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Relationships between dental appearance, self-esteem, socio-economic status and oral health-related quality of life in UK schoolchildren: A three-year cohort study

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Running title: Impact of malocclusion: a 3-year cohort study

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Summary

Objectives: To examine the relationships between dental appearance, characteristics of the individual and their environment and OHQoL in young people over time.

Methods: 374 young people (122 boys, 252 girls) aged 11-12 years from 7 different UK schools were recruited at baseline and 258 (78 boys, 180 girls) followed-up 3 years later, aged 14-15 years (69% response rate). Participants completed a measure of OHQoL (CPQ11-14 ISF-16) and self-esteem (SE, CHQ-CF87). A clinical examination was undertaken, including clinician and self-assessed normative measures of need (IOTN) and dental caries. The Index of Multiple Deprivation was used to indicate socio-economic status (SES).

Results: There was a general improvement between baseline and follow-up in the measures of malocclusion, as well as OHQoL. Multiple linear regression indicated that there were significant cross-sectional associations at baseline between OHQoL and SES (rho = -0.11; P=0.006), SE (rho = -0.50; P<0.001) and self-assessed IOTN (rho = 0.27; P<0.001). There were significant longitudinal associations between the change in OHQoL and change in SE (rho = -0.46; P<0.001) and change in the DMFS (rho = -0.24; P=0.001). The mean improvement in the total CPQ11-14 ISF-16 score for those with a history of orthodontic treatment was 3.2 (SD 6.9; P=0.009) and 2.4 (SD 8.8; P<0.001) for those with no history of treatment. The difference was not statistically significant (P=0.584).

Conclusions: OHQoL improved in young people over time, whether they gave a history of orthodontic treatment or not. Individual and environmental characteristics influence OHQoL and should be taken into account in future studies.

Introduction

A recent systematic review has found a modest association between malocclusion and poor oral health-related quality of life (OHQoL) (1); however the authors conclude that most studies contributing to these findings have been cross-sectional, involving patients groups and with no theoretical basis for the outcomes collected or analyses conducted. Several studies have suggested that orthodontic treatment leads to an improvement in OHQoL, but again these are mainly cross-sectional and clinic based (2).

In many studies it is assumed that there is a direct relationship between the clinical features of malocclusion and OHQoL, without taking into account other factors that might influence this relationship, such as the individual's psychological well-being or their socioeconomic status.(3, 4, 5). Agou and colleagues (6, 7), in Canada, found a significant correlation between OHQoL and self-esteem; however the authors were not confident about the direction of the association, i.e. whether improved psychological well-being led to improved OHQoL or vice versa.

The Wilson and Cleary theoretical model of health (8) has been used to conceptualize the relationships between clinical factors, characteristics of the individual, their environment and health-related quality of life (9). The model proposes a taxonomy of different measures of health outcomes at five levels: biological and physiological, symptoms, functioning, general health perceptions, and overall quality of life. Each of the levels is related and influenced by characteristics of the individual and of the environment.

Baker and colleagues used the Wilson and Cleary model to inform their choice of outcomes in a longitudinal study investigating the OHQoL of young people (10). They found that by including outcomes, such as the participant's sense of coherence (a characteristic of the individual) and parental income (a characteristic of their environment) they were able to explain more fully the impact of oral health on well-being.

The aim of this study was to examine, within a cohort of UK schoolchildren, the relationship between the appearance of the teeth, dental health and OHQoL over time, as well as any influences of the characteristics of the individual and their environment, using the Wilson and Cleary model of health as a theoretical basis.

The specific objectives were to:

- Examine the cross-sectional relationships between OHQoL and socio-economic status (SES), self-esteem (SE), gender, self-assessed appearance of the teeth and DMFS at age 11 to 12 years;
- Examine the longitudinal relationships between change in the OHQoL between the ages of 11/12 and 14/15 years and SES, changes in SE, self-assessed appearance of the teeth and DMFS, as well as gender and history of orthodontic treatment.

Participants and methods

This study was conducted in a convenience sample of schoolchildren attending seven publicly funded schools in UK. Ethical approval for the study was obtained from the School of Health and Related Research Ethics Committee on behalf of the University of Sheffield (February 2006) and permission obtained from the Local Education Authority of each area sampled. The schools were selected to represent areas with both good and poor access to orthodontic services (11). Baseline data collection was undertaken with children in school year seven (aged 11-12 years) to represent the stage at which a malocclusion of the secondary teeth becomes apparent, but is usually before any active intervention has taken place. A follow-up examination was undertaken three years later when the children were in school year 10 (aged 14-15 years) and it was anticipated that most orthodontic treatment would have been completed. The baseline examinations were carried out in 2007-08 and the follow-up examinations in 2010-11.

Two weeks before each school visit potential participants were given written information about the study to take home, as well as a consent form for the parents to sign and return. Participants attending on the day provided written assent to take part and were invited to complete a measure of OHQoL (CPQ_{11-14} ISF-16)(12) and the Child Health Questionnaire self-esteem measure (CHQ-CF87)(13). It was stressed that the participants should complete the measures by themselves, without consultation with their friends or teacher. This took place immediately prior to the clinical examination by the trained and calibrated research team.

Children were excluded at baseline if they had a previous history of orthodontic treatment, were wearing an orthodontic appliance, if they had a cleft lip or palate or syndrome or if they were unable to complete the questionnaire without minimal assistance.

Variables

Variables were chosen to reflect a simplified version of the Wilson and Cleary model of health, which was used as the analytical framework (Figure 1). These included characteristics of the individual, their environment, as well as clinical indicators of malocclusion, together with oral symptoms and functional status (OHQoL).

