosocial research. It also supports the argument of the role of SE as an effect modifier. This hypothesis agrees with empirical psychological evidence that denotes the stability of the SE construct as a personal resource that might moderate the effects of conditions or events. Self-concept is broad ranging and relates to personal self-concept (facts or one’s own opinions about oneself), social self-concept (one’s perceptions about how one is regarded by others), and self-ideals (what or how one would like to be). With this definition, it is unlikely that impaired perception of orofacial appearance as a result of malocclusion would translate to
diminished SE. The relationship between normative measures of malocclusion, SE, and OHRQoL should be clarified if we are to meaningfully interpret the results of clinical investigations using OHRQoL outcomes.

Therefore, we examined the role of SE as a mediator influencing OHRQoL outcomes in children seeking orthodontic treatment. We hypothesized that children with high SE would have better OHRQoL than those with low SE.

MATERIAL AND METHODS

Participants in the study were children aged 11 to 14 years, attending orthodontic clinics at the Faculty of Dentistry, University of Toronto, in Canada. Most children were motivated by their parents to seek orthodontic consultation. A convenient consecutive sampling approach was used. The children were recruited at their first visit for orthodontic screening. The parents signed a consent form, and all children agreed to participate. To be eligible, the child had to be fluent in English and in good general health. Children with severe dentofacial deformities were excluded. The University Research Ethics Board approved all study procedures.

All children completed the CPQ11-14 and the SE subscale of the child health questionnaire (CHQ-CF87) before treatment. The questionnaires were completed by the children unassisted by parents or investigators. The dental aesthetic index (DAI) was used to determine the clinical need for orthodontic treatment. Age, sex, and ethnic background were recorded because of their potential associations with both outcome and explanatory variables. Socioeconomic status, however, was not assessed because it was previously shown to have no bearing on CPQ11-14 scores when examined in similar groups.

The CPQ 11-14 is a child OHRQoL instrument. The age-specific questionnaire (11-14 years) consists of 37 items, grouped into 4 domains: oral symptoms (OS), functional limitations (FL), emotional well-being (EW), and social well-being (SW). Each item asked about the frequency of events, as applied to the teeth, lips, and jaws, in the last 3 months. The response options were “never, once or twice, sometimes, often,” and “every day or almost every day.” Although the instrument is designed to yield an overall score, a separate score can be generated for each of the 4 subscales. Higher scores signify worse OHRQoL. The validity and reliability of this questionnaire have been established in clinical and general population samples.

The children’s SE was measured by using the SE subdomain of the CHQ-CF87, a widely used and validated self-report instrument. The following dimensions of SE are captured in the 14-item measure developed by Landgraf and Abetz: satisfaction with school and athletic ability, looks or appearance, ability to get along with others and family, and perception of life overall. Responses are given on a 5-point Likert scale (very satisfied to very unsatisfied). Low SE scores indicate significant dissatisfaction with abilities, looks, family and peer relationships, and life overall. Specific instructions confirming the generic nature of the measure were added at the beginning of the questionnaire.

The severity of each child’s orthodontic condition was assessed by using study models taken at the initial visit with a widely used orthodontic index, the DAI, which measures the social acceptability of a child’s dental appearance. The rating is based on the measurement of 10 occlusal traits; each trait is multiplied by a weight. The products are summed, and a constant is added to give the DAI score; scores range from 13 (most acceptable) to 100 (least acceptable) and can be collapsed into 4 malocclusion severity levels: 13 to 25, minor or none; 26 to 31, definite; 32 to 35, severe; and 36 and over, handicapping.

The DAI ratings were recorded by 3 trained and calibrated examiners. To assess intra- and interexaminer reliability, the raters independently assessed a random 10% sample of the models and then reassessed the models 1 week later. Intraexaminer reliability for the DAI raters was almost perfect with intraclass correlation coefficients of 0.96, 0.91, and 0.97, respectively, and the interexaminer reliability was high at 0.81.

Statistical analysis

The data were analyzed by using SPSS software (version 12, SPSS, Chicago, Ill). Additive scale and subscale scores for the CPQ11-14 and the CHQ-CF87 were calculated by summing the item response codes. Data analyses included descriptive statistics, bivariate analyses, and multiple regression models.

RESULTS

One hundred ninety-nine children (102 girls, 97 boys) entered the study. Their mean age was 12.7 years (SD, 1.1). Seventy-six percent of the subjects were white. The sample distribution of DAI categories was minor malocclusion (8.4%), definite malocclusion (27.2%), severe malocclusion (20.4%), and handicapping malocclusion (44%). The truncated distribution can be expected in such a sample of children seeking orthodontic treatment at a teaching institution. SE scores ranged
from 50 to 100 with a mean score of 84 (SD = 13.4). The sample mean SE score was not significantly different from that of reported norms for normal schoolchildren (mean, 81.8; SD, 15.8). DAI scores, total, and individual subscale CPQ11-14 scores for high and low SE children are summarized in Table I. Low SE children had significantly higher total CPQ11-14, OS, FL, EW, and SW domain scores than high SE children even though they had similar malocclusions (DAI scores).

The Pearson correlation between the overall CPQ11-14 and SE scores was significant ($r = -0.43, P < 0.01$), indicating moderate negative association between the 2 scales. Similar associations were observed between SE and all 4 CPQ11-14 subscales for the overall sample and for the sample divided according to malocclusion severity (Table II): OS ($r = -0.27, P < 0.01$); FL ($r = -0.32, P < 0.01$); EW ($r = -0.42, P < 0.01$), and SW ($r = -0.38, P < 0.01$). A significant, but weak, correlation was noted between the overall CPQ11-14 scores and DAI scores ($r = 0.16, P < 0.05$). When the association was examined according to the SE categories, children with low SE had no correlation for DAI scores and CPQ11-14 scores (Table III).

Hierarchical multiple regression models were used to explore the relationship between SE and CPQ11-14 and its subscale scores. Two key issues were addressed: the total amount of variance explained, and the independent and separate variance contributions of the clinical condition (DAI scores) and psychological factors (SE).

After controlling for age, sex, and ethnicity, the 2 main effects (SE and DAI) were entered into the regression equation and tested for overall significance.

### Table I. Summary statistics for the study variables

<table>
<thead>
<tr>
<th>DAI Category</th>
<th>OS Domain</th>
<th>FL Domain</th>
<th>EW Domain</th>
<th>SW Domain</th>
<th>Total CPQ11-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low SE children (N = 71)</td>
<td>6.6 (2.9)</td>
<td>6.9 (5.3)</td>
<td>7.7 (5.8)</td>
<td>7.1 (6.4)</td>
<td>28.4 (16.3)</td>
</tr>
<tr>
<td>High SE children (N = 128)</td>
<td>5.2 (3.2)*</td>
<td>4.8 (4.1)*</td>
<td>4.7 (4.9)*</td>
<td>4.3 (4.8)*</td>
<td>19.4 (13.2)*</td>
</tr>
</tbody>
</table>

*Correlation significant at $P < 0.05$.
†Correlation significant at $P < 0.01$.
‡SE classification, using norms reported by Landgraf and Abetz.

### Table II. Pearson correlation coefficient between reported total and subscale OHRQoL (CPQ11-14) scores and SE according to malocclusion category

<table>
<thead>
<tr>
<th>DAI Category</th>
<th>OS Domain</th>
<th>FL Domain</th>
<th>EW Domain</th>
<th>SW Domain</th>
<th>Total CPQ11-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor N = 16</td>
<td>$-0.13$</td>
<td>$-0.49$</td>
<td>$-0.42$</td>
<td>$-0.33$</td>
<td>$-0.54^*$</td>
</tr>
<tr>
<td>Definite N = 52</td>
<td>$-0.15$</td>
<td>$-0.36^*$</td>
<td>$-0.55^*$</td>
<td>$-0.37^*$</td>
<td>$-0.45^*$</td>
</tr>
<tr>
<td>Severe N = 39</td>
<td>$-0.19$</td>
<td>$-0.24$</td>
<td>$-0.41^*$</td>
<td>$-0.39^*$</td>
<td>$-0.39^*$</td>
</tr>
<tr>
<td>Handicapping N = 84</td>
<td>$-0.25^*$</td>
<td>$-0.25^*$</td>
<td>$-0.23^*$</td>
<td>$-0.24^*$</td>
<td>$-0.31^*$</td>
</tr>
<tr>
<td>Overall sample N = 191</td>
<td>$-0.27^*$</td>
<td>$-0.32^*$</td>
<td>$-0.42^*$</td>
<td>$-0.38^*$</td>
<td>$-0.43^*$</td>
</tr>
</tbody>
</table>

*Correlation significant at 0.05 level (2-tailed).
†Correlation significant at 0.01 level (2-tailed).
‡Malocclusion classification, using cutoff points from Estioko et al.

### Table III. Pearson correlation coefficients between reported total and subscale OHRQoL (CPQ11-14) scores and DAI according to SE category

<table>
<thead>
<tr>
<th>SE Category</th>
<th>OS Domain</th>
<th>FL Domain</th>
<th>EW Domain</th>
<th>SW Domain</th>
<th>Total CPQ11-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low SE children (N = 71)</td>
<td>0.05</td>
<td>0.04</td>
<td>0.04</td>
<td>$-0.03$</td>
<td>0.01</td>
</tr>
<tr>
<td>High SE children (N = 128)</td>
<td>$-0.08$</td>
<td>0.14</td>
<td>0.26†</td>
<td>0.28†</td>
<td>0.23*</td>
</tr>
<tr>
<td>Overall sample N = 191</td>
<td>$-0.02$</td>
<td>0.09</td>
<td>0.17*</td>
<td>0.19†</td>
<td>0.16*</td>
</tr>
</tbody>
</table>

*Correlation significant at 0.05 level (2-tailed).
†Correlation significant at 0.01 level (2-tailed).
‡SE classification, using norms reported by Landgraf and Abetz.
Table IV summarizes the results of the regression model and the total amount of variance, in overall and subscale CPQ11-14 scores, explained by introducing each variable.

Eighteen percent of the total variance in CPQ11-14 scores was explained by the combined model. The explanatory power was highest for the EW scale \(R^2 = 0.17\) and lowest for the OS subscale \(R^2 = 0.04\). As illustrated in the Figure, children with low SE consistently reported worse OHRQoL across the different DAI categories than children with high SE.

Fig 1. Error bars comparing CPQ11-14 scores between high and low SE children across the malocclusion categories.

Table IV

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Independent variable</th>
<th>Total adjusted (R^2)</th>
<th>(R^2) change</th>
<th>Standard beta</th>
<th>(t)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total CPQ11-14</td>
<td>Step 1: DAI</td>
<td>0.183</td>
<td>0.017</td>
<td>0.18</td>
<td>2.70</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>Step 2: SE</td>
<td>0.166</td>
<td>-0.041</td>
<td>0.01</td>
<td>-6.26</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>OS domain</td>
<td>Step 1: DAI</td>
<td>0.036</td>
<td>-0.013</td>
<td>0.00</td>
<td>0.01</td>
<td>0.99</td>
</tr>
<tr>
<td></td>
<td>Step 2: SE</td>
<td>0.049</td>
<td>-0.23</td>
<td>-3.27</td>
<td>&lt;0.01</td>
<td></td>
</tr>
<tr>
<td>FL domain</td>
<td>Step 1: DAI</td>
<td>0.106</td>
<td>0.010</td>
<td>0.10</td>
<td>1.45</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>Step 2: SE</td>
<td>0.096</td>
<td>-0.32</td>
<td>-4.57</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>EW domain</td>
<td>Step 1: DAI</td>
<td>0.166</td>
<td>0.015</td>
<td>0.21</td>
<td>3.11</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>Step 2: SE</td>
<td>0.141</td>
<td>-0.39</td>
<td>-5.90</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>SW domain</td>
<td>Step 1: DAI</td>
<td>0.144</td>
<td>0.036</td>
<td>0.19</td>
<td>2.81</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>Step 2: SE</td>
<td>0.108</td>
<td>-0.34</td>
<td>-4.96</td>
<td>&lt;0.001</td>
<td></td>
</tr>
</tbody>
</table>

**DISCUSSION**

These results support the postulated mediator role of SE when evaluating OHRQoL in children coming for orthodontic treatment. This indicates that the child’s psychological profile can influence the social and emotional impacts of malocclusion, because those with high SE are more likely to report better OHRQoL.

