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Systematic review

The impact of malocclusion on the quality of life among children and adolescents: a systematic review of quantitative studies

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Summary

Background: Among child and adolescent patients, persistent but untreated malocclusions may or may not have psychological and social impacts on the individual's quality of life.
Objectives: To gain knowledge of malocclusions and its impact on oral health-related quality of life (OHRQOL), we conducted a systematic review of quantitative studies for evidence regarding the influence of malocclusions on OHRQOL in children and adolescents.
Materials and methods: Five databases (MEDLINE via PubMed, EMBASE, Psychinfo, CINAHL, and the Cochrane Library) were searched using specified indexing terms.The following inclusion criteria were used: child or adolescent study population; healthy study participants without syndromes such as cleft lip/palate or severe illness; no previous or ongoing orthodontic treatment among participants; a focus on malocclusions and quality of life; controlled or subgrouped according to malocclusions/no malocclusions; malocclusions and/or orthodontic treatment need assessed by professionals using standardized measures; self-assessed OHRQOL estimated using validated questionnaire instruments; full-text articles written in English or Scandinavian languages. Quality of evidence was classified according to GRADE guidelines as high, moderate, or low.
Results: The search produced 1142 titles and abstracts. Based on pre-established criteria, the full-text versions of 70 articles were obtained, 22 of which satisfied the inclusion criteria. After data extraction and interpretation, six publications were deemed eligible for full inclusion. All six were of cross-sectional design, and the quality of evidence was high in four cases and moderate in the remaining two. The four studies with a high level of quality reported that anterior malocclusion had a negative impact on OHRQOL, and the two with a moderate level of quality reported that increased orthodontic treatment need had a negative impact on OHRQOL.
Conclusion: The scientific evidence was considered strong since four studies with high level of quality reported that malocclusions have negative effects on OHRQOL, predominantly in the dimensions of emotional and social wellbeing.

Introduction

The reported prevalence of malocclusions is over 60% in preschool children and between 43 and 78% in schoolchildren (1–4). The most common malocclusions are anterior open bite, excessive overjet, Class II malocclusions, and posterior crossbite (4–8). In older children and adolescents, crowded teeth due to space deficiency in the dental arches are frequent (3, 9, 10).

It has long been recognized that different malocclusions are associated with impaired oral health and/or function. This, together with the risk of personal dissatisfaction with visible malocclusions, is considered an important treatment-motivating factor. Excessive overjet with incomplete lip closure is associated with higher prevalence of dental trauma to the upper incisors (11). A systematic review from 2012 concluded that there is a medium-to-low level of evidence that untreated posterior crossbite can cause facial asymmetries, and it is reasonable to believe that such an asymmetry may have an impact on quality of life from a functional as well as an aesthetic point of view (12). Another systematic review reported a medium-to-high level of evidence regarding the association between posterior crossbite and temporomandibular symptoms (13). Visible malocclusions, excessive overjet with incomplete lip closure, crowded incisors, and large diastema between incisors have been associated with bullying and a lower self-esteem among teenagers (14–17).

Malocclusion treatments are commonly performed during adolescence, when the permanent dentition is emerging. Other reasons for treatment at this age are that adolescence is seen as the point where the individual has begun to consider their own appearance to be of great importance, and has gained the autonomy to independently request or reject orthodontic treatment. Thus, it is reasonable to assume that among child and early adolescent patients, persistent but untreated malocclusions may have psychological and social impacts on the individual's quality of life.

The impact of oral diseases or disorders on oral health-related quality of life (OHRQOL) can be assessed using quantitative evaluations such as questionnaires. One systematic review, which included studies until December 2007, reported a moderate association between malocclusion/orthodontic treatment need and OHRQOL in adults, adolescents, and children (18). Since then, a number of new studies have been conducted among different populations in order to gain knowledge of malocclusions and their impact on OHRQOL. It is important to update current knowledge on the topic, providing a solid evidence base for clinical practitioners to rely on, and so a systematic evaluation of more recent knowledge seems motivated. Therefore, the aim of this study was to conduct a systematic review of quantitative studies for evidence regarding the influence of malocclusions on OHRQOL in children and adolescents.

