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## **Original article**

# The evolution of self-esteem before, during and after orthodontic treatment in adolescents with dental malocclusion, a prospective cohort study

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#### **Summary**

**Objectives:** This study aimed (1) to investigate the evolution of self-esteem through orthodontic treatment, and (2) to study how key demographic factors would affect these evolutions and to assess relationships between self-esteem and orthodontic treatment need.

**Methods:** This longitudinal prospective cohort study comprised of 326 adolescents (172 girls and 154 boys) aged 11–16 years; data were obtained from 325 adolescents at T0 and 123 at T2. Three hundred twenty-one adolescents filled in questionnaires at T0, whereas 118 at T2. They were selected in the University Hospitals Leuven, Belgium, where they all received orthodontic treatment. Self-esteem was assessed with the Dutch adaptation of the Harter's test and treatment need was defined by the Index of Orthodontic Treatment Need (IOTN). Data were analysed with multivariate linear models and Spearman correlations.

**Results:** There was no evidence of a change in global self-esteem during orthodontic treatment. A significant gender by time interaction for scholastic competence (P < 0.05), a decrease in self-esteem for females, and an increase for males between T0 and T1 was observed. A significant age (at T0) by time interaction for physical appearance and global self-worth (P < 0.05) and a negative correlation between self-esteem and self-assessed IOTN aesthetic component for the subdomain of close friendship (P < 0.05) were found.

**Conclusions:** Global self-esteem acts as a stable construct during orthodontic treatment. The subdomains of self-esteem could be influenced by age and gender. Self-esteem and the subjective need for orthodontic treatment were found to be negatively correlated.

#### Introduction

Quality of life has been described by the World Health Organization as 'the individuals' perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns' (1). The Oral Health-Related Quality of Life (OHRQoL) reflects the impact of oral conditions on daily life in different domains such as functional limitations, emotional and social well-being, school performance, and peer interaction (2, 3). The Wilson and Cleary model shows that OHRQoL can be influenced by malocclusion through a variety of different factors, such as symptom status, functional status, and general oral health perception, and that this process could in fact be affected by self-esteem (SE) (3–6). Some evidence was found for a correlation between self-esteem and OHRQoL, but the direction of this association is unclear (6). However, clear evidence to support the importance of self-esteem in the association between malocclusion and OHRQoL is currently still lacking.

It can be concluded from earlier studies that the OHRQoL deteriorates during orthodontic treatment and ameliorates again after treatment completion. It can also be assumed that self-esteem works as a protecting factor for OHRQoL, as adolescents with higher self-esteem show less deterioration in OHRQoL (7, 8).

The concept of self-esteem refers to a person's feeling of selfworth (9). It has been stated that adolescents with a low self-esteem have a higher chance of developing poorer mental and physical health, worse economic well-being, and higher levels of criminal activity during adulthood (10). Moreover, the developmental process of self-esteem must be considered as one of the most relevant ones (Al-Masoodi, unpublished work). During transformation from childhood to adolescence, subjects have to deal with important choices related to school, friendship. or leisure-time activities, all leading to the development of their personality in different domains. This goes together with physical changes during puberty, as well as changes in mental abilities and in social relationships such as family and friends (3).

Contrary to OHRQoL, self-esteem is assumed to be a relatively stable trait (11). Self-esteem has been described as a multidimensional concept, for which Harter developed a tool to measure feelings of both global and specific self-worth (12, 13). Global self-esteem refers to the feeling and appraisal of oneself as a person, while specific self-concepts refer to the beliefs and values in different domains, such as school competence or close friendship (14).

Longitudinal studies in which the influence of self-esteem on the impact of malocclusion is investigated are lacking in orthodontic literature. Earlier studies did not elaborate on the effects of orthodontic treatment on self-esteem, neither did they explain the role of self-esteem in the association between subjective orthodontic treatment need and OHRQoL. Understanding the interaction of these psychosocial measures is crucial to develop effective orthodontic care (3).

