# Subjective Orthodontic Treatment Outcomes in a Medicaid Population

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Abstract

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**Introduction:** Orthodontic treatment outcomes have traditionally been determined according to objective measures, but some researchers and clinicians have turned their focus to subjective outcome measures, such as oral health-related quality of life (OHQoL) and body image (BI). A randomized clinical trial (RCT) compared the objective outcomes of interceptive (ETX) and comprehensive (CTX) orthodontic treatment in a Medicaid population. The aim of the current study was to compare the subjective treatment outcomes of these two groups. **Methods:** An attempt was made to contact all of the subjects who had completed the RCT. Of 134 subjects, 58 (27 ETX, 31 CTX) completed two questionnaires—one for OHQoL and one for BI. The questionnaire results of the two treatment groups were compared using Student's *t*-tests. Univariate linear regression analyses were performed to identify socio-demographic and occlusal/skeletal variables

that predicted OHQoL and BI scores. Predictors of appointment-keeping were also identified using the same statistical method. **Results:** Mean overall OHQoL and BI scores were better for the CTX group than the ETX group. Incisor irregularity and anterior dental esthetics at the end of the trial were found to predict long-term OHQoL and BI scores, whereas ethnicity was found to predict failed and late appointment rates. **Conclusions:** In adolescent patients with Medicaid insurance, comprehensive orthodontic treatment produces long-term subjective outcomes, which are superior to interceptive treatment alone.

# TABLE OF CONTENTS

Page

# LIST OF FIGURES

# LIST OF TABLES

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# DEDICATION

To Sugar Mama and Bwana

# Introduction

The success of orthodontic treatment has traditionally been determined by comparing the post-treatment tooth positions and relationships of the hard and soft tissues to established norms or ideals. This emphasis on objective treatment outcomes seems appropriate, given that the correction of tooth malposition and associated orofacial disharmonies through tooth movement and growth modification are viewed as the goals of orthodontic therapy.

However, in recent years, there has been a trend toward measuring treatment outcomes according to *subjective*—in addition to *objective*—measures. After all, since psychosocial concerns are often the reason adolescent patients and their parents seek orthodontic treatment, it follows that treatment success should be evaluated with more patient-centered criteria in mind [de Oliveira and Sheiham, 2008]. Subjective measures such as oral health-related quality of life (OHQoL), body image, and others have been quantified in an attempt to determine the psychosocial impact of malocclusion and orthodontic treatment on adolescent populations.

One study of nearly 1700 15- and 16-year-old Brazilians revealed a higher OHQoL in those who had received orthodontic treatment [de Oliveira and Sheiham, 2004], and it has been demonstrated that individuals with a normal dental appearance are perceived as more attractive, more sought after as friends, and more intelligent [Shaw, 1981]. Conversely, unattractive occlusal traits in school children have been linked to teasing and ridicule by classmates [Shaw et al., 1980]. Orthodontic treatment need in Saudi Arabian young adults was associated with such diverse impacts as mouth aching, self-consciousness, tension, irritability, embarrassment, taste quality, relaxation, and life

satisfaction [Hassan and Amin, 2010]. More commonly, however, researchers have linked orthodontic treatment to improvements in emotional and social well-being, but not in oral symptoms or functional limitations, such as mastication or speech articulation [O'Brien, 2005; Zhang et al., 2006].

A systematic review identified 23 articles pertaining to malocclusion/orthodontic treatment need and standardized OHQoL measures. While the search period was set to 1960-2007, the oldest of the 23 articles was from 2000, demonstrating that the focus on patient-centered outcomes in orthodontics is a recent development. Most of the studies that met the inclusion criteria reported an association between malocclusion/treatment need and OHQoL, but the strength of the association was generally moderate at best, partially owing to the largely cross-sectional design of the studies [Liu et al., 2009].

An OHQoL instrument used widely with children and adolescents is the Child Oral Health-Related Quality of Life questionnaire (COHQoL). The COHQoL has been shown to reliably reflect global oral health and overall well-being [Jokovic et al., 2002]. In a trial of 430 12- and 13-year-olds in New Zealand who were administered the $CPQ_{11\text{-}14}$ (the version of the COHQoL for 11- to 14- year-olds), adolescents with a handicapping malocclusion scored worse than those in the minor/no malocclusion category. However, in agreement with previous findings, this difference was only seen in the Emotional and Social Well-being domains. No difference was seen across groups in the Oral Symptoms or Functional Limitations domains [Foster-Page et al., 2005].

The body image instrument titled "Images of Yourself" was derived from Secord and Jourard's body cathexis scale. This scale was first modified by Kiyak et al. to include the assessment of more body parts, particularly those related to facial features [Kiyak et al.,

1986]. These authors demonstrated a greater increase in body image scores for adults undergoing surgical orthodontics than for those undergoing conventional orthodontic treatment. The instrument was further revised by Tung and Kiyak to be used with younger populations [Tung and Kiyak, 1998]. King et al. found improvements in the facial and teeth domains of the body image scores of 126 adolescents who had received comprehensive orthodontic treatment. However, overall body image scores did not improve [King et al., Spring 2012].

Some authors have investigated relationships between specific malocclusion features and psychosocial well-being. For example, overjet has been shown to be associated with a lower OHQoL, poorer self-rating of one's teeth, and teasing by classmates. Other malocclusion characteristics that have been linked to psychosocial well-being are spacing, incisor irregularity, and extreme deep bite [Helm et al., 1985; Johal et al., 2007; Kiplelainen et al., 1993].

Few studies have examined subjective treatment outcomes in low-income populations, despite indications that both subjective and objective treatment need may be higher in ethnic minority groups, which are disproportionately represented in the Medicaid population [Kelley et al., 1973; Nelson et al., 2004]. Cost serves as a barrier to orthodontic treatment for adolescents from low-income families who could benefit from orthodontic therapy. While some of these adolescents would qualify for Medicaid-funded treatment, many providers are reluctant to accept them as patients. In 1999 less than 1% of Medicaid-eligible children in the state of Washington received orthodontic care [King et al., 2006]. This is partly because only the most severe malocclusions qualify for treatment, yet another factor is the critical shortage of orthodontists who accept Medicaid payments for

reimbursement. Only 31% of Washington orthodontists and 24% of North Carolina orthodontists report participating in Medicaid. Low reimbursement rates were the primary reason given for non-participation, but clinicians have also cited excessive bureaucracy and poor patient compliance [Im et al., 2007; King et al., 2006].

There is some evidence to support concerns regarding compliance. Medicaid patients at one university clinic missed more appointments than private pay or insurance patients [Horsley et al., 2007]. In another study, Medicaid patients receiving early treatment missed more appointments and had worse oral hygiene than their private-pay counterparts. However, their objective treatment outcomes were similar to private-pay subjects [Mirabelli et al., 2005].

In a randomized clinical trial begun in 2003 at the University of Washington (Disparities RCT), adolescents who qualified for orthodontic care under Medicaid were randomized to either early orthodontic treatment in the mixed dentition or comprehensive treatment in the permanent dentition. The trial aimed to test the hypothesis that access to care may be increased for Medicaid patients by adopting an interceptive model for orthodontic treatment, the argument being that orthodontists may be persuaded to treat more Medicaid-eligible patients if treatments were shorter and simpler. However, some orthodontists object to an interceptive model, given that early treatment does not usually produce a "finished" result, and most interceptive patients will not qualify for Medicaid-funded phase II treatment [Jolley et al., 2010].

Consistent with the results of previous studies supporting the efficacy of treatment in the mixed dentition [Keeling et al., 1998; King and Brudvik, 2010; Pangrazio-Kulbersh, 1999; Tulloch et al., 1998], subjects in the Disparities RCT showed significant improvement

in PAR and ICON scores following interceptive treatment compared to those who were only observed during the same period [Jolley et al., 2010]. However, a comparison of the two groups at the completion of the trial revealed greater improvements in PAR and ICON scores for the comprehensive subjects [King et al., July 2012].

The first aim of the current retrospective study was to describe the subjective outcomes in the Disparities RCT subjects several years after treatment and to compare those outcomes between treatment groups. The results could be valuable for clinicians who currently treat or are considering accepting Medicaid-eligible patients. Another aim was to identify specific malocclusion features whose severity or improvement is associated with better subjective treatment outcomes. This information could help guide the decision-making process of practitioners when determining whether to treat a Medicaid patient interceptively or wait to do comprehensive treatment. For patients who are treated in the mixed dentition, these results could assist in determining which occlusal variables should be prioritized to achieve a satisfactory long-term psychosocial outcome in a reasonable period of time.

Further, hypothesizing that factors which are unrelated to a patient's dentition may be just as important to psychosocial well-being as occlusal measures, the influence of socio-demographic variables on subjective treatment outcomes was also evaluated. Finally, given practitioners' concerns regarding compliance in Medicaid populations, an attempt was made to identify patient characteristics (occlusal or socio-demographic) that are associated with compliance outcomes.

## Materials and Methods

The population for this study was derived from the Disparities RCT. The subjects were Medicaid-eligible pre-adolescent children between the dental ages of 8 and 11 who were screened at the University of Washington or Odessa Brown Children's Clinic, a public health clinic in Seattle. Half of the subjects were randomized to up to two years of early orthodontic treatment in the mixed dentition followed by two years of observation (Early Treatment Group--ETX). The other half of the subjects was randomized to two years of observation followed by two years of comprehensive orthodontic treatment (Comprehensive Treatment Group—CTX). A total of 170 subjects were enrolled, and 134 subjects (65—ETX and 69—CTX) completed the trial. The details of the RCT study design and results have been previously reported [King et al., July 2012].

An attempt was made to contact each of the 134 subjects who completed the RCT by telephone. Those subjects who were successfully contacted were invited to participate in the current study by completing two questionnaires, Tung and Kiyak's Body Image instrument (BI) and a revised version of the $CPQ_{11\text{-}14}$ (COHQoL). Some of the language of the $CPQ_{11\text{-}14}$ was modified for this study to be appropriate for the current age range of the subjects (14-21 years). The BI questionnaire (without language modifications) had previously been administered to the subjects as part of the RCT. BI data were available at the beginning of the trial (T1), following early treatment or two years of observation (T2), and at the completion of the trial (T3). See Figure 1 for a description of each timepoint.