This sample of Canadian children seeking orthodontic treatment reported significantly more negative oral impacts (mean CPQ11-14, 22.8; SD, 15.2) than schoolchildren of comparable age in the United Kingdom\(^3\) and New Zealand.\(^3\) The reported psychosocial impacts are similar to those reported for Nigerian orthodontic patients, emphasizing the negative consequences of malocclusion.\(^37\)

The tenuous but significant association between DAI scores and patient-based measures concurs with earlier studies.\(^2\,3\,5\,6\,18\) Since the correlation coefficient was small, we cannot conclusively state that increased malocclusion severity produced a direct increase in CPQ11-14 scores. This was further confirmed by the minor independent contribution of DAI scores to the variance in CPQ11-14 scores. Interestingly, CPQ11-14 scores reported by children with low SE were not correlated with the normative severity of malocclusion (Table III). This seems to suggest that children with low SE report negative OHRQoL impacts that do not necessarily correspond to their orthodontic treatment needs. Obviously, there are many reasons that children seek orthodontic treatment, and these are not always related to the severity of malocclusion.\(^38\)

As hypothesized, high SE was associated with better OHRQoL. The moderately low correlation coefficient indicates that other factors might contribute to both constructs. The variance in CPQ11-14 scores in children coming for orthodontic treatment was explained by the child’s SE to a reasonable extent.\(^39\)

Not surprisingly, analysis of the CPQ11-14 domain correlations showed that SE and DAI mostly contribu-
uted to the child’s emotional and social well-being. This is logical when we consider that the most common reason for seeking orthodontic treatment is to correct dental esthetics.\textsuperscript{11,40,41} As previously demonstrated by many investigators, it is unlikely that oral symptoms (bleeding gums, pain in the teeth)\textsuperscript{42-44} and functional limitations (speech problems, difficulty in mouth opening, and eating) are greatly influenced by psychological factors or the normative severity of malocclusion.\textsuperscript{45,46}

The SE results support the findings of Marques et al,\textsuperscript{17} who identified low SE as a risk factor for worsening malocclusion esthetic effects, and Onyeaso,\textsuperscript{18} who found significant positive associations between SE and orthodontic concern. Our findings are also consistent with associations reported for different age groups.\textsuperscript{16,47} The effect of personality traits on perceived impacts of dental esthetics is similar to that reported by Klages et al.\textsuperscript{48}

This study had some limitations. The lack of temporality limited the confidence in establishing the direction of association in this study. Although SE was significantly associated with OHRQoL, the question remains whether SE improves OHRQoL, or vice versa. There are arguments for the association in either direction or both directions.\textsuperscript{49} The reported results represent only the baseline of an inception-controlled cohort study. All patients will be followed and assessed after orthodontic treatment to evaluate changes in OHRQoL and to ascertain the proposed hypothesis. Meanwhile, our belief that SE is a personal resource that facilitates coping with less favorable conditions such as poor dental esthetics is corroborated by many psychological studies including Harter’s popular article about SE.\textsuperscript{50}

This study also has implications for topical orthodontic decision-making research. The current consensus is that decisions should be based on individual psychosocial indications.\textsuperscript{51,52} The self-report CPQ11-14 is potentially a proxy measure to replace subjective clinical opinions for determining treatment timing especially for psychosocially compromised children. This is because the CPQ11-14 reflects the contribution of the child’s SE in ameliorating the clinical severity of malocclusion; this allows for prioritization of treatment needs according to child’s level of daily disruption. With this approach, dental services should correspond more closely to consumer-based health needs and focus more on improving the quality of life.

CONCLUSIONS

SE significantly impacted the relationship between malocclusion and well-being in children seeking orthodontic treatment. Longitudinal data will be of value to confirm this finding. Investigators should consider the need to control for baseline psychological attributes when assessing OHRQoL outcomes in orthodontics.

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Manuscript III: Does Orthodontic Treatment Improve Children’s Oral Health Related Quality of Life?
Does Orthodontic Treatment Improve Children’s Oral Health Related Quality of Life?

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Running head: CPQ11-14, orthodontics, and oral health related quality of life
Key words: CPQ11-14, orthodontics, oral-health related quality of life

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Agou S, Locker D, Streiner DL, Tompson B. Does Orthodontic Treatment Improve Children’s Oral Health Related Quality of Life?

Community Dentistry and Oral Epidemiology

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Based on a thesis submitted to the school of graduate studies, University of Toronto, in partial fulfillment of the requirements for the PhD degree. A preliminary report was presented at the International Association of Dental Research meeting in Toronto (2008).
OBJECTIVES: The main objective of this longitudinal clinical study is to establish Oral Health Related Quality Of Life (OH-QOL) gains following orthodontic treatment compared to a sample of untreated controls. The secondary objective is to confirm the longitudinal psychometric properties of the Child Perception Questionnaire (CPQ11-14).

METHODS: In this prospective clinical study, children receiving treatment were compared to wait-list controls awaiting treatment. The CPQ11-14 was administered at baseline and at follow-up. Global Transition Ratings (GTR) were used to assess satisfaction with dental appearance and function. Occlusal changes were measured using the Dental Aesthetic Index (DAI).

RESULTS: 118 eleven to 14-year-old children attending the orthodontic clinics at the University of Toronto participated in this study. Treatment subjects reported significantly better CPQ11-14 scores at follow-up ($p<0.05$) compared to untreated controls. At the sub-domain level, no changes were observed for the oral symptoms and functional limitations sub-domains. However, emotional and social wellbeing sub-domains changed significantly after providing orthodontic treatment. Analysis of responses to GTR showed that orthodontic treatment contributed significantly to increased satisfaction with dental appearance and function. CPQ11-14 change scores closely corresponded to children’s responses to GTR ($p<0.001$).

CONCLUSIONS: The results support the hypothesis that orthodontic treatment improves OH-QOL outcomes in children. Improvements were most evident for the social and emotional wellbeing sub-domains of CPQ11-14. Association between CPQ11-14 change scores and GTR helps in confirming the longitudinal psychometric properties of the
CPQ11-14 instrument. The findings are yet to be examined in view of important contextual factors moderating the relationship between orthodontics and OH-QOL.
Introduction

In 1946, the World Health Organization defined health as being not only the absence of disease but also the presence of physical, mental, and social well-being (1). Since then, the concept of oral health related quality-of-life (OH-QOL) has become increasingly more important in oral health practice and research. The field of orthodontics, however, has lagged behind. Only recently, a number of leading scientists in the field of orthodontic outcome research have emphasized that the measurement of OH-QOL outcomes is central to the development of oral health services (2-5).

With this new research direction, the use of OH-QOL measures as an outcome assessment tool in orthodontic research has increased exponentially. The number of studies listing “OH-QOL” as a key word in the orthodontic literature in the MEDLINE database has increased from only eight studies in the early nineties (1991-1996), to just less than 30 papers during the subsequent five years (1997-2002), to over 100 articles published in the last five years (2003-2008). These numbers clearly indicate that orthodontic researchers are moving away from the traditional clinician-centered model towards the modern patient-centered model of assessment. These new research movements are, in fact, both important and timely considering the significant debates regarding the long term psychosocial benefits of orthodontic treatment (6,7).

As would be expected, early studies examining the effect of conventional orthodontic treatment on OH-QOL reports were, for the most part, cross-sectional in nature. Most studies found associations between orthodontics and better OH-QOL or between increased treatment needs and worse OH-QOL (8-17). For instance, in a survey of Brazilian schoolchildren, adolescents who had completed orthodontic treatment had a
better OH-QOL than those currently under treatment or those who never had treatment (11). These findings were confirmed in a more recent case-control study of a similar population (17).

Although these findings highlight the positive impacts of orthodontic treatment, these studies are obviously limited by their design. According to the widely accepted guidelines of evidence-based dentistry, these studies merely indicate the presence of significant associations between better OH-QOL and orthodontic treatment. Hence, there is a clear need for a prospective longitudinal clinical study in order to establish a cause-and-effect relationship between OH-QOL and orthodontic treatment. This need for a rigorous assessment of treatment effects was certainly urged by many reviewers of the orthodontic literature (5,18-20).

Therefore, we decided to undertake this prospective longitudinal design study in order to assess the hypothesis that orthodontic treatment improves OH-QOL in children.

Since changes in children’s’ psychosocial awareness over time can make repeated measurements difficult to compare (21,22), we decided to compare children receiving treatment to those awaiting treatment. The inclusion of a control group in the present study was essential in order to interpret the findings and exclude any age-related effects in this dynamic group of growing children.

OH-QOL was assessed using the Child Perception Questionnaire (CPQ11-14). The CPQ11-14 is one of the most widely used OH-QOL measures in orthodontics. It is a valid and reliable OH-QOL instrument that was developed and tested for use in children aged 11 to 14 years, a common age for undergoing orthodontic treatment. Cunningham describes it as the questionnaire of choice in future orthodontic QOL research (2007)(23),
because of its established discriminative properties (24-28) and responsiveness to change in orthodontic status (29-31). Since evaluation of the psychometric properties of any instrument is an ongoing iterative process (32), we also used this opportunity to confirm the longitudinal psychometric properties of the CPQ11-14 in orthodontic settings.

There is no preferred method to assess change in children’s quality of life studies. This study used Global Transition Ratings (GTR) alongside changes in CPQ11-14 scores to assess changes in OH-QOL. GTR represent patients’ overall assessment of how their condition has changed over a specified timeframe. Although opposed by some (33), the use of GTR was advocated by OH-QOL researchers, because they are simple, integrate patients’ values and avoid the statistical issues associated with change scores (34).

To summarize, the objectives of this longitudinal clinical study are twofold, first, to establish OH-QOL gains following orthodontic treatment compared to a sample of untreated controls, and, second, to confirm the psychometric properties of the CPQ11-14 in an orthodontic sample.

**MATERIALS AND METHODS**

**Study Design**

This is a longitudinal two-group cohort study designed to assess changes in OH-QOL following orthodontic treatment. Participants receiving treatment were compared to patients awaiting treatment.

**Study Subjects**

Subjects were 11- to 14-year-old children with a definite clinical need for orthodontic treatment as assessed by the Dental Aesthetic Index (DAI) (35). Treatment subjects were
recruited from the graduate orthodontic clinic during their first diagnostic visit (T1). Control subjects were consecutively recruited during their first orthodontic screening visit prior to being placed on a wait-list (T1). All data were collected by the first author. To be eligible, the child had to be fluent in English and be in good general health. Children with severe dento-facial deformities, warranting surgical intervention, were not included in this study. Parents’ consents and children’s assents were obtained and the University Research Ethics Board approved all study procedures. Treatment was completed at the graduate orthodontic clinic as routinely prescribed using fixed appliance therapy. The treatment duration typically ranged from 24 to 28 months. Follow-up data were collected at the first retention check appointment after braces were removed (T2) for subjects receiving treatment. T2 data for control subjects were collected after a comparable time interval between T1 and T2 for treatment subjects. Questionnaires were mailed to their home address with a prepaid self-addressed envelope. A second copy was mailed if the follow-up questionnaire had not been returned within one month.

Procedure

All children independently completed a copy of the Child Perception Questionnaire (CPQ11-14) before starting orthodontic treatment. The DAI was used to determine the severity of malocclusion. Age and gender were recorded because of their potential association with outcome and explanatory variables.

Measures

*The Child Perception Questionnaire (CPQ 11-14)*
The CPQ 11-14 is an age-specific child OH-QOL instrument designed for use in 11- to 14-year-old children. It consists of 37 items, grouped into four domains: Oral Symptoms (OS), Functional Limitations (FL), Emotional Well-being (EWB), and Social Well-being (SWB). Responses can be summed to generate an overall score or a separate score for each of the four sub-domains.

The questionnaire included the two GTR of orthodontic treatment effects on oral health and on life overall (24). In addition, children also completed a short questionnaire designed to assess their satisfaction with their teeth compared to the first time they answered the questionnaire. The first two questions asked were: “How happy are you with the way your teeth look?” and “How happy are you with the way your teeth come together?” Response options were “Very happy”, “Happy”, “Unhappy”, and “Very Unhappy”. The other two questions assessed improvement in dental aesthetics and occlusion on a seven point Likert scale. They asked: ‘Do you think the way your teeth look has:’ and ‘Do you think the way your teeth come together has:’ Response options for these two questions were ‘improved a lot’, ‘improved somewhat’, ‘improved a little’, ‘stayed the same’, ‘worsened a little’, ‘worsened somewhat’, ‘worsened a lot’.

*The Dental Aesthetic Index (DAI)*

The severity of each child’s orthodontic condition was assessed using study models taken at the initial visit and following orthodontic treatment and recorded objectively with the DAI (35). DAI scores range from 13 (the most acceptable) to 100 (the least acceptable). The DAI ratings were recorded by three trained and calibrated examiners. DAI raters independently assessed a random 10% sample of the models and then reassessed the models after a one-week interval. The inter-examiner reliability was high with Intra-class
Correlation Coefficients (ICC) based on a two-way repeated measures ANOVA of 0.81. Intra-examiner reliability for the three raters was also high with ICC of 0.96, 0.91, and 0.97.

**Data analysis**

The data were analyzed using SPSS, Version 16 (SPSS, Chicago, IL, USA). Additive scale and sub-domain scores for the CPQ11-14 were calculated by summing the item response codes. Distributions of responses to GTR were individually summarized for each question.

Paired t-tests were used to test the statistical significance of within group changes over time. To assess the effect of providing orthodontic treatment on OH-QOL while controlling for baseline variations, we used an ANCOVA model, where treatment status (treatment vs. controls) was entered as a fixed factor and baseline scores were controlled for as covariates. The ANCOVA model was used to estimate the adjusted mean overall and sub-domain CPQ11-14 scores (Table 1).

In order to assess the longitudinal psychometric properties of CPQ11-14 to change, change scores were computed by subtracting post-treatment scores from pretreatment scores. Change scores were then compared against responses to GTR assessing improvement in oral health and life overall.

**Results**

Of the 199 children, (98 treatment subjects and 101 control subjects), who entered the study, 118 subjects were successfully followed-up. Follow-up data were obtained from 74 treatment subjects and 44 control subjects. Despite the persistent recall efforts, 35.6% of wait-list subjects sought orthodontic treatment elsewhere and 20.8% were lost to
follow-up. In addition, 24.5% of the treatment subjects were lost to follow-up. Nevertheless, the relatively high attrition rates did not influence the distribution of baseline characteristics between retained and original subjects, at least for the variables measured (Agou et al, in press).

At the outset of the study, 50.0% were girls with a mean age of 14.9 years. Initially, 92% of the subjects had significant malocclusion as measured by the DAI. DAI scores ranged from 17.0 to 74.8 with a mean of 35.46 (SD=8.63).

DAI scores of the treatment group were significantly reduced following orthodontic treatment to 22.49 (SD=2.86). On the other hand, DAI scores for the wait-list group remained unchanged indicating a persistent need for orthodontic treatment (33.56; SD=7.14).

