



Concept Paper Form

Provisional Paper Title: Do malocclusion and orthodontic treatment affect self-perceived attractiveness, oral health-related quality of life and life satisfaction in the long-term?
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Objective of the study:

Physical attractiveness is associated with social acceptance ^{1,2}. Dental malocclusions play a significant role in perceptions of physical attractiveness. There is low level evidence that dental malocclusions adversely affect an individual's psycho-social health but whether these effects last into adulthood is unknown. Orthodontic professionals often cite the importance of the psychological benefits of correcting malocclusions however there is a paucity of evidence to show this ³. Several systematic reviews have found the benefits of orthodontic treatment for oral health-related quality of life to be modest at best, concluding that more robust longitudinal research is needed. Of the few longitudinal studies that have been conducted to investigate this relationship, none have controlled for potential confounders of oral health-related quality of life, such as periodontal disease, dry mouth, missing teeth or dental caries. Given that orthodontic treatment is more commonly performed with the goal of enhancing facial and dental aesthetics than for functional purposes, it seems an important area for further research.

The purpose of this study is to investigate the following questions:

Is malocclusion during adolescence associated with poorer oral health-related quality of life, self-rated dental appearance and higher life satisfaction later in life?

Does correction of malocclusion result in better oral health-related quality of life,

higher self-rated dental attractiveness and higher life satisfaction in adulthood compared to uncorrected malocclusions?

Data analysis methods:

Statistical analyses will be conducted using I/C STATA 15 software (Stata, Texas, USA).

The assumption of normal distribution of data will be firstly tested using Shapiro-Wilk and Kolmogorov-Smirnov tests. We will then test for an association between malocclusion status (age 15, 18, 45 years) and oral health-related quality of life (age 32, 38, 45 years), Diener life satisfaction (age 38, 45 years) and perceived attractiveness (age 38, 45 years) using univariate, bivariate and multivariate analyses.

We will conduct two primary analyses and one secondary analysis

Primary Analysis 1: we will use correlations and multivariate regression to test for an association between malocclusion status and oral health-related quality of life.

The first part of this analysis will assess childhood malocclusion status and adult OHRQoL. DAI score at age 15 will be treated as a continuous variable and bivariate analyses will be conducted to look for an association between DAI score at age 15 and OHIP-14 score at ages 32, 38, and 45. The specific bivariate tests to be used (e.g. Spearman or Pearson correlation analyses) will be decided after the result of normality tests.

The next part of this analysis will use multivariate general linear or multinomial logistic regression modelling to test for an association between malocclusion status and oral health related quality of life, when controlling for other variables. DAI score will be treated as an ordinal categorical variable. DAI scores will be categorised into four groups: no malocclusion-mild (DAI < 25), definite malocclusion (DAI 26-30), severe malocclusion (DAI 31-35), handicapping malocclusion (DAI > 36) ^{4,5}.

Next, we will assess whether changes in malocclusion are associated with oral health-related quality of life. For this analysis, there will be three categories based on malocclusion status at age 15 and age 45. A change in total DAI score is considered to be clinically significant if it is greater than 5 or more. The first category is, 'improved malocclusion' and is defined by a reduction in DAI score by 5 or more at age 45 compared to age 15. The 'no change in malocclusion' group has a DAI score at age 45 within 4 points of the age 15 DAI score. The 'worsened malocclusion' group have a 5 or more point increase in DAI score from age 15 to age 45.

Another way we will assess how changes in malocclusion affect adulthood OHRQoL is as follows. DAI will be treated as a binary variable with “no malocclusion” group being defined as a DAI score less than or equal to 25 and “malocclusion” being defined as a DAI score greater than 25.

The individuals will be categorised into four predetermined “transition groups”

1. No malocclusion at age 15 and no malocclusion at age 45
2. No malocclusion at age 15 and malocclusion at age 45
3. Malocclusion at age 15 and no malocclusion at age 45
4. Malocclusion at age 15 and malocclusion at age 45

We will first undertake descriptive statistics to assess differences between the four groups with regards to age, gender and socioeconomic status. We will then conduct multivariate regression modeling (Student-T test if normally distributed or Mann-Whitney test if not normally distributed) to explore whether any observed association persists between malocclusion transition groups and OHRQoL when adjusting for potential confounders.

Primary Analysis 2: we will use correlations and multivariate regression to investigate whether malocclusion status is correlated with greater life satisfaction

Age 45 Deiner Life satisfaction score will be used and will be converted to a Z-score, mean = 0, standard deviation = 1. A comparison of the age 45 and age 38 Deiner Life Satisfaction score will be undertaken.

