Community Dental Health (2024) **41,** 5–13
Received 18 June 2023; Accepted 27 July 2023

doi:10.1922/CDH_00125Theodoridou09

Need for orthodontic treatment and oral health-related quality of life in children and adolescents – A systematic review

Maria-Zoi Theodoridou, Alexandros Heraclides and Demetris Lamnisos

Department of Health Sciences, European University of Cyprus, Cyprus

Objectives: To determine the relationship between the need for orthodontic treatment and OHRQoL in children and adolescents, and to identify potential modifying factors of this relationship. ***Methods***: Systematic review, starting with searches of PubMed, Scopus, and EBSCO Discovery Service. Observational studies which examined the relationship between the need for orthodontic treatment and OHRQoL, in children and adolescents, were considered eligible. ***Results***: Eighteen studies were included, of which, one was a prospective cohort study and 17 were cross-sectional. Twelve of 18 studies reported a relationship between the need for orthodontic treatment and OHRQoL, while the remainder failed to demonstrate a clear relationship. Gender and self-esteem were found to modify this relationship. ***Conclusions***: Need for orthodontic treatment is associated with OHRQoL in children and adolescents. Gender and self-esteem are potential effect modifiers of this relationship.

Keywords*: Adolescent, Quality of life, Child, Oral-health related quality of life, Orthodontic treatment need, Index for orthodontic treatment need*

Introduction

Oral health is linked to a person's mental and physical health (Locker 2001). Malocclusions are oral conditions that can affect the aesthetics and function of the face (Almeida *et al*., 2014). The need for orthodontic treatment can be defined as the benefit an individual will receive from the treatment, depending on the severity of the presenting malocclusion, as well as the patient's own perception of the problem. Children and their parents believe that orthodontic treatment can improve their dental function, esthetics and quality of life (Liu *et al*., 2009; Mandall *et al*., 2000). Moreover, psychosocial aspects of the OHRQoL (such as showing the teeth with no concerns and not being mocked because of the appearance of the teeth) are among the main reasons for patients seeking orthodontic treatment (Liu *et al*., 2009), but some individuals can have a marked degree of dento-facial deformity and be unconcerned with their appearance. Thus, orthodontic treatment need assessment should consider factors related to the perspectives of patients as well as occlusal parameters from the clinicians' perceptive (Gherunpong *et al*., 2006; Liu *et al*., 2009, Tsakos 2008; Zhang *et al*., 2006). The need for orthodontic treatment, thus, may arise from the orthodontist's (normative) and/or patient's (subjective) perspective.

The concept of oral health-related quality of life (OHRQoL) has been introduced to consider impacts of oral conditions on the patients' social and mental well-being (Zhang *et al*., 2006; Abreu *et al*., 2013). As the patients' perception is crucial to the assessment of overall need, specific measures of OHRQoL assessing the impact of the mouth on daily living have been developed for children and adolescents, to capture the patients' perception, of which the Child Perceptions Questionnaire (CPQ11-14), the Child-Oral Impacts on Daily Performance (OIDP), and Child Oral Health Impact Profile (OHIP) have good psychometric properties (Zaror *et al*., 2019).

Lately, the relationship between the need for orthodontic treatment and OHRQoL has been investigated (Barbosa and Gavião, 2008). The most widely used indices to assess the need for orthodontic treatment are the IOTN-Index of Orthodontic Treatment Need, the DAI-Dental Aesthetic Index, the ICON-Index of Complexity Outcome and Need, and the PAR-Peer Assessment Rating (Bellot-Arcís *et al*., 2012). Few studies have found a strong relationship between the need for orthodontic treatment and OHRQoL (Johal *et al*., 2007; Kok *et al*., 2004), while another could not find a correlation (Locker *et al*., 2004). Thus, the relationship between the two concepts requires clarification.

Therefore, the aim of this systematic review was to examine the relationship between the need for orthodontic treatment and OHRQoL, in children and adolescents, and to identify potential modifiers of this relationship.