Materials and methods

The literature review was systematically conducted according to Goodman's model (19), which comprises the following steps: 1. definition of the research question, 2. formulation of a plan for the literature search, 3. literature search and retrieval of publications, and 4). data extraction, interpretation, and evaluation of evidence from the literature retrieved.

Definition of the research question

It is reasonable to assume that malocclusions have a psychological and social impact on the individual. The question to be addressed in this review was: Do malocclusions have an impact on OHRQOL in children and adolescents?

Formulation of a plan for the literature search

A literature search was conducted to identify all studies evaluating impact of malocclusions on OHRQOL. Five electronic databases (MEDLINE via PubMed, EMBASE, Psychinfo, CINAHL, and the Cochrane Library) were searched for articles published between 1960 and January 2014. The following search syntax was used: 'quality of life' (MeSH term) OR 'self concept' (MeSH term) OR 'patient satisfaction' (MeSH term) OR 'personal satisfaction' (MeSH term) OR 'well being' (text word) OR 'wellbeing' (text word) AND 'malocclusion' (MeSH term) OR 'orthodontics' (MeSH term) OR 'dental esthetics' (MeSH term). A filter for 'child 6–12 years and adolescent 13–18 years' was applied. The computerized search was accomplished with the assistance of a specialist in informatics at the Medical Library, Orebro University, Sweden.

Literature search and retrieval of publications

Prior to reading the retrieved titles, abstracts, and articles, consensus was reached on the following inclusion criteria:

- Child or adolescent study population
- Healthy study participants without syndromes such as cleft lip/palate or severe illness
- No previous or ongoing orthodontic treatment among participants
- A focus on malocclusions and quality of life
- Controlled or subgrouped categorization according to malocclusions/no malocclusions
- Malocclusions and/or orthodontic treatment need assessed by professionals using standardized measures
- Self-assessed OHRQOL estimated using validated questionnaire instruments
- Full-text articles written in English or Scandinavian languages

Three independent researchers determined eligibility of potential studies. The titles and abstracts of all potentially relevant studies were independently reviewed, and then full-text articles corresponding to the selected abstracts/titles were retrieved. An article was ordered in full-text if at least one of the three reviewers considered it to be relevant, or if the title and abstract did not provide sufficient information. Each full-text version was analysed and evaluated according to a preset protocol by the three researchers independently on the basis of the initial inclusion criteria. In case of interexaminer conflicts each article was reread and discussed until consensus was reached. The reference lists of articles deemed eligible were also manually searched for additional articles.

Data extraction, interpretation, quality assessment, and evaluation of evidence

Quality of evidence was classified as high, moderate, or low according to the GRADE system (20). The quality assessments were performed according to a protocol by the three researchers independently. Any discrepancies between the researchers in these assessments were solved by discussion until consensus was achieved. To qualify for high quality, the following criteria should be fulfilled: Sufficient material, relevant subgrouping, drop-out presented with a rate not greater than 30% and control of the important confounders; caries, socio-economic factors, age and gender. If one of the criteria above was lacking, the article was downgraded to moderate. Reasons for further downgrading the quality rating of a study included shortcomings in study design, study limitations, inconsistency of results, lack of adjustment for

potential confounders (caries, gender, age, and socio-economic factors), imprecision, and reporting bias. Consequently, studies with no consideration of caries (an important confounder), with a drop-out rate greater than 30%, or with no drop-out analysis presented were classified as low-quality. Data from studies assessed as high or moderate quality were tabulated on the following items: author, country, year of publication, study design, study population, assessment of OHRQOL, assessment of malocclusions or treatment need, results/conclusions, and finally study quality.