The ANCOVA models indicated that there was a significant reduction in overall CPQ11-14, SWB, and EWB scores for treatment subjects, but not for wait-list controls ($p<0.05$). Conversely, the OS and FL scores remained unchanged for both groups over the course of this study. The estimated adjusted mean overall and sub-domain CPQ11-14 scores are summarized in Table 1.

Responses to GTR assessing satisfaction with dental aesthetics and occlusion at T1 and T2 for both study groups are graphically represented in Figures 1 and 2. Table 2 summarizes treatment and control children’s responses to global questions assessing improvement in oral health, life overall, dental aesthetics and occlusion. The figures clearly favor the treated group for both dental aesthetics and occlusion.

When CPQ11-14 change scores of the overall sample were compared against responses to GTR assessing change in life overall and in oral health, a clear gradient existed across
children who reported improvement, those who remained the same, and those who worsened over time (Table 3). GTR were significantly correlated with CPQ11-14 change scores ($p<0.01$).

**Discussion:**

This longitudinal study is a step forward towards providing the empirical evidence needed to validate the common assumption that orthodontic treatment improves OH-QOL. The results extend the findings of earlier cross-sectional studies examining malocclusion and OH-QOL from consistent associations to a causal relationship (20). According to the findings of this study, orthodontic treatment produces a measurable improvement in OH-QOL of treated children compared to untreated wait-list controls. In addition, responses to the GTR clearly demonstrate the positive changes in aesthetics and occlusion brought about by orthodontic treatment. These findings are timely and answer many of the recently raised questions concerning the psychosocial benefits of orthodontic treatment in children.

Improvement in OH-QOL following treatment was most evident for the social and emotional domains of the CPQ11-14. This is not surprising in view of earlier studies using the CPQ11-14. A study of New Zealand schoolchildren revealed a distinct gradient in the mean EWB and SWB domain scores across increasing severities of malocclusion (25). Similar results were described for British and Canadian children with malocclusion (29,31). OH-QOL data from cross-sectional studies have repeatedly linked orthodontic treatment to better socio-emotional wellbeing and malocclusion to teasing, bullying, and lower OH-QOL. For example, difficulty with smiling due to the misalignment of teeth has been found to be one of the most important impacts of children's OH-QOL (36).
Thus, it is reasonable to assume that the benefits of orthodontic treatment are more likely to impact children’s day-to-day social and emotional activities than any other domains of OH-QOL.

The lack of significant improvement in the OS and FL domains following treatment was also expected. In fact, O’Brien deemed these two domains to be irrelevant to orthodontic patients (29). This is also consistent with a comprehensive review of the orthodontic literature, which concluded that conventional orthodontics does not improve patients’ speech or mastication (19).

Wearing a fixed orthodontic appliance typically compromises the functional aspects of daily life like eating and speaking. In a study that focused on OH-QOL assessment during the initial stages of orthodontic treatment, Zhang et al (2007) reported that children experienced a deterioration of OS and FL within the first six months of treatment (37). Another study indicated that more than 90% of subjects wearing fixed orthodontic appliances experienced at least one negative impact as assessed by the Oral Impact on Daily Performance (38). Our data indicate that children recover from the negative functional impacts associated with treatment soon after the removal of fixed appliances.

When the effect of age was examined, there was an overall tendency for CPQ11-14 scores to decrease over time. At first glance, this may seem to contradict the general hypothesis that children give increasing attention to peers and become preoccupied with others' views of self as they enter early adolescence (39). Nevertheless, this decline in CPQ11-14 scores may represent a process of adaptation to the oral health condition. This explanation is supported by Kok et al, who suggest that children may respond with better OH-QOL when a questionnaire is re-administered at a later time (8). Decline in CPQ11-
14 scores for children in the treatment group was significantly larger than that of the control group and thus, can not be solely attributed to age-related effects. Having a control group was essential to isolate treatment effects and exclude effects stemming from cognitive or developmental changes.

Differences between treatment and control subjects also emerged when analyzing responses to GTR. At baseline, the groups responded to global questions, asking about happiness with the way teeth look and come together, in a strikingly comparable fashion. Yet, at follow-up, responses to these two questions differentiated noticeably between those who had been treated and those who had not (Figures 1 and 2). Over 70% of treatment subjects were either happy or very happy with their aesthetics and occlusion compared to only 10% of those awaiting treatment. When children were asked if their occlusion or aesthetics had changed over time, 100% of treatment subjects reported some degree of improvement. On the other hand, over half of the control subjects discerned that their aesthetics and occlusion had either remained the same or deteriorated compared to the first time they had answered the questionnaire.

Similarly, when asked to rate their oral health, only 6.7% of treatment subjects reported no improvement following orthodontics compared to approximately 50% of controls. 10% of those who were treated said that their life overall had worsened, while approximately two thirds of those who were not treated, 55.9%, reported that their life had remained the same, or worsened to some degree. To summarize, for all questions, the majority of children with malocclusion who were treated reported that they had improved, whereas children who did not receive treatment had an equal chance of getting better or worse.
Although these results demonstrate the presence of significant treatment effects, one must be cautious in interpreting results from GTR. These retrospective judgments of change are subjected to significant recall bias. According to Streiner and Norman (2008), children may simply not remember their baseline state. When children are asked how they felt two or three years ago, they first reflect on their current state (how do I feel today?), this in turn triggers an “implicit theory of change” where children contemplate how they think the treatment influenced their lives, they then try to estimate what their initial state must have been (33). This theory of implicit change questions the robustness of GTR as direct measures of change. Therefore, responses to GTR must be interpreted in light of analysis of CPQ11-14 scores.

Longitudinal analyses of overall CPQ11-14 scores for both groups and data extracted from responses to global questions were also used to confirm the psychometric properties of the CPQ11-14. Change scores were examined against the different responses to GTR. There were significant associations, in the expected direction, between children’s global judgment regarding improvement of oral health and life overall CPQ11-14 scores ($p<0.01$ for all analyses). Moreover, we found that those reporting improvement on the GTR had positive changes scores, those reporting deterioration had negative change scores and those who report no change had scores close to zero (Table 3). Since children’s global judgment closely corresponded to changes in CPQ11-14 scores, it is reasonable to conclude that the CPQ11-14 possesses good longitudinal psychometric properties.

Nevertheless, the clinical relevance of these findings is yet to be determined. Clinical relevance is usually assessed in quality of life research by calculating the Minimal Important Differences (MID) (40). However, determining the MID in growing children
using anchor measures like the GTR used in this study, might be problematic (22). In addition to potential recall bias, children may change their conceptualization of health as they grow. Therefore, alternative strategies are needed to establish the MID for OH-QOL data in the context of orthodontic treatment.

The fact that this study concluded that orthodontics does contribute to improvement in children’s social and emotional wellbeing emphasizes the importance of selecting the appropriate measure when examining psychosocial constructs. Outcomes of any longitudinal psychosocial study are highly dependent on the operational definition of the instruments used (6). For the most part, earlier studies assessing psychosocial gain after orthodontics focused on measuring self esteem and general wellbeing, which are relatively stable constructs that are unlikely to change by minor changes in teeth position (6,41). On the other hand, whenever oral specific measurements are employed, research clearly identifies the positive impacts of orthodontics on the daily aspects of children’s lives (11,42). In fact, de Oliveira states that outcome research on the treatment of malocclusion requires the use of OH-QOL measures (13).

The CPQ11-14 is a generic OH-QOL measure. Although some argue that OH-QOL measures should be condition-specific in order to be appropriately used in orthodontic patients (15,29), generic instruments are useful for making comparisons with the general populations, which is particularly helpful in interpreting the results, making it possible to evaluate the relative impacts of therapies and healthcare programs (43).

The results from this study have important implications at many levels (44,45). Data from the present study help establishing a baseline for comparing treatment outcomes similar to the manner by which normative measures are used (46). The clear benefits of
orthodontic treatment demonstrated in this sample could be also used to inform policy makers about the importance of treatment. However, long term follow-ups are needed to confirm these benefits. It is also necessary to examine how contextual factors like, personality, social, and environmental factors moderate the relationship between OH-QOL and orthodontic treatment.

**Conclusion:**

In conclusion, the results of this study support the hypothesis that orthodontic treatment improves OH-QOL outcomes in children. Improvements were most evident for the social and emotional wellbeing domains of CPQ11-14. Analysis of CPQ11-14 individual domain scores corroborates the majority of literature indicating that the most significant impacts of orthodontics on OH-QOL are psychosocial in nature. Association between CPQ11-14 change scores and GTR confirms the longitudinal psychometric properties of the CPQ11-14 instrument. The findings are yet to be examined in view of important contextual factors moderating the relationship between orthodontics and OH-QOL.


(40) Guyatt G, Schunemann H. How can quality of life researchers make their work more useful to health workers and their patients? Qual.Life Res. 2007 Sep;16(7):1097-1105.


### TABLES

Table 1: Main study variables at baseline (T1) and follow-up (T2) for treatment and control groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>Treatment</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T1 (N=98)</td>
<td>T2 (N=74)</td>
</tr>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>CPQ11-14</td>
<td>21.05 (15.09)</td>
<td>16.16 (10.99)*</td>
</tr>
<tr>
<td></td>
<td>1.00-68.00</td>
<td>0.00-44.00</td>
</tr>
<tr>
<td>OS</td>
<td>5.58 (3.40)</td>
<td>5.26 (3.15)</td>
</tr>
<tr>
<td></td>
<td>0-17.00</td>
<td>0-13.00</td>
</tr>
<tr>
<td>FL</td>
<td>5.09 (4.15)</td>
<td>5.41 (4.26)</td>
</tr>
<tr>
<td></td>
<td>0-21.00</td>
<td>0-18.00</td>
</tr>
<tr>
<td>EWB</td>
<td>5.19 (5.09)</td>
<td>2.51 (2.96)*</td>
</tr>
<tr>
<td></td>
<td>0-24.00</td>
<td>0-12.00</td>
</tr>
<tr>
<td>SWB</td>
<td>5.18 (5.39)</td>
<td>2.99 (3.59)*</td>
</tr>
<tr>
<td></td>
<td>0-27.00</td>
<td>0-17.00</td>
</tr>
</tbody>
</table>

SD: Standard Deviation; SE: Standard Error
Lower CPQ11-14 scores represent better oral quality of life.
* Paired $t$ statistics were significant ($p<0.05$), indicating within group changes over time
† ANCOVA statistics were significant ($p<0.05$), indicating between group differences over time
Table 2: Percentage of subjects responding to GTR for treatment and control groups.

<table>
<thead>
<tr>
<th>Response to GTR</th>
<th>Aesthetic</th>
<th></th>
<th>Occlusion</th>
<th></th>
<th>Oral Health</th>
<th></th>
<th>Life Overall</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T(%)</td>
<td>C(%)</td>
<td>T(%)</td>
<td>C(%)</td>
<td>T(%)</td>
<td>C(%)</td>
<td>T(%)</td>
<td>C(%)</td>
</tr>
<tr>
<td>Improved a lot</td>
<td>94.7</td>
<td>25.6</td>
<td>93.3</td>
<td>25.6</td>
<td>46.7</td>
<td>9.1</td>
<td>42.7</td>
<td>15.9</td>
</tr>
<tr>
<td>Improved somewhat</td>
<td>4.0</td>
<td>25.6</td>
<td>5.3</td>
<td>20.9</td>
<td>32.0</td>
<td>25.0</td>
<td>32.0</td>
<td>18.2</td>
</tr>
<tr>
<td>Improved a little</td>
<td>1.3</td>
<td>2.3</td>
<td>1.3</td>
<td>4.7</td>
<td>9.3</td>
<td>11.4</td>
<td>18.7</td>
<td>18.2</td>
</tr>
<tr>
<td>Remained the same</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>34.9</td>
<td>9.3</td>
<td>40.9</td>
<td>6.7</td>
<td>31.8</td>
</tr>
<tr>
<td>Worsened a little</td>
<td>0</td>
<td>37.2</td>
<td>0</td>
<td>4.7</td>
<td>2.7</td>
<td>6.8</td>
<td>0</td>
<td>9.1</td>
</tr>
<tr>
<td>Worsened somewhat</td>
<td>0</td>
<td>7.0</td>
<td>0</td>
<td>7.0</td>
<td>0</td>
<td>2.3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Worsened a lot</td>
<td>0</td>
<td>2.3</td>
<td>0</td>
<td>2.3</td>
<td>0</td>
<td>4.5</td>
<td>0</td>
<td>6.8</td>
</tr>
</tbody>
</table>

T: Treatment group  
C: Control group
Table 3: Mean CPQ11-14 change scores per GTR category for the overall sample

<table>
<thead>
<tr>
<th>Mean CPQ11-14 change scores</th>
<th>OH*</th>
<th>$r$</th>
<th>Life over all*</th>
<th>$r$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved</td>
<td>6.56 (15.74)</td>
<td>0.34**</td>
<td>5.11 (15.20)</td>
<td>0.28**</td>
</tr>
<tr>
<td>Stayed the same</td>
<td>-1.04 (18.65)</td>
<td></td>
<td>3.79 (21.07)</td>
<td></td>
</tr>
<tr>
<td>Worsened</td>
<td>-16.38 (23.08)</td>
<td></td>
<td>-20.43 (23.63)</td>
<td></td>
</tr>
</tbody>
</table>

*ANOVA results were significant at $p<0.001$ and $F$ ratio of 7.95
†ANOVA results were significant at $p<0.001$ and $F$ ratio of 7.51
** $r$ (Pearson Correlation Coefficient) is significant at the 0.01 level (2-tailed).
Figure 1: Percentage of subjects reporting satisfaction with dental occlusion for treatment and control groups at baseline (T1) and follow-up (T2).
Figure 2: Percentage of subjects reporting satisfaction with dental aesthetics for treatment and control groups at baseline (T1) and follow-up (T2).
Manuscript IV: Does Psychological Well-being Influence Oral Health Related Quality of Life in Children Receiving Orthodontic Treatment?
Does Psychological Well-being Influence Oral Health Related Quality of Life Reports in Children Receiving Orthodontic Treatment?