The first analysis will assess childhood malocclusion status and Diener Life Satisfaction Scale

- DAI score at age 15 will be treated as a continuous variable and bivariate analysis will be conducted to look for an association between DAI score at age 15 and Diener Life Satisfaction categories (extremely dissatisfied, slightly dissatisfied, neutral, slightly satisfied, satisfied)⁶ at age 45
- DAI score at age 15 and age 45 will be obtained and an analysis which assesses the correlation between malocclusion transition groups (as discussed in primary analysis 1) and changes in Life Satisfaction at these same time points will be assessed.

Secondary Analysis: to investigate the extent to which personality modifies any associations observed

- Personality traits have been investigated at ages 18 and 26 using the multidimensional perception questionnaire.
- OHIP-14 total score will be treated as a continuous variable and bivariate analysis will be conducted to see whether poorer quality of life (higher

overall OHIP-14 score) is associated with specific personality traits
As part of the primary analysis 1, personality traits will be introduced during multivariate analysis to see whether the strength of the association

Variables needed at which ages:

Variables needed at which ages:

As well as dental data, some non-dental variables are requested. These include variables on personality (Multidimensional Personality Questionnaire), sex, socioeconomic status and Diener Satisfaction with Life Scale.

Variables are needed from ages 15, 18, 26, 32, 38, 45.

Independent Variables:

Malocclusion Examinations:

Orthodontic examinations were completed at ages 15, 18 and 45 years. The Dental Aesthetic Index was used to score the severity of any malocclusion. The overall Dental Aesthetic Index score is calculated by adding the scores of these weighted components and summing with a constant of 13^{4,5}. Accordingly, the severity of malocclusion can be classified into 1 of 4 categories normal or minor malocclusion (0-25), definite malocclusion (26-31), severe malocclusion (32-35) or handicapping malocclusion (>36)^{4,5}.

History of orthodontic treatment was recorded at age 15, 18 and 26 based on a questionnaire completed by participants and this included whether or not the individual had had fixed or removable appliances.

Dependent Variables

Self-perceived dental appearance

At age 15, 18 and 26 the study participants were asked to rate their dental appearance relative to others. This outcome measures were 'below average', 'average' or 'above average'. A previously published article using this data showed that 37% of individuals with severe malocclusions who had not received orthodontic treatment rated themselves above average in terms of dental appearance compared with 63.2% of those who had received orthodontic treatment⁷. We plan to use this same variable in our analysis of untreated and treated malocclusion.

The Satisfaction with Life Scale

Life satisfaction refers to a judgemental process, in which individuals assess the quality of their lives on the basis of their own unique criteria⁸. The Satisfaction With Life Scale items are global in nature to

allow the individual to weight domains of their lives in terms of their own values⁹. Individuals have unique criteria for judgement of a good life¹⁰. Life satisfaction reflects a long-term perspective and reflects conscious goals and values.

The five items produce a score ranging from 5 to 35⁹. A score of 20 represents the *neutral* point on the scale, the point at which respondents are equally satisfied and dissatisfied with their life. A score of 5-9 indicates *extremely dissatisfied*, a score of 15-19 indicates slightly dissatisfied, a score of 21-25 represents *slightly satisfied* and a score of 26-30 indicates satisfied. Normative values for different subpopulations, such as healthcare workers or students, are available however given the diversity of our study sample, they will not be applied to each individual⁹. Most populations fall in the range of 23-28, indicating that they are slightly satisfied to satisfied⁹.

Measures of life satisfaction must demonstrate that they are reflective of more than momentary mood states in order to make inferences about life satisfaction whilst still remaining sensitive to change. The SWLS has been examined for reliability and sensitivity in a number of studies and has shown strong internal reliability and moderate temporal stability.

The 5 items include:

1. In most ways my life is close to ideal
2. The conditions of my life are excellent
3. I am satisfied with my life
4. So far I have gotten the important things I want in life
5. If I could live my life over, I would change almost nothing

A score of 1-7 is given to each item (1=strongly disagree, 2=disagree, 3=slightly disagree, 4= neither agree nor disagree, 5=slightly agree, 6 = agree, 7 = strongly agree).