Methods

The review was conducted in accordance with the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Liberati *et al*., 2009), and the corresponding extension for abstracts (Beller *et al*., 2013).

Three electronic databases (MEDLINE, Scopus, EBSCO Discovery Service) were searched up to December 2022. MESH terms and the respective keywords were used appropriate to each database (Supplementary table available at: https://euccc-my.sharepoint.com/:w:/g/personal/d_lamnisos_euc_ac_cy/Eby1tkZgBFpOm3_Z4N-79p3oBg4jTp2xdVC6HQ_brapZlcg). The search did not

Correspondence to: Dr. Maria-Zoi Theodoridou Email: mariza.theodoridou@gmail.com

include any restrictions on publication year or language. The reference lists of identified sources were searched manually, to identify additional studies.

The eligibility criteria were derived using the PICOS approach (Problem/Patients/Population, Intervention/Exposure, Comparison, Outcome, and Study Type/Design. Table 1) (Amir-Behghadami and Janati, 2020). Studies reporting mainly on the severity of malocclusion were not included. Only studies published in English were included. After eliminating duplicates, all remaining articles were screened sequentially by title, abstract, and full text. For studies published in multiple languages, the English version was assessed.

The following data were extracted from the eligible reports: article, study design, setting/country, number of participants (M/F), age in years, characteristics of patients, the indices for the need of orthodontic treatment assessment as intervention, the OHRQoL questionnaires as outcome, and results. The data were also classified according to the assessment of orthodontic treatment need: a) as normative, b) as subjective and c) as normative and subjective need.

Risk of bias in the sources was assessed for cohort and cross-sectional studies using the Newcastle-Ottawa Scale (NOS) (Modesti *et al*., 2016; Stang, 2010). Due to the heterogeneity between studies, no formal meta-analysis was attempted. Therefore, the included studies were described briefly, with only qualitative data synthesis.

Results

Among the 3045 reports identified from the databases and other sources, 1589 were reviewed on the basis of title and abstract, after removing duplicate studies (Figure 1). After excluding 1560 studies, 29 remained for full-text evaluation. Finally, 18 studies were included for a qualitative evaluation.

The characteristics of the 18 studies are summarized in Table 2. Most were conducted in schools (Bhatia *et al*., 2016; Choi *et al*., 2019; De Oliveira and Sheiham, 2003; Eslamipour *et al*., 2014; Gatto *et al*., 2019; Herkrath *et al*., 2019; Kavaliauskienė *et al*., 2018; Mary *et al*., 2017; Tsakos *et al*., 2006) with the others in hospitals (Kragt *et al*., 2017; Kragt *et al*., 2018; Nguee *et al*., 2020), in universities (Hassan *et al*., 2014; Zhang *et al*., 2009), in hospital university and in an orthodontic private clinic (Kunz *et al*., 2018), in public dental centers (Dimberg *et al*., 2015), and in educational districts (Naseh *et al*., 2016). All were cross-sectional except for one prospective design (Kunz *et al*., 2018). In total, 21007 children and adolescents were included, and the need for orthodontic treatment was assessed either with IOTN-DHC index (normative assessment) (Bhatia *et al*., 2016; Choi *et al*., 2019; De Baets *et al*., 2012; De Oliveira and Sheiham, 2003; Dimberg *et al*., 2015; Eslamipour *et al*., 2014; Hassan *et al*., 2014; Kavaliauskienė *et al*., 2018; Kragt *et al*., 2017; Kunz *et al*., 2018; Mary *et al*., 2017; Nguee *et al*., 2020; Tsakos *et al*., 2006; Zhang *et al*., 2009), AC-IOTN (subjective assessment) (Bhatia *et al*., 2016; De Baets *et al*., 2012; Kragt *et al*., 2017; Kunz *et al*., 2018; Naseh *et al*., 2016; Nguee *et al*., 2020; Tsakos *et al*., 2006; Zhang *et al*., 2009), or DAI and ICON (normative and subjective assessment) (Gatto *et al*., 2019; Herkrath *et al*., 2019; Kunz e*t al*., 2018; Zhang *et al*., 2009), or parental questionnaires (subjective assessment) (Kragt *et al*., 2017; Kragt *et al*., 2018).