Therefore, the aims of the present study were 1. to investigate the evolution of self-esteem through orthodontic treatment and 2. to study how key demographic factors would affect these evolutions and to assess relationships between self-esteem and orthodontic treatment need.

#### **Methods**

#### Study population and inclusion criteria

This study is an observational prospective cohort study that compares longitudinal results of self-esteem during and after orthodontic treatment with baseline results among adolescents. Approval was obtained by the medical ethical committee of the University Hospitals Leuven with registration number ML5739.

At the first consultation at the Department of Orthodontics, all patients aged 11–16 years were asked to fill in questionnaires (T0). For our baseline sample, we excluded adolescents with psychological problems reported by their parents, adolescents who previously underwent or were still undergoing orthodontic treatment, adolescents with craniofacial anomalies, adolescents who did not understand Dutch, or adolescents whose parents or caregivers did not understand Dutch. If orthodontic treatment was needed and the patient decided to start treatment, they were asked to complete study questionnaires at two other moments, namely 1 year after the start of treatment (T1) and at 1 month after the end of treatment (T2). Three hundred twenty-six adolescents were eligible to participate. Data were obtained from 325 adolescents at T0 and 123 at T2. Three hundred twenty-one adolescents filled in questionnaires at T0, whereas 118 at T2. For example, at T0 and T2, four and five patients, respectively, failed to complete the questionnaires and were, therefore, excluded from the analysis. Missing values came from patients who failed or refused to complete the questionnaire during and after treatment.

#### Self-esteem

Self-esteem was assessed with the Competentie Belevingsschaal voor Adolescenten, CBSA, which is the Dutch adaptation of the Harter's Self-Perception Profile for Adolescents (SPPA), generally considered as one of the most used scales to assess adolescents' self-esteem (15). The CBSA questionnaire consists of a list of 35 questions to evaluate the adolescents' self-perception in six specific domains: scholastic competence (Sc), social acceptance (Sa), athletic competence (Ac), physical appearance (Pa), behavioural conduct (Bc), close friendship (Cf), as well as a separate global self-worth subscale (Gs). Harter's multidimensional model is composed of eight specific domains, including job competence and romantic appeal, which were not relevant for our study (13). Self-esteem is a wide concept involving subconcepts such as self-perception and global self-worth. Harter refers to her questionnaire specifically measuring self-perception in eight specific domains and one separate global self-worth. These terms will be consequently used further on in this manuscript. By using the age norms of the CBSA, raw results were converted to age-related scores (Rs) (7, 12).

The adolescent was provided with two alternative phrases per item of the CBSA and was asked to choose the description that was most like him or her, scoring them as 'really true for me' or 'sort of true for me'. Items were scored on a four-point scale and recoded, higher numbers representing positive self-perceptions. Positively and negatively worded descriptions were randomly distributed. The questionnaire is composed in a specific way, largely to decrease the possibility of answers being guided by social desirability (16). The CBSA questionnaire was acquired by forward–backward translation technique and was tested for validity and retest stability (Pearson correlations 0.67 to 0.87) (Van Damme, unpublished work) (12). The reliability of the subscales of the CBSA has proven to be good (Cronbach's  $\alpha \ge 0.70$ , N = 744) (17).

#### Orthodontic treatment need

Objective and subjective orthodontic treatment need were assessed by using the Index of Orthodontic Treatment Need (IOTN) (18). The practitioner scored objective orthodontic treatment need by the Dental Health Component (DHC) of this index during direct oral examination. The subjective orthodontic treatment need was evaluated by the adolescent and the practitioner by the aesthetic component (AC) of IOTN. Therefore, a dental attractiveness scale was used, which consists of 10 photographs with descending attractiveness. Evaluations were made by self-matching the dental attractiveness of anterior tooth arrangement of the patient to one of the photographs (18).