Characteristics of the individual

Self-esteem was found to be the individual characteristic most frequently described in relation to malocclusion (7, 14, 15, 16). The self-esteem of participants was assessed using a 14-item measure, which was part of the Child Health Questionnaire-Child Self-Report Form (CHQ-CF87) developed specifically for use with children and adolescents (13). It aims to capture the following dimensions of self-esteem: satisfaction with school and athletic ability, looks/appearance, ability to get along with others and the family, and life overall over the previous four weeks. Scale scoring was carried out according to the CHQ manual (17). The response options were coded 1 = Very badly to 5 = Very good. Raw scores were generated by calculating the mean of the 14 items for those participants who responded to seven items or more and the raw scores were transformed to standardized scores from 0 to 100. Higher scores are an indication of higher self-esteem.

Characteristics of the environment

The socio-economic status (SES) of each participant was indicated using the Index of Multiple Deprivation (IMD) derived from their home postcode (18). If the participant was reluctant or unable to provide their home postcode, then the postcode of the school was substituted. The IMD score was recoded into quartiles based on the 2010 rankings from 1 (most deprived) to 4 (least deprived).

Physiological (clinical) variables

Several clinical variables were used to describe the malocclusion. The Index of Orthodontic Treatment Need (IOTN) (19) has been used extensively to evaluate actual and self-perceived treatment needs. The IOTN dental health component (DHC) was assessed clinically by two trained and calibrated orthodontists. Higher values suggest a greater need for treatment. To obtain a self-perceived aesthetic component the IOTN AC was used with the ten standard pictures of teeth shown to the children, who were then asked to choose where they thought the appearance of their teeth was on the scale of 1 to 10. Again higher IOTN AC scores indicate a worse aesthetic appearance. To derive the clinician-assessed IOTN AC a frontal view of the anterior teeth with the lips retracted was taken, for each participant, using a digital camera and examined at a later date by a trained and calibrated orthodontist. These assessments were repeated two weeks later and there was substantial agreement between the two readings (unweighted kappa 0.72, 95% CI 0.65 to 0.79).

Before the start of the study the two orthodontic assessors received training in the use of the IOTN DHC and AC with an experienced examiner who acted as the gold standard. Inter-examiner agreement was almost perfect or substantial (DHC weighted kappa 0.87, 95% CI 0.73 to 1.00; AC weighted kappa 0.80, 95% CI 0.69 to 0.99).

Caries experience was assessed by two examiners who were trained and calibrated. They determined the mean number of decayed, missing and filled permanent tooth surfaces (DMFS) based on the criteria recommended by the British Association for the Study of Community Dentistry (20).

Oral health-related quality of life

Data were collected using the CPQ ISF-16 for children aged 11-14 years of age (12). Each response was coded from 0 = 'Never' to 4 = ‘Everyday/almost everyday' and a total CPQ_{11-14} ISF-16 score calculated. This measure was supplemented with several questions to evaluate a global rating of oral health (0 = ‘Excellent’ to 4 = ‘Poor’), a global rating of impact on life overall (0 = ‘Not at all’ to 4 = ‘Very much’) and a rating of satisfaction with the appearance of their own teeth (0 = ‘Very satisfied’ to 4 = ‘Very dissatisfied’) (21). Higher scores indicate worse OHQoL.

Data analysis

Data from a previous cross-sectional study involving UK schoolchildren (22) was used to inform a sample size calculation based on uneven group sizes (treated and untreated groups). The original data were skewed, therefore logged values were applied to transform the data to a normal distribution. The calculation determined that a final sample size of 198 would be required to detect a difference in means of 0.100 (logged value of difference in the total CPQ_{11-14} ISF-16 score between treated and untreated samples) assuming that the common

standard deviation is 0.200 (logged value), when the proportion of those with a history of orthodontic treatment by the age of 15 years is 32% (23) with a power of 90% and significance level of P<0.05. Allowing for 40% dropout at the baseline examination and 80% attendance at follow-up, 400 children would be needed at the 11-12 years old baseline data collection.

Data analysis was undertaken to examine two relationships:

Cross-sectional relationships at baseline: A bivariate analysis and multivariate linear regression were used to evaluate the associations between the dependent variable of OHQoL (total CPQ_{11-14} ISF-16 score) at baseline and the explanatory variables of gender, socio-economic status (IMD), self-esteem (CHQ-CF87), self-assessed IOTN AC and dental health (DMFS). The self-assessed IOTN AC was the only indicator of normative orthodontic need included in the model, as significant correlations were found between the self-assessed IOTN AC and the clinician-assessed IOTN AC (Pearson's correlation coefficient 0.452, P<0.001) and the clinician-assessed IOTN AC and the clinician-assessed IOTN DHC (Pearson's correlation coefficient 0.469, P<0.001). The self-assessed IOTN AC was considered to be the most meaningful variable describing the extent of the malocclusion to the young person.

Longitudinal relationships: A bivariate analysis and multivariate linear regression were used to investigate the longitudinal associations between the change in the OHQoL (total CPQ_{11-14} ISF-16 score) from baseline to follow-up (dependent variable) and the independent variables of gender, the socio-economic status (IMD) at follow-up, the change in the self-esteem score (CHQ-CF87), change in self-assessed IOTN AC, change in the DMFS score and whether the young person reported having orthodontic treatment since the baseline examination.

The descriptive, bivariate and multivariate analyses were conducted using SPSS v20 (IBM Corp, NY, USA).