The methodological quality of the prospective study was poor in terms of results (Kunz *et al*., 2018), whereas most of the cross-sectional studies were judged to be satisfactory or of good quality (Table 3). Only three cross-sectional studies lacked satisfactory methodological quality, mostly due to sample selection (Dimberg *et al*., 2016; Tsakos *et al*., 2006; Zhang *et al*., 2009).

Table 1. Eligibility criteria for the selection of the studies.

Category	*Inclusion criteria*	*Exclusion criteria*
Population	Studies on children and adolescents of any gender	Patients with craniofacial syndromes and/or cleft lip palate Patients with temporomandibular joint disorders
Exposure	Need for orthodontic treatment (normative and/or subjective) with all possible indices	Studies that assess the relationship between the severity of malocclussion and OHRQoL
Comparison	Children and adolescents without need for orthodontic treatment	
Outcome	Assessment of OHRQoL with all the available questionaires	Ongoing studies
Study design	Case-control Cohort studies Cross-sectional studies	Unsupported opinion of expert Editor's choices Replies to the author/editor Interviews Commentaries Books'/conferences' abstracts Summaries Studies with missing or inappropriate data Studies with no English abstract Case reports or reports of cases Narrative reviews* Systematic reviews* Meta-analyses*

*After checking the reference lists for relevant article

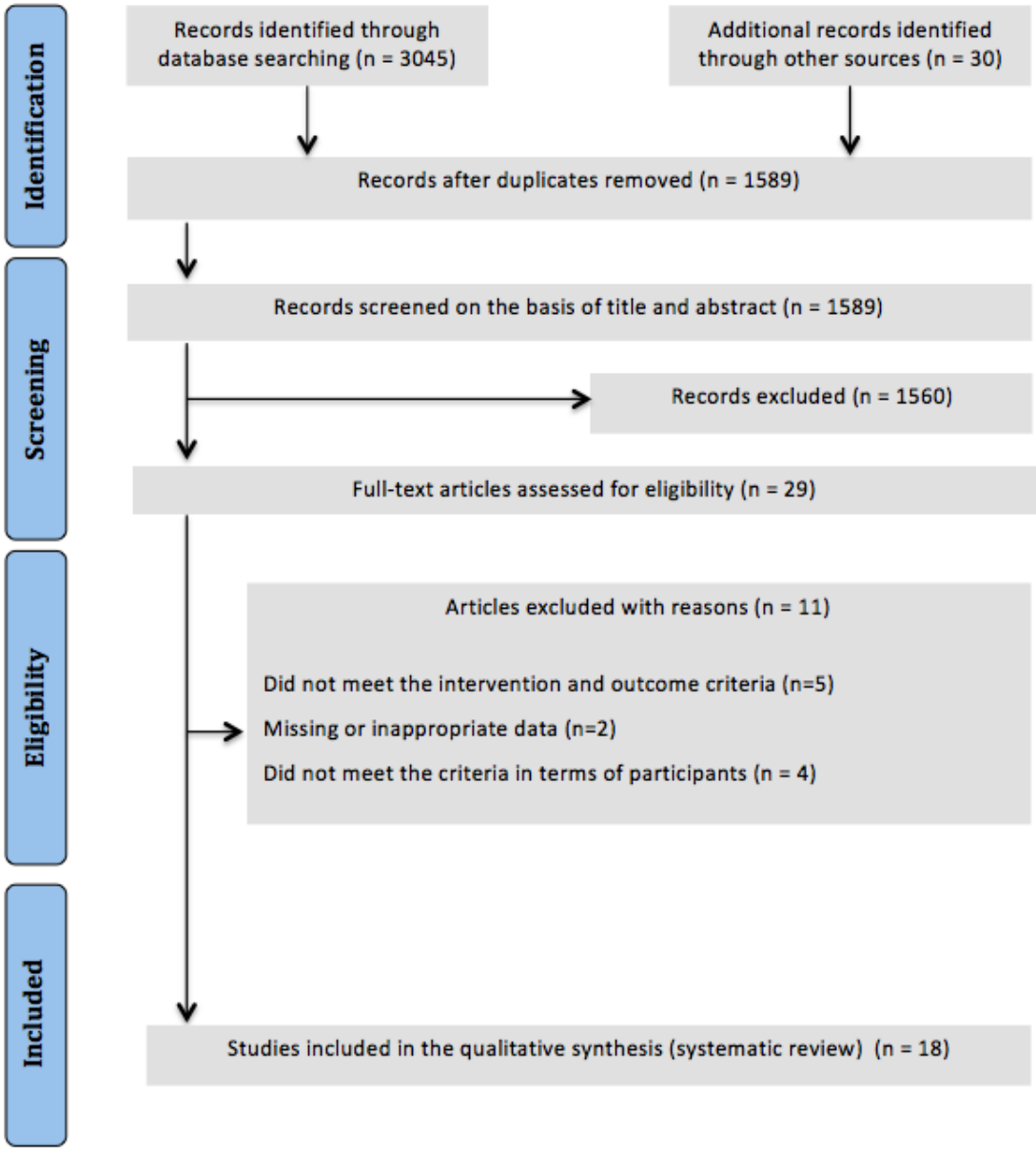

Figure 1. *Study selection flow diagram PRISMA flow diagram illustrating the study selection process.*

The included studies were classified according to whether orthodontic treatment need was assessed with normative or subjective need or both.