Individuals who agreed to participate were given the option of completing the questionnaires online or by mail. Those who chose the online option were emailed the link to the website where they could access the questionnaires. Up to two reminder emails were

sent at one-week intervals if the questionnaires had not been completed. Those who chose regular mail received no reminders. Consent was obtained from each subject who was 18 years of age or older and the parent or guardian of each minor subject. Assent was obtained from each minor subject. Participants were instructed to complete the questionnaires without parental help and were compensated with a $20 gift certificate to an online retailer. The Seattle Children's Hospital and Regional Medical Center Institutional Review Board approved the study.

T1 and T3 study casts were scored independently and in random order by two examiners who were blinded to treatment group assignment. The following occlusal variables were recorded: overjet, overbite, incisor irregularity, midline discrepancy, and presence of anterior open bite, crossbite, or impinging bite. Incisor irregularity was measured according to the method of Little [1975] with the following two exceptions: 1) maxillary and mandibular incisor irregularity were summed to obtain an overall score 2) contact point displacement was measured the same whether crowding or spacing was present in the dental arch.

Inter-examiner and intra-examiner reliability were determined by measuring 30 sets of casts (15 T1 and 15 T2) twice, approximately two weeks apart. The error rate was calculated with Dahlberg's formula. Additionally, if the examiners' measurements differed by more than 3 mm for Irregularity Index or 1 mm for overjet, overbite, or midline discrepancy, the casts were re-scored until satisfactory agreement was achieved. All disagreements on the presence of anterior open bite, crossbite, and impinging deep bite were resolved via consensus.

Lateral cephalometric radiographs from T1 and T3 were scanned and imported into Dolphin Orthodontic Imaging Software (Patterson Dental Supply, Saint Paul, MN). A single examiner blinded to treatment group assignment identified anatomical landmarks to obtain the following cephalometric measurements: ANB, maxillary incisor proclination (U1 to N-A, degrees), mandibular plane angle (S-N to M-P, degrees), ratio of lower anterior facial height to total anterior facial height (ANS to menton divided by N to menton, percentage), and facial convexity (N-subnasale-soft tissue pogonion, degrees).

Some of the data for the current study had already been gathered for previous studies. ICON Esthetic Index scores had been determined by two calibrated examiners. The number of failed and tardy appointments had been compiled. The following socio-demographic data had been recorded at baseline; birth date; gender; ethnicity; household size; language spoken at home; parent's education level, marital status, and employment status; and number of siblings and adults in household who had received orthodontic treatment.

All data were analyzed with statistical software SPSS for Mac (version 19.0, SPSS, Armonk, NY). To test for sampling bias, independent samples *t*-tests and chi-squared tests were used to compare the socio-demographic and occlusal characteristics of the RCT subjects who responded to the questionnaires with those who did not.

The effect of treatment group assignment on subjective treatment outcomes was evaluated using independent samples *t*-tests. The T4 BI scores and BI score changes over time of ETX respondents were compared to the scores of CTX respondents. The comparisons were repeated for T4 COHQoL scores, but changes in COHQoL over time were

not analyzed since this questionnaire was not administered at T1 or T3. Overall and component scores of both instruments were evaluated.

To search for predictors of subjective treatment outcomes, univariate linear regression analyses were performed with overall COHQoL and BI scores as the dependent variables and socio-demographic, occlusal, and compliance measures as the explanatory variables. To search for predictors of compliance, the analyses were repeated with percentages of failed and tardy appointments as the dependent variables. For all analyses, the significance level was set at $P < .05$.

# Results

Inter-examiner and intra-examiner reliability for cast and cephalometric measurements were found to be acceptable. For cast measurements, mean intra-examiner reliability ranged from 0.19 mm for overjet (Examiner #2) to 1.47 mm for incisor irregularity (Examiner #1). Inter-examiner reliability ranged from 0.25 mm for overbite to 1.77 mm for incisor irregularity. For cephalometric measurements, intra-examiner reliability ranged from $0.66^0$ for ANB to $1.95^0$ for maxillary incisor proclination. Error rates as determined using Dahlberg's formula are presented in Table 1.

A flow chart detailing subject recruitment can be found in Figure 1. Of 134 total subjects, 99 were successfully contacted. Of those, 95 agreed to participate. The parents of 3 subjects refused to provide consent, and 1 subject was disabled and could not complete the questionnaires. Only 5 individuals opted to receive the questionnaires by mail. Of 95 subjects who agreed to participate, only 58 actually completed the questionnaires. These represented 34% of the original sample. Respondents were evenly distributed between treatment groups, with 27 from the ETX group and 31 from the CTX group.

Only a few significant differences were found between the subjects who completed the questionnaires and those who did not (Tables 2-3). Respondents were more often female (64% vs. 41%), had a lower Incisor Irregularity Index at T3 (4.4 mm vs. 6.0 mm), and had a higher ANB at T3 ($3.9^0$ vs. $2.6^0$).

Overall and component COHQoL scores at long-term follow-up (T4) for all 58 respondents by treatment group can be found in Figure 2. The overall scores and all of the domain scores except Oral Symptoms were significantly lower for the CTX group (reflecting a *higher* quality of life) than the ETX group.

Long-term follow-up (T4) BI showed a similar pattern, with comprehensive subjects scoring higher (*better* body image) than early treatment subjects on overall BI and Facial, Mouth, and Teeth components (Figure 3). There was no difference between groups in the Facial Profile component. The greatest difference between groups occurred in the Teeth component, with comprehensive subjects scoring 1.35 points higher than the early treatment subjects. This finding was highly significant ($P < .001$). No differences were found between groups when comparing *changes* in BI scores, whether from T1 to T4, T3 to T4, or end of treatment to T4 (Figures 4-6). Surprisingly, on the whole BI scores appeared to decrease over time, even from baseline to follow-up. A notable exception was changes in Teeth component scores, which were higher at T4 than T1. However, there was a clear trend for scores to decrease *less* for the CTX group than the ETX group.

When univariate linear regression analyses were performed, the only variables found to be significant predictors of overall COHQoL at T4 (follow-up) were T3 (end of trial) Irregularity index ($P < .05$), change in Irregularity Index from T1 to T3 ($P < .05$) and ICON Esthetic Index score at T3 ($P < .01$, Table 4). The latter represents a subject's dental esthetics as judged by an examiner comparing diagnostic casts with 10 intraoral frontal-view reference photographs. A score of 1 is the most esthetic; 10 is the least esthetic. The regression results indicate that every additional ICON Esthetic Index point (*worse* esthetics) was associated with an increase of 2.58 points on the COHQoL scale (*lower* quality of life). Similarly, every additional millimeter of incisor irregularity at T3 was associated with 1.42 additional COHQoL points, and every mm of *correction* of incisor irregularity from T1 to T3 predicted a 0.60 point decrease in COHQoL score.

Significant predictors of T4 (follow-up) Body Image were T1 (baseline) parent/guardian employment status, change in Irregularity Index during the course of the trial (T1 to T3), change in overjet , T3 midline discrepancy, and T3 open bite (Table 5). The only variable that reached a high level of significance was change in overjet ($P$ = .001). Improvements from T1 to T3 in irregularity index, overjet, and midline discrepancy all predicted a better BI score, although the effects were minimal and unlikely to be clinically significant. Interestingly, a subject whose parent was employed had, on average, a BI score 0.36 points lower than a subject whose parent was not employed. Of all the predictors of BI, the presence of open bite at T3 had the largest effect. This effect was unexpected in that, on average, subjects without an open bite had a BI score 0.53 points *lower* than subjects with an open bite.

Parent/guardian employment status, ethnicity, language spoken at home, change in Irregularity Index (T1to T3), and change in overbite (T1 to T3) were all found to be predictors of appointment keeping (Table 6). Subjects of employed parents failed 4.2% more appointments than subjects whose parents were not employed. Asian and Hispanic subjects had the lowest failed appointment rate, followed by Caucasians and then African/African-Americans. The failed appointment rate was lowest for subjects who spoke Mandarin or Cantonese at home; there was no statistical difference among subjects who spoke other languages. The predictive value of changes in incisor irregularity or overbite from T1 to T3, while statistically significant, was low. For every millimeter of improvement in Irregularity Index, the failed appointment rate decreased by 0.3%. For every millimeter decrease in overbite, the rate decreased by 1.3%.

Only ethnicity was found to predict the rate of appointment tardiness (Table 7). Caucasian subjects had the lowest tardy rate, followed closely by Asians and Hispanics. African/African-American subjects had the highest tardy rate. No baseline occlusal variables were found to have predictive value for either appointment keeping or appointment tardiness.

# Discussion

No other study to date has quantified long-term subjective treatment outcomes such as oral health-related quality of life and body image in a Medicaid population. With the recent downturn in the U.S. economy influencing the funding of public health programs, it is important to demonstrate the benefits to low-income individuals of orthodontic treatment, which is largely viewed as elective. While current criteria rely solely on normative measures to determine eligibility for treatment, it has been argued that the psychosocial impact of an individual's malocclusion and the potential for improvement in this area should be factored into the allocation of scarce public health resources [de Oliveira and Sheiham, 2008]. Clinicians who treat low-income patients would benefit from information about how to most favorably influence their long-term psychological well-being, both by treating them at the optimal time and by focusing their efforts on correcting conditions that are strongly correlated to psychological outcomes.

In this study, subjects who underwent two years of observation followed by comprehensive orthodontic treatment had a higher oral health-related quality of life and body image than subjects who received limited treatment in the mixed dentition. This result was consistent for overall scores on the two instruments, as well as for nearly all of the domain and component scores.

Previous research utilizing the quality of life instrument we used in this study ($CPQ_{11\text{-}14}$) has shown an association between orthodontic treatment need and Emotional and Social Well-being domain scores, but not Oral Symptoms or Functional Limitations scores [Foster-Page et al., 2005]. Therefore, it is not surprising that the CTX subjects, whose malocclusion was less severe than the ETX subjects at the end of the trial as measured with

PAR [King et al., July 2012], demonstrated a better quality of life from an emotional and social perspective. It is also not unexpected that the CTX subjects' oral symptoms were no more or less severe than their ETX counterparts. However, the fact that the CTX group reported fewer functional limitations suggests that comprehensive treatment produces better subjective outcomes in several psychosocial areas as compared to early treatment alone.