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Running head: CPQ11-14, OH-QOL, and adolescent’s psychological well-being
Key words: CPQ11-14, psychological well-being, orthodontics, oral-health related quality of life

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Agou S, Locker D, Tompson B, Streiner DL. Does Psychological Well-being Influence Oral Health Related Quality of Life Reports in Children Receiving Orthodontic Treatment?

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Based on a thesis submitted to the school of graduate studies, University of Toronto, in partial fulfillment of the requirements for the PhD degree. A preliminary report was presented at the International Association of Dental Research meeting in Toronto (2008)
ABSTRACT

INTRODUCTION: Although the associations between oral biological variables such as malocclusion and Oral Health-related Quality of Life (OH-QOL) have been explored, little research has been done to address the influence of psychological characteristics on perceived OH-QOL. Hence, the aim of this study was to assess OH-QOL outcomes in orthodontics while controlling for individual psychological characteristics. We postulated that children with better Psychological Well-being (PWB) would experience fewer negative OH-QOL impacts, regardless of their orthodontic treatment status.

METHODS: 118 (74 treatment and 44 wait-list) eleven to 14-year-old children seeking treatment at the orthodontic clinics at the University of Toronto, participated in this study. The Child Perception Questionnaire (CPQ11-14) and the PWB subscale of the Child Health Questionnaire were administered at baseline and follow-up. Occlusal changes were assessed using the Dental Aesthetic Index (DAI). A wait-list comparison group was used to account for age related effects.

RESULTS: Although treatment subjects reported significantly better OH-QOL scores at follow-up, the results were significantly modified by the individual’s PWB status ($p<0.01$). Further, multivariate analysis showed that PWB contributed significantly to the variance in CPQ11-14 scores (26%). In contrast, the amount of variance explained by the treatment status alone was relatively small (9%).

CONCLUSIONS: The results of this study support the postulated moderator role of PWB when evaluating OH-QOL outcomes in children undergoing orthodontic treatment. Children with better PWB are, in general, more likely to report better OH-QOL regardless of their orthodontic treatment status. On the other hand, children with low
PWB, who did not receive orthodontic treatment, experienced worse OH-QOL, compared to those who received treatment. This suggests that children with low PWB can benefit from orthodontic treatment, nonetheless, further work, with larger sample sizes and longer follow-ups, is needed to confirm this finding and to improve our understanding of how other psychological factors relate to patients’ oral quality of life.
INTRODUCTION

As orthodontic outcome research continues to move away from the traditional biomedical model (1) towards a biopsychosocial perspective (2), an increasing amount of attention is being given to the concept of Oral Health-related Quality of Life (OH-QOL) (3). OH-QOL is defined as the absence of negative impacts of oral conditions on social life and a positive sense of dentofacial self-confidence (4). Emerging studies using reliable OH-QOL measures have identified differences between treated and untreated orthodontic patients (5-9). For example, a Brazilian study of 1,675 adolescents indicated that children who had completed orthodontic treatment reported fewer OH-QOL impacts than those who were never treated (5). These differences are mostly related to socioemotional aspects of well-being such as; smiling, laughing, and showing teeth without embarrassment (8, 9).

Such differences between treated and untreated subjects are, indeed, expected in light of studies emphasizing the importance of dentofacial aesthetics in daily social interactions. For instance, unattractive dentition has been associated with teasing, bullying (10, 11), and negative OH-QOL impacts (5, 11-13). In fact, improving dental aesthetics and subsequently, Psychological Well-being (PWB), are frequently stated reasons for seeking orthodontic treatment during childhood and adolescence (14, 15). However, the bulk of evidence denoting the relative stability of PWB undermines this assumption (16-19). Further, no studies have been published that describe how OH-QOL and PWB change over the period of orthodontic treatment.
Attempts to correlate OH-QOL reports with clinical orthodontic indicators, on the other hand, have often reached equivocal conclusions (20-23). In many of these studies, children reporting worse OH-QOL were not consistently those with worse malocclusions. It is possible that some children with severe malocclusion may be more emotionally resilient to the challenges engendered by their condition. Hence, accurate interpretation of OH-QOL measures requires an understanding of not only their psychometric properties, but also the contextual factors which might influence children’s assessments of their health and well-being (24). In fact, a recent long-term study evaluating psychosocial outcomes in orthodontics suggested that analyzing the effects of orthodontic treatment on psychological health without considering intervening factors may lead to invalid conclusions about the efficacy of treatment (19). This is corroborated by cross-sectional reports recognizing the effect of innate personality traits on children’s perception of dentofacial aesthetics ((25-27), and patients’ evaluations of the impact of their health on daily functioning (28-30).

Contemporary models of disease/disorder and its consequences, which integrate both biological and psychological aspects of health, support this holistic thinking paradigm (31). For example, according to the Wilson-Cleary model, health-related quality of life outcomes experienced by an individual are determined not only by the nature and severity of the disease/disorder, but also by the characteristics of the individual and their environment (32). That being said, a thorough examination of the orthodontic OH-QOL literature using the Wilson-Cleary model as conceptual framework reveals that, for the most part, studies have focused on the associations between biological variables and OH-QOL (23, 33, 34), with very little emphasis on the psychological characteristics of
children receiving orthodontic treatment (35). This is surprising considering that research has shown that determinants of health-related quality of life are mainly psychological in nature (36). Hence, psychological factors such as PWB are certainly important moderators of OH-QOL (37).

Since the relationship between psychological factors and OH-QOL remains largely unexamined in orthodontic patients, the present study was undertaken to answer the question: do individual psychological characteristics affect children’s OH-QOL reports? The specific objectives of this longitudinal investigation were to explore the effect of PWB on reported OH-QOL in children receiving orthodontic treatment and to compare this effect to a sample of untreated wait-list controls. We hypothesized that children with better PWB would experience fewer negative impacts, regardless of their orthodontic treatment status. According to this hypothesis, children’s assessment of OH-QOL will be influenced by their PWB. To demonstrate this moderating role of PWB, we compared OH-QOL in children with high and low PWB. We expected that OH-QOL outcomes wouldn't change for those in the high PWB group, but may change for those in the low group.

Since medical research has shown that psychological variables are likely to affect the more subjective domains of quality of life reports (38), we expected that the influence of PWB would be more pronounced for the more subjective social and emotional dimensions of the OH-QOL measure used in this study, than for the more objective dimensions addressing functional limitations and oral symptoms.

MATERIALS AND METHODS
**Study Design**

This study used a two group before-and-after design to assess changes in OH-QOL following orthodontic treatment. Patients receiving treatment were the focal group of interest, whereas patients awaiting treatment represented the comparison group.

**Study Subjects**

To be eligible, the child had to be fluent in English and be in good general health. Children with severe dento-facial deformities were excluded. Parents’ consents and children’s assents were obtained and the University Research Ethics Board approved all study procedures. Subjects were not offered incentives or compensation for participating in the study. Treatment subjects were consecutively recruited from the graduate orthodontic clinic at the University of Toronto during their first assessment visit. Control subjects, on the other hand, were consecutively recruited from the Faculty of Dentistry clinics during their first orthodontic screening visit. All 11- to 14-year-old subjects who met the eligibility criteria were recruited by the first author.

**Procedure**

All children completed a copy of the Child Perception Questionnaire (CPQ11-14) and the PWB subscale of the Child Health Questionnaire at baseline (T1) and follow-up (T2). Questionnaires were completed by the children unassisted by parents or investigators. The Dental Aesthetic Index (DAI) (39) was used to determine the clinical severity of malocclusion. Age and gender were recorded because of their potential association with outcome and explanatory variables. Treatment was completed at the graduate orthodontic clinic as routinely prescribed using fixed appliance therapy. On average, treatment lasted
for 26 months. T2 data were collected at the first retention check appointment for treatment subjects and after an equivalent duration of T1-T2 time interval for control subjects.

**Measures**

*The Child Perception Questionnaire (CPQ 11-14)*

The CPQ 11-14 is a child OH-QOL instrument. The age-specific questionnaire (11 to 14 years) consists of 37 items, grouped into four domains: Oral Symptoms (OS), Functional Limitations (FL), Emotional Well-being (EWB), and Social Well-being (SWB). Each item asks about the frequency of events, as applied to the teeth, lips, and jaws, in the last three months. The response options were “never”, “once or twice”, “sometimes”, “often”, and “every day or almost every day”. Additive scale and subscale scores for the CPQ11-14 were calculated by summing the item response codes. Although the instrument is designed to yield an overall score, a separate score can be generated for each of the four subscales. Higher scores signify worse OH-QOL. The validity, reliability, and responsiveness of this measure have been established in different settings (6, 21, 23, 33, 40-43). This measure examines the impacts of oral conditions on children’s EWB and SWB; nonetheless, it is important not to confuse these two domains with the more generic PWB. EWB and SWB focus specifically on the impacts of oral health condition on children’s daily functioning, whereas PWB takes into account the effect of all aspects of health and daily life on well-being.

*The Child Health Questionnaire*
Children’s PWB was measured using the PWB sub-domain of the Child Health Questionnaire. This questionnaire is a widely used and validated self-report instrument (44). The 16-item PWB scale measures the frequency of both negative and positive feelings. The items capture anxiety, depression, and happiness. Frequency is measured using a five-level continuum that ranges from "all of the time" to "none of the time". The scores were calculated using Landgraf’s user’s manual (45). Higher scores indicate better PWB; a score of a 100, for example, indicates that the child feels peaceful, happy, and calm all of the time. In contrast, lower scores indicate that the child has feelings of anxiety and depression. Specific instructions confirming the generic nature of the measure were added at the beginning of the questionnaire.

*The Dental Aesthetic Index (DAI)*

The severity of each treatment and control subject’s orthodontic condition was assessed using study models taken at T1 and T2 using the DAI (39). Although other treatment need indices like the Index of Orthodontic Treatment Need and the Index of Complexity, Outcome, and Need are available, the DAI was chosen because it incorporates the social acceptability of a child’s dental appearance. The rating is based on the measurement of ten occlusal traits; each trait is multiplied by a weight derived from the judgment of lay persons. The products are summed and a constant is added to give a DAI score. DAI scores range from 13 (the most acceptable) to 100 (the least acceptable).

The DAI ratings were recorded by three trained and calibrated examiners. Intra and inter-examiner reliability was evaluated by raters independently assessing a random 10% sample of the models and then reassessing the models after a one-week interval. Intra-examiner reliability for the DAI raters was high with Intra-class Correlation Coefficients
of 0.96, 0.91, and 0.97 respectively. The inter-examiner reliability was also high (Intra-class Correlation Coefficients = 0.81).

**Data analysis**

The data were analyzed using SPSS, version 16 (SPSS, Chicago, IL, USA). Data analyses included descriptive statistics, bivariate and multivariate analyses. Paired *t*-tests were used to assess within group changes over time for each of the treatment and control groups. The *p* value for all tests was set at *p*<0.05.

Analyses of covariance (ANCOVA) models were then used to explore between group differences. The first goal was to evaluate the relationship between the provision of orthodontic treatment and changes in OH-QOL, represented by overall and individual CPQ11-14 scores, while controlling for baseline CPQ11-14 scores, age, and malocclusion severity. This analysis plan, represented in model 1 (Table 2) aims to address the question: “Is there a difference in reported OH-QOL between treatment and control subjects?”. The second goal was to evaluate the role of PWB on moderating OH-QOL outcomes by using a second ANCOVA model (model 2 in Table 2). This model addresses the following question: “If there is a difference in OH-QOL scores between treatment and control subjects, does it remain significant after controlling for PWB?”.

**RESULTS**

50% of the 118 study subjects followed-up over the course of this study were girls and 76% were Caucasians, with a mean age of 12.9 (SD=0.98) years at baseline. According to published DAI categories (39), 44.2% of the overall sample had handicapping
malocclusion, 25.7% had severe malocclusion, 23.9% had definite malocclusion, and 6.2% had minor malocclusion.

Although follow-up data were successfully obtained from 118 subjects (74 treatment and 44 control subjects), 199 children were recruited at the onset of the study. To ensure that the relatively large percentage of drop-out (40.71%) did not compromise the comparability of baseline characteristics between the treatment and control groups, T1 data of original and retained subjects for both treatment and control groups were contrasted in Table 2. *t* statistics indicated that all variables studied were comparable for both groups at the onset of the study. Hence, the subjects lost to follow-up did not influence the distribution of these variables.

Table 2 also summarizes T2 data for treatment and control subjects. In addition, a guide to interpreting these scores is provided in Table 1. It is noteworthy that CPQ11-14, EWB, SWB, and DAI scores for the treatment subjects were the only variables that changed significantly over the study period. In contrast, these scores did not change significantly for the control group. As expected, PWB scores remained relatively constant over time for both treatment and control subjects. Further, these PWB scores were slightly higher, but not significantly different from those reported for normal school children (44).

As mentioned earlier, ANCOVA models were used to test the difference in reported OH-QOL between treatment and control subjects. Treatment status was entered into the ANCOVA model as a fixed factor and tested for overall effect on CPQ11-14 overall and subscales scores at follow-up. For each scale, the first model controlled for age, baseline scores, and initial severity of malocclusion (DAI), while the second model controlled for
PWB in addition. Table 3 provides a summary of the ANCOVA models, and the total amount of variance explained by each model.