Results

The flow of participants through the study is shown in Figure 2. A total of 404 children from the seven schools initially consented to take part and 24 withdrew their consent or were wearing orthodontic appliances on the day. A further six participants were lost from the baseline data collection due to non-completion of more than four missing responses in their questionnaires leaving a baseline sample of 374 participants aged 11-12 years. A measure of self-esteem was not included in the baseline examination for the first two schools visited, but was added for the remaining five schools and for the follow-up data collection. There were, therefore, 300 participants with full baseline data, including demographics, clinical assessment, OHQoL and self-esteem. Two participants had missing DMFS values, one had a missing self-assessed IOTN AC score and one participant had

both missing DMFS and self-assessed IOTN AC score; therefore 296 participants were included in the cross-sectional analysis of the relationships in the baseline data.

At the follow-up visit three years later, 116 of the original participants withdrew consent, were absent or otherwise not available on the day of the visit; therefore data were collected on 258 (69% response rate). Twenty participants were wearing orthodontic appliances and were excluded, 21 completed the questionnaire, but subsequently withdrew consent for the clinical examination; therefore 217 participants had complete demographic, clinical and OHQoL data (58% response rate). Nine individuals had four or fewer missing responses and these were replaced with a mean value for their school. The number of participants with complete demographic, clinical, OHQoL and self-esteem data was 173 (58% response rate for those with baseline self-esteem scores). This was the sample included in the longitudinal analysis examining the relationships with the change in OHQoL.

Descriptive statistics

Descriptive data concerning the demographics, IOTN and caries experience for 374 participants at baseline (T1) and 217 participants at follow-up 3 years later (T2) are shown in Table 1. Baseline assessments for those individuals lost-to-follow-up are also shown. There was a higher proportion of girls recruited than boys, as the two London schools sampled were girls only; however the girl:boy ratio is approximately equal to the gender proportions receiving orthodontic treatment in the UK (24). Those who were lost-to-follow-up had slightly increased proportions from higher socio-economic groups and had more severe malocclusions judged by the IOTN DHC, clinician and self-assessed IOTN AC.

The IOTN DHC was judged to have improved between T1 and T2 in approximately one third of participants (35.0%), irrespective of whether they had a history of orthodontic treatment or not. In 39.2% there was no change; however in a quarter of participants (25.8%) the IOTN DHC was scored higher at T2. Generally the clinician-assessed IOTN AC improved between T1 and T2 (51.6%) or there was no change (40.1%). Only in 18 out of 217 participants (8.3%) was the clinician-assessed IOTN AC worse at T2 compared to T1. This trend was also observed, but was less marked, in the self-assessed IOTN AC (43.3% improved; 29.0% no different); however a significant minority of participants (27.6%) judged their own IOTN AC to be worse at T2.

The caries data at T1, with 64.8% free from obvious dental caries, were very close to the national average for 12 year-olds in the UK, which is currently 66.6% (25). The mean number of decayed, missing or filled surfaces (DMFS) was 1.30 (95% CI 1.03 to 1.65). The DMFS was significantly worse at T2 (mean difference 1.2, SD 3.0; $P<0.001$, paired *t* test).

Table 1 also shows the baseline and follow-up data for the total CPQ $_{11\text{-}14}$ ISF-16 scores, as well as the CHQ-CF87 scores. The CPQ 11-14 ISF-16 domain scores are available in an online supplement. There was a significant reduction in the total $CPQ_{11\text{-}14}$ ISF-16 score between T1 and T2 (mean difference 2.0, SD 8.7; P=0.003 paired *t* test) suggesting that OHQoL improved over time; however there was also a significant reduction in self-esteem (mean difference 5.4, SD 14.9; P<0.001 paired *t* test). There were no differences between the baseline self-esteem scores of those participants who were followed-up and lost-to-follow-up (P=0.137 independent *t* test). Data for the global oral health, life overall and satisfaction questions at baseline and follow-up are available in the online supplement.

The proportion with a history of undergoing orthodontic treatment, but not still wearing appliances was much lower than originally anticipated (35 out of 217, 16.2%). The mean improvement in the total $CPQ_{11\text{-}14}$ ISF-16 score was 3.2 (SD 6.9; P=0.009 paired *t* test) in those with a history of orthodontic treatment and 2.4 (SD 8.8; P<0.001 paired *t* test) in those with no history of orthodontic treatment, but the difference was not statistically significant (P=0.584; independent *t* test).

Cross-sectional relationships at baseline

The multivariate analysis found significant cross-sectional associations between OHQoL (total $CPQ_{11\text{-}14}$ ISF-16 scores) and three independent variables at baseline (socio-economic status, self-esteem and self-assessed IOTN AC) (Table 2). Examination of the bivariate relationships in the multivariate analysis showed that there was a significant negative association between socio-economic status and OHQoL (rho = -0.11; P=0.034) i.e. the lower the socio-economic status, the worse the OHQoL at baseline. There was also a significant negative association between the CHQ-CF87 scores (self-esteem) and the total $CPQ_{11\text{-}14}$ ISF-16 scores (rho = -0.50; P<0.001), which suggests that those participants with low self-esteem had poorer OHQoL and vice versa. There was a significant positive association between the self-assessed AC scores and the total $CPQ_{11\text{-}14}$ ISF-16 scores (rho = 0.27; P<0.001) i.e. those who assessed the appearance of their teeth to be poor had worse OHQoL.

The participant's DMFS score was not a significant variable in the regression model, but the bivariate analysis suggested that there was a significant association (p=0.039); however the correlation was low (rho = 0.10). The gender of the participant was not significantly associated with OHQoL in either the multivariate or bivariate analysis (rho = 0.35; P=0.275). The regression model had an R Square value of 0.32 (adjusted R Square 0.31).