Results

General results

The search of electronic databases produced 1142 titles and abstracts; see Figure 1 for the PRISMA-compliant selection process (21). Based on the initial inclusion criteria, the full-text versions of 70 articles were analysed; following this, 22 articles remained for the final quality analysis (Figure 1). Articles excluded due to the reason 'not following the objective of the review did either not cover malocclusions related to OHRQOL, dealt with orthodontic patients under

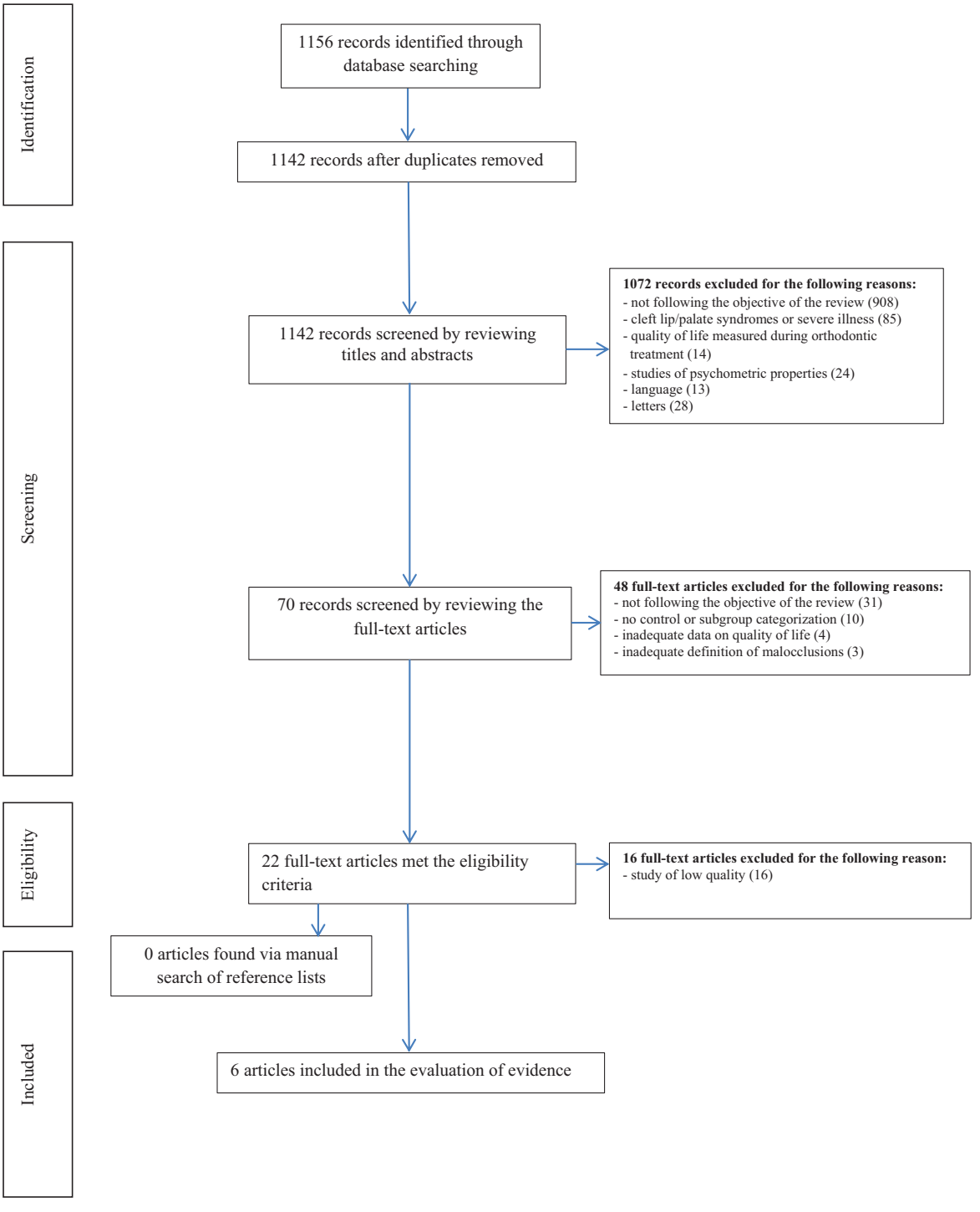

Figure 1. Flow of information through the different phases of the systematic review.

or after treatment, focused on adult populations or specific groups such as patients undergoing orthognathic surgery or combinations.