The results indicated a significant difference in overall CPQ11-14, SWB and EWB scores between treatment and control subjects \((p<0.05)\). However, after considering PWB as a covariate, the effect of providing orthodontic treatment was no longer significant, as measured by the overall CPQ11-14 and SWB scores \((p=0.23)\). Emotional well-being was the only scale where the difference between treatment and control subjects remained significant after controlling for clinical and psychological confounders. To illustrate the results, the adjusted mean CPQ11-14, SWB and, EWB scores for both treatment and control groups are presented in Table 4.

The contribution of DAI scores was non-significant, with exception to the SWB subscale. DAI scores significantly contributed to the variance in SWB scores in both ANCOVA models. In addition, age effects were evident for the overall CPQ11-14, oral symptoms, and functional limitations subscales. Nonetheless, these effects were apparent only after controlling for PWB. The moderating role of PWB was further examined by adding the “Group by PWB status” as an interaction term in a separate ANCOVA model (not included in Table 3). The results were statistically significant with an \(F\) ratio of 7.01 \((p<0.01)\) and an adjusted \(R^2\) of 26.8%. Since using normative reference groups is recommended to meaningfully interpret the results from quality of life surveys (46), we dichotomized PWB around the mode (76.6%), which approximates the population norms published by Landgraf and others (44, 47-49). We then examined CPQ11-14 scores in the high and low PWB groups at T1 and T2. The direction of change was evaluated for both treatment and control subjects (Table 5).
DISCUSSION

Although medical studies have stressed the importance of accounting for psychological parameters whenever quality of life is used as a primary outcome (50, 51), a critical analysis of orthodontic psychosocial outcome research reveals that most studies have failed to do so. Hence, the results of the present study are timely, filling a research gap identified by many researchers (3, 52). To the best of our knowledge, this is the first controlled longitudinal study evaluating OH-QOL outcomes of orthodontic treatment in light of pre-treatment psychological attributes. The results of this study support the postulated moderator role of PWB when evaluating OH-QOL outcomes in children receiving orthodontic treatment.

The oral health impacts reported by participating subjects were not entirely dependent on the associated clinical conditions. Rather, PWB influenced participants’ perception of oral health problems to a significant degree. Children reporting better PWB are more likely to report better OH-QOL regardless of their treatment status. As hypothesized, the contribution of PWB to the variance in OH-QOL was considerably greater for the SWB and EWB subscales, compared to the oral symptoms and functional limitations subscales (Table 3).

The lack of significant changes in the PWB construct over the study period conforms to the hedonic treadmill theory, holding that well-being, for most people, is a relatively constant state (18). The data presented add to the bulk of evidence supporting this theory. The data also agree with other studies that invalidate the assumption that improving dental aesthetics can have a significant effect on a child’s PWB (17, 53).
This sample of Canadian children reported significant reduction in negative oral impacts following orthodontic treatment (mean CPQ11-14 reduction= 4.88, SD= 14.57) compared to control subjects of similar age, gender, and dental condition (mean CPQ11-14 reduction= 0.93, SD= 21.72). These results concur with other studies highlighting the positive effect of orthodontic treatment on OH-QOL (5, 8, 9). For instance, CPQ11-14 scores improved significantly following orthodontic treatment of children in Hong Kong. Similarly, de Oliveira’s cross-sectional study of 1,675 schoolchildren found comparable treatment effects using other OH-QOL measures (5).

In-depth analysis of the present data, however, revealed that the effect of orthodontic treatment is less dramatic when viewed in the context of the children’s psychological profiles. The differences between treatment and control subjects clearly diminish after accounting for PWB (Table 4). Results from the multivariate analyses showed that, for all scales, PWB explained additional variance in the dependent variables (overall and subscale CPQ11-14 scores). For example, the ANCOVA models accounting for PWB explained about one-third of the variance in overall CPQ11-14, EWB, and SWB scores, with PWB contributing the most to the explanatory power. This was observed for both treatment and control subjects. As expected, the PWB of children participating in this study influenced reports of oral symptoms and function to lesser extent.

The PWB results of this study help to clarify the findings of earlier work with the CPQ11-14 in orthodontic patients, which found that the correlations between CPQ11-14 and clinical indices are rather weak (6, 23, 40). A recent meta-analysis, which concluded that determinants of quality of life are mainly psychological in nature also supports this explanation (38). Altogether, these results confirm the validity of contemporary
conceptual models of disease and its consequences, which emphasize the importance of personal, social, and environmental factors in moderating patient-centered quality of life outcome (32).

Considering that some studies have affirmed the relationship between malocclusion, orthodontic treatment, and reported OH-QOL, it seemed important to control for the initial severity of malocclusion and treatment status. Less than 10% of the variance in overall CPQ11-14 scores was explained by the treatment status alone, indicating a definite, but relatively small effect. The results support the findings of a long-term British study (53), which concluded that orthodontic treatment had little positive impact on psychological health and quality of life in adulthood, when self-esteem at baseline was controlled for. Nevertheless, analyses of individual CPQ11-14 subscales demonstrated that treatment effects varied across the four subscales. The EWB subscale was the only scale for which treatment effects remained significant after adjusting for other clinical and psychological factors. Conversely, the SWB subscale was the only scale to which DAI scores made a significant contribution, making this subscale the closest to correspond to objective treatment needs.

The associations between psychological factors and perceived social and emotional impacts of oral health concur with what has been previously reported for children, adolescents, and young adults (13, 22, 24-26, 54-56). Overall, this study emphasizes the extent to which psychological factors can modify children’s perception of their actual oral health status.

A closer examination of the items comprising each scale helps to explain these findings. The EWB subscale focuses on internal feelings such as; being worried, embarrassed, or
concerned about looks. In contrast, the SWB subscale consists of items assessing the impacts of malocclusion on various social interactions, including speaking in class, social activities, smiling, talking to other children, or being teased by other children. It is also important to consider that data were collected shortly after termination of treatment. It is not surprising then that orthodontic treatment did not have an immediate effect on children’s SWB. Children may simply need time to translate the emotional gains following treatment to their external environment. In general, the SWB and EWB findings concur with past studies documenting the negative effects of malocclusion on children’s lives (10, 57-59).

In addition, treatment effects varied depending on the child’s PWB. In the present study, children with high PWB scores were more likely to report significant improvement in OH-QOL after treatment, compared to those with low PWB scores (Table 5). Evaluation of the overall sample suggests that there is a trend for CPQ11-14 scores to improve over time regardless of the treatment status. Nevertheless, a closer evaluation of CPQ11-14 scores per PWB group (Table 5) reveals that children with low PWB who did not receive orthodontic treatment reported worse CPQ11-14 scores over time, compared to those who received treatment.

This change in behavior of the CPQ11-14 after accounting for the PWB status highlights the importance of considering the child’s psychological profile when evaluating OH-QOL outcomes in orthodontics. It is important to note, however, that these results should be interpreted with caution because of the small sample size in each cell. Nevertheless, the effect of PWB on reported OH-QOL is worthy of further investigation with larger samples and longer follow-ups.
Information generated from this study will be of great value to both clinical and policy relevant research. Researchers interested in capturing the multidimensional aspects of oral health should consider the PWB of participating subjects while designing their studies. While some investigators may consider the PWB variable as “noise”, it may be also an important determinant of OH-QOL (37). Further, the minor contribution of DAI scores to the variance in CPQ11-14 scores demonstrates the limitations of clinical indicators in interpreting OH-QOL data.

Clinically, the results support the argument that orthodontists should include the psychological dimension in their assessment when prioritizing treatment needs and evaluating outcomes. Since children with low PWB scores appeared to suffer more impacts as a result of their malocclusion, it seems logical to grant them priority accessing orthodontic care. This could be achieved by using proxy measures that reflect children’s experience, such as the self-report CPQ11-14. Nevertheless, worse OH-QOL scores alone may not be sufficient to indicate clinically worse oral health. Further work is needed to refine existing OH-QOL measures in order to correspond more closely to objective health needs. For example, results from the CPQ11-14 subscales analyses can guide research to develop short forms of this measure intended for specific purposes.

There are some inherent limitations relevant to most studies of orthodontic treatment. Since randomization is difficult to achieve in orthodontics (19, 60), a longitudinal observational design offered the best, and most feasible alternative approach. Follow-up data confirmed our preliminary findings (61), and established directionality between OH-QOL and PWB. The presence of a control group helped to draw conclusions related to treatment effects rather than changes stemming from the dynamic nature of psychological
constructs in growing children (62). Despite the persistence of our recall efforts, this study was also limited by the relatively high attrition rate. This was mostly because of wait-list patients seeking alternative care or relocating outside the city. Although it is possible to assume that those who sought alternative treatment were the ones with worse malocclusion or worse PWB, the distribution of the main baseline characteristics between original and retained subjects were comparable, at least for the variables measured (Table 2). Nevertheless, the ANCOVA results should be interpreted with caution, especially considering the lack of randomization and the observational nature of this study (63).

It is important to reconsider the current biomedical and restricted paradigm on OH-QOL and to begin to think about the series of processes by which social and psychological factors influence OH-QOL reports (64). This study lays the grounds for developing a conceptual understanding of the interaction between reported OH-QOL and individual’s PWB. Although PWB explained the variance in CPQ11-14 to a reasonable extent, the lack of comparable studies in the literature makes it difficult to generalize the findings. Further, the relatively low $R^2$ values associated with the models indicate that there may be other determinants of OH-QOL. For instance, the direct contribution of factors such as; other oral health problems, social support, or personality traits was not assessed in this investigation. Hence, further work should be attempted, to study these factors with larger sample sizes, different age groups, and longer follow-ups in order to improve the quantity and quality of orthodontic OH-QOL data. The use of complex structural equation modeling or path analysis can also add to our understanding of how the various aspects of psychological health relate to patients’ oral quality of life. Thus, an impetus for further meaningful OH-QOL research in orthodontics will be provided.
CONCLUSION

In conclusion, the findings of this study highlight the importance of considering inherent psychological parameters in orthodontic psychosocial research. More specifically, the results support the moderator role of PWB when evaluating OH-QOL outcomes in children with malocclusion. Children with better PWB are, in general, more likely to report better OH-QOL regardless of their orthodontic treatment status. On the other hand, children with low PWB, who did not receive orthodontic treatment, experienced worse OH-QOL, compared to those who received treatment. This suggests that children with low PWB may benefit from orthodontic treatment, nonetheless, further work, with larger sample sizes and longer follow-ups, is needed to confirm this finding and to improve our understanding of how other psychological factors relate to patients’ oral quality of life.
References


Table 1: The main study variables and their interpretation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Interpretation</th>
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<tr>
<td>CPQ11-4</td>
<td>The Child Perception Questionnaire</td>
<td>Lower CPQ11-14 scores represent better oral quality of life</td>
</tr>
<tr>
<td>OS</td>
<td>Oral Symptoms</td>
<td>Lower CPQ11-14 scores represent better oral quality of life</td>
</tr>
<tr>
<td>FL</td>
<td>Functional Limitation</td>
<td>Lower CPQ11-14 scores represent better oral quality of life</td>
</tr>
<tr>
<td>EWB</td>
<td>Emotional Wellbeing</td>
<td>Lower CPQ11-14 scores represent better oral quality of life</td>
</tr>
<tr>
<td>SWB</td>
<td>Social Wellbeing</td>
<td>Lower CPQ11-14 scores represent better oral quality of life</td>
</tr>
<tr>
<td>PWB</td>
<td>Psychological Wellbeing</td>
<td>Lower PWB scores represent worse psychological well-being</td>
</tr>
<tr>
<td>DAI</td>
<td>The Dental Aesthetic Index</td>
<td>Lower DAI scores represent better occlusion</td>
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Table 2: Main study variables at T1 and T2 for treatment and control groups.

<table>
<thead>
<tr>
<th>Group</th>
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<th>Control</th>
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<td>T2</td>
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<td>Time</td>
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<td>Retained</td>
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<td>OS</td>
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<td>FL</td>
<td>5.09 (4.15)</td>
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<td>EWB</td>
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<td>SWB</td>
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<td>5.32 (5.46)</td>
<td>2.99 (3.59)*</td>
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<td>0.00-27.00</td>
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<tr>
<td>PWB</td>
<td>80.66 (10.09)</td>
<td>79.78 (9.29)</td>
<td>81.68 (10.52)</td>
<td>78.33 (12.98)</td>
<td>78.05 (11.7)</td>
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<td>51.56-100</td>
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<td>28.13-98.44</td>
<td>48.44-98.44</td>
<td>43.75-100</td>
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<td>DAI</td>
<td>34.21 (8.18)</td>
<td>33.72 (7.78)</td>
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<td>25.80-53.80</td>
<td>23.60-44.40</td>
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*paired t statistics significant at \( p<0.01 \)
Table 3: ANCOVA models showing contribution of covariates to overall and subscale (T2) CPQ11-14 scores

<table>
<thead>
<tr>
<th></th>
<th>(T2) CPQ11-14</th>
<th>(T2) EWB</th>
<th>(T2) SWB</th>
<th>(T2) FL</th>
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<tr>
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<td>Model 1</td>
<td>Model 2</td>
<td>Model 1</td>
</tr>
<tr>
<td><strong>F Statistics</strong></td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Age</td>
<td>0.57</td>
<td>5.79**</td>
<td>.023</td>
<td>1.59</td>
<td>0.00</td>
</tr>
<tr>
<td>Baseline scores</td>
<td>6.51**</td>
<td>7.81**</td>
<td>1.89</td>
<td>2.09</td>
<td>6.52*</td>
</tr>
<tr>
<td>DAI</td>
<td>0.58</td>
<td>0.39</td>
<td>0.21</td>
<td>0.11</td>
<td>4.85*</td>
</tr>
<tr>
<td>PWB</td>
<td>---</td>
<td>27.09**</td>
<td>---</td>
<td>22.15**</td>
<td>---</td>
</tr>
<tr>
<td>Treatment status</td>
<td>4.17*</td>
<td>1.31</td>
<td>14.97**</td>
<td>10.17**</td>
<td>3.62*</td>
</tr>
<tr>
<td>Corrected Model</td>
<td>3.79**</td>
<td>8.9**</td>
<td>5.02**</td>
<td>9.08**</td>
<td>4.78**</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.09</td>
<td>0.26</td>
<td>0.13</td>
<td>0.27</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Model 1: controls for age, DAI, Baseline scores, and treatment status.
Model 2: controls for all the variables in model 1 in addition to PWB status.