Longitudinal relationships

The multivariate analysis demonstrated significant longitudinal associations between the change in the OHQoL from baseline to follow-up (change in total $CPQ_{11\text{-}14}$ ISF-16 scores) and two independent variables, namely self-esteem and DMFS (Table 3). Examination of the bivariate relationships in the multivariate analysis showed that

there was a significant negative association between the changes in the CHQ-CF87 scores (rho = -0.46; P<0.001) and changes in the total CPQ_{11-14} ISF-16 scores. This suggests that as the self-esteem improves (a higher CHQ-CF87 score) the OHQoL improves (a lower total CPQ_{11-14} ISF-16) and vice versa.

There was also a significant negative association between the change in the DMFS score and change in the total CPQ_{11-14} ISF-16 scores (rho = -0.24; P=0.001). This suggests that if the DMFS score increased between baseline and follow-up, the OHQoL improved, which is difficult to explain. Further examination of the DMFS data showed that the majority of participants (59%) had no change in their DMFS scores and this was reflected in a small change in their total CPQ_{11-14} ISF-16 scores (mean change = -0.9). In a significant minority of participants (37.6%) the DMFS scores worsened; however they recorded a mean reduction of 4.1 in their total CPQ_{11-14} ISF-16 scores. In only a small proportion of participants (3.5%) the DMFS score improved and they demonstrated a mean reduction in their total CPQ_{11-14} ISF-16 scores of 2.5, which was smaller than those in whom the DMFS score increased.

There were no associations between the change in the OHQoL and gender (rho = 0.059; P=0.219) or socio-economic status (rho = -0.001; P=0.493). Neither were there associations between changes in OHQoL and changes in the self-assessed IOTN AC (rho = 0.089; P=0.121) or in those that reported a history of orthodontic treatment; however as noted previously the number of individuals who had worn braces was quite small (33 out of 173 with full longitudinal data, 19.1%). The model had an R Square value of 0.25 (adjusted R Square 0.22).

Discussion

This longitudinal study of XX schoolchildren examined the cross-sectional and longitudinal relationships between OHQoL and various factors. The study used a theoretical model of health to inform the choice of variables and analyses. The main finding was to further support the premise in the Wilson and Cleary model that factors concerning the individual (self-esteem) and their environment (socio-economic status) have an important direct relationship with OHQoL. Although there was a significant relationship at baseline, between OHQoL and the opinions of young people concerning the appearance of their teeth (self-assessed IOTN AC), there were no longitudinal relationships between changes in the OHQoL and changes in the self-assessed IOTN AC or in those with a history of orthodontic treatment.

Effect of self-esteem

The findings of this study suggest that those with higher self-esteem have less frequent impacts from their malocclusion and any improvement in OHQoL over time is associated with an increase in self-esteem. One possible explanation for why those with severe malocclusion, but high self-esteem apparently have less frequent OHQoL impacts than those with low self-esteem; is that high self-esteem is a psychological resource that protects

an individual from the effects of a condition (7, 26). Another alternative explanation could be that children with low self-esteem focus more on their malocclusion and believe that if this were to be corrected it might be the key to solving other problems (27).

The apparent direction of the relationship between self-esteem and OHQoL needs to be investigated further. If self-esteem is shown to have a direct relationship with OHQoL, this might suggest that interventions to improve self-esteem could provide an opportunity to reduce the impact of malocclusion. Indeed, therapeutic interventions to boost self-esteem have already been recommended to reduce the impact of other conditions, including cleft lip and palate (28). Such interventions may reduce an individual's perceived need for orthodontic treatment; however further research is needed. Further discussion of the effects of self-esteem is available in the online supplement.

The effect of socio-economic status

A relationship was found between socio-economic status and OHQoL at baseline. This concurs with Locker who found that there were disparities in OHQoL among a group of Canadian schoolchildren, with children from low income households having the poorest OHQoL (26). Moreover, Mtaya and colleagues suggested that childrens' concerns about their dental appearance are influenced by the social and cultural context in which they live (29).

These studies confirmed the link between socio-economic status and OHQoL and convincingly demonstrate that socio-economic status can influence the frequency of impacts of malocclusion on OHQoL. This link can be explained in different ways (30). First, income has a direct effect on the ability to access goods, services, and other resources that promote health. Second, there may be an indirect mechanism in terms of differential exposure to risk factors and health behaviours. Third, the relationship between socio-economic status and health outcomes may be the result of differences in psychological assets and psychosocial resources. It has been suggested that traits and factors such as optimism, coping styles, social support, and personal control are related to health outcomes and appear to vary across socio-economic groups (31). Further discussion of the effects of socio-economic status is available in the online supplement.

The effect of clinical factors

There was a significant cross-sectional association between the child self-assessed IOTN AC and OHQoL at baseline; however there was no relationship between the improvement in the self-assessed IOTN AC and OHQoL over time. The IOTN AC was developed to more accurately reflect the psychosocial opinion of schoolchildren about the appearance of their teeth and our study appears to confirm this cross-sectionally, but not longitudinally. This agrees with the work of Kok and colleagues (32); however more work needs to be undertaken to assess the validity and responsiveness of IOTN AC in young people over time.

There was no association between the change in the OHQoL and a self-reported history of undergoing orthodontic treatment. Participants who were wearing orthodontic appliances at the time of the follow-up data collection were excluded, as orthodontic treatment has been shown to have an adverse effect on OHQoL (33). Several cross-sectional studies have suggested that individuals who have undergone orthodontic treatment have a better OHQoL than those who have not had treatment (2, 7, 34, 35). Although this study found a slightly greater improvement in the total CPQ_{11-14} ISF-16 score in those with a history of orthodontic treatment, this was not statistically significant and we were unable to find a relationship between a history of orthodontic treatment and an improvement in OHQoL with time. The proportion of participants at 3-year follow-up who were wearing appliances or who reported having worn appliances was lower than expected at 23%. This is compared to 32% in the most recent child dental health survey in the UK (23), but was the same as a New Zealand sample of 255 children aged 16 years (36). More longitudinal studies are required in patients undergoing orthodontic treatment to determine the effect of correcting malocclusion on OHQoL.