It should be remembered that the $CPQ^{11-14}$ was developed for younger adolescents and has not been validated in a late adolescent/young adult population. However, we felt that this instrument was appropriate for our participants, most of whom were in their late teens (mean age = 17.5 yrs, range = 14.1 – 21.1 yrs). A few of the items required minor modifications, but these did not significantly alter the content of the questions. For example, "other young people" was substituted for "other children" on several items. To our knowledge, there is no oral health-related quality of life instrument validated for this age range, and instruments such as the Dental Impact on Daily Living [Leao and Sheiham, 1996] and the Oral Health Impact Profile [Slade and Spencer, 1994] were developed specifically for middle-aged and older adults, respectively.

Long-term overall BI scores were superior in the CTX group, as were the Facial, Mouth, and Teeth components of BI. There was no difference between groups in the Facial Profile component. It may be that individuals, while highly conscious of their dental esthetics [Shaw, 1980], are relatively unaware of their facial profile and how it compares to those of other individuals.

Due to the design of the Disparities clinical trial, the ETX subjects had been out of treatment longer than the CTX subjects at T4 (6.10 years vs. 3.46 yrs, respectively). It is

possible that this contributed to the differences seen between treatment groups in subjective outcomes through the following two mechanisms: relapse and adaptation. All ETX subjects received retainers at the end of treatment and were seen regularly for retainer checks. It is not uncommon for retainers delivered in the mixed dentition to require multiple adjustments as the permanent teeth erupt. Often the original retainers fit so poorly that a new set must be fabricated unless a second phase of treatment will be started soon. Many of the ETX subjects were forced to go without retainers after some time because Washington State Medicaid only covers one set of retainers, and the subjects' families couldn't afford to buy replacement retainers. The ensuing potential for relapse in the early treatment group may have led to poor quality of life scores, reflecting the negative impacts of malocclusion on their self image and daily activities. Alternatively, the poor scores could simply reflect the additional time that ETX subjects had to become accustomed to their improved oral condition and appearance. In other words, they may have 'gotten used to' their new condition. This tendency for short-lived improvements in happiness to diminish over time has been termed "Hedonic adaptation" [Brickman and Campbell, 1971].

It is worth noting that the protocol for the RCT, wherein subjects who were two to three years away from full permanent dentition were assigned to either interceptive or comprehensive treatment, mimics the normal situation in clinical practice. Orthodontists regularly examine children in the mixed dentition and must decide whether to treat them immediately or wait until the permanent teeth have erupted. This decision carries additional weight in a Medicaid population because the majority of patients who undergo a first phase of treatment will not qualify for a second phase [Jolley et al, 2010]. Therefore,

orthodontists often shoulder the burden of deciding between the immediate benefits of early treatment and the long-term advantages of comprehensive treatment. The results of this study suggest that the average patient will benefit more from a psychosocial standpoint if treatment is delayed until adolescence.

Figure 8 compares our sample's COHQoL scores with those from previous studies. De Oliveira et al. [2008] surveyed 187 adolescents (mean age 12.2 years) who sought orthodontic treatment at a clinic in Bedfordshire, UK. Their mean score of 18.4 fell in between the two groups of the current study (CTX—14.2, ETX—26.3). The 430 New Zealand adolescents tested by Foster Page et al. [2005] represented a population-based sample (mean age 12.7 years), but their mean overall COHQoL score of 17.3 was similar. The scores reported for orthodontic and pediatric subjects by Jokovic et al. [2002] were close to those of our CTX subjects, but the craniofacial mean score of 31.4 was well above (*worse* quality of life) that of our ETX subjects. Participants of Jokovic's study were asked to indicate how much they believed their oral or orofacial condition affected their overall well-being. Those who reported that they were 'not at all affected' had a mean COHQoL score of 15.2. Those who reported being 'affected a lot' had a mean score of 36.6. These results suggest that our CTX subjects experience little to no negative impacts due to their current oral condition, whereas ETX subjects experience at least some, and possibly many, negative impacts. These results must be interpreted with caution, however, due to significant differences between the samples, including age, ethnicity, and other characteristics.

Tung and Kiyak [1998] administered the BI instrument to 75 fourth- and fifth-graders in Seattle, Washington and Anchorage, Alaska. The mean age of their subjects was

10.9 years (range 8.8-12.5 years). Subjects were untreated, currently undergoing treatment, or had finished treatment. The overall, Facial, and Facial Profile BI scores (3.48, 3.45, 3.58) were very similar to the scores of our CTX subjects (3.51, 3.61, 3.42). Mouth and Teeth component scores were not reported. These authors reported that history of orthodontic treatment was not correlated with Body Image score.

It is interesting that while follow-up (T4) Body Image scores were clearly different between treatment groups, *changes* in Body Image—whether from baseline or end of the trial to T4—were not statistically different. Additionally—and unexpectedly—Body Image scores generally *decreased* in both groups. However, there was a definite trend favoring the comprehensive treatment group (i.e. the BI of CTX subjects still decreased but less so than ETX subjects). We believe that these unfavorable changes might reflect "teenage angst", i.e. the increasing self-criticism of individuals as they develop from children and adolescents into young adults [Baldwin and Hoffmann 2002].

The univariate linear regression analyses showed that improvements in the following occlusal variables predicted a better long-term (T4) oral health-related quality of life: anterior alignment at the end of the trial (T3), ICON Esthetic Index score at T3, and improvement in anterior alignment from T1 to T3. When considering the large number of statistical comparisons that were performed, a *P*-value of 0.49 for the latter of these, *change* in anterior alignment, was not compelling. For the ICON Esthetic Index, a single point increase (*worse* esthetics) predicted a COHQoL score increase of two and a half points (*worse* quality of life). An association between perceived dental esthetics and quality of life has been demonstrated previously [Klages, 2004]. On the surface, our results suggest that, ultimately, a patient's quality of life is most affected by whether or not he/she perceives

his/her front teeth to be "straight." The importance of other treatment considerations should not be underestimated, however, given that anterior dental esthetics are largely determined by factors such as overjet, incisor angulation, and overbite.

No socio-demographic variables were predictive of COHQoL. While this would not be expected for a general quality of life instrument, it must be remembered that as an oral health-related QoL instrument, the $CPQ_{11-14}$ was designed to elicit the impact of an individual's oral condition on his or her daily life. Prior to responding to each question, participants are specifically instructed to ask themselves "*Does this happen to me because of my teeth, lips, mouth, or jaws?*"

Improvement in anterior alignment and overjet from T1 to T3, coincident dental midlines, and having an employed parent or guardian all predicted a better long-term BI score. Once again accounting for a large number of comparisons, only improvement in overjet during the course of the trial was convincingly correlated with BI scores at T4. Each millimeter of overjet correction was associated with a 0.09 point increase in Body Image. Therefore, a reduction in overjet from 8 mm to 2 mm (roughly equivalent to the correction of a full-cusp class II malocclusion) was associated with a half point increase in Body Image.

One of the limitations of our study is that we did not gather additional records from our subjects, so we could only evaluate the explanatory value of dental and skeletal characteristics at *the end of the trial* (T3) on *long-term* (T4) subjective treatment outcomes. Therefore, the results of the linear regression analyses must be viewed with caution, given that they don't account for potential post-treatment relapse, which could have been significant in some cases. Unfortunately, it was not feasible to take records on the survey respondents for this study.

The only occlusal variables found to predict failed appointment rate were change in incisor irregularity and change in overbite. In each case, the effects were very small. No occlusal variables were predictive of the rate of tardy appointments. The fact that the nature or severity of a subject's malocclusion were essentially unrelated to his or her ability to make it to appointments on time was anticipated. We had hypothesized, however, that socio-demographic factors would be important in determining appointment-keeping behavior, and this proved to be true. Parental employment status, ethnicity, and language spoken at home were all found to predict failed appointment rate, while ethnicity was found to predict tardy appointment rate.

With a *P*-value of 0.036. parental employment status appeared to be relatively unimportant, but ethnicity and language were highly significant predictors. Given the interrelationship between these two variables, a linear regression was performed with both of them as explanatory variables. This analysis identified ethnicity as the only significant predictor of failed appointment rate. Similarly, ethnicity was the only variable (occlusal or socio-demographic) that was associated with late appointment rate.

The underlying causes for this disparity are likely varied and complex. It may be that individuals of different ethnic backgrounds face dissimilar barriers to accessing care. In other words, culture may be more important than economics when it comes to who gets orthodontic treatment. Another contributor could be an ethnic/cultural variance in orthodontic utility, or the relative values that different individuals assign to orthodontic treatment and/or the absence of malocclusion [Scheppers et al 2005].

For the orthodontic practitioner who accepts Medicaid insurance, it is vital to recognize that interceptive treatment has been demonstrated to reduce malocclusion

severity, and is often appropriate. However, the majority of interceptive patients will not qualify for Medicaid-funded phase II treatment [Jolley et al. 2010], so often it will be advantageous to wait for a single phase of comprehensive treatment in the permanent dentition, given that this has been shown to result in superior objective and subjective outcomes on average.

When interceptive treatment is utilized, clinicians should remember that subjective outcomes are closely associated with anterior dental esthetics, so long-term retention is encouraged, even if the treatment goals are limited. For Medicaid patients who can't afford phase II treatment, this may entail making a second set of retainers after the eruption of the permanent dentition.

Finally, while intuitively one might think that malocclusion severity influences appointment-keeping behavior, it appears that it is more closely related to socio-demographic factors such as ethnicity. Missed and late appointments have the potential to adversely affect the financial health of practices that accept Medicaid patients, and could also lead to longer treatment times and inferior outcomes. Additional research is needed to investigate the effects of culture on appointment-keeping and other compliance measures. Meanwhile, providers are encouraged to consider cultural influences when scheduling patients and communicating with patients and parents about the importance of regular visits.

# Conclusions

1. In a Medicaid population, adolescent subjects who received comprehensive orthodontic treatment had better long-term subjective treatment outcomes (oral health-related quality of life and body image) than subjects who received interceptive orthodontic treatment alone.
2. Better *long-term* oral health-related quality of life was associated with decreased incisor irregularity and better anterior dental esthetics *at the end of the trial*.
3. Better *long-term* body image was associated with greater reduction in overjet *during the course of the trial.*
4. Appointment-keeping, measured as failed and late appointments, was unrelated to any measure of malocclusion, but it varied by up to 13% among ethnicities.