* $p<0.05$

** $p<0.01$
**Table 4**: Observed and adjusted mean (T2) CPQ11-14, EWB and SWB scores

<table>
<thead>
<tr>
<th>Scale</th>
<th>Group</th>
<th>Observed scores</th>
<th>Adjusted scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SE)</td>
</tr>
<tr>
<td>CPQ11-14</td>
<td>Treatment</td>
<td>16.16 (10.99)</td>
<td>17.93 (1.44)*</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>23.14 (17.97)</td>
<td>20.89 (1.90)*</td>
</tr>
<tr>
<td>EWB</td>
<td>Treatment</td>
<td>2.51 (2.96)</td>
<td>2.99 (0.57)*b</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>6.82 (7.56)</td>
<td>6.16 (0.76)b</td>
</tr>
<tr>
<td>SWB</td>
<td>Treatment</td>
<td>3.03 (3.59)</td>
<td>3.48 (0.51)c</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>5.29 (6.44)</td>
<td>4.50 (0.68)c</td>
</tr>
</tbody>
</table>

SE Standard Error  
SD Standard Deviation  
*aCovariates appearing in the model are evaluated at the following values: CPQ11-14 = 22.47, DAI = 34.56, PWB = 80.52*  
*bCovariates appearing in the model are evaluated at the following values: EWB = 5.70, DAI = 34.61, PWB = 80.43*  
*cCovariates appearing in the model are evaluated at the following values: SWB = 5.38, DAI = 34.61, PWB = 80.43*
Table 5: Mean T1 and T2 CPQ11-14 scores for treatment and control groups based on PWB status.

<table>
<thead>
<tr>
<th>PWB status*</th>
<th>Treatment status</th>
<th>Mean CPQ11-14 at T1 (SD) Range</th>
<th>Mean CPQ11-14 at T2 (SD) Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low PWB</td>
<td>Treatment group</td>
<td>24.00 (12.77) 6.00-54.00</td>
<td>22.22 (11.16) 6.00-44.00</td>
</tr>
<tr>
<td></td>
<td>(N=23)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control group</td>
<td>21.68 (14.67) 5.00-63.00</td>
<td>30.00 (20.97) 5.00-73.00</td>
</tr>
<tr>
<td></td>
<td>(N=19)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High PWB</td>
<td>Treatment group</td>
<td>20.88 (14.79) 3.00-68.00</td>
<td>14.69 (9.57) 3.00-39.00</td>
</tr>
<tr>
<td></td>
<td>(N=51)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control group</td>
<td>25.88 (17.26) 3.00-80.00</td>
<td>17.92 (13.54) 2.00-51.00</td>
</tr>
<tr>
<td></td>
<td>(N=25)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*High PWB ≥ 76.6, low PWB < 76.6 (PWB was dichotomized around the mode based on published population norms (44, 47-49).)
The US Department of Health and Human Services’ initiative “Healthy People 2010” has as its first goal “to help individuals of all ages increase life expectancy and improve their quality of life”; consequently, QOL issues are coming to the forefront of public health policy agendas (47). Additionally, the movement toward evidence-based dentistry has created a demand for patient data that can document the patient’s perception of treatment need and treatment benefits (344). Hence, clinicians are increasingly being asked to justify decisions on clinical diagnosis and treatment outcomes with respect to patients’ QOL.

It is not surprising, therefore, that the concept of QOL and its relationship to treatment needs and outcomes is currently a “hot topic” in dentistry. OH-QOL instruments provide a valid method to evaluate needs and outcomes important to both the clinician and the patient. In fact, some even argue that OH-QOL should be integral in overall patient assessment as well as in gauging the efficacy of the treatment from the patient’s perspective (344,345). This is particularly applicable to orthodontics, where clinicians treat malocclusions that often carry a large psychosocial component. Nonetheless, QOL outcomes of orthodontics in children have not been well investigated. Therefore, this research was designed to study OH-QOL outcomes in children seeking orthodontic treatment.

The issues related to and arising from the studies presented in this dissertation are discussed in Manuscripts I-IV. The following is a summary of the research objectives, findings, and limitations of the study. It also discusses the relevance of these findings and
the need for future research to enhance our understanding of children’s OH-QOL measures.

This study asked four main questions: 1) Is the child OH-QOL questionnaire sensitive to change in the context of orthodontic treatment?; 2) Does SE impact OH-QOL reports in children with malocclusion?; 3) Does orthodontic treatment improve children’s OH-QOL?; and 4) Does PWB influence OH-QOL in children receiving orthodontic treatment?

A longitudinal two-phase study was designed and implemented to help answer these questions. The data provide new evidence of adolescents’ OH-QOL where information has previously been lacking. For instance, this project has established that 1) The CPQ11-14 is sensitive to change when used with children receiving orthodontic treatment; 2) The impact of malocclusion on OH-QOL is substantial in children with low SE, and SE is a salient determinant of OH-QOL in children seeking orthodontic treatment; 3) Orthodontic treatment improves OH-QOL outcomes in children, and these improvements were most evident for the social and emotional domains of OH-QOL; and 4) Children with better PWB are more likely to report better OH-QOL, regardless of their orthodontic treatment status.

There is compelling evidence in the literature to support these findings. These are discussed in depth in the manuscripts presented in chapter 7. Altogether, this dissertation has demonstrated that SE and PWB should not be viewed as outcome measures in orthodontics, but as moderators or effect-modifiers. Although OH-QOL outcomes were enhanced following orthodontic treatment, the degree of this enhancement was dependant on the individual’s psychological status. Notably, social and emotional OH-QOL
domains were more likely to be affected by such psychological factors. These results support the notion that a person’s quality of life is more of a state of mind, not only a state of health (127). Further, the results from this study confirm the central idea that the desire for orthodontic treatment is not necessarily related to the structural or functional need for treatment (346) and that the effects of malocclusion are not necessarily related to the severity of malocclusion (16,61,347).

Several methodological challenges were confronted during the conception and implementation of this study. The assessment of change, in general, is a complex process. This was complicated further by the circumstances of the current study. Issues like the multi-faceted dynamic nature of children, the long duration of orthodontic treatment, and the quasi-experimental study design demanded the inclusion of a control group to enable a meaningful interpretation of the results.

Nonetheless, despite our persistent recall efforts, the overall response rate was 59.29%. Although this approximates the response rates reported for Canadian studies using postal surveys (348,349), the relatively high attrition rate of the control group could have resulted in a biased assessment of treatment effects. As Streiner and Norman explain, uncontrolled pre-existing differences between groups in quasi-experimental designs could lead to statistical complications related to the effect of regression to the mean that can not be accounted for by ANCOVA (129).

This phenomenon is known as the “Lord’s Paradox” (350); it refers to the relationship between a continuous outcome (e.g., OH-QOL at follow-up) and a categorical exposure (e.g., the treatment/control groups) being reversed when an additional continuous covariate (e.g., baseline OH-QOL) is introduced to the analysis.
The accuracy of the results is conditional on the absence of baseline differences between groups. To rule out the possibility of this non-response bias, the pre-treatment characteristics of original and retained subjects were contrasted (manuscript IV). Fortunately, at least for the variables measured, the groups were comparable, which allowed for proper interpretation of the ANCOVA results. Thus, it is fair to conclude that the results are valid for the population of Canadian children seeking orthodontic treatment. However, the results remain limited by the convenient clinical sample used, especially considering that children are, in general, not a homogenous group. Future studies of other populations that include mid-treatment and post-retention assessments, in addition to pre- and post-treatment observations, can ascertain these results by the use of advanced statistical tests such as growth curves.

During the course of the present study, a new questionnaire titled the “condition-specific Child-OIDP (CS-OIDP)” was developed (352). The CS-OIDP allows for analysis of condition-specific impacts on daily performance by attributing impacts to specific oral conditions or diseases according to the respondent’s perceptions. The developers claim that this feature facilitates its use in needs assessment and for planning oral health care services to provide targeted interventions, increases acceptability to subjects by including only relevant dimensions (47), and may render the measure more sensitive and responsive to small changes in oral health (353).

Although it was recently found that the CS-OIDP, attributed to malocclusion, was better able than OHIP to discriminate between adolescents with and without normative needs for orthodontic treatment (352), its longitudinal psychometric properties remain unknown. Hence, there is no evidence on whether generic or condition-specific OH-QOL
measures are more appropriate for assessing longitudinal outcomes in the context of orthodontic intervention. Thus, besides being the best available measure at the time of study conception, the decision to use the generic CPQ11-14 was based on its established psychometric properties. Further, because the CPQ11-14 is a generic measure, it has the clear advantage of allowing for comparisons between conditions and across studies, which can aid in the allocation of resources among multiple service systems (31). Although generic measures may include a range of questions, some of which may not be relevant to orthodontics (56,57), they do have a great potential to pick-up unforeseen side-effects which may go undetected by a specific instrument (32,161).

Childhood oral diseases and disorders are numerous. It would be impractical for both patients and clinicians to evaluate individual change on several condition-specific OH-QOL measures at each clinical/research encounter. However, since comorbidity is not uncommon, a minor adaptation of the current CPQ11-14 to help in attributing the reported impacts to a particular oral condition might enhance the interpretability of the results. After all, continuous refinement of the instrument as it is being used was one of the objectives of the developers of the CPQ11-14, who viewed its development and testing as an iterative process (118).

In this study, patients’ PWB and SE were more important than normative evaluation when considering OH-QOL measures. While this speaks to the holistic nature of the quality of life construct, it leads to several important questions: should orthodontists be more concerned with patients who have treatment needs and psychosocial implications? Should more government funding be available for those
patients where there is strong associated psychosocial component? If so, how could clinicians incorporate it into overall patients’ assessment?

Further, identifying and classifying OH outcomes for various oro-facial conditions along a continuum of impairment, function, and disability can ultimately be used to establish benchmarks for the allocation of resources. In fact, patient-based health outcome measures are now generally accepted as necessary complements to clinical indicators for the assessment of population health needs and the evaluation of health interventions and programs (354). Therefore, the results of this study can usefully contribute to the development of policy recommendations for promoting quality of life. For example, while orthodontic treatment was mandatory or highly desirable for 13.7% of Canadian children surveyed in 1989, only 2.9% were actually under treatment (20). Hence, OH-QOL data can be valuable in efficient allocation of the limited financial resources to patients who are likely to benefit the most from treatment. However, given the shortcomings with either the objective or subjective approach to outcome assessment, a combination of both approaches is preferable for assessing outcomes in children and adolescents.

In addition, this study has important implications for topical orthodontic decision-making research. The current consensus is that treatment timing decisions should be based on individual psychosocial indications (355,356). The self-report CPQ11-14 is potentially a useful proxy measure to supplement subjective clinical opinions for determining treatment timing especially for psychosocially compromised children. This is because the CPQ11-14 reflects the contribution of the child’s SE and PWB in ameliorating the clinical severity of malocclusion; this allows for timing of treatment
according to child’s level of daily disruption. With this approach, dental services should correspond more closely to consumer-based health needs and focus more on improving the quality of life.

Further, providers need to pay more attention to patient-driven information, including evaluation of comfort, functioning, aesthetics, and psychological implications of the condition (357). Certainly, all who work with or are otherwise concerned with children would hold as one of their most important goals to ensure that children experience a life of quality (31). Hence, OH-QOL information could help the orthodontist to better diagnose and evaluate treatment and to better understand the concerns and personality of each patient, which would ultimately lead to improvement of the quality of care (12,21). That being said, current instruments pertain to a research setting more so than a clinical one, so there is a need to make the CPQ11-14 more user-friendly for various clinical contexts.

Information generated from this study would not only support the value of orthodontic intervention but would also enhance our understanding of children’s psychosocial perspective. QOL is, by nature, a holistic concept; therefore, the influence of diseases/conditions is very difficult to separate from the influence of all other experiences, both at the theoretical level and the individual patient level (31). The importance of controlling for psychological states when assessing OH-QOL is well reflected in Drotar’s comment regarding pediatric H-QOL measures assessing asthma:

“A child who experiences limitations of daily activities because of the exacerbation of symptoms of a chronic condition may experience increased depressed mood, which is a plausible consequence of his/her increased activity
limitations. However, if this child happens to have a comorbid depressive disorder, her H-QOL would also be limited, but for very different reasons. Consequently, very different clinical interventions would be indicated depending on the specific cause of the child's diminished H-QOL. Yet, despite the importance of this issue for clinical assessment, the precise causal influence of children's psychological status on H-QOL (and vice versa) has not been adequately specified or tested in models of pediatric measurement. (358) p.360

Further, as diminished H-QOL has also been linked to increased likelihood of risky health behaviors such as drinking or smoking (359), efforts to better understand adolescents’ social and emotional health as possible determinants of adverse behaviors are now the focus of many public health agencies. It has been suggested that psycho-educational interventions like social skills training, cognitive behavioral therapy, empowerment or motivational programs, and health education programs may be useful for adolescents (5,360,361). Nonetheless, the value of such interventions has not been scientifically determined. Therefore, these implications can not be extended to OH-QOL.