One interesting finding from this study is that there was a general improvement in the assessment of the severity of malocclusion over time with both clinician and participant-assessed indices of treatment need. Foster Page and colleagues (37) found that nearly one quarter of participants (23.9%) demonstrated an improvement in their orthodontic treatment need category as measured with the Dental Aesthetic Index between the ages of 13 and 16 years. This compared with nearly half of participants (47.8%) in the need category staying the same and just over one quarter (28.2%) getting worse. The greatest improvement was in the category of maxillary anterior irregularity. This is a very visible characteristic which will also be scored with IOTN AC.

The association between OHQoL and dental caries, in terms of DMFS, was inconsistent. There was no significant association between the two factors in the cross-sectional multivariate analysis, but the bivariate analysis suggested a very weak association. There was a significant association between the change in OHQoL and change in the DMFS, suggesting that even if the dental health worsened over time (the DMFS score increased) the OHQoL improved, which is difficult to explain. This inconsistency between OHQoL and caries data has been found in previous studies (38, 39) and needs to be investigated further. The effect of gender in this study is discussed in the online supplement.

Limitations of the study

It should be borne in mind that the sample used in this study was a convenience, rather than a random sample of schoolchildren in the UK. This method of sampling should be taken into account when making wider generalisation of the findings to the population as a whole; however, attempts were made to include children

from areas with varying levels of access to orthodontic services in the UK. In contrast, a number of previous studies evaluating OHQoL have used clinic-based, rather than school-based populations (40, 41).

The response rate for all participants from baseline to follow-up was a reasonable 69% and comparable to other longitudinal, population-based, rather than clinic-based studies, at 3 years (14). Although we did achieve the estimated sample size of 198 in the follow-up examination, because CHQ-CF87 was not included in the baseline data collection for two schools early in the study, the response rate for the longitudinal element was 58% (n = 173/296) for those with baseline self-esteem data, but below half of the original baseline sample (46%; n = 173/374). There is the risk that those participants who provided data for the follow-up examination were different to those who did not provide data, thereby introducing the possibility of non-response bias (42). We found it increasingly difficult to obtain the full cooperation of schools as the children got older, due to the pressures of formal examinations and assessments. Also participants withdrew for a variety of reasons, rather than in a systematic way, which might help to alleviate the risk of non-response bias.

Another possible limitation was the CPQ_{11-14} ISF-16 used to assess child OHQoL in this study. Marshman and colleagues reported concerns expressed by young people with malocclusions about the face and content validity of CPQ ISF-16, and suggested that further consideration should be given to the need for a child-centred malocclusion-specific OHQoL measure (43).

Implications of the study

This study found no significant association between improvement in the OHQoL of a young person and a history of orthodontic treatment, although the numbers undergoing treatment were quite small and those still in treatment were excluded. One aim of orthodontic treatment is to reduce the social impact on a young person of the appearance of their teeth. This should, theoretically, lead to an improvement in their OHQoL. Orthodontic treatment is currently prioritised based on the Index of Orthodontic Treatment Need (IOTN) in the UK National Health Services. Current UK policies, including the National Service Framework for Children, Young People and Maternity Services (44) recommend that services should be designed to meet the needs of children and their families. There is an apparent conflict between the prioritisation of orthodontic treatment based on normative need and attempts to provide treatment based on children's perceived needs. This study found that the impact of malocclusion, in terms of OHQoL, was inconsistently related to the aesthetic component of the IOTN index (i.e. there was a cross-sectional relationship at baseline, but not a longitudinal relationship). Moreover, there was a more consistent relationship between OHQoL and self-esteem. These findings have implications for the assessment of the need for orthodontics treatment of individual children and populations in the future. Further

research is needed to investigate methods of the assessment of treatment need that capture OHQoL, self-esteem and clinical need.

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Figures legends

Figure 1 – The theoretical framework based on a simplified Wilson and Cleary Model linking the clinical and non-clinical variables.

Figure 2 – Chart showing the flow of participants through the study.

Table legends

Table 1 – Descriptive statistics showing the demographics, clinical malocclusion assessments, caries rates, Total CPQ11-14 ISF-16 scores, as well as self-esteem scores from CHQ-CF87 for all participants at baseline (T1), the follow-up group after 3 years (T2) and the baseline assessments for those individuals lost-to-follow-up.

Table 2 – Cross-sectional baseline relationships investigated using multivariate regression analysis with dependent variable Baseline Total CPQ_{11-14} ISF-16 score (n=296).

Table 3 – Longitudinal relationships investigating using multivariate regression analysis with dependent variable change in Total CPQ_{11-14} ISF-16 scores (n=173).

Figure 3 – The theoretical framework based on a simplified Wilson and Cleary Model linking the clinical and non-clinical variables.