#### **Covariates**

In orthodontic literature, it has been described that self-esteem is influenced by several mediators, although there is no consensus over their influence on self-esteem. In our study, we tested the influence of gender, age, educational level of the adolescent, and socio-economic status and educational degree of the parents on self-esteem. The educational level of the adolescent was scored at T0 by him/herself, the socio-economic status of the parents was based on the Erikson– Goldthorpe–Portocarero classification and the International Standard Classification of Education, reported by the parent (19). There is low to moderate evidence that OHRQoL is influenced by subjective orthodontic treatment need and that self-esteem is a protective factor for OHRQoL (7). To test whether a relationship exists between orthodontic treatment need and self-esteem, self-esteem was evaluated for an association over time with the objective and subjective orthodontic treatment need. In order to do this, patients scored the AC of IOTN and practitioners scored the DHC of the same scale.

#### Statistical analysis

Analyses were performed separately for each self-perception domain. Multivariate linear models were used for data analysis, to deal with the longitudinal nature of the data. Self-esteem scores were modelled as the dependent variables, and an unstructured covariance matrix was modelled to account for correlations between repeated measurements. Time was modelled as a factor to estimate differences in self-esteem between the three measurement occasions (T0-T1-T2). Interaction models were used to study differential evolutions over time for different patient characteristics, defined by the abovementioned covariates. Dental health or aesthetic component were modelled as ordinal variables and the change in self-esteem was estimated for increasing objective/subjective need for treatment. Data was analysed from all patients that finished treatment in 2017. Not all patients completed the questionnaires at all time points. Given the applied statistical model, results were unbiased under the missing-atrandom (MAR) assumption that dropout may depend on previous observations but not on unobserved data (20, 21).

Spearman correlations were estimated between rating of AC and DHC at different time points. Results were presented with 95% confidence intervals and *P*-values. All tests were two-sided, and a 5% significance level was assumed for all analyses. No corrections for multiple testing were applied. Analyses were performed using SAS software (version 9.4 of the SAS System for Windows).

#### **Results**

In total, 326 adolescents were included in our study (172 girls and 154 boys) with a mean age at T0 of 13.1 years [standard deviation (SD): 1.18 years]. Most of them were Caucasian (93.23 %). They all underwent orthodontic treatment, with a mean duration of 3.3 years (mean time period T0–T2: 36.6 months, SD: 9.72, range: 13.2–79.2; mean time period T1–T2: 21.2 months, SD: 8.32, range: 0.0–61.6). The number of actual participants at each variable is listed in Table 1.

By comparing the mean scores of all seven subscales of the CBSA at T0, T1, and T2, the evolution of self-esteem over time was

assessed. Results in Table 2 show no evidence of a change in selfperception over time on any of the scales.

Thereafter, we attempted to investigate if the evolution of self-esteem depends on patient characteristics. We tested whether several moderators such as gender, age, educational level of the child, and socio-economic status do influence self-esteem. A significant gender by time interaction was observed for scholastic competence. Results suggest a trend towards decreasing self-esteem for females and increasing self-esteem for males between T0 and T1. No further evolutions are suggested between T1 and T2 (Figure 1).

A significant age (at T0) by time interaction was observed for physical appearance and global self-worth. Results suggest a trend towards improvement/stabilization of self-perception in younger children, whereas a trend towards decreased self-perception is suggested for older children (Figures 2 and 3). Third, there is no evidence that the evolution of self-perception differs over time according to the socio-economic status.

Further, we investigated the relationship between self-esteem and orthodontic treatment need. Our findings suggest a negative association between self-esteem and the opinions of adolescents concerning the appearance of their teeth (self-assessed IOTN AC). Results are significant for the subdomain of close friendship (Table 3).

Lastly, we found no evidence of an association between the objective need for orthodontic treatment, assessed with DHC scored by the practitioner, and self-esteem.

#### **Discussion**

The main findings of the present study suggest that self-esteem acts as a stable construct during orthodontic treatment. As described earlier in orthodontic literature, self-esteem acts as a protective factor for OHRQoL during orthodontic treatment (22). This implies that adolescents with higher self-esteem at baseline will report a better OHRQoL before, during, and after orthodontic treatment. Adolescents with low self-esteem could experience more discomfort due to their orthodontic treatment, which has also been found in a previous study (6).