Oral Health-related Quality of Life

The short form OHIP-14 was administered by trained interviewers at ages 32, 38, 45. The OHIP-14 is a valid and commonly used tool to measure oral health-related quality of life (OHRQoL) ¹¹. The OHIP-14 is a 14-item questionnaire which asks the study members how often they have experienced specific problems in the past 4 weeks ¹¹. The study participants report impact for each item using a 5-point Likert-type scale (4, very often; 3, fairly often; 2, occasionally; 1, hardly ever; and 0, never) ¹¹. OHIP-14 scores may range from 0-56 and higher overall score indicates a greater impact on OHRQoL ¹¹. The 14 items are organized into seven domains; functional limitation, physical pain, physical disability, psychological disability, social disability and handicap ¹¹.

Personality Traits

Personality traits have a significant role in dissatisfaction with appearance following orthodontic treatment, particularly among those who are impulsive, stress-reactive or socially-isolated ¹². Personality traits are likely to be associated with resilience to bullying, ability to adapt to their malocclusion and overall perception of their quality of life ¹³. When investigating potential effects of orthodontic treatment, the need to consider the effect of personality traits on perceived quality of life or life satisfaction is paramount given the subjective nature of these measures.

Personality characteristics were measured at age 18 and 26 using a modified Multidimensional Personality Questionnaire (MPQ). The MPQ is a 177-item questionnaire which examines a broad range of individual differences in emotional and behavioral style. The instrument provides a comprehensive profile based on 10 distinct personality traits, which are defined into three distinct superfactor groups. The first superfactor, 'constraint', includes personality traits such as traditionalism, harm avoidance and control. These people tend to be restrained, cautious and conventional while low scorers are impulsive, fearless and sensation-seeking and reject conventional strictures on their behavior ¹². The second superfactor, negative emotionality, includes personality traits such as aggression, alienation and stress reaction. High scorers tend to be easily stressed and harassed and are prone to experiencing negative emotions such as anger or anxiety ¹². The third superfactor includes the personality traits of achievement, social potency, well-being and social closeness. People who score highly in this section tend to interact positively with their environment and are ready to experience positive emotions ¹²

Superfactor	Personality Traits	Description of a high scorer
Constraint	Traditionalism	Desires a conservative social environment, endorses high moral standards
	Harm avoidance	Avoids excitement and danger, prefers safe activities even if they are tedious
	Control	Is reflective, cautious, careful and rational
Negative emotionality	Aggression	Hurts others for own advantage: will frighten and cause discomfort for others
	Alienation	Feels mistreated, victimized, betrayed, and the target of false rumours
	Stress reaction	Nervous, vulnerable, sensitive, prone to worry
Positive emotionality	Achievement	Works hard; enjoys demanding projects and working long hours
	Social Potency	Forceful and decisive, fond of influencing others, fond of leadership roles
	Well-being	Has a happy, cheerful disposition, feels good about self and sees a bright future
	Social closeness	Sociable; likes people and turns to others for comfort

Table adapted from Barker et al., 2005 and Caspi 1997

Socioeconomic Status (childhood and adult)

Parents' Socioeconomic Status (SES).

The socioeconomic statuses of cohort members' families were measured using a 6-point scale that assessed parents' occupational statuses, defined based on average income and educational levels derived from the New Zealand Census. Parents' occupational statuses were assessed when Study

members were born and again at subsequent assessments up to age-15 years. The highest occupational status of either parent was averaged across the childhood assessments.

Occupational prestige.

Study members' occupational prestige was measured from self-reported occupation according to the New Zealand Socioeconomic Index (NZSEI-06), a 6-point scale that assessed self-reported occupational status and allocates each occupation to 1 of 6 categories (1 = unskilled laborer, 6 = professional)¹⁴. Homemakers and those not working were pro-rated based on their occupation at the previous interview (when they were aged 32 years). The mean occupational prestige score in the cohort was 3.77 (SD=1.44).

Age 15, from dental15 dataset

s1185	Do you think your front teeth are pleasant to look at
s1186	Do you think your front teeth are crooked?
s1187	Do you think your front teeth stick out?
s1188	How do you feel about your front teeth?
s1189	Would you like to change the way your front teeth look:
s1190	in general, compared to other people your age, do you think the appearance of your teeth is:
s1191	in general, compared to other persons your age, would you say your dental health is:
s1192	if you have had orthodontic treatment (teeth straightened), do you think the result was:
a1452	lower lip palatal to upper teeth
a1453	lower lip palatal to upper teeth
a1454	occlusal interference
a1455	facial asymmetry
a1456	gross facial unbalance
a1457	definite mandibular prognathism
a1458	definite mandibular retrognathism
a1459	missing teeth (DAI)
a1460	crowding of incisors (0,1,2 segments - DAI)
a1461	incisal spacing (0,1,2 segments - DAI)
b227	upper anterior crowding (mm)
b228	upper anterior spacing (mm)
b229	upper anterior central diastema (DAI-mm)
a1462	upper anterior mid-line deviation
b230	upper anterior largest anterior irregularity (DAI-mm)
b231	lower anterior crowding (mm)