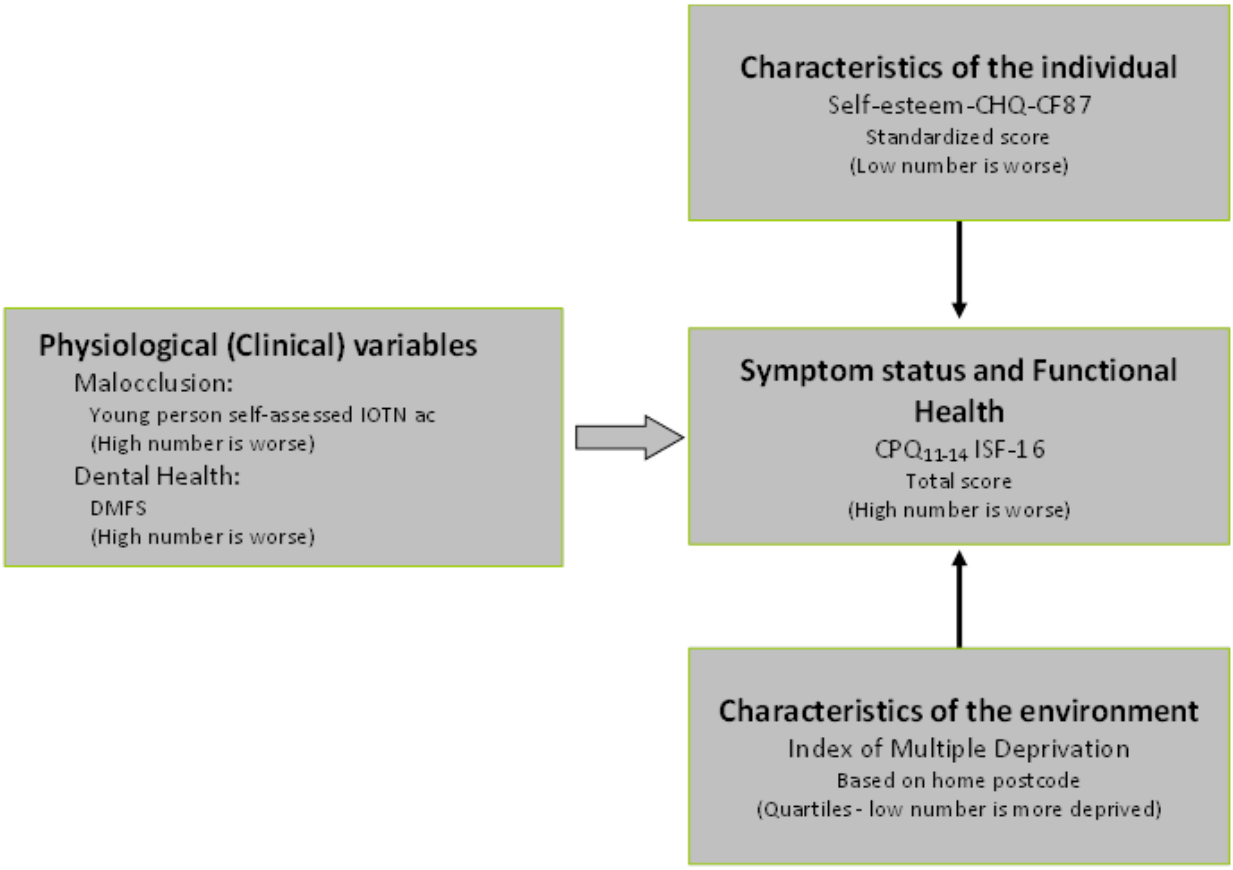
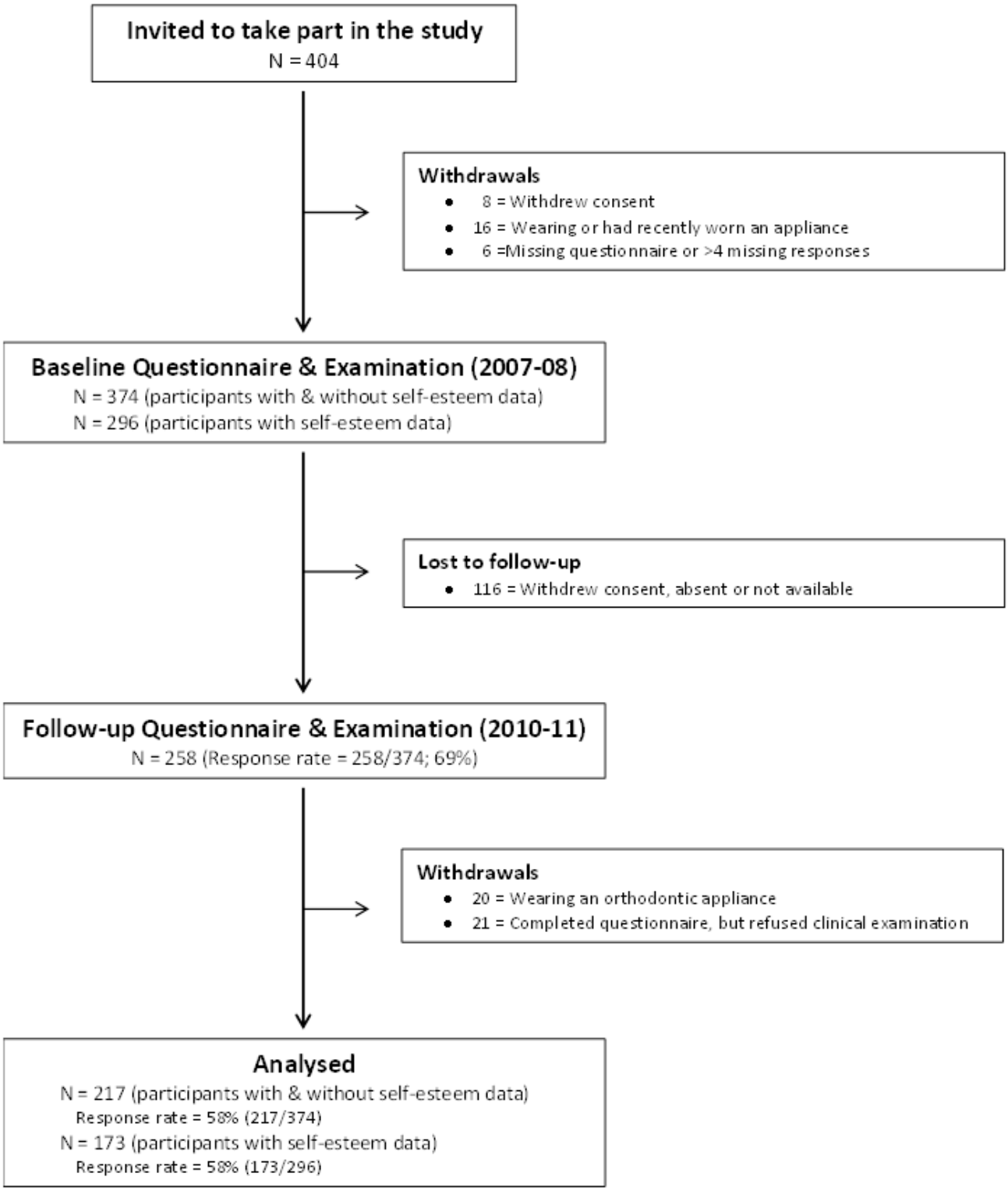