Seven studies measured normative orthodontic treatment need with the IOTN-DHC (Choi *et al*., 2019; De Oliveira and Sheiham, 2003; Dimberg *et al*., 2015; Eslamipour *et al*., 2014; Hassan *et al*., 2014; Kavaliauskienė *et al*., 2018; Mary *et al*., 2017). An association was found between the total COHIP score and the IOTN (Choi *et al*., 2019), and between two measures of OHRQoL and the IOTN-DHC (De Oliveira and Sheiham, 2003). Similarly, differences were found in OHRQoL scores between the three groups who had a need for orthodontic treatment (No or slight need, borderline need, and definite need group) (Eslamipour *et al*., 2014). More children with normative treatment need had impacts on oral health than those without (Hassan *et al*., 2014), and differences in OHIP-14 scores were found in those with need for orthodontic treatment (Mary *et al*., 2017). However, 2 studies failed to find an association (Dimberg *et al*., 2016; Kavaliauskienė *et al*., 2018).

Two studies assessed the subjective need for orthodontic treatment with the IOTN-AC and with parental questionnaires. Their results are contradictory, one associated greater subjective need for orthodontic treatment with worse OHRQoL (Kragt *et al*., 2018), and the other found an association only between subjective need for orthodontic treatment and functional limitation, but not in other domains (Naseh *et al*., 2016).

Nine studies assessed normative and subjective orthodontic treatment need using DAI, ICON, IOTN or parental questionnaires (Bhatia *et al*., 2016; De Baets *et al*., 2012; Gatto *et al*., 2019; Herkrath *et al*., 2019; Kragt *et al*., 2017; Kunz *et al*., 2018; Nguee *et al*., 2020; Tsakos *et al*., 2006; Zhang *et al*., 2009). Four studies using IOTN found a relationship between treatment need and OHRQoL (Bhatia *et al*., 2016; De Baets *et al*., 2012; Nguee *et al*., 2020; Tsakos *et al*., 2006;). More specifically, IOTN scores correlated with all four domains of CPQ (Bhatia *et al*., 2016), total CPQ scores (De Baets *et al*., 2012), COHIP scores (Nguee *et al*., 2020) and C-OIDP (Tsakos *et al*., 2006).

Table 2. Characteristics of the 18 studies included in the current systematic review.