Six studies were included in the final evaluation of evidence, four with a high level of quality and two with a moderate level of quality (22–27). The other 16 studies were assessed as having a low level of quality; none of them considered all of the important confounders, and some also utilized insufficient statistical analysis, used selected material, or did not declare the drop-out rate (28–43) (Table 1). All six studies included in our final analysis were of cross-sectional design (22–27). Five were performed in Brazil (22–25, 27), and one in New Zealand (26).

In four studies the population was based on schoolchildren (22, 23, 25, 26). In another, a group of schoolchildren served as a control group for comparison to a group of children waiting for orthodontic treatment (24). Finally, one study had a study population nested in a birth cohort (27) (Table 2).

One of the studies (24) compared two separate groups, while the remaining five allowed subgrouping according to type of malocclusions and/or orthodontic treatment need (Table 2). Malocclusion or treatment need was assessed with the Dental Aesthetic Index (DAI) (45) in five studies (22, 23, 25–27), and with the dental health component and/or aesthetic component of the Index of Orthodontic Treatment Need (IOTN) (47) in the other (24) (Table 2). OHRQOL was evaluated with the Child Perception Questionnaire (CPQ11-14 or 8–10) (44) in four studies (22, 23, 25, 26), the Oral Health Impact profile (OHIP-14) (46) in one study (24), and the Oral Impact on Daily Performance (OIDP) (48) in the final study (27) (Table 2).

Impact of malocclusion on OHRQOL

Four studies reported that severe malocclusions, predominantly anterior crowding, spaced dentition, or increased overjet had a negative impact on OHRQOL (23, 25–27). Two studies stated that increased orthodontic treatment need had a negative impact on OHRQOL (22, 24). In addition, two studies revealed that malocclusions predominantly affected the dimensions of emotional wellbeing and social wellbeing (25, 26).

In five of the studies, the samples included subjects in pre- or early adolescence; in all these studies, the associations between malocclusions or treatment need were confirmed by multivariate analyses with confounders taken into account (22, 24–27). The sixth study reported a negative effect of malocclusion on OHRQOL, in particular in terms of anterior spacing or overjet, in even younger children (8–10 years) (23).

Evaluation of evidence

There was a high level of underlying scientific evidence for the negative effects of severe malocclusions on OHRQOL in children and adolescents (23, 25–27). Two studies also confirmed this association for specific malocclusions in the aesthetic zone: anterior crowding, diastema between incisors, and increased overjet (23, 27). There was a

Table 1. Studies with a low level of quality, and the reasons for the quality level.

References, country	Reasons for low level of quality
De Baets *et al.* (28), Belgium	Selected material
	Important cofounders not considered
Herkrath *et al.* (29), Brazil	Important confounders not considered
Kolawole *et al.* (30), Nigeria	Important confounders not considered
	Statistical analysis not sufficient
Heravi *et al.* (31), Iran	Only boys included
	Important confounders not considered
	Statistical analysis not sufficient
Shah *et al.* (32), USA	Drop-outs not presented
	Important confounders not considered
Anosike *et al.* (33), Nigeria	Important confounders not considered
	Statistical analysis not sufficient
de Paula *et al.* (34), Brazil	Drop-outs not presented
	Important confounders not considered
Zhang *et al.* (35), Hong Kong	Selected material
	Important confounders not considered
Marques *et al.* (36), Brazil	Important confounders not considered
Taylor *et al.* (37), USA	Drop-outs not presented
	Important confounders not considered
Onyeaso (38), Nigeria	Important confounders not considered
	Statistical analysis not sufficient
	Difficult to interpret the results
Bernabé *et al.* (39), Brazil	Important confounders not considered
	Invalid method of categorizing malocclusions (only considering posterior–anterior discrepancies)
Bernabé *et al.* (40), Brazil	Important confounders not considered
Agou *et al.* (41), Canada	Limitations in the sample
	Exclusion criteria not specified
	Important confounders not considered
	Large attrition
	Statistical methods not described
Johal *et al.* (42), UK	Selected material
	Important confounders not considered
Marques *et al.* (43), Brazil	Important confounders not considered

Table 2. Summary of OHRQOL studies included in the quality assessment, listed in reverse order of publication.