Figure 4 – Chart showing the flow of participants through the study.



Tables

Table 2 – Descriptive statistics showing the demographics, clinical malocclusion assessments, caries rates, Total CPQ11-14 ISF-16 scores, as well as self-esteem scores from CHQ-CF87 for all participants at baseline (T1), the follow-up group after 3 years (T2) and the baseline assessments for those individuals lost-to-follow-up.

		Baseline – T1 (n = 374)		Follow-up – T2 (N = 217)		Lost-to-follow-up baseline scores (N = 157)	
Gender	**Boys**	122	32.6%	61	28.1%	61	38.9%
	Girls	252	67.4%	156	71.9%	96	61.1%
	n	374		217		157	
SES	**1st quartile (most deprived)**	157	42.0%	105	48.4%	50	31.8%
	2nd quartile	83	22.2%	40	18.4%	45	28.7%
	3rd quartile	62	16.6%	38	17.5%	19	12.1%
	4th quartile (least deprived)	72	19.3%	34	15.7%	43	27.4%
	n	374		217		157	
IOTN DHC	**No Need**	96	25.7%	71	32.9%	35	22.4%
	Borderline Need	138	37.0%	90	41.7%	60	38.5%
	Definite Need	139	37.3%	55	25.5%	61	39.1%
	n	373		216		156	
Clinician-assessed IOTN AC	**1 to 4**	255	69.9%	187	86.2%	97	64.7%
	5 to 7	101	27.7%	28	12.9%	48	32.0%
	8 to 10	9	2.5%	2	0.9%	5	3.3%
	n	365		217		150	
Self-assessed IOTN AC	**1 to 4**	319	85.5%	204	94.9%	129	82.2%
	5 to 7	31	8.3%	7	3.3%	17	10.8%
	8 to 10	23	6.2%	4	1.9%	11	7.0%
	n	373		217		157	
Caries	**Free obvious caries**	241	64.8%	105	48.4%	93	60.0%
	Mean DMFS (SD)	1.30	3.1	2.5	4.7	1.4	2.9
	95% CI	1.03	1.65	1.86	3.11	0.98	1.89
	n	372		217		155	
Oral health-related quality of life	**Total CPQ_{11-14} ISF-16 score (mean & sd)**	13.7	8.2	11.2	6.7	13.6	8.4
	n	374		217		157	
Self-esteem	**CHQ-CF87 standardized score (mean & sd)**	80.0	14.4	75.6	13.0	78.6	14.8
	n	300		217		156	

Table 2 – Cross-sectional baseline relationships investigated using multivariate regression analysis with dependent variable Baseline Total CPQ_{11-14} ISF-16 score (n=296)

	Unstandardized Coefficients		95% CI for B		Standardized Coefficients	t	P
	B	SE	Lower Limit	Upper Limit	Beta		
(Constant)	36.8	3.4	30.2	43.4		11.0	<0.001
Gender	-0.9	1.0	-3.0	1.1	-0.1	-0.9	0.367
Socioeconomic status	-1.1	0.4	-1.8	-0.3	-0.2	-2.8	0.006
Self-esteem score	-0.3	0.0	-0.3	-0.2	-0.5	-10.1	<0.001
Child self-assessed IOTN AC	1.0	0.2	0.5	1.4	0.2	4.4	<0.001
DMFS	0.2	0.1	-0.1	0.4	0.1	1.2	0.222

Table 3 – Longitudinal relationships investigating using multivariate regression analysis with dependent variable change in Total CPQ_{11-14} ISF-16 scores (n=173)

	Unstandardized Coefficients		95% CI for B		Standardized Coefficients	t	P
	B	Std. Error	Lower Limit	Upper Limit	Beta		
(Constant)	-5.6	3.7	-13.0	1.7		-1.5	0.129
Gender	1.3	1.6	-1.9	4.5	0.1	0.8	0.430
Socioeconomic status	0.4	0.6	-0.8	1.7	0.1	0.7	0.482
Change in self-esteem score	-0.2	0.0	-0.3	-0.2	-0.4	-6.1	<0.001
Change in child self-assessed IOTN AC	0.4	0.3	-0.2	1.0	0.1	1.4	0.167
Change in DMFS	-0.4	0.2	-0.8	0.0	-0.2	-2.2	0.029
History of orthodontic treatment	-1.1	1.6	-4.3	2.0	-0.1	-0.7	0.476

Relationships between dental appearance, self-esteem, socio-economic status and oral health-related quality of life in UK schoolchildren: A three-year cohort study – Online supplement

Results

Table A1 shows that the proportions of scores for the global oral health, life overall and satisfaction questions at baseline and follow-up. The majority of participants at baseline judged their oral health to be Good, Very good or Excellent (83.6%), it affected their life Very little or Not very much (69.5%); however a smaller proportion were Satisfied or Very satisfied with the appearance of their teeth (52.4%). These proportions remained similar for the participants who were in the Follow-up group (86.6%; 61.1%; 52.5%). The baseline data of the participants who were lost to follow-up showed that this group did not respond differently to the three global questions (Table 2).