b232	lower anterior spacing (mm)
a1463	lower anterior mid-line deviation
b233	lower anterior largest anterior irregularity (DAI-mm)
a1464	premolars - blocked out or impacted (record number)
b234	anterior maxillary overjet (DAI-mm)
b235	anterior mandibular overjet (DAI-mm)
b236	anterior overbite (mm)
a1465	anterior cross-bite (see forms for teeth affected)
b237	anterior open-bite (mm)
a1466	posterior cross-bite
a1467	posterior open-bite
a1468	left molar relation
a1469	right molar relation
a1470	molar relation - largest deviation (DAI)
dai_15	P15: DAI score
a1481	have you ever had your bite checked by an orthodontist?
a1482	have you ever had your teeth straightened?
a1483	teeth being straightened now?
a1484	what treatment is, or has been, done?
a1485	Do you feel the treatment was, or is, worthwhile?
a1486	who straightened, or is straightening, your teeth?
a1481	have you ever had your bite checked by an orthodontist?

Age 18, from dental18 dataset

a1288	P18: Missing teeth
a1289	P18: Crowding of incisors
a1290	P18: Incisal spacing
a1291	P18: Central diastema - upper anterior
b261	P18: Largest anterior irregularity - upper (mm)
b262	P18: Largest anterior irregularity - lower (mm)
b263	P18: Maxillary overjet (mm)
b264	P18: Mandibular overjet (mm)
a1292	P18: Largest open bite (mm)
a1293	P18: Molar relation: largest deviation
b265	P18: Would treatment benefit the occlusion?
b266	P18: Would treatment benefit the appearance?
a1352	Ever had teeth straightened?
dai_18	P18: DAI score

Age 45 years, from DentalDAI_P45

orthoDAI1_max_p45	Number of missing maxillary teeth
orthoDAI1_mand_p45	Number of missing mandibular teeth
orthoDAI2_p45	Crowding in the incisal segments
orthoDAI3_p45	Spacing in the incisal segments
orthoDAI4_p45	Size of midline diastema
orthoDAI5_p45	Largest maxillary irregularity
orthoDAI6_p45	Largest mandibular irregularity
orthoDAI7_p45	Maxillary overjet
orthoitem5_p45	Overbite
orthoDAI8_p45	Mandibular overjet
orthoitem6_p45	Number of anterior teeth in cross bite
orthoDAI9_p45	Vertical open bite
orthoitem7_p45	Number of posterior teeth in cross bite left
orthoitem8_p45	Size of posterior cross bite left
orthoitem9_p45	Number of posterior teeth in cross bite right
orthoitem10_p45	Size of posterior cross bite right
orthoitem11_p45	Posterior open bite
orthoDAI10_p45	Molar relationship
orthoitem12a_p45	Irregularity Index 33/32
orthoitem12b_p45	Irregularity Index 32/31
orthoitem12c_p45	Irregularity Index 31/41
orthoitem12d_p45	Irregularity Index 41/42
orthoitem12e_p45	Irregularity Index 42/43
orthoitem13a_p45	Lower fixed retainer
orthoitem13b_p45	Fixed retainer comments
orthoDAI_p45	P45: DAI score

Significance of the Study (for theory, research methods or clinical practice):

Malocclusion has been shown to adversely affect an individual's quality of life through unfavorable social interactions with peers however there is very little strong evidence to support the claim that orthodontic treatment can improve quality of life, self-perceived attractiveness and overall life satisfaction.

Oral Health-related Quality of Life

Research into the effect of orthodontic treatment on changes in oral health-related quality of life has steadily increased over the last decade, including three systematic reviews 15–17. Despite interest on this topic, the evidence remains limited with a lack of appropriately designed longitudinal studies 15–17. One systematic review assessed the literature on whether malocclusion was associated with poorer quality of life among children and adolescents and concluded that there is 'strong' scientific evidence to suggest that malocclusions have a negative effect on oral health-related quality of life; however the studies included were all cross-sectional 15.