References, country	Study design	Study population	Assessment of OHRQOL	Assessment of malocclusions or treatment need	Results/conclusions	Study quality/comments
Ukra *et al.* (26), New Zealand	Cross-sectional	783 schoolchildren (411 boys and 372 girls) recruited from five schools in Taranaki and four schools in Otago, New Zealand. Age: 12–13 years Divided into four subgroups of malocclusions: minor definite severe handicapping	CPQ 11–14* Self-assessed	DAI** ≤25 = minor 26–30 = definite 31–35 = severe >36 = handicapping	Malocclusion appeared to have a negative impact on OHRQOL, subscales of emotional and social wellbeing, with means (SD) from 2.0 (2.5) to 3.4 (3.1) and 1.5 (1.9) to 2.9 (2.8), respectively, for the different malocclusion levels ($P < 0.001$ and $P < 0.001$). The association was evident in both the Taranaki and the Otago population, despite distinct differences in socio-demographic characteristics. The association was confirmed in multiple linear regression analysis with confounders taken into account. Definite, severe and handicapping malocclusion had negative impacts on OHRQOL total score (Beta 1.87, 2.67, and 3.78; 95% CI 0.49–3.25, 0.85–4.50, and 2.20–5.36; $P = 0.008$, $P = 0.004$, and $P < 0.001$)	High + sufficient material + subgrouping according to orthodontic treatment need + power analysis performed + drop-outs <5% + control of confounders: gender, caries, and socio-economic factors
Scapini *et al.* (25), Brazil	Cross-sectional	632 schoolchildren (270 boys and 362 girls) recruited from 12 randomly selected schools in Osorio, Brazil. Age: 11–14 years Divided into four subgroups of malocclusions: minor definite severe handicapping	CPQ 11–14* Self-assessed	DAI** ≤25 = minor 26–30 = definite 31–35 = severe >36 = handicapping In multiple linear regression dichotomized into malocclusion or not (0 = minor/none).	Increased severity of malocclusions was associated with higher impact on OHRQOL, subscales of emotional and social wellbeing, with means (SD) from 2.92(3.01) to 4.04 (3.15) and 2.16 (2.29) to 3.45 (3.03), respectively for the different malocclusion levels ($P = 0.035$ and $P < 0.001$). The association was confirmed in multiple linear regression analysis with confounders taken into account. Malocclusion had negative impact on OHRQOL (Beta 0.850; 95% CI 0.217–1.483, $P = 0.009$)	High + sufficient material + subgrouping according to orthodontic treatment need + power analysis performed + drop-outs 19.5% + control of confounders: age, gender, ethnic group, caries, dental trauma, and socio-economic factors

(*Continued*)