Discussion

Effect of self-esteem

Many different concepts of the self have been mentioned in the literature. Self-esteem was chosen as one of the individual characteristics because it is the concept of the self most often researched with respect to malocclusion; however it is a dynamic construct especially in children of this age (1). Several longitudinal studies have examined young people over relatively short periods of time, usually a few months when psychosocial outcomes are likely to be relatively stable (2, 3). We chose a reasonably long follow-up time to allow for any possible orthodontic treatment to be completed and indeed we had to exclude several participants from the follow-up data collection, as they were still wearing orthodontic appliances. The years between 11 and 15 are a formative time in a young person's life, when they are changing from a child to an adult and developing a sense of self (4). The psychological make-up of these young people is likely to be changing and the results suggested a slight decrease in the self-esteem of participants between the ages of 11-12 and 14 -15 years. This is contrary to the results of other longitudinal cohort studies that followed individuals up for longer time periods and found that self-esteem increased (5, 6); however the participants in these studies were much older at follow-up than the participants in our study. Other characteristics of the individual were not included in this study, such as sense of coherence, locus of control or coping and their role should be investigated in future research on the impact of malocclusion and oral health conditions more generally (2).

The stability of OHQoL over time is unclear (7, 8). Several longitudinal studies have shown an improvement in OHQoL at follow-up (2, 9, 10); however little work has been undertaken into the longitudinal evaluative properties of OHQoL measures (11). Wong and colleagues concluded that OHQoL, measured using $CPQ_{11\text{-}14}$, had

moderate stability over time in Hong Kong adolescents and Foster-Page and colleagues concluded that CPQ_{11-14} had acceptable responsiveness in a similarly aged sample in New Zealand (12).

The effect of socio-economic status

Sanders and Spencer found that childhood circumstances, as indicated by socio-economic status, influenced adult psychological and psychosocial attributes, such as sense of coherence, social support and stress, and these in turn influenced oral health outcomes in terms of the social impact of dental disease (13). However, more information on the mechanisms by which social class or deprivation influence oral health is required (14). It has been suggested that to better understand the relationship between socio-economic status and OHQoL, researchers need to employ sensitive longitudinal research designs and analytical approaches that take advantage of variations of times of measurement, as the influence of socio-economic status on OHQoL is dynamic and can be cumulative (15). Moreover, more attention should be focused on the role of psychosocial factors, such as occupational hierarchies, as it is believed to be involved in generating inequalities at the upper, as well as the lower end of the socio-economic spectrum (14).

The effect of gender

Little work has been carried out examining the differences in OHQoL between boys and girls. Wong and colleagues (9) found that girls had better OHQoL in the social well-being domain using CPQ RSF-8 than boys, even though they had initially hypothesised that it would be worse in girls. We did find that girls had a worse OHQoL than boys at follow-up, but the finding was only just statistically significant at the 5 percent significance level. There was a higher proportion of girls than boys in the baseline and follow-up samples of our study. Two of the schools sampled contained only girls and these schools proved particularly efficient at retaining participants at follow-up. We did not find a significant effect of gender on OHQoL; however larger samples would be required to test this hypothesis.

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Table

Table A1 – Responses to CPQ_{11-14} ISF-16 Global Oral Health, Life Overall and Satisfaction with dental appearance questions, as well as Total and Domain scores, for all participants at baseline (T1), the follow-up group after 3 years (T2) and the baseline scores for the lost-to-follow-up group.

		Baseline – T1 (n = 374)		Follow-up – T2 (N = 217)		Lost to follow-up baseline scores (N = 157)	
Global Oral Health Scores	**Excellent**	13	3.5%	11	5.1%	9	5.8%
	Very Good	94	25.3%	68	31.3%	27	17.3%
	Good	204	54.8%	109	50.2%	87	55.8%
	Fair	51	13.7%	26	12.0%	27	17.3%
	Poor	10	2.7%	3	1.4%	6	3.8%
	n	372		217		156	
Life Overall	**Not at all**	95	25.7%	55	25.5%	43	27.7%
	Very little	162	43.8%	77	35.6%	57	36.8%
	Some	81	21.9%	55	25.5%	41	26.5%
	A lot	17	4.6%	18	8.3%	5	3.2%
	Very much	15	4.1%	11	5.1%	9	5.8%
	n	370		216		155	
Satisfaction with dental appearance	**Very satisfied**	36	9.7%	23	10.6%	18	11.5%
	Satisfied	159	42.7%	91	41.9%	57	36.5%
	Neither satisfied or dissatisfied	125	33.6%	61	28.1%	58	37.2%
	Dissatisfied	39	10.5%	35	16.1%	16	10.3%
	Very Dissatisfied	13	3.5%	7	3.2%	7	4.5%
	n	372		217		156	
Oral health-related quality of life	**Total CPQ_{11-14} ISF-16 score (mean & sd)**	13.7	8.2	11.2	6.7	13.6	8.4
	Domain scores						
	Oral symptoms	4.5	2.4	3.8	1.9	4.4	2.4
	Functional limitations	3.1	2.4	2.7	2.3	3.0	2.4
	Emotional well-being	3.5	3.3	2.9	2.9	3.4	3.3
	Social well-being	2.7	2.7	1.8	2.0	2.8	3.0
	n	374		217		157	