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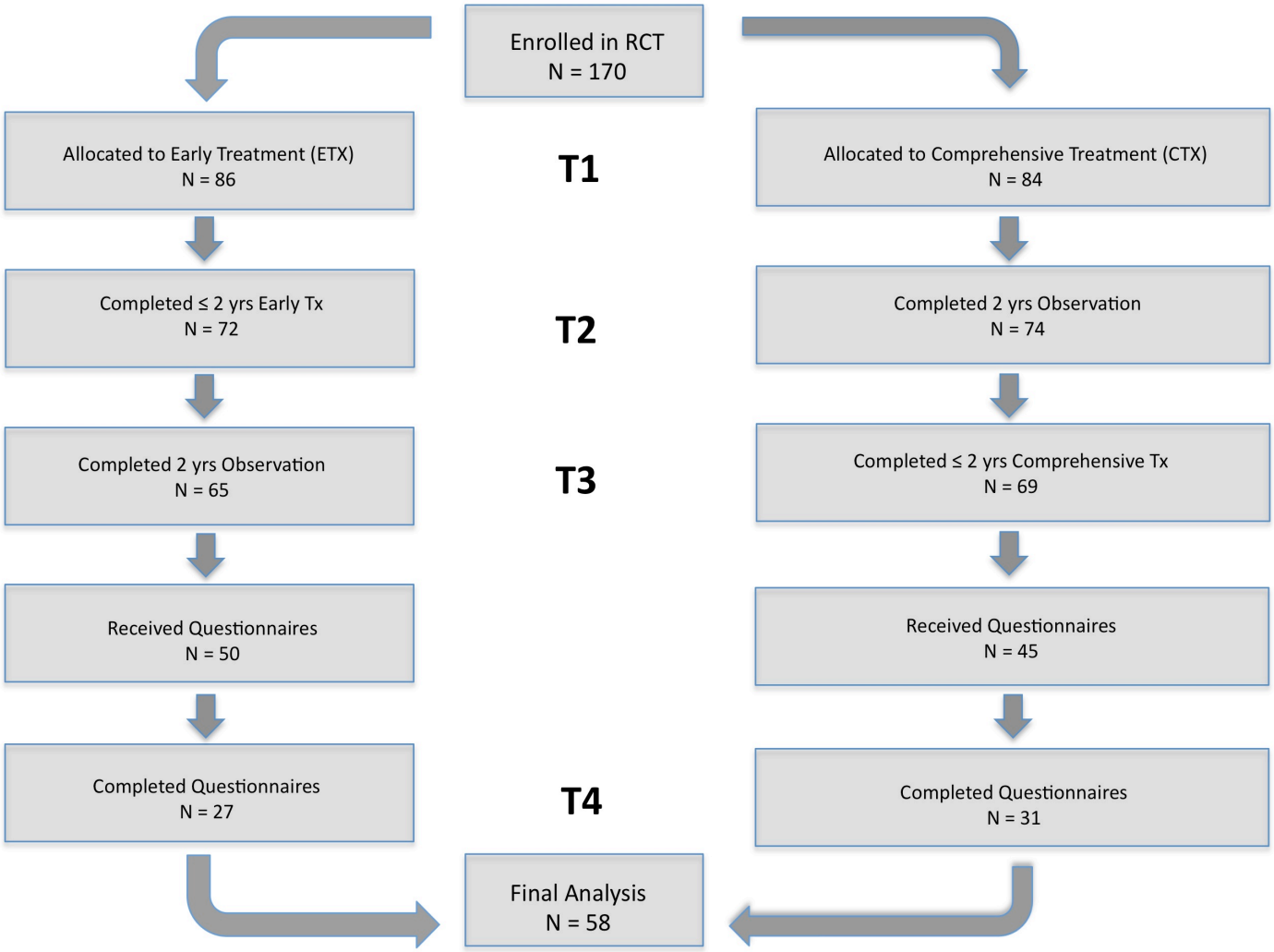
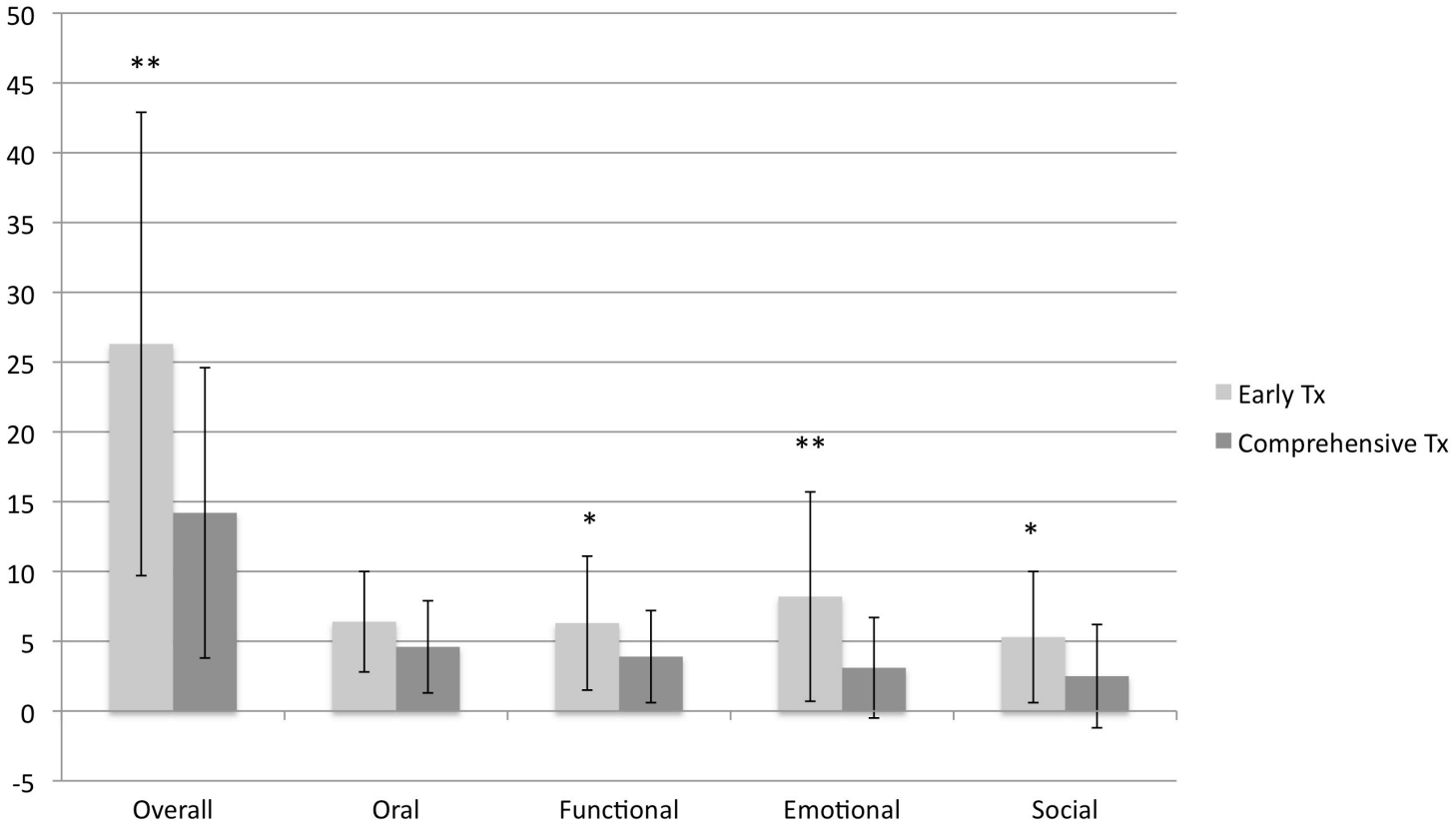
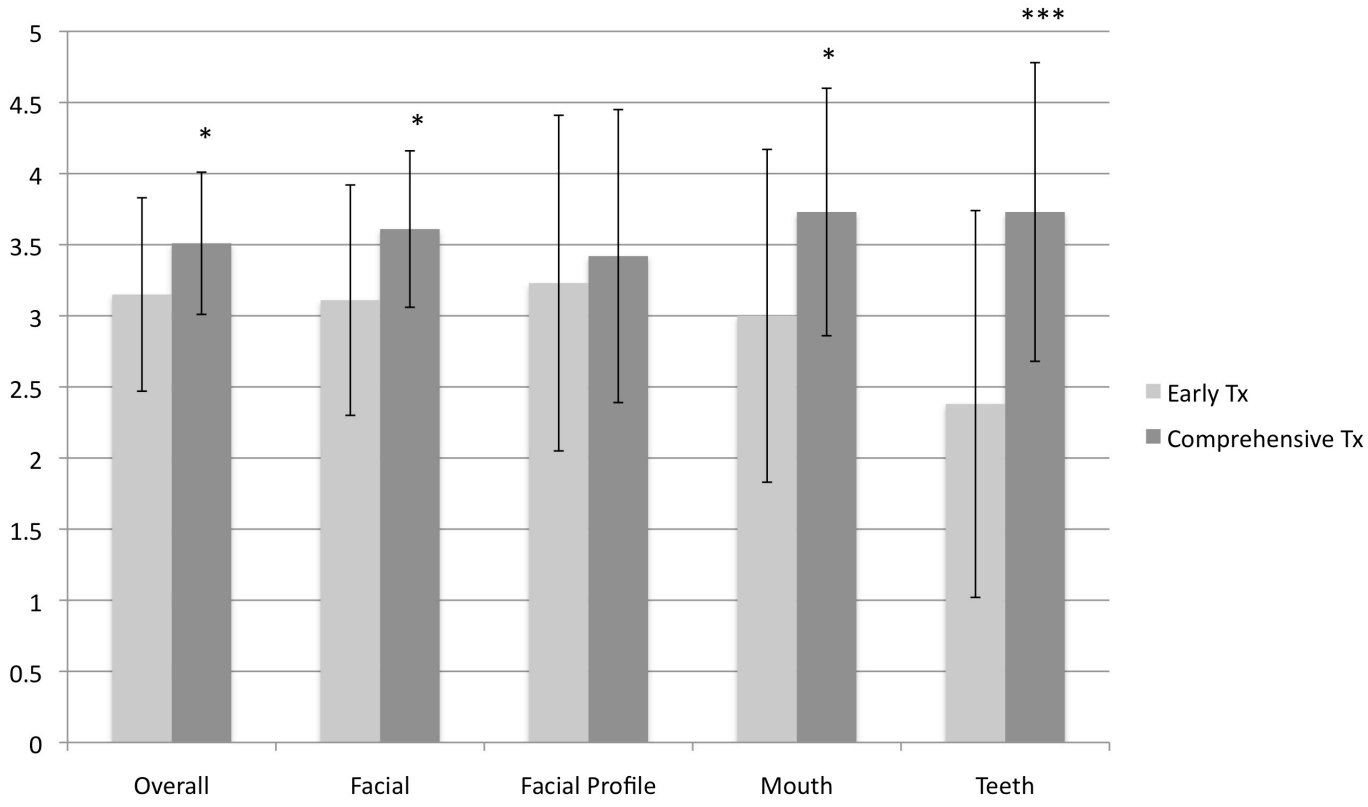