Although the statement of self-esteem as a stable construct for global feelings of self-worth is true, our results suggest that changes in self-esteem do take place in specific areas. Regarding gender differences, a significant gender by time interaction for scholastic competence was found in the present study. These results suggest a trend of decreasing self-perception for girls and increasing self-perception for boys between T0 and T1. This could be explained by findings of other researchers, who showed that boys are more confident about their academic competence and girls have a tendency to underestimate their competence, which would be domain specific (23). Developmental and educational researchers have also found that boys are more confident about their academic

Table 1. Descriptive statistics showing the number of participants for clinical malocclusion assessment and self-esteem at baseline (T0),after 1 year of orthodontic treatment (T1), and 1 month after the end of treatment (T2). AC, aesthetic component; DHC, Dental Health Component; IOTN, Index of Orthodontic Treatment Need; SE, self-esteem.

| Variable | Participants at T0 |      | Participants at T1 |      | Participants at T2 |      |
|----------|--------------------|------|--------------------|------|--------------------|------|
|          | N                  | %    | N                  | %    | N                  | %    |
| DHC IOTN | 325                | 99.7 | 141                | 43.2 | 123                | 37.7 |
| AC IOTN  | 323                | 99   | 142                | 43.5 | 118                | 36.2 |
| SE       | 321                | 98.5 | 142                | 43.5 | 118                | 36.2 |

| Table 2. Global effect of athletic competence; Pathletic competen | of time for all scales of self-esteem<br>a, physical appearance; Bc, behavio | . CI, confidence interval; Sc, schola<br>oural conduct; Cf: close friendship; C | stic competence; Sa, social accepta<br>Ss: global self-worth. | ince; Ac, |
|---|--|---|---|-----------|
|   | Age-related scores: mean (95% CI)  |   |   |           |
| S   | TO   | T1  | TO  | D         |

| Score | Т0                | T1                | T2                | P-value |  |
|-------|-------------------|-------------------|-------------------|---------|--|
| Sc    | 13.5 (13.2; 13.9) | 13.5 (13.0; 14.0) | 13.5 (13.0; 14.0) | 0.9579  |  |
| Sa    | 15.7 (15.4; 16.0) | 15.8 (15.4; 16.2) | 15.3 (14.9; 15.8) | 0.1755  |  |
| Ac    | 13.8 (13.4; 14.2) | 13.5 (12.9; 14.1) | 13.3 (12.8; 13.9) | 0.2035  |  |
| Pa    | 14.2 (13.8; 14.6) | 14.1 (13.6; 14.7) | 14.0 (13.4; 14.6) | 0.7970  |  |
| Bc    | 15.0 (14.6; 15.3) | 15.0 (14.5; 15.5) | 15.4 (14.9; 15.9) | 0.2438  |  |
| Cf    | 17.3 (17.0; 17.5) | 17.4 (16.9; 17.9) | 17.0 (16.6; 17.4) | 0.3336  |  |
| Gs    | 15.6 (15.2; 15.9) | 15.2 (14.7; 15.6) | 14.9 (14.4; 15.5) | 0.0564  |  |
|       |                   |                   |                   |         |  |



Figure 1. Evolution of self-perception for boys and girls over time for scholastic competence. RS\_Sc, age-related score for scholastic competence; T0, at baseline;T1, after 1 year of orthodontic treatment;T2, 1 month after the end of treatment.



**Figure 2.** Physical appearance for age 12 and 14 over time. RS\_Pa, age-related score for physical appearance; T0, at baseline; T1, after 1 year of orthodontic treatment; T2, 1 month after the end of treatment.

competence (23). Further, the difference in self-esteem between boys and girls in early adolescence has been explained (24). In our results, girls showed a lower self-perception concerning the domain of scholastic competence.