While the main research questions highlighted above were addressed, several others arise as the experimental work is put in context with our current knowledge. For instance, it remains unanswered if we are truly assessing QOL or merely measuring day-to-day impacts on daily life. As Locker indicates, the qualitative component of the development process of the CPQ11-14 does not meet the full requirements for a QOL measure. Nonetheless, the relatively strong correlation \((r=0.4; p<0.05)\) between CPQ11-14 scores and ratings of life overall implies that the questionnaire goes beyond the
assessment of daily activities to address aspects that have some effect on life as whole (43).

In addition, the role other contextual factors play in moderating health reports needs to be further examined. A person’s QOL, even when exclusively “health-related”, has different components, significance, and meaning that are unique for each person (127). This issue will no doubt continue to receive empirical attention to uncover the relatively independent sources of variance in OH-QOL owing to cultural, social, environmental contexts, as well as personal influences. Of particular interest here are the interactions amongst personality types, parents’ behavior, body image, and cultural norms. The use of qualitative analysis, structural equation modeling, or path analysis can also add to our understanding of how the various aspects of psychological health relate to patients’ oral quality of life and to evaluate their causal relationships (84). Thus, an impetus for further meaningful OH-QOL research in orthodontics will be provided.

Another important question to address is whether the OH-QOL differences observed in this study are clinically important. In general, responsiveness studies in children have been limited by the absence of empirical standards to define clinically meaningful changes in pediatric oral health status (31,358). Although some advocated the use of GTR to determine such a change, the clustered distribution of the sample precluded such assessment. Hence, alternate methods to determine the minimally important difference need to be further explored.

Nonetheless, the tendency for researchers to utilize diverse definitions, criteria, and measures of OH-QOL limits comparisons of results across studies and populations and, therefore, may retard the progress of research in the field of pediatric OH-QOL.
Having a common definition and assessment method of OH-QOL, standardizing scoring methods, and establishing population norms can significantly enhance the progress of further research (31).

Current conceptual and statistical advances have provided investigators with powerful tools to research OH-QOL in children. OH-QOL notion has the potential to represent the ultimate standard against which to judge the impact of malocclusion and orthodontics on children. However, despite recent progress, research has only begun to scratch the surface of the needs in the field.

This research suggests that the answer to the focal question of this project, “Does orthodontics improve OH-QOL reports in children?”, is far from being simple. OH-QOL is a complex and a multidimensional construct that is influenced by many factors deserving further investigation. Oro-facial conditions, including malocclusion, and their treatment represent only one aspect of these factors. Therefore, while the overall results support the existence of OH-QOL improvement following orthodontic treatment, higher OH-QOL was experienced when the child had positive PWB. Hence, the long-term retention of these benefits under the influence of contextual factors is yet to be affirmed (362). The empirical knowledge base for children’s OH-QOL is in an early stage of development, and we strongly believe that it will be worthwhile to further this development.
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Appendix A: Flowchart detailing the data collection progress

Data Collection

**Treatment Group**
Graduate Orthodontic clinic
100

- 2 subjects were excluded
- T1=98
  - M=42  F=56
- 13 subjects were still in treatment
- 11 subjects changed address

**Control Group**
Graduate Orthodontic wait-list
120

- 19 subjects were excluded
- T1=101
  - M=55  F=46
- 36 subjects sought treatment elsewhere
- 21 subjects changed address

T2=74
M=34  F=40

T2=44
M=25  F=19
Appendix B-1: Participant Information Sheet

“ASSESSING THE EVALUATIVE PROPERTIES OF THE CHILD ORAL HEALTH QUALITY OF LIFE QUESTIONNAIRE (COHQoL) IN THE CONTEXT OF ORTHODONTIC TREATMENT”

**Participant Information Sheet**

**Investigators:**
- Dr. David Locker  Professor, Faculty of Dentistry, University of Toronto  
  Tel: 416-979-4907, ext 4490
- Dr. Bryan Tompson  Professor, Faculty of Dentistry, University of Toronto  
  Tel: 416-979-4900, ext 4605
- Dr. Shoroog Agou  Ph.D candidate, Faculty of Dentistry, University of Toronto  
  Tel: 416-979-4907, ext 4664

**Why are we doing this study?**
We are doing this study to find out about problems children may have in their daily lives because of their teeth and mouth. We also want to find out how much the treatment they receive in this Clinic helps them not to have these problems.

**What will happen during this study?**
You and your child will fill out a questionnaire now and when your child’s treatment in this Clinic is finished. This will take no more than 10 minutes. Some questions will ask if your child has pain in his/her teeth and mouth, and if your child can chew some foods. Other questions will ask whether your child’s schoolwork or other things he/she does is affected by his/her teeth and mouth. We will also get information about your child’s teeth and mouth from the dentist and the dental records in this Clinic.

**Are there good things and bad things about this study?**
No. There is nothing in this study that can hurt either you or your child. There are no right or wrong answers. The things you tell us will help dentists to be better at treating children like your child. However, you will not benefit directly from taking part in the study.

**Who will know about what I did in the study?**
Only people who are helping with the study will see your responses to the questions. Neither your name nor your child’s name will be used on any documents reporting the results from the study. However, the researchers have an obligation to report suspicions of child abuse and neglect.

**Do my child and I have to take part in the study?**
No. Only you can decide about your and your child’s participation in the study. Even if you and your child decide to take part and later change your mind about that, nobody can make you stay in the study. No matter whether you and your child choose to be in the study or not, the dentists in this Clinic will keep providing care to your child and the members of your family.

**Who do I contact if I have any questions about the study?**
Please contact: Shoroog Agou, Research Associate, Faculty of Dentistry, University of Toronto, Tel: 416-979-4907, ext. 4664.
In addition, if you have any questions about your rights as a research participant you may contact: Dr. Rachel Zand, Manager Ethics Review Unit, University of Toronto, Tel: 416-946-3389.
Appendix B-2: Consent Form

“ASSESSING THE EVALUATIVE PROPERTIES OF THE CHILD ORAL HEALTH QUALITY OF LIFE QUESTIONNAIRE (COHQoL) IN THE CONTEXT OF ORTHODONTIC TREATMENT ”

Consent form

By signing this form I agree that the study described in the Participant Information Sheet has been explained to me and that I have been given a copy of the information sheet and the consent form. I have been also informed that information about my child’s dental health will be obtained from the dentist and the records at the Faculty of Dentistry, University of Toronto. All my questions about the study have been answered and I have been given the name of the person who I may contact if I want any further information. I understand that my child has the right not to take part in the study and the right to stop any time. I have been told that no matter what my child decides to do, he/she will continue to receive care at the Faculty of Dentistry, University of Toronto. I have been assured that my name, my child’s name and information collected will be known only to people who are helping with the study and will be not used on any documents reporting the results from the study. I also understand that the researchers have an obligation to report suspicions of child abuse or neglect. I have been informed that if I have any questions about my and my child’s rights as a research participant I may contact: Dr. Rachel Zand, Manager Ethics Review Unit, University of Toronto, Tel. 416-946-3389.

I hereby consent for my child ____________________________ to participate.

(name of child)

_________________________________
Parent’s or Guardian’s name

Name of person who obtained consent

Signature of person who obtained consent

Date _____________________________
Appendix B-3: Assent form

“ASSESSING THE EVALUATIVE PROPERTIES OF THE CHILD ORAL HEALTH QUALITY OF LIFE QUESTIONNAIRE (COHQoL) IN THE CONTEXT OF ORTHODONTIC TREATMENT”

Assent form

Investigators:
Dr. David Locker  Professor, Faculty of Dentistry, University of Toronto
Tel: 416-979-4907, ext 4490
Dr. Bryan Tompson  Professor, Faculty of Dentistry, University of Toronto
Tel: 416-979-4900, ext 4605
Dr. Shoroog Agou  Ph.D candidate, Faculty of Dentistry, University of Toronto
Tel: 416-979-4907, ext 4664

Why are we doing this study?
We are doing this study to find out about problems that children may have because of their teeth and mouth. We also want to find out how much treatment they receive in this Clinic that helps them not to have these problems.

What will happen during this study?
You will fill out a questionnaire now and when your treatment in this Clinic is finished. This will take no more than 10 minutes. Some questions will ask if your teeth and mouth hurt, and if you can chew some foods. Other questions will ask whether your teeth and mouth affect your schoolwork or other things you do. We will also ask your dentist in this Clinic to tell us about your teeth and mouth.

Are there good things and bad things about this study?
No. There is nothing in this study that can hurt you. There are no right or wrong answers. The things you tell us will help dentists to be better at treating children like you.

Who will know about what I did in the study?
Only people who are helping with the study will see your responses to the questions. Your name will not be used anywhere.

Do I have to take part in the study?
No. Only you can decide if you want to be in the study. Even if you decide to take part and later change your mind about that, nobody can make you stay in the study. No matter whether you choose to be in the study or not, your dentist in this Clinic will keep helping you with your teeth and mouth.

ASSENT:

“I was present when _________________________________ was given the above information about the study and he/she gave his/her verbal assent”

________________________________
Name of the person who obtained assent

________________________________     ________________
Signature of the person who obtained assent    Date
Dear Parent,

We appreciate your and child’s participation in our study while he/she was attending the Orthodontic Clinic at the Faculty of Dentistry in 2004. As you recall, we asked you to answer questions asking about experiences related to his/her teeth and mouth.

At this time, we would like to ask you and your child to complete the same questionnaire. This is part of the research that is being conducted by the Faculty of Dentistry, University of Toronto to find out how children feel about their teeth and mouth after their treatment in the Orthodontic Clinic has been completed.

Your participation is entirely voluntary. All responses will be kept confidential and will not be released in a manner that would identify you or your child.

We hope that you will find time to complete the questionnaire. The return envelope is provided in this package.

If you have any questions regarding this research or the questionnaire, please phone Dr. Shoroog Agou at 416-979-4901, ext 4664.

Thanks again for your and your child’s valuable assistance in this research.

Yours sincerely,

Shoroog Agou
Appendix C: The Child Perception Questionnaire

CHILD ORAL HEALTH QUESTIONNAIRE
11-14 years

Hello,

Thanks for agreeing to help us with our study!

This study is being done so that there will be more understanding about problems children may have because of their teeth, mouth, lips and jaws. By answering the questions, you will help us learn more about young people’s experiences.

PLEASE REMEMBER:

- Don’t write your name on the questionnaire
- This is not a test and there are no right or wrong answers
- Answer as honestly as you can. Don’t talk to anyone about the questions when you are answering them. Your answers are private; no one you know will see them.
- Read each question carefully and think about your experiences in the past 3 months when you answer.
- Before you answer, ask yourself: “Does this happen to me because of problems with my teeth, lips, mouth or jaws?”
- Put an X in the box for the answer that is best for you

Community Dental Health Services Research Unit
Faculty of Dentistry, University of Toronto
124 Edward Street, Toronto ON, M5S 1G6

Supported by: The Hospital for Sick Children Foundation
FIRST, A FEW QUESTIONS ABOUT YOU

1. Are you a boy or a girl?
   - Boy
   - Girl

2. When were you born? ___/___/___

3. Would you say the health of your teeth, lips, jaws and mouth is:
   - Excellent
   - Very good
   - Good
   - Fair
   - Poor

4. How much does the condition of your teeth, lips, jaws or mouth affect your life overall?
   - Not at all
   - Very little
   - Some
   - A lot
   - Very much
QUESTIONS ABOUT ORAL PROBLEMS

In the past 3 months, how often have you had:

5. Pain in your teeth, lips, jaws or mouth?
   □ Never
   □ Once or twice
   □ Sometimes
   □ Often
   □ Everyday or almost every day

6. Bleeding gums?
   □ Never
   □ Once or twice
   □ Sometimes
   □ Often
   □ Everyday or almost every day

7. Sores in your mouth?
   □ Never
   □ Once or twice
   □ Sometimes
   □ Often
   □ Everyday or almost every day

8. Bad breath?
   □ Never
   □ Once or twice
   □ Sometimes
   □ Often
   □ Everyday or almost every day

9. Food stuck in or between your teeth?
   □ Never
   □ Once or twice
   □ Sometimes
   □ Often
   □ Everyday or almost every day
10. Food stuck in the top of your mouth?

☐ Never
☐ Once or twice
☐ Sometimes
☐ Often
☐ Everyday or almost every day

For the next questions...

Has this happened because of your teeth, lips, jaws or mouth?

In the past 3 months, how often have you:

11. Breathed through your mouth?

☐ Never
☐ Once or twice
☐ Sometimes
☐ Often
☐ Everyday or almost every day

12. Taken longer than others to eat a meal?

☐ Never
☐ Once or twice
☐ Sometimes
☐ Often
☐ Everyday or almost every day

13. Had trouble sleeping?

☐ Never
☐ Once or twice
☐ Sometimes
☐ Often
☐ Everyday or almost every day
In the past 3 months, because of your teeth, lips, mouth or jaws, how often has it been:

14. Difficult to bite or chew food like apples, corn on the cob or steak?
   - Never
   - Once or twice
   - Sometimes
   - Often
   - Everyday or almost every day

15. Difficult to open your mouth wide?
   - Never
   - Once or twice
   - Sometimes
   - Often
   - Everyday or almost every day

16. Difficult to say any words?
   - Never
   - Once or twice
   - Sometimes
   - Often
   - Everyday or almost every day

17. Difficult to eat foods you would like to eat?
   - Never
   - Once or twice
   - Sometimes
   - Often
   - Everyday or almost every day

18. Difficult to drink with a straw?
   - Never
   - Once or twice
   - Sometimes
   - Often
   - Everyday or almost every day
19. Difficult to drink or eat hot or cold foods?