Figure 1. Flow diagram for study subjects




*$P$ <0.05 **$P$ <0.01

Figure 2. Overall and domain COHQoL scores with standard deviations at T4 (N = 58)




*$P$ <0.05 ***$P$ <0.001

Figure 3. Overall and component Body Image scores with standard deviations at T4 (N = 58)

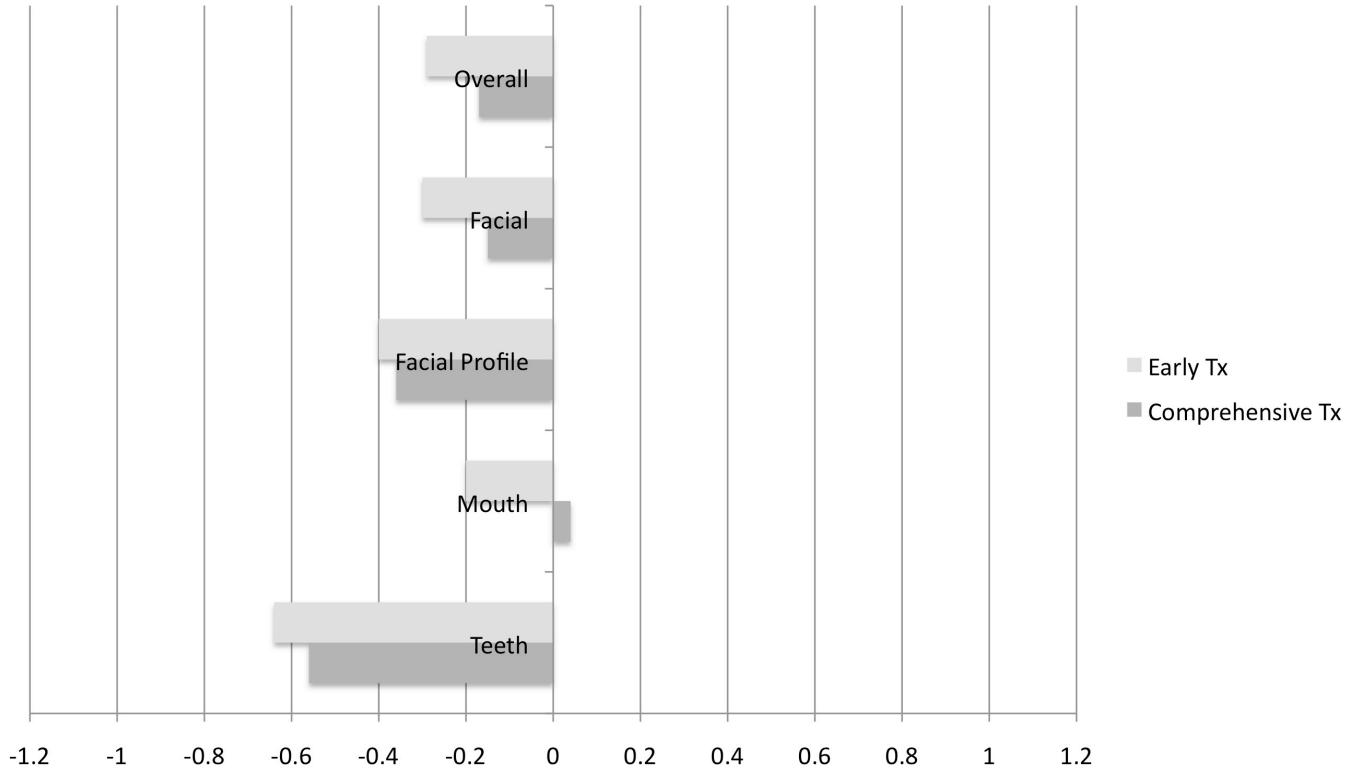



Figure 4. Change in overall and component Body Image scores from T3 to T4 (N = 58). Negative score reflects a decrease in Body Image.

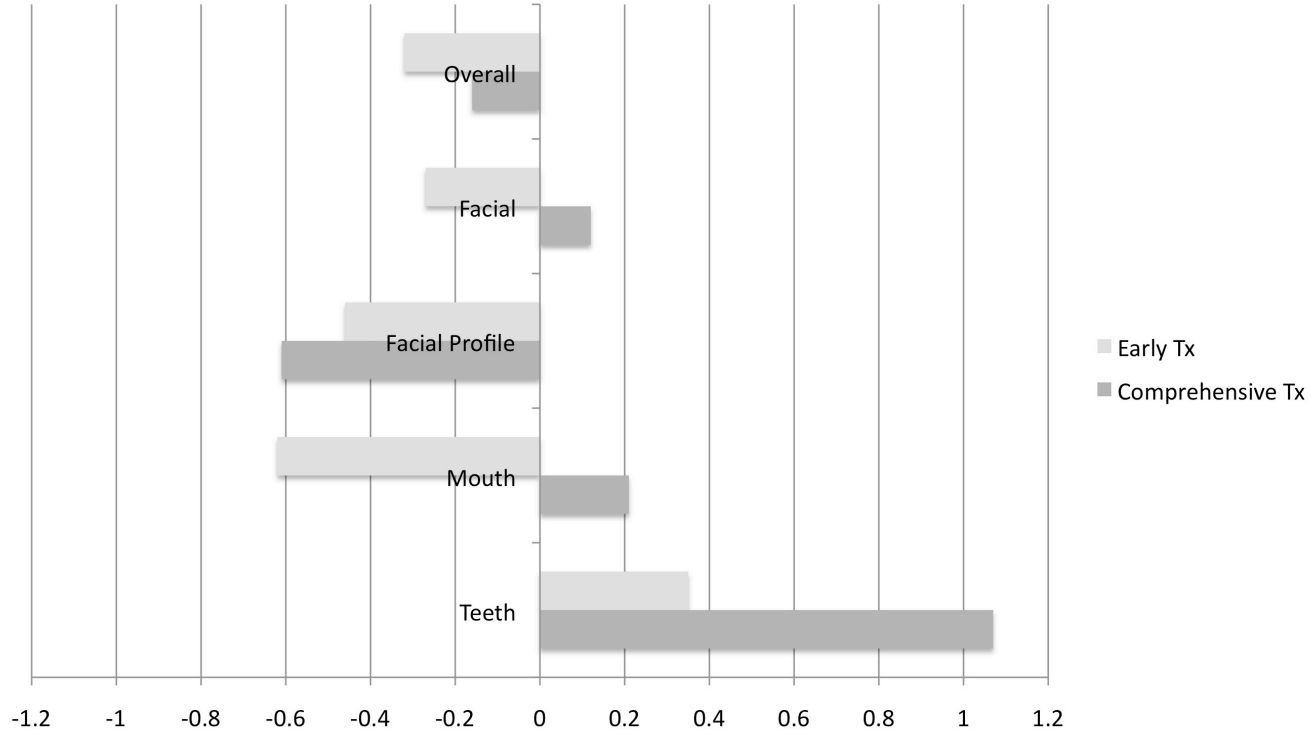



Figure 5. Change in overall and component Body Image scores from T1 to T4 (N = 58). Negative score reflects a decrease in Body Image.

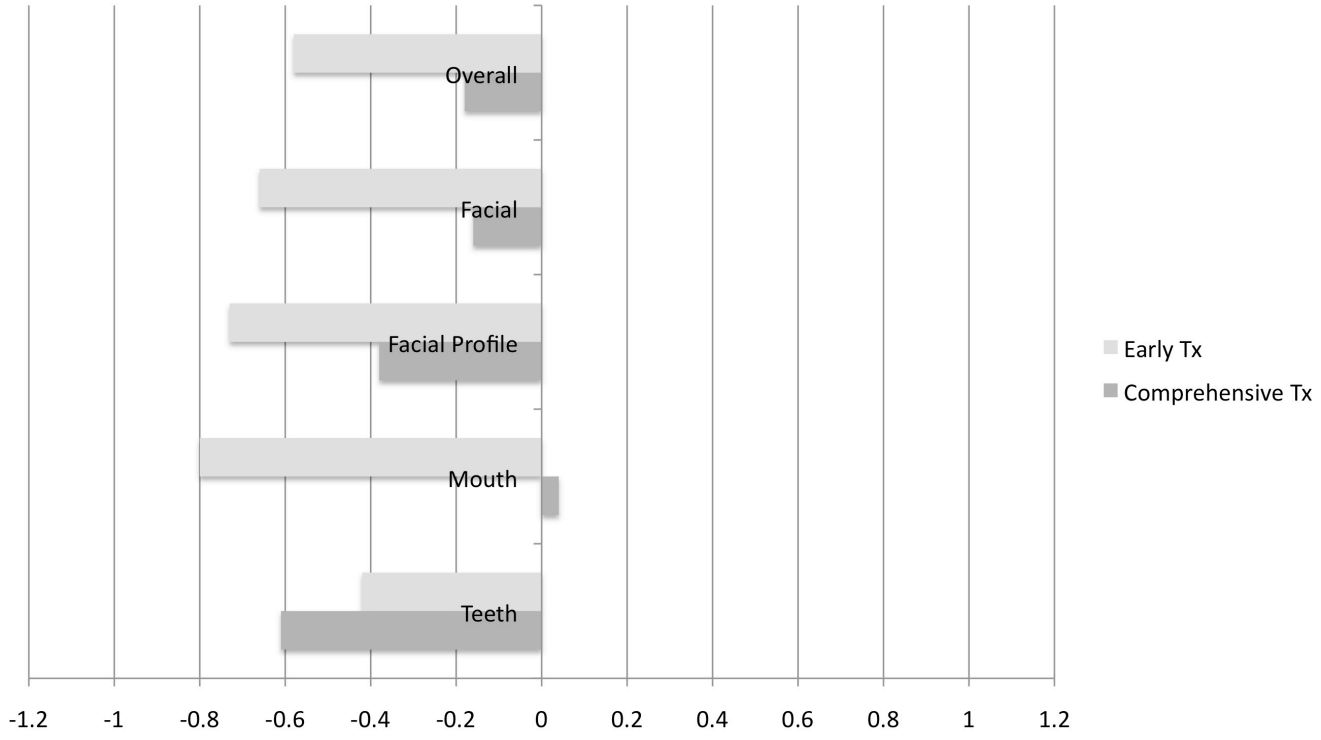



Figure 6. Change in overall and component Body Image scores from end of treatment to T4 (N = 58). Negative score reflects a decrease in Body Image.