Article	*Design*	*Setting/*	*No. participants (M/F)*	*Age in years*	*Participant characteristics*	*Outcome*		*Results*
Bhatia et al., 2016	Cross-sectional	School, India	604 (298/306)	11-14	Children attending school	IOTN-DHC AC-IOTN	CPQ 11-14	IOTN correlated with all four domains of CPQ scores. Boys showed impact on emotional wellbeing. Girls showed impact on emotional and social wellbeing
Choi et al., 2019	Cross-sectional	School, Korea	2010 (1066/944)	8-15	Children attending school	IOTN-DHC	COHIP	COHIP correlated with IOTN, after adjustment for gender, age, socioeconomic level and caries status
De Baets et al., 2012	Cross-sectional	University Hospital, Belgium	223 (113/110)	11-16	Every healthy child registering at Department of Orthodontics	-IOTN-DHC -AC-IOTN	CPQ 11-14	Correlation between orthodontic treatment need and CPQ scores. No evidence that SE moderates the relationship
De Oliveira and Sheiham 2003	Cross-sectional	School, Brazil	1675 (724/951)	15-16	Adolescents from a list of public and private urban schools	IOTN-DHC	OIDP-17 / OHIP-14-18	OHRQoL correlated with the dental health component of IOTN index
Dimberg et al., 2015	Cross-sectional	Public health clinics, Sweden	257 (121/136)	9.8-13.5	Children with at least one Scandinavian parent	IOTN-DHC	CPQ11–14–ISF:16	No association between OHRQoL and orthodontic treatment need
Eslamipour et al., 2014	Cross-sectional	Schools, Iran	1227 (588/639)	11-18	Middle and high school students, with no current or previous orthodontic treatment	IOTN-DHC	CPQ 11-14 / COHIP-14-18	OHRQoL related to orthodontic treatment need.
Gatto et al., 2019	Cross-sectional	Public schools, Brazil	815 (327/488)	11-16	Students of the 7th, 8th and 9th grades of primary school	DAI	OHIP-14	Need for orthodontic treatment not related to OHRQoL
Hassan et al., 2014	Cross-sectional	University, Saudi Arabia	120 (36/84)	12-15	Patients seeking orthodontic treatment	IOTN-DHC	OHRQoL Scales–Version C(child) και Version PG(Parent/ guardian)	Orthodontic treatment need related to mouth pain, chewing and biting, school and play.
Herkrath et al., 2019	Cross-sectional	Schools, Brazil	406 (171/235)	12	7th grade students in public schools in the eastern periphery of the city	DAI	CPQ 11-14	DAI unrelated to CPQ 11-14. Children with low treatment need and lower self-esteem had worse OHRQoL. Self-esteem did not influence the association between DAI and OHRQoL in children with greater treatment need
Kavaliauskienė et al., 2018	Cross-sectional	Schools, Lithuania	911 (370/541)	11-18	Adolescents 11-18 years old	IOTN-DHC	CPQ	OHRQoL unrelated to IOTN

Table 2 continued overleaf...

Table 2. Characteristics of the 18 studies included in the current systematic review continued...