Another reported the associations between malocclusion and quality of life to be modest at best, again based mostly on cross-sectional studies 16. This review included 19 cross-sectional studies of low-level evidence. There were four longitudinal studies included in this analysis however the heterogeneity of different methods for assessing malocclusion and quality of life meant that no meta-analysis could be conducted 16. Two of the longitudinal studies were based on the same source of data and suffered poor retention of participants with only 33% returning for 20-year follow up 18,19. The third study was a validation of the child-perception questionnaire and had a very short follow-up period 20. The final longitudinal study included in this systematic review assessed the effectiveness of early intervention with twin-block therapy so the results are only be generalizable to 8-10 year olds with class II division 1 malocclusions (increased overjet). The study was a randomized control trial with a 15-month follow up period so did not effectively assess long term quality of life 21.

Changes in oral health-related quality of life due to orthodontic treatment before the age of 18 were the subject of a third systematic review, which reported moderate improvements in emotional and social well-being following treatment 17. This study included 9 cohort studies, 3 cross-sectional studies and 1 case-control. This study was able to show the overall changes in oral health-related quality of life before and after orthodontic treatment derived from 4 cohort studies 17,22–25. The pooled standardized mean difference in the reduction of total OHRQoL before and after orthodontic treatment was -0.75 (95% CI -1.15 to -0.36) 17. Although this demonstrated statistically significant improvement in OHRQoL, this data should be interpreted cautiously as there was significant heterogeneity between the studies. The most significant differences were found in the psychological and social domains 17.

Forest plot taken from Javidi et al., 2017

All studies concluded that high quality longitudinal research is required to draw accurate conclusions about any effects of malocclusion on oral health-related quality of life.

Life Satisfaction

Research into the effect of orthodontic treatment on overall Life Satisfaction is sparse. Traditionally, the cognitive-judgmental aspect of subjective well-being has received less attention than more objective measures. Life satisfaction refers to a judgemental process, in which individuals assess the quality of their lives on the basis of their own unique criteria⁸. There tends to be less affected by unconscious motives and the influence of bodily states¹⁰. This study is highly unique as to the best of the authors knowledge there are no other studies that have used the Diener Life Satisfaction scale as a health outcome measure in this setting. We propose that given the significant effect that changing a person's smile could have, we hypothesize that we will see a difference in the overall life satisfaction between people who have untreated malocclusions and people who have an ideal occlusion.

Malocclusion and Orthodontic Treatment in New Zealand

Dental malocclusions are highly prevalent, affecting up to 78% of school children according to one New Zealand-based study ²⁶. In New Zealand, most orthodontic treatment is privately-funded, but a few exceptions do apply. Children with very severe malocclusions or craniofacial deformities such as cleft lip/palate may qualify for publicly-funded care through District Health Boards (DHBs). Furthermore, public treatment is unavailable in many parts of New Zealand. Among DHBs that do offer this type of care, eligibility is generally based on clinical severity of malocclusions or skeletal discrepancies, according to grading based on standardized measures such as the Dental Aesthetic Index.

Other children may successfully apply for free treatment through charitable trusts such as Wish for a Smile (NZAO, 2018). When applying for such charitable care, children and their families write applications, generally describing how the malocclusion affects the child's quality of life and the family's difficulty in accessing care. These are evaluated more 'qualitatively' than the clinical index-based criteria applied in DHBs. It might be argued that such a process more closely considers psycho-social effect of untreated malocclusions however the use of a quantitative measure, such as OHIP-14, may provide a less subjective means for selection.

It remains unclear whether correction of malocclusions may benefit an individual's life satisfaction and quality of life, particularly in the long-term¹⁹. Even among patients with severe malocclusions, any beneficial effect that orthodontic treatment may have on oral health-related quality of life appear to diminish over time ²⁷. It is unclear whether this is due to a shift in the patient's attitudes, relapse of the malocclusion, or other contributory factors, such as, tooth loss or decay²⁷. No high-quality longitudinal population-based studies

have investigated whether malocclusion and orthodontic treatment affect OHRQoL and life-satisfaction through the life-course. Multiple systematic reviews have concluded that this is needed to address the gap in our knowledge 15–17.

This research has the potential to improve our understanding of the long-term psychosocial effects of malocclusion and the potential benefits of orthodontic treatment which is highly relevant to clinical orthodontic practice, given that it is often the rationale behind most patients undertaking treatment. The study may provide evidence for adjusting the eligibility criteria for severe malocclusions and may be used to promote improved access and financial support to individuals who are affected by severe malocclusions.

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