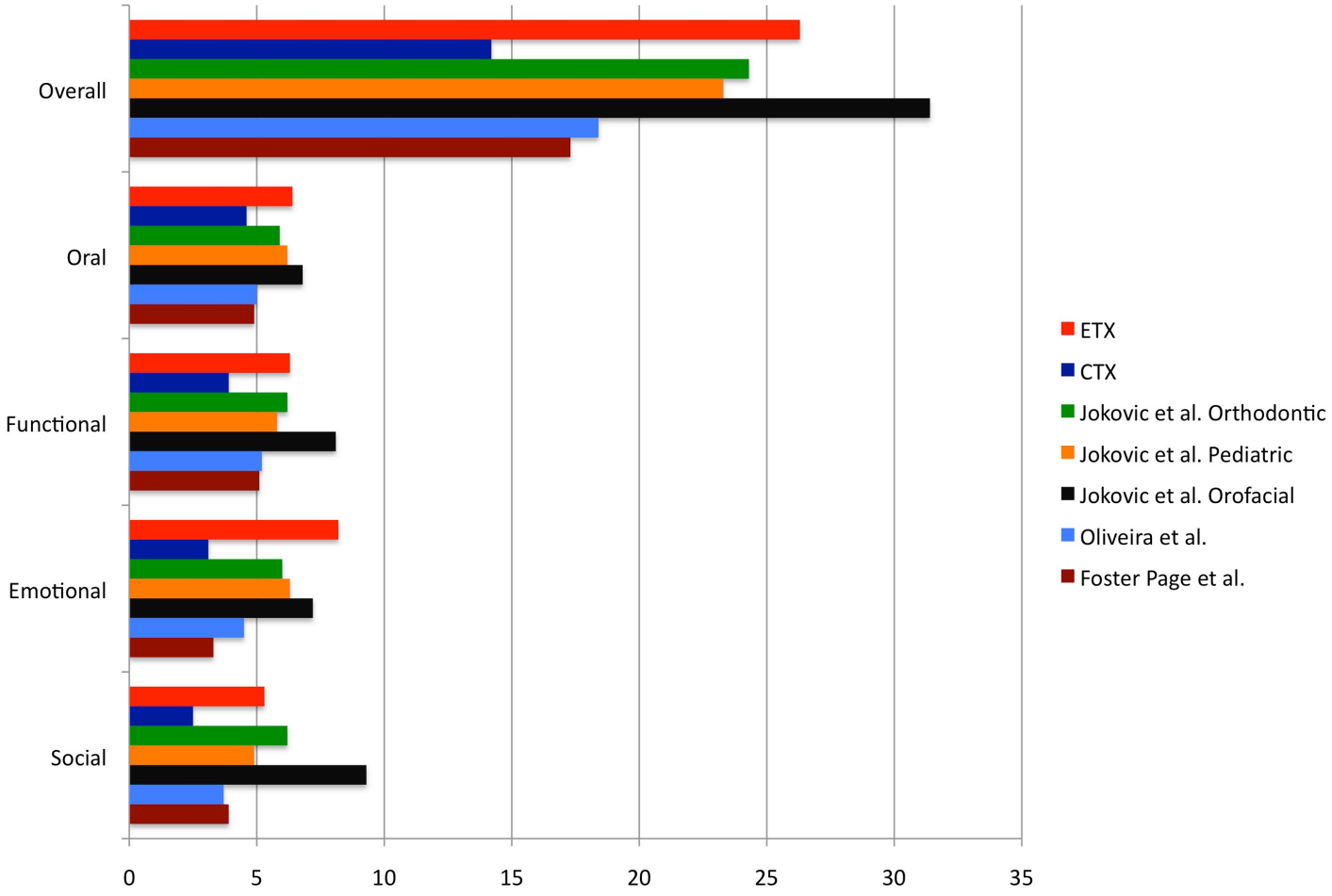



Figure 7. COHQoL scores of ETX and CTX subjects compared to various study populations

**Table 1.** Reliability as measured with Dahlberg's formula

| | Incisor irregularity (mm) | Overjet (mm) | Overbite (mm) | Midline discrepancy (mm) | ANB (°) | U1-SN (°) | MP-SN (°) | Facial Convexity (°) | LAFH (%) |
|---|---|---|---|---|---|---|---|---|---|
| Examiner #1 | 1.47 | 0.23 | 0.25 | 0.34 | 0.66 | 1.95 | 0.95 | 1.2 | 0.80 |
| Examiner #2 | 1.03 | 0.19 | 0.33 | 0.32 | | | | | |
| Inter-examiner | 1.77 | 0.32 | 0.25 | 0.41 | | | | | |

**Table 2.** Socio-demographic characteristics of respondents and other subjects

| | | Respondents | Non-respondents | P-value |
|---|---|---|---|---|
| N | | 58 | 76 | |
| Current age (yrs) | | 17.5 (1.4) | 17.8 (1.4) | 0.303 |
| Age at T1 (yrs) | | 9.2 (1.1) | 9.4 (1.2) | 0.443 |
| Time since T3 (yrs) | | 3.7 (0.8) | 3.8 (0.7) | 0.452 |
| Time since end of Tx (yrs) | | 4.6 (1.6) | 4.8 (1.4) | |
| Number of people in household | | 3.9 (1.6) | 4.3 (1.6) | 0.18 |
| Parent/guardian education (yrs) | | 12.1 (3.4) | 11.8 (3.3) | 0.597 |
| **Sex** | **Male** | **36.2%** | **59.0%** | **0.008**** |
| Ethnicity | | | | 0.82 |
| | Caucasian | 15.5% | 15.4% | |
| | African/African-American | 34.5% | 42.3% | |
| | Asian | 27.6% | 19.2% | |
| | Hispanic | 12.1% | 11.5% | |
| | Other | 10.3% | 11.5% | |
| Language spoken at home | | | | 0.303 |
| | English | 70.7% | 75.6% | |
| | Somalian/Ethiopian | 3.4% | 9.0% | |
| | Vietnamese | 12.1% | 5.1% | |
| | Mandarin/Cantonese | 5.2% | 2.6% | |
| | Spanish | 8.6% | 7.7% | |
| Parent/guardian marital status | | | | 0.514 |
| | Married | 47.4% | 41.3% | |
| | Divorced | 10.5% | 13.3% | |
| | Single | 26.3% | 32.0% | |
| | Other/No response | 15.8% | 13.3% | |
| One or more siblings had Tx | | 13.8% | 20.5% | 0.302 |
| One or more adults in household had Tx | | 1.7% | 3.8% | 0.448 |
| Parent/guardian employed | | 61.0% | 39.0% | 0.746 |

**$P < 0.01$

**Table 3.** Occlusal characteristics of respondents and other subjects

| | | Respondents | Non-respondents | P-value |
|---|---|---|---|---|
| N | | 56 | 78 | |
| Incisor irregularity (mm) | T1 | 12.8 (6.0) | 13.6 (6.0) | 0.449 |
| | **T3** | **4.4 (3.7)** | **6.0 (4.4)** | **0.046*** |
| Overjet (mm) | T1 | 5.0 (3.4) | 5.1 (3.5) | 0.917 |
| | T3 | 3.8 (1.8) | 3.7 (2.3) | 0.831 |
| Overbite (mm) | T1 | 2.7 (2.2) | 2.4 (1.7) | 0.421 |
| | T3 | 2.3 (1.6) | 2.3 (1.4) | 1 |
| Midline discrepancy (mm) | T1 | 1.0 (1.0) | 1.0 (1.2) | 0.99 |
| | T3 | 0.5 (0.9) | 6.0 (1.0) | 0.705 |
| ICON Esthetic Index | T1 | 7.5 (2.0) | 7.3 (1.0) | 0.442 |
| | T3 | 4.1 (2.0) | 4.3 (3.0) | 0.677 |
| ANB (°) | T1 | 4.1 (3.4) | 4.1 (3.1) | 0.907 |
| | **T3** | **3.9 (2.7)** | **2.6 (3.3)** | **0.047*** |
| U1-SN (°) | T1 | 26.2 (8.4) | 28.9 (7.7) | 0.108 |
| | T3 | 25.1 (8.3) | 28.1 (7.7) | 0.093 |
| LAFH (%) | T1 | 57.1 (2.8) | 57.6 (3.0) | 0.327 |
| | T3 | 56.9 (2.8) | 56.9 (2.7) | 0.999 |
| MP-SN (°) | T1 | 39.3 (6.2) | 38.3 (6.7) | 0.442 |
| | T3 | 38.1 (6.2) | 36.4 (6.7) | 0.228 |
| Facial convexity (°) | T1 | 162.0 (7.9) | 160.8 (7.1) | 0.481 |
| | T3 | 160.6 (6.0) | 161.9 (7.9) | 0.429 |
| Open bite | T1 | 16.1% | 20.8% | 0.49 |
| | T3 | 13.6% | 13.2% | 0.952 |
| Impinging bite | T1 | 32.1% | 33.5% | 0.969 |
| | T3 | 13.6% | 8.8% | 0.445 |
| Crossbite | T1 | 42.9% | 45.5% | 0.768 |
| | T3 | 4.5% | 13.2% | 0.099 |