Table 2. *(Continued)*

References, country	Study design	Study population	Assessment of OHRQOL	Assessment of malocclusions or treatment need	Results/conclusions	Study quality/comments
Sardenberg *et al.* (23), Brazil	Cross-sectional	1204 schoolchildren recruited from public and private schools in Belo Horizonte, Brazil. Age: 8–10 years Divided into two subgroups of malocclusions: malocclusion absent malocclusion present	CPQ 11–14* Self-assessed <10 = low impact >10 = high impact	DAI** <25 = malocclusion absent ≥25 = malocclusion present	A high negative impact on OHRQOL occurred in 42% of those with no malocclusion and 57% of those with malocclusion. Schoolchildren with malocclusion were 1.3 times (95% CI: 1.15–1.46; $P < 0.001$) more likely to experience a negative impact on OHRQOL than those without malocclusion. Confounders were taken into account in a Poisson regression analysis. Anterior spacing ($P < 0.001$), maxillary overjet ($P < 0.001$), and anterior mandibular overjet ($P = 0.024$) all had a negative impact on OHRQOL	High + sufficient material + subgrouping according to malocclusions and/or orthodontic treatment need + power analysis performed + drop-outs 16.2% + control of confounders: gender, caries, and socio-economic factors
Paula *et al.* (22), Brazil	Cross-sectional	515 schoolchildren (225 boys, 290 girls) recruited from the city of Juiz de Fora, Brazil. Age: 12 years Divided into subgroups according to orthodontic treatment need: treatment need no treatment need	CPQ 11–14* Self-assessed	DAI** <31 = no treatment need ≥31 = treatment need	A CPQ score higher than median was found in 64% of those with treatment need and 45% of those with no treatment need ($P = 0.0001$). The association was confirmed ($P = 0.0019$) in multiple Poisson regression analysis with confounders taken into account.	Moderate + sufficient material + subgrouping according to treatment need + power analysis performed - drop-outs not presented + control of confounders: gender, caries, dental treatment need, and socio-economic factors
Feu *et al.* (24), Brazil	Cross-sectional	225 patients at Department of Orthodontics, Rio de Janeiro State University, Brazil. Age: 12-15 years Mean age: 13.4 years Two separate groups: Orthodontic group 92 patients scheduled for orthodontic evaluation 46 boys, 46 girls Comparison group 102 age-matched children from a public school near the university clinic 60 boys, 42 girls	OHIP-14*** Self-assessed	IOTN-DHC**** IOTN-AC***** <5 = no aesthetic orthodontic treatment need ≥5 = aesthetic orthodontic treatment need IOTN-DHC**** 4 or 5 = treatment need	The orthodontic group had an odds ratio of 4.7 (95% CI: 1.4–5.7; $P < 0.001$) for lower OHRQOL, in comparison to the control group. When controlling for DMFT, DHC, AC examiner, and AC self- perception in a logistic regression analysis, the orthodontic group had a 3.1 times higher chance of reporting worse OHRQOL (95% CI: 1.5–6.3)	Moderate + sufficient material + defined comparable groups + power analysis performed + drop-outs 8.8% + Control of confounder: caries - no control of confounders: gender, and socio-economic factors

(*Continued*)

Table 2. *(Continued)*

References, country	Study design	Study population	Assessment of OHRQOL	Assessment of malocclusions or treatment need	Results/conclusions	Study quality/comments
Peres *et al.* (27), Brazil	Cross-sectional	339 children nested in a birth cohort (182 boys, 157 girls) from five maternity hospitals in the city of Pelotas, Brazil. Age: 12 years Divided into subgroups of specific malocclusions dichotomized into yes or no: incisal crowding maxillary anterior crowding mandible anterior crowding maxillary overjet >3 mm anterior open bite	OIDP******-short version Self-assessed	DAI** Following variables dichotomized into yes or no: incisal crowding maxillary anterior crowding mandible anterior crowding maxillary overjet >3 mm anterior open bite	Incisal crowding was related to worse OHRQOL with a rate ratio (RR) of 1.5 (95% CI: 1.2–1.9; $P < 0.001$). This association was confirmed (RR: 1.4; 95% CI: 1.1–1.8; $P = 0.003$) in multiple Poisson regression analysis with confounders taken into account	High + sufficient material + subgrouping according to malocclusions - no power analysis presented + drop-out 5% + control of confounders: gender, caries, dental pain, fluorosis, gingival bleeding, and socio-economic factors

*Child Perception Questionnaire 11–14 years (44).
**Dental Aesthetic Index (45).
***Oral Health Impact Profile (46).
****Index of Orthodontic Treatment Need—Dental Health Component (47).
*****Index of Orthodontic Treatment Need—Aesthetic Component (47).
******Oral Impact on Daily Performance (48).

moderate level of scientific evidence for the association between severe or moderate treatment need and an impact on OHRQOL (22, 24).

All six studies were judged to have used sufficient sample size, though one (27) being a birth cohort, did not calculate a prior estimate of sample size. Drop-out rates were disclosed in five studies (23–27), and ranged from 5 to 19.5% (Table 2). Moreover, all four studies judged as high quality had taken into account all the most important confounders (caries, gender, age, and socio-economic factors) in their final presentation of the results (23, 25–27).

Two studies were downgraded to moderate quality. In one (22), no presentation of drop-out rate was evident and caries was not considered as a confounder. In the other (24), caries was the only confounder considered when processing the results.