- Never
- Once or twice
- Sometimes
- Often
- Everyday or almost every day

QUESTIONS ABOUT FEELINGS

Have you had the feeling because of your teeth, lips, jaws or mouth? If you felt this way for another reason, answer 'Never'.

In the past 3 months, how often have you:

20. Felt irritable or frustrated?

- Never
- Once or twice
- Sometimes
- Often
- Everyday or almost every day

21. Felt unsure of yourself?

- Never
- Once or twice
- Sometimes
- Often
- Everyday or almost every day

22. Felt shy or embarrassed?

- Never
- Once or twice
- Sometimes
- Often
- Everyday or almost every day
In the past 3 months, because of your teeth, lips, mouth or jaws, how often have you:

23. Been concerned what other people think about your teeth, lips, mouth or jaws?
   - Never
   - Once or twice
   - Sometimes
   - Often
   - Everyday or almost every day

24. Worried that you are not as good-looking as others?
   - Never
   - Once or twice
   - Sometimes
   - Often
   - Everyday or almost every day

25. Been upset?
   - Never
   - Once or twice
   - Sometimes
   - Often
   - Everyday or almost every day

26. Felt nervous or afraid?
   - Never
   - Once or twice
   - Sometimes
   - Often
   - Everyday or almost every day

27. Worried that you are not as healthy as others?
   - Never
   - Once or twice
   - Sometimes
   - Often
   - Everyday or almost every day
28. Worried that you are different than other people?
☐ Never
☐ Once or twice
☐ Sometimes
☐ Often
☐ Everyday or almost every day

**QUESTIONS ABOUT SCHOOL**

*Have you had these experiences because of your teeth, lips, jaws or mouth? If it was for another reason, answer ‘Never’.*

**In the past 3 months, how often have you:**

29. Missed school because of pain, appointments, or surgery?
☐ Never
☐ Once or twice
☐ Sometimes
☐ Often
☐ Everyday or almost every day

30. Had a hard time paying attention in school?
☐ Never
☐ Once or twice
☐ Sometimes
☐ Often
☐ Everyday or almost every day

31. Had difficulty doing your homework?
☐ Never
☐ Once or twice
☐ Sometimes
☐ Often
☐ Everyday or almost every day

32. Not wanted to speak or read out loud in class?
☐ Never
☐ Once or twice
☐ Sometimes
☐ Often
☐ Everyday or almost every day
QUESTIONS ABOUT YOUR SPARE-TIME ACTIVITIES & BEING WITH OTHER PEOPLE

Have you had these experiences because of your teeth, lips, jaws or mouth? If it was for another reason, answer ‘Never’.

In the past 3 months, how often have you

33. Avoided taking part in activities like sports, clubs, drama, music, school trips?
   □ Never
   □ Once or twice
   □ Sometimes
   □ Often
   □ Everyday or almost every day

34. Not wanted to talk to other children?
   □ Never
   □ Once or twice
   □ Sometimes
   □ Often
   □ Everyday or almost every day

35. Avoided smiling or laughing when around other children?
   □ Never
   □ Once or twice
   □ Sometimes
   □ Often
   □ Everyday or almost every day

36. Had difficulty playing a musical instrument such as a recorder, flute, clarinet, trumpet?
   □ Never
   □ Once or twice
   □ Sometimes
   □ Often
   □ Everyday or almost every day
37. Not wanted to spend time with other children?

- Never
- Once or twice
- Sometimes
- Often
- Everyday or almost every day

38. Argued with other children or your family?

- Never
- Once or twice
- Sometimes
- Often
- Everyday or almost every day

39. Other children teased you or called you names?

- Never
- Once or twice
- Sometimes
- Often
- Everyday or almost every day

40. Other children made you feel left out?

- Never
- Once or twice
- Sometimes
- Often
- Everyday or almost every day

41. Other children asked you questions about your teeth, lips, jaws or mouth?

- Never
- Once or twice
- Sometimes
- Often
- Everyday or almost every day
THERE, IT'S FINISHED!

Just one more thing. To test how good this questionnaire is at giving us the information we need, we would like a group of children to complete it again.

Would you be willing to help us by completing another copy of the questionnaire soon? We would mail it to you in the next 2 weeks.

YES ☐

THANK YOU FOR HELPING US
Appendix D: Global Transition Ratings (Treatment Group)

Please answer the following questions:

1. **Compared to the time before orthodontic treatment (braces), how happy are you with the way your teeth look now?**
   - Very happy
   - Happy
   - Unhappy
   - Very unhappy

2. **Compared to the time before orthodontic treatment (braces), how happy are you with the way your teeth come together now?**
   - Very happy
   - Happy
   - Unhappy
   - Very unhappy

3. **Compared to the time before orthodontic treatment (braces), do you think the way your teeth look has:**
   - Improved a lot
   - Improved somewhat
   - Improved a little
   - Stayed the same
   - Worsened a little
   - Worsened somewhat
   - Worsened a lot

4. **Compared to the time before orthodontic treatment (braces), do you think the way your teeth come together has:**
   - Improved a lot
   - Improved somewhat
   - Improved a little
   - Stayed the same
   - Worsened a little
   - Worsened somewhat
   - Worsened a lot

5. **Think about the health of your teeth, lips, jaws, and mouth. Compared to the time before you started orthodontic treatment (braces), has it:**
   - Improved a lot
   - Improved somewhat
   - Improved a little
   - Stayed the same
6. Think about how your life overall is affected by your teeth, lips, jaws, and mouth. Compared to the time before you started orthodontic treatment (braces), has it:

- Improved a lot
- Improved somewhat
- Improved a little
- Stayed the same
- Worsened a little
- Worsened somewhat
- Worsened a lot
Appendix E: Global Transition Ratings (Control Group)

Please answer the following questions:

1. Compared to the first time you answered this questionnaire, how happy are you with the way your teeth look now?
   - Very happy
   - Happy
   - Unhappy
   - Very unhappy

2. Compared to the first time you answered this questionnaire, how happy are you with the way your teeth come together now?
   - Very happy
   - Happy
   - Unhappy
   - Very unhappy

3. Compared to the first time you answered this questionnaire, do you think the way your teeth look has:
   - Improved a lot
   - Improved somewhat
   - Improved a little
   - Stayed the same
   - Worsened a little
   - Worsened somewhat
   - Worsened a lot

4. Compared to the first time you answered this questionnaire, do you think the way your teeth come together has:
   - Improved a lot
   - Improved somewhat
   - Improved a little
   - Stayed the same
   - Worsened a little
   - Worsened somewhat
   - Worsened a lot

5. Think about the health of your teeth, lips, jaws, and mouth. Compared to the first time you answered this questionnaire, has it:
   - Improved a lot
   - Improved somewhat
   - Improved a little
   - Stayed the same
• Worsened a little
• Worsened somewhat
• Worsened a lot

6. Think about how your life overall is affected by your teeth, lips, jaws, and mouth. Compared to the first time you answered this questionnaire, has it:
• Improved a lot
• Improved somewhat
• Improved a little
• Stayed the same
• Worsened a little
• Worsened somewhat
• Worsened a lot
Appendix F: Self-Esteem scale

CHILD HEALTH QUESTIONNAIRE

How do you generally feel about yourself?

Hello,

Thanks for agreeing to help us with our study. By answering the questions, you will help us learn more about experiences children may have. This questionnaire asks about your moods and feeling and how you feel about yourself and life overall.

- Answer by checking the appropriate box for each question.
- Certain questions may look alike but each one is different.
- Some questions ask about problems you may not have. That is great, but it’s important for us to know. Please answer each question.
- There are no right or wrong answers. If you are unsure how to answer a question, please give the best answer you can and make a comment in the margin. All comments will be read, so please feel free to make as many as you wish.

Community Dental Health Research Unit
Faculty of Dentistry, University of Toronto
124 Edward Street, Toronto ON, M5G 1G6
**SELF ESTEEM**

How do you feel about yourself, school, and others? It may be helpful if you keep in mind how other children your age might feel about these areas.

**During the past 4 weeks, how good or bad have you felt about:**

<table>
<thead>
<tr>
<th></th>
<th>Very good</th>
<th>Somewhat good</th>
<th>Neither good nor bad</th>
<th>Some what badly</th>
<th>Very Badly</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Yourself?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Your schoolwork?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Your ability to play sports?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Your friendships?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. The things you CAN do?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. The way you get along with others?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. Your body and your looks?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. The way you seem to feel most of the time?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. The way you get along with your family?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j. The way life seems to be for you?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>k. Your ability to be a friend for others?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>l. The way others seem to feel about you?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>m. Your ability to talk with others?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n. Your health in general?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Child Health Questionnaire- Child self report form 87 (CHQ-CF87)
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Appendix G: Psychological Wellbeing scale

**PSYCHOLOGICAL WELLBEING**

The following phrases are about children’s moods and feelings they may have.

During the past 4 weeks, how much of the time did you:

<table>
<thead>
<tr>
<th></th>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Feel sad</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Feel like crying</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Feel afraid or scared</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Worry about things</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Feel lonely</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Feel unhappy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. Feel nervous</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. Feel bothered or upset</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Feel happy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j. Feel cheerful</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>k. Enjoy the things you do</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>l. Have fun</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>m. Feel jittery or restless</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n. Have trouble sleeping</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o. Have headaches</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p. Like yourself</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Child Health Questionnaire- Child self report form 87 (CHQ-CF87)  
1991, 1996 © Landgraf and Ware
What is the date today? / / Month/day/year

Thank you for helping us
Appendix H: The Dental Aesthetic Index Recording Form

ID # _____________________ Date __________________

Name ____________________ Male ____ Female ____ Date of Birth __________

Geographic Location ____________________ Ethnic Group ____________ Examiner ___________

Cases Needing Referral for Further Evaluation

Gross Anomaly
Cleft Lip or Palate
Traumatic or Surgical Defect
Deep Overbite Impinging on gingival Tissue

Have you ever had orthodontic treatment? Yes           No

Have any of your teeth been extracted to improve appearance?  Yes          No

If Yes, which teeth?

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 CONSTANT</td>
<td></td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>1 Missing incisor, canine and premolar teeth—Maxillary and Mandibular Enter total #</td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>2 Crowding in the incisal segments</td>
<td>0 = no segment crowded</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>2 Crowding in the incisal segments</td>
<td>1 = segment crowded</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2 Crowding in the incisal segments</td>
<td>2 = 2 segments crowded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Spacing in the incisal segments</td>
<td>0 = no spacing</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3 Spacing in the incisal segments</td>
<td>1 = 1 segment spaced</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Spacing in the incisal segments</td>
<td>2 = 2 segments spaced</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Diastema in mm</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>5 Largest anterior irregularity—Maxilla (upper) in mm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>6 Largest anterior irregularity—Mandible (lower) in mm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>7 Anterior Maxillary Overjet (upper) in mm</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>8 Anterior Mandibular Overjet (lower) in mm</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>9 Vertical anterior openbite in mm</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>10 Antero-posterior molar relation</td>
<td>Normal=0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Antero-posterior molar relation</td>
<td>½ cusp=1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Antero-posterior molar relation</td>
<td>Full cusp=2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 TOTAL (add lines 0 through 11)</td>
<td></td>
<td></td>
<td>214</td>
</tr>
</tbody>
</table>

DIRECTIONS FOR CALCULATING A DAI SCORE

For lines 1-10, multiply Column A by Column B and enter the result in Column C. Then: add Column C including Line 0 to obtain DAI score.
Appendix I: The Peer Assessment Rating Form

<table>
<thead>
<tr>
<th>PAR Index Components</th>
<th>Before Treatment</th>
<th>Total</th>
<th>After Treatment</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Anterior Segment</td>
<td>R: (3-2) (2-1) (1-1) UW W</td>
<td></td>
<td>R: (3-2) (2-1) (1-1) UW W</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L: (1-2) (2-3)</td>
<td></td>
<td>L: (1-2) (2-3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>x1</td>
<td></td>
<td>x1</td>
<td></td>
</tr>
<tr>
<td>Lower Anterior Segment</td>
<td>R: (3-2) (2-1) (1-1)</td>
<td></td>
<td>R: (3-2) (2-1) (1-1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L: (1-2) (2-3)</td>
<td></td>
<td>L: (1-2) (2-3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>x1</td>
<td></td>
<td>x1</td>
<td></td>
</tr>
<tr>
<td>Right Buccal Occlusion</td>
<td>AP</td>
<td></td>
<td>AP</td>
<td></td>
</tr>
<tr>
<td>Transverse</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>x1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left Buccal Occlusion</td>
<td>AP</td>
<td></td>
<td>AP</td>
<td></td>
</tr>
<tr>
<td>Transverse</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>x1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overjet/Anterior Crossbite</td>
<td>/</td>
<td></td>
<td></td>
<td>x6</td>
</tr>
<tr>
<td></td>
<td>x6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overbite/Open Bite</td>
<td>/</td>
<td></td>
<td></td>
<td>x2</td>
</tr>
<tr>
<td></td>
<td>x2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Centerline</td>
<td></td>
<td></td>
<td></td>
<td>x4</td>
</tr>
<tr>
<td></td>
<td>x4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals:</td>
<td></td>
<td></td>
<td>Totals:</td>
<td></td>
</tr>
</tbody>
</table>

Measured Incisor Overjet       | Percent Resolved: ____________________________ |
| mm                           | Notation: ___________________________________ |

Date of Examination: ____________________________

Provider Name: ____________________________
Provider No.: ____________________________
Telephone No.: ____________________________

Patient Name: ____________________________
ID No.: ____________________________
Birth Date: ____________________________