**$P$ <0.05

**Table 4.** Regression coefficients for socio-demographic and occlusal variables with overall COHQoL score as dependent variable

| | | | Confidence Interval | | |
|---|---|---|---|---|---|
| Socio-demographic variables | | B | Lower Bound | Upper Bound | P-value |
| Current age | | -0.22 | -3.03 | 2.58 | 0.875 |
| Age at T1 | | 0.00 | -3.49 | 3.50 | 0.999 |
| Time since T3 | | 4.20 | -0.65 | 9.05 | 0.089 |
| Number of people in household | | -1.53 | -4.09 | 1.03 | 0.235 |
| Parent/guardian education | | 1.10 | -0.10 | 2.30 | 0.071 |
| Failed appointment rate | | 21.49 | -18.90 | 61.88 | 0.29 |
| Late appointment rate | | -10.01 | -38.99 | 18.97 | 0.491 |
| One or more siblings had Tx | Yes | -5.42 | -16.73 | 5.90 | 0.342 |
| One or more adults in household had Tx | Yes | 2.64 | -26.70 | 31.97 | 0.858 |
| Parent/guardian employed | Yes | -1.15 | -9.32 | 7.03 | 0.78 |
| Sex | Female | -1.52 | -9.69 | 6.66 | 0.711 |
| Ethnicity | | | | | 0.681 |
| | African/African-American | 0 | | | |
| | Hispanic | -8.26 | -21.52 | 4.99 | |
| | Asian | -1.30 | -11.42 | 8.82 | |
| | Caucasian | 1.11 | -11.00 | 13.23 | |
| Language spoken at home | | | | | 0.275 |
| | English | 0 | | | |
| | Spanish | -8.57 | -22.49 | 5.36 | |
| | Vietnamese | -3.51 | -15.53 | 8.52 | |
| | Mandarin/Cantonese | 4.97 | -12.62 | 22.55 | |
| | Somalian/Ethiopian | -19.37 | -40.66 | 1.93 | |
| Parent/guardian marital status | | | | | 0.215 |
| | Married | 0 | | | |
| | Divorced | -9.32 | -22.49 | 3.86 | |
| | Single | -0.68 | -10.08 | 8.72 | |
| Occlusal variables | | | | | |
| **Incisor irregularity** | **T3** | **1.42** | **0.29** | **2.56** | **0.015*** |
| | **ΔT1-T3** | **0.60** | **0.00** | **1.20** | **0.049*** |
| Overjet | T3 | 0.51 | -2.05 | 3.07 | 0.69 |
| | ΔT1-T3 | 1.11 | -0.44 | 2.66 | 0.156 |
| Overbite | T3 | 0.77 | -1.97 | 3.51 | 0.575 |
| | ΔT1-T3 | 0.33 | -1.92 | 2.58 | 0.771 |
| Midline discrepancy | T3 | 3.66 | -0.96 | 8.27 | 0.117 |
| | ΔT1-T3 | 0.94 | -2.83 | 4.72 | 0.616 |
| **ICON Esthetic Index** | **T3** | **2.58** | **0.71** | **4.44** | **0.008**** |
| | ΔT1-T3 | 1.01 | -0.78 | 2.80 | 0.259 |
| ANB | T3 | -1.10 | -2.93 | 0.73 | 0.232 |
| | ΔT1-T3 | -0.21 | -3.59 | 3.18 | 0.902 |
| U1-SN | T3 | 0.52 | -0.06 | 1.10 | 0.075 |
| | ΔT1-T3 | 0.25 | -0.39 | 0.88 | 0.432 |
| LAFH | T3 | -1.56 | -3.27 | 0.16 | 0.074 |
| | ΔT1-T3 | -1.54 | -4.47 | 1.40 | 0.29 |
| MP-SN | T3 | -0.35 | -1.13 | 0.44 | 0.378 |
| | ΔT1-T3 | 0.72 | -1.20 | 2.64 | 0.446 |
| Facial convexity | T3 | 0.55 | -0.33 | 1.43 | 0.211 |
| | ΔT1-T3 | 0.52 | -1.50 | 2.54 | 0.588 |
| Open bite (Yes) | T3 | 3.93 | -9.01 | 16.87 | 0.543 |
| Change in open bite (T1-T3) | | | | | 0.286 |
| | Never present | 0 | | | |
| | Corrected | -9.77 | -25.08 | 5.55 | |
| | Uncorrected | 10.90 | -6.55 | 28.35 | |
| | Developed during Tx | -5.10 | -22.55 | 12.35 | |
| Impinging bite (Yes) | T3 | 3.93 | -9.01 | 16.87 | 0.543 |
| Change in impinging bite (T1-T3) | | | | | 0.782 |
| | Never present | 0 | | | |
| | Corrected | 1.72 | -8.73 | 12.18 | |
| | Uncorrected | 7.81 | -8.28 | 23.90 | |
| | Developed during Tx | -2.19 | -24.18 | 19.79 | |
| Crossbite (Yes) | T3 | 11.76 | -9.34 | 32.86 | 0.267 |
| Change in crossbite (T1-T3) | | | | | 0.432 |
| | Never present | 0 | | | |
| | Corrected | -3.30 | -13.10 | 6.50 | |
| | Uncorrected | 10.74 | -10.72 | 32.21 | |
| | Developed during Tx | N/A | N/A | N/A | |

*$P$ <0.05  **$P$ <0.01

**Table 5.** Regression coefficients for socio-demographic and occlusal variables with overall Body Image score as dependent variable

| | | | Confidence Interval | | |
|---|---|---|---|---|---|
| Socio-demographic variables | | B | Lower Bound | Upper Bound | P-value |
| Current age | | 0.04 | -0.08 | 0.16 | 0.490 |
| Age at T1 | | 0.03 | -0.12 | 0.17 | 0.716 |
| Time since T3 | | -0.10 | -0.28 | 0.09 | 0.294 |
| Number of people in household | | 0.10 | -0.01 | 0.20 | 0.062 |
| Parent/guardian education | | -0.04 | -0.09 | 0.01 | 0.110 |
| Failed appointment rate | | 1.57 | -0.29 | 3.43 | 0.096 |
| Late appointment rate | | 1.58 | -0.12 | 3.27 | 0.068 |
| One or more siblings had Tx | Yes | 0.21 | -0.28 | 0.71 | 0.396 |
| One or more adults in household had Tx | Yes | -0.15 | -1.41 | 1.11 | 0.808 |
| **Parent/guardian employed** | **Yes** | **0.36** | **0.04** | **0.69** | **0.031*** |
| Sex | Female | 0.07 | -0.27 | 0.41 | 0.671 |
| Ethnicity | | | | | 0.263 |
| | African/African-American | 0 | | | |
| | Hispanic | -0.32 | -0.86 | 0.21 | |
| | Asian | -0.42 | -0.83 | -0.01 | |
| | Caucasian | -0.16 | -0.65 | 0.34 | |
| Language spoken at home | | | | | 0.314 |
| | English | 0 | | | |
| | Spanish | -0.15 | -0.73 | 0.43 | |
| | Vietnamese | -0.26 | -0.76 | 0.24 | |
| | Mandarin/Cantonese | -0.44 | -1.17 | 0.29 | |
| | Somalian/Ethiopian | 0.61 | -0.27 | 1.49 | |
| Parent/guardian marital status | | | | | 0.567 |
| | Married | 0 | | | |
| | Divorced | 0.02 | -5.41 | 0.58 | |
| | Single | 0.16 | -0.25 | 0.56 | |
| Occlusal variables | | | | | |
| Incisor irregularity | T3 | -0.04 | -0.09 | 0.01 | 0.081 |
| | **ΔT1-T3** | **-0.03** | **-0.05** | **0.00** | **0.037*** |
| Overjet | T3 | -0.02 | -0.12 | 0.08 | 0.647 |
| | **ΔT1-T3** | **-0.09** | **-0.15** | **-0.04** | **0.001**** |
| Overbite | T3 | -0.05 | -0.15 | 0.06 | 0.401 |
| | ΔT1-T3 | -0.02 | -0.11 | 0.07 | 0.639 |
| **Midline discrepancy** | **T3** | **-0.18** | **-0.36** | **0.00** | **0.048*** |
| | ΔT1-T3 | -0.08 | -0.23 | 0.07 | 0.271 |
| ICON Esthetic Index | T3 | 0.02 | -0.05 | 0.10 | 0.528 |
| | ΔT1-T3 | 0.00 | -0.07 | 0.07 | 0.991 |
| ANB | T3 | 0.06 | -0.01 | 0.12 | 0.079 |
| | ΔT1-T3 | -0.03 | -0.14 | 0.09 | 0.645 |
| U1-SN | T3 | -0.01 | -0.04 | 0.01 | 0.195 |
| | ΔT1-T3 | -0.02 | -0.04 | 0.00 | 0.056 |
| LAFH | T3 | 0.04 | -0.02 | 0.11 | 0.163 |
| | ΔT1-T3 | 0.03 | -0.08 | 0.13 | 0.581 |
| MP-SN | T3 | 0.02 | -0.01 | 0.05 | 0.208 |
| | ΔT1-T3 | 0.00 | -0.06 | 0.07 | 0.935 |
| Facial convexity | T3 | -0.03 | -0.06 | 0.01 | 0.149 |
| | ΔT1-T3 | 0.00 | -0.06 | 0.07 | 0.972 |
| **Open bite (Yes)** | **T3** | **0.53** | **0.05** | **1.02** | **.032*** |
| Change in open bite (T1-T3) | | | | | |
| | Never present | 0.00 | | | |
| | Corrected | -0.10 | -0.69 | 0.50 | 0.746 |
| | Uncorrected | 0.61 | -0.07 | 1.29 | 0.079 |
| | Developed during Tx | 0.44 | -0.24 | 1.12 | 0.198 |
| Impinging bite (Yes) | T3 | -0.16 | -0.67 | 0.35 | 0.530 |
| Change in impinging bite (T1-T3) | | | | | |
| | Never present | 0.00 | | | |
| | Corrected | 0.14 | -0.27 | 0.54 | 0.496 |
| | Uncorrected | 0.13 | -0.50 | 0.75 | 0.687 |
| | Developed during Tx | -0.60 | -1.45 | 0.25 | 0.160 |
| Crossbite Yes) | T3 | -0.31 | -1.15 | 0.53 | 0.459 |
| Change in crossbite (T1-T3) | | | | | |
| | Never present | 0.00 | | | |
| | Corrected | -0.18 | -0.57 | 0.21 | 0.357 |
| | Uncorrected | -0.37 | -1.22 | 0.48 | 0.389 |
| | Developed during Tx | | | | |