Kragt et al., 2017	Cross-sectional	Hospital, Netherlands	3774(1873/1901)	9.49-10.45	Birth cohort invited to participate	IOTN-DHC AC-IOTN Parental subjective assessment	COHIP-ortho (parents' assesment)	Subjective orthodontic treatment predicted worse OHRQoL. Relationship stronger in girls than in boys
Kragt et al., 2018	Cross-sectional	Hospital, Netherlands	3849(1914/1935)	10	Birth cohort invited to participate	Parental subjective assessment	COHIP-ortho (parents' assesment)	Higher subjective orthodontic treatment need predicted worse OHRQoL Relationship stronger in children with lower SE
Kunz et al., 2018	Prospective-cohort	University Hospitals and Orthodontic clinic, Germany	250(131/119)	7-17	Children with an indication for orthodontic diagnosis	IOTN-DHC/ DAI -OTN-AC/ DAI	COHIP-G19	Normative orthodontic treatment need predicted OHRQoL
Mary et al., 2017	Cross-sectional	School, India	342(196/146)	14-19	354 students 14-19 years old	IOTN-DHC (	OHIP-14	OHIP-14 scores related to need for orthodontic treatment
Naseh et al., 2016	Cross-sectional	Educational structures, Iran	250(125/125)	11-14	250 students	AC-IOTN	CPQ 11-14	Subjective orthodontic treatment need predicted functional limitations. No associations for other domains.
Nguee et al., 2020	Cross-sectional	Hospital, Netherlands	3048(1517/1531)	9.5-10	Birth cohort invited to participate	-IOTN-DHC -AC-IOTN	COHIP-ortho (parents' assesment)	Orthodontic treatment need predicted OHRQoL
Tsakos et al., 2006	Cross-sectional	School, Thailand	1034(542/492)	11-12	Primary school students	IOTN	Child-OIDP	Large differences between normative need and OHRQoL. Many children had need without effects, and vice versa.
Zhang et al., 2009	Cross-sectional	University, Hong-Kong	212(103/109)	13.2 μ.o	Children seeking orthodontic treatment at the University of Hong Kong School of Dentistry	IOTN-DHC/ AC-IOTN/ DAI/ICON	CPQ	CPQ related to treatment need, regardless of the orthodontic indices used

IOTN-DHC = Normative assessment of orthodontic treatment need
AC-IOTN = Subjective assessment of orthodontic treatment need
DAI = Normative and subjective assessment of orthodontic treatment need

Table 3. Methodological quality assessment of the included studies based on the Newcastle-Ottawa Quality Assessment Scale (NOS).

Cohort study									
	DOMAINS								
Article	*Selection*			*Comparability**		*Outcome*			*Methodological quality (Score)*
	Representativeness of the exposed cohort	*Selection of the non-exposed cohort*	*Ascertainment of exposure*	*Demonstration that outcome of interest was not present at start of study*	*Comparability of cohorts on the basis of the design or analysis*	*Assessment of outcome*	*Was follow-up long enough for outcomes to occur*	*Adequacy of follow up of cohorts*	
Kunz et al., 2018	★	★	★	-	★	★	-	-	Poor (5)

Cross-sectional studies								
	DOMAINS							
Article	*Selection*				*Comparability*	*Outcome*		*Methodological quality (Score)*
	Representativeness of the sample	*Sample Size*	*Non-respondents*	*Ascertainment of the exposure (risk factor)*	*The subjects in different outcome groups are comparable, based on the study design or analysis. Confounding factors are controlled*	*Assessment of the outcome*	*Statistical test*	
Bhatia et al., 2016	★	-	-	★	★ ★	★	-	Satisfactory (5)
Choi et al., 2019	★	★	-	★	★	★	★	Satisfactory (6)
De Baets et al., 2012	★	-	-	★	★ ★	★	★	Satisfactory (6)
De Oliveira and Sheiham 2003	★	★	-	★	★	★	★	Satisfactory (6)
Dimberg et al., 2015	★	-	-	★	★	★ ★	★	Satisfactory (6)
Eslamipour et al., 2014	★	★	-	★ ★	★	★	★	Good (7)
Gatto et al., 2019	★	★	-	★	★ ★	★	★	Good (7)
Hassan et al., 2014	★	-	-	★ ★	★	★	★	Satisfactory (6)
Herkrath et al., 2019	★	★	-	★	★ ★	★	★	Good (7)
Kavaliauskienė et al., 2018	★	★	★	★	★ ★	★	★	Good (8)
Kragt et al., 2017	★	-	-	★ ★	★ ★	★	★	Good (7)
Kragt et al., 2018	★	★	★	★	★ ★	★	★	Good (8)
Mary et al., 2017	★	-	-	★ ★	★	★	-	Satisfactory (5)
Naseh et al., 2016	★	-	-	★	★	★	-	Not satisfactory (4)
Nguee et al., 2020	★	★	-	★ ★	★ ★	★	★	Good (8)
Tsakos et al., 2006	-	-	-	★	★	★	★	Not satisfactory (4)
Zhang et al., 2009	-	-	-	★	★	★	★	Not satisfactory (4)

Cohort study: A maximum of 4 stars can be awarded for the selection. A maximum of 2 stars can be awarded for the comparability. A maximum of 3 stars can be awarded for the outcome.
*A maximum of 2 stars can be awarded for this item. A study controlling for age receives one star, and a study controlling for other major risk factors receives an additional star. Cross-sectional studies: A maximum of 5 stars can be awarded for the selection. A maximum of 2 stars can be awarded for the comparability. A maximum of 3 stars can be awarded for the outcome.