Discussion

This systematic review, including a full analysis of six cross-sectional studies, found that there is high-quality evidence that severe malocclusions in the aesthetic zone have an impact on OHRQOL in children and adolescents, predominantly in the dimensions of emotional and social wellbeing. These findings are new and describes more in detail the relationship between malocclusions and OHRQOL compared with the systematic review by Liu *et al.* (18) who come to the conclusion that there was an association (albeit modest) between malocclusion/orthodontic treatment need and quality of life. It is worth discussing whether a cross-sectional study is able to produce high-value evidence. According to the GRADE system, the study design is always indicative of the level of evidence (20). However, such a strict implication when grading cross-sectional studies has recently been questioned. Consequently, it is possible for a cross-sectional observational study to be assessed as having a high level of quality if the study is designed in such a way that it permits good control of differences between study and control groups regarding four types of bias: selection, performance, attrition, and detection bias (49). Hence, in this systematic review, all four studies evaluated as having a high level of quality had taken into account all important types of bias.

The literature search initially revealed 1142 publications, but only 22 quantitative studies were qualified for evaluation in this review. Such an outcome is not unusual when systematic reviews are assessed since the literature search initially and intentionally was designed to include as many articles as possible in order not to inadvertently miss or disregard any article. The selection was performed systematically as described in the Materials and Methods section. Sixteen studies were judged as low-quality and hence excluded from the final evaluation due to lack of consideration of important confounders like caries, gender, age, and socio-economic factors; insufficient statistical analysis; the use of improper or selected material; large attrition; or no declaration of the drop-out rate.

A systematic review presented in 2009 concluded that the level of evidence was moderate for the association between malocclusions/orthodontic treatment need and health-related quality of life (18). Our review found a high level of evidence that severe malocclusions, especially in the aesthetic zone (anterior crowding, diastema mediale, increased overjet), have negative effects on OHRQOL in children and adolescents, predominantly in the dimensions of emotional and social wellbeing. Four of the six studies were produced within the past 2 years, indicating that high-quality studies that are carefully planned and performed in accordance with the research question are now emerging within this field (22, 23, 25, 26).

When assessing the impact of malocclusions on OHRQOL, it is important to also consider untreated subjects with different malocclusions and level of treatment need, in order that the results will be comparable on group and individual levels, as well as ensuring that confounders to malocclusions are taken into consideration. Studies with longitudinal design following an untreated group are preferred, but are lacking. Conceivably, the reason for the shortage of longitudinal studies is ethical; it may be ethically questionable to longitudinally follow a group of children and adolescents with pronounced malocclusions, without performing any orthodontic treatment.

The studies assessed in this review were predominantly from Brazil, and studies from other parts of the world (Africa, the USA, Asia, and Europe) were few or lacking. Apparently, Brazilian researchers have performed a collective initiative to identify the impact of malocclusions on oral health-related quality of life among children and adolescents. Due to cultural differences between countries, results may be different when comparing studies from different parts of the world. Thus, the studies from Brazil should inspire scientists in other parts of the world to perform new studies in order to contribute to the knowledge of how malocclusions affect children and young people's quality of life.

The results also revealed that severe malocclusions have an impact on OHRQOL, predominantly in the emotional and social dimensions. To further achieve a more comprehensive analysis on both group and individual level, it is recommended that future studies should also involve qualitative methods. The validity and quality in measuring OHRQOL with quantitative methods are considered adequate on a group level, while interviews with open-ended questions would be more sensitive at the individual level. Perhaps a suitable combination for future research would be quantitative measure via instruments and qualitative measure via interviews, giving even more nuanced information on how malocclusions may affect OHRQOL. Moreover, if future studies utilize consistent methods and comparable groups as well as being conducted with greater geographical spread, meta-analysis can also be performed.

The restrictions concerning language and to some extent number of databases when searching the literature might imply that some studies were not identified. The strength of the evidence in a systematic review is probably more dependent on assessing the quality of the included studies than on the degree of comprehensiveness (50).

Conclusion

The scientific evidence was considered strong since four studies with high level of quality reported that malocclusions in the aesthetic zone have negative effects on OHRQOL, predominantly in the dimensions of emotional and social wellbeing.

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