*$P$ <0.05 **$P$ <0.01

**Table 6.** Regression coefficients for socio-demographic and occlusal variables with failed appointment rate as dependent variable. Failed appt rate = (cancelled appts + no-shows)/scheduled appts.

| | | | Confidence Interval | | |
|---|---|---|---|---|---|
| Socio-demographic variables | | B | Lower Bound | Upper Bound | P-value |
| Age at T1 | | 0.01 | -0.01 | 0.02 | 0.594 |
| Number of people in household | | 0.01 | 0.00 | 0.02 | 0.172 |
| Parent/guardian education | | 0.00 | 0.00 | 0.01 | 0.192 |
| One or more siblings had Tx | Yes | 0.03 | -0.03 | 0.08 | 0.335 |
| One or more adults in household had Tx | Yes | 0.00 | -0.12 | 0.11 | 0.984 |
| **Parent/guardian employed** | **Yes** | **0.042** | **0.003** | **0.081** | **0.037*** |
| Sex | Female | 0.02 | -0.02 | 0.06 | 0.339 |
| **Ethnicity** | | | | | **0.000***** |
| | **African/African-American** | **0** | | | |
| | **Hispanic** | **-0.10** | **-0.16** | **-0.04** | **0.001**** |
| | **Asian** | **-0.10** | **-0.15** | **-0.05** | **0.000***** |
| | **Caucasian** | **-0.08** | **-0.13** | **-0.03** | **0.004**** |
| | | | | | |
| **Langage spoken at home** | | | | | **0.015*** |
| | English | 0 | | | |
| | Spanish | -0.07 | -0.14 | 0.00 | 0.050 |
| | Vietnamese | -0.05 | -0.12 | 0.03 | 0.210 |
| | **Mandarin/Cantonese** | **-0.14** | **-0.23** | **-0.05** | **0.004**** |
| | Somalian/Ethiopian | 0.01 | -0.08 | 0.10 | 0.832 |
| Parent/guardian marital status | | | | | 0.213 |
| | Married | 0 | | | |
| | Divorced | -0.01 | -0.07 | 0.06 | |
| | Single | 0.04 | 0.00 | 0.09 | |
| | | | | | |
| Occlusal variables | | | | | |
| Incisor irregularity | T1 | 0.00 | -0.01 | 0.00 | 0.266 |
| | **ΔT1-T3** | **0.003** | **0.001** | **0.006** | **0.018*** |
| Overjet | T1 | 0.00 | 0.00 | 0.01 | 0.403 |
| | ΔT1-T3 | 0.00 | -0.01 | 0.01 | 0.684 |
| Overbite | T1 | -0.01 | -0.02 | 0.00 | 0.139 |
| | **ΔT1-T3** | **0.013** | **0.001** | **0.024** | **0.031*** |
| Midline discrepancy | T1 | | | | |
| | ΔT1-T3 | | | | |
| ICON Esthetic Index | T1 | 0.01 | -0.01 | 0.02 | 0.450 |
| | ΔT1-T3 | 0.01 | 0.00 | 0.01 | 0.189 |
| ANB | T1 | 0.01 | 0.00 | 0.01 | 0.171 |
| | ΔT1-T3 | -0.01 | -0.02 | 0.01 | 0.425 |
| U1-SN | T1 | 0.00 | 0.00 | 0.00 | 0.574 |
| | ΔT1-T3 | 0.00 | -0.01 | 0.00 | 0.194 |
| LAFH | T1 | 0.01 | 0.00 | 0.01 | 0.112 |
| | ΔT1-T3 | 0.00 | -0.01 | 0.02 | 0.698 |
| MP-SN | T1 | 0.00 | 0.00 | 0.00 | 0.688 |
| | ΔT1-T3 | 0.00 | -0.01 | 0.01 | 0.841 |
| Facial convexity | T1 | 0.00 | 0.00 | 0.00 | 0.446 |
| | ΔT1-T3 | 0.01 | 0.00 | 0.01 | 0.083 |
| Open bite (Yes) | T1 | 0.04 | -0.01 | 0.09 | 0.097 |
| Change in open bite (T1-T3) | | | | | 0.081 |
| | Never present | 0 | | | |
| | Corrected | 0.03 | -0.05 | 0.10 | |
| | Uncorrected | 0.08 | 0.02 | 0.15 | |
| | Developed during Tx | -0.04 | -0.16 | 0.08 | |
| Impinging bite (Yes) | T1 | 0.02 | -0.02 | 0.07 | 0.315 |
| Change in impinging bite (T1-T3) | | | | | 0.087 |
| | Never present | 0 | | | |
| | Corrected | 0.01 | -0.04 | 0.06 | |
| | Uncorrected | 0.01 | -0.07 | 0.08 | |
| | Developed during Tx | 0.02 | -0.09 | 0.13 | |
| Crossbite (Yes) | T1 | -0.02 | -0.06 | 0.02 | 0.418 |
| Change in crossbite (T1-T3) | | | | | 0.391 |
| | Never present | 0 | | | |
| | Corrected | -0.03 | -0.07 | 0.02 | |
| | Uncorrected | 0.01 | -0.07 | 0.08 | |
| | Developed during Tx | | | | |

*$P$ <0.05 **$P$ <0.01 ***$P$ <0.001

**Table 7.** Regression coefficients for socio-demographic and occlusal variables with tardy appointment rate as dependent variable. Tardy appt rate = tardy appts/(scheduled appts - failed appts).

| Socio-demographic variables | | B | Confidence Interval Lower Bound | Confidence Interval Upper Bound | P-value |
|---|---|---|---|---|---|
| Age at T1 | | 0.00 | -0.02 | 0.03 | 0.789 |
| Number of people in household | | 0.01 | 0.00 | 0.03 | 0.124 |
| Parent/guardian education | | 0.01 | -0.01 | 0.02 | 0.318 |
| One or more siblings had Tx | Yes | 0.01 | -0.07 | 0.09 | 0.774 |
| One or more adults in household had Tx | Yes | -0.05 | -0.23 | 0.12 | 0.566 |
| Parent/guardian employed | Yes | 0.05 | -0.01 | 0.11 | 0.109 |
| Sex | Female | 0.01 | -0.05 | 0.07 | 0.710 |
| **Ethnicity** | | | | | **0.002**** |
| | **African/African-American** | **0.00** | | | |
| | **Hispanic** | **-0.10** | **-0.18** | **-0.01** | **0.031*** |
| | **Asian** | **-0.12** | **-0.19** | **-0.05** | **0.001**** |
| | **Caucasian** | **-0.13** | **-0.21** | **-0.05** | **0.001**** |
| Language spoken at home | | | | | 0.246 |
| | English | 0.00 | | | |
| | Spanish | -0.01 | -0.11 | 0.10 | |
| | Vietnamese | -0.07 | -0.19 | 0.04 | |
| | Mandarin/Cantonese | -0.07 | -0.21 | 0.07 | |
| | Somalian/Ethiopian | 0.10 | -0.02 | 0.23 | |
| Parent/guardian marital status | | | | | 0.354 |
| | Married | 0.00 | | | |
| | Divorced | -0.03 | -0.12 | 0.07 | |
| | Single | 0.05 | -0.02 | 0.12 | |
| | | | | | |
| | | | | | |
| Irregularity index | T1 | 0.00 | -0.01 | 0.00 | 0.360 |
| | ΔT1-T3 | 0.00 | 0.00 | 0.01 | 0.153 |
| Overjet | T1 | 0.00 | -0.01 | 0.01 | 0.453 |
| | ΔT1-T3 | 0.00 | -0.01 | 0.01 | 0.615 |
| Overbite | T1 | -0.01 | -0.03 | 0.00 | 0.148 |
| | ΔT1-T3 | 0.02 | 0.00 | 0.03 | 0.069 |
| Midline discrepancy | T1 | -0.02 | -0.04 | 0.01 | 0.255 |
| | ΔT1-T3 | 0.02 | 0.00 | 0.05 | 0.055 |
| ICON esthetic score | T1 | 0.01 | -0.01 | 0.03 | 0.524 |
| | ΔT1-T3 | 0.00 | -0.01 | 0.02 | 0.549 |
| ANB | T1 | 0.00 | -0.01 | 0.01 | 0.675 |
| | ΔT1-T3 | 0.00 | -0.02 | 0.02 | 0.873 |
| U1-SN | T1 | 0.00 | 0.00 | 0.01 | 0.582 |
| | ΔT1-T3 | 0.00 | -0.01 | 0.00 | 0.200 |
| LFH | T1 | 0.01 | -0.01 | 0.02 | 0.231 |
| | ΔT1-T3 | 0.00 | -0.02 | 0.02 | 0.691 |
| MP-SN | T1 | 0.00 | -0.01 | 0.01 | 0.809 |
| | ΔT1-T3 | 0.00 | -0.01 | 0.02 | 0.425 |
| Facial Convexity | T1 | 0.00 | 0.00 | 0.01 | 0.669 |
| | ΔT1-T3 | | | | |
| Open bite | T1 | 0.05 | -0.03 | 0.13 | 0.198 |
| Change in Open Bite (T1-T3) | | | | | 0.091 |
| | Never present | 0.00 | | | |
| | Corrected | 0.06 | -0.05 | 0.17 | |
| | Uncorrected | 0.10 | 0.01 | 0.20 | |
| | Developed during Tx | 0.13 | -0.05 | 0.30 | |
| Impinging bite | T1 | 0.00 | -0.06 | 0.07 | 0.916 |
| Change in Impinging Bite (T1-T3) | | | | | 0.975 |
| | Never present | 0.00 | | | |
| | Corrected | -0.01 | -0.08 | 0.07 | |
| | Uncorrected | -0.02 | -0.13 | 0.10 | |
| | Developed during Tx | 0.02 | -0.14 | 0.18 | |
| Crossbite | T1 | 0.00 | -0.06 | 0.06 | 0.962 |
| Change in Crossbite (T1-T3) | | | | | 0.744 |
| | Never present | 0.00 | | | |
| | Corrected | -0.02 | -0.08 | 0.04 | |
| | Uncorrected | 0.02 | -0.09 | 0.12 | |
| | T1-T3 | 0.00 | -0.01 | 0.02 | |

*$P$ <0.05 **$P$ <0.01