Besides, our findings reveal a different evolution of self-perception over time for physical appearance and global self-worth. These results suggest a trend towards improvement/stabilization of selfperception in younger children (aged 12), whereas a trend towards decreased self-perception is suggested for older children (aged 14). To our knowledge, these findings haven't been found in literature



Figure 3. Global self-worth for age 12 and 14 over time. RS\_Gs, age-related score for global self-esteem. T0, at baseline; T1, after 1 year of orthodontic treatment; T2, 1 month after the end of treatment.

earlier. The cause of this difference is unclear, but these results could imply that an earlier start with orthodontic treatment would affect self-esteem less than an orthodontic treatment in an adolescent of 14 years old.

Previous studies have found a positive relationship between academic achievement and self-esteem (25, 26). In the present study, no evidence was found regarding the fact that the evolution of self-esteem differs over time according to the educational level of the child. Researchers have also found that self-esteem is positively associated with the socio-economic status (6, 27, 28). Despite these reports, no evidence was found in our study between the evolution of self-perception and socio-economic status.

Interestingly, we found a negative association between selfesteem and the opinions of adolescents concerning the appearance of their teeth, with results being significant for the subdomain of close friendship. This means that high orthodontic treatment need can lead to a low self-esteem. Future research is needed to evaluate if working on self-esteem can influence orthodontic treatment need. No evidence was found for an association between the objective need for orthodontic treatment and self-esteem. Adolescents with higher self-esteem report better OHRQoL (7), but no association exists between objective orthodontic treatment need and self-esteem. There are many reasons for adolescents to seek orthodontic treatment, and these are not always necessarily based on a severe malocclusion. These results are also supported by other investigators (29).

This study has some limitations that need to be taken into consideration. First, the sample of adolescents was taken exclusively from the University Hospitals Leuven, and no patients from private Table 3. Association of self-esteem with aesthetic component assessed by the child. Slope is the change of the score for a 1-unit increase of the aesthetic component, a negative slope means a negative association between aesthetic component and self-esteem. Cl, confidence interval; Sc, scholastic competence; Sa, social acceptance; Ac, athletic competence; Pa, physical appearance; Bc, behavioural conduct; Cf: close friendship; Gs: global self-worth.

|       | Age-related scores      |         |  |  |
|-------|-------------------------|---------|--|--|
| Label | Slope (95% CI)          | P-value |  |  |
| Sc    | -0.021 (-0.154; 0.112)  | 0.7553  |  |  |
| Sa    | -0.062 (-0.184; 0.060)  | 0.3201  |  |  |
| Ac    | -0.025 (-0.169; 0.119)  | 0.7315  |  |  |
| Pa    | -0.090 (-0.229; 0.050)  | 0.2072  |  |  |
| Bc    | -0.046 (-0.184; 0.092)  | 0.5155  |  |  |
| Cf    | -0.133 (-0.254; -0.012) | 0.0315  |  |  |
| Gs    | -0.043 (-0.176; 0.090)  | 0.5226  |  |  |

practices were included. This could explain the fact that our baseline scores of self-esteems are higher than the Flemish standard group. This should be taken into account when extending our results to the Belgian population. Another limitation of the study is the dropout. A follow-up rate of 36.8% is low, albeit this is a longitudinal study over an extended period. The high dropout can be caused by multiple reasons such as non-compliance and uncompleted questionnaires, which is inherent to the study design. Finally, we obtained the results by statistical multiple testing, which increases the chance of false positive results.

In spite of the factors mentioned above, this study has several strengths, such as the prospective study design and the long-term follow-up both during and after completion of orthodontic treatment, which can be found in very few studies. To obtain our findings, only validated measures of self-esteem and treatment need were used.

#### Conclusion

During orthodontic treatment, global self-esteem acts as a stable construct. However, we assume that self-esteem can be influenced by age and gender. Lastly, the patient's self-assessed aesthetic treatment need and his/her self-esteem were found to be negatively correlated for the domain of close friendship.

#### **Conflict of interest**

The authors declare no potential conflicts of interest with respect to the authorship and/or publication of this article.

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