Three studies used the IOTN with parental questionnaires (Kragt *et al*., 2017), with the DAI (Kunz *et al*., 2018), and with the DAI and ICON combined (Zhang *et al*., 2009). All three found a relationship between orthodontic treatment need and OHRQoL.

Lastly, two studies used the DAI to measure orthodontic treatment need and found no association with OHIP-14 or CPQ 11-14 scores (Gatto *et al*., 2019; Herkrath *et al*., 2019).

Six studies considered whether gender or self-esteem could modify the relationship between orthodontic treatment need and OHRQoL (Bhatia *et al*., 2016; De Baets *et al*., 2012; Herkrath *et al*., 2019; Kragt *et al*., 2018; Kragt *et al*., 2017; Naseh *et al*., 2016). In one study, orthodontic treatment need was only related to the emotional well-being of boys, while among girls both emotional and social well-being were affected (Bhatia *et al*., 2016). Subjective orthodontic treatment need was more strongly related to OHRQoL in girls than boys in another (Kragt *et al*., 2017).

Two studies found a modifying effect of self-esteem on the relationship between orthodontic treatment need and OHRQoL (Herkrath *et al*., 2019; Kragt *et al*., 2018). Children with lower orthodontic treatment need and lower self-esteem had worse OHRQoL, whereas self-esteem did not influence the association in children with orthodontic treatment need (Herkrath *et al*., 2019). Children with lower self-esteem had a stronger relationship subjective orthodontic and OHRQoL than children with higher self-esteem (Kragt *et al*., 2018). A third study found no evidence an effect of self-esteem on the relationship between treatment need and OHRQoL (De Baets *et al*., 2012).

Discussion

This systematic review evaluated evidence from cross-sectional studies and a cohort study, published up to December 2022, examining the relationship between orthodontic treatment need and OHRQoL in children and adolescents. Fourteen studies demonstrated an association between treatment need and OHRQoL, whereas four did not. To our knowledge, this is the first systematic review that examines this relationship, whereas others mainly focus on the relationship between malocclusion and OHRQoL. In addition to the indices of malocclusion alone, we included indices of patients' or parents' subjective perceptions of need. A child being bullied for his/her physical appearance has an important reason for treatment.

All but 4 studies (Dimberg *et al*., 2015; Gatto *et al*., 2019; Herkrath *et al*., 2019; Kavaliauskienė *et al*., 2018) demonstrated an association between the need for orthodontic treatment and OHRQoL. Consistent with the latter findings are 2 other studies, which reported no association between the need for orthodontic treatment and OHRQoL (de Oliveira *et al*., 2008; Locker *et al*., 2004), although 2 others report associations between them (Kok *et al*., 2004; Johal *et al*, 2007).

The findings of this study highlight an association between the need for orthodontic treatment and OHRQoL. Among the studies using indices of normative need alone and both normative and subjective need, most concluded that individuals with orthodontic treatment need have more aesthetic and functional limitations resulting in psychological distress and lower quality of life. Far fewer studies found no association between OHRQoL and treatment need. However, they report that the need for orthodontic treatment affects emotional and social domains and highlight that the effect of poor occlusion and the need for orthodontic treatment has a greater negative effect on OHRQoL at ages 16-18 years compared to early adolescence (11-14 years).

Findings of studies using indices of subjective orthodontic treatment alone are contradictory. This is probably due to the nature of the questionnaires with their more subjective approach to need by the patients and/or their parents, whereas studies using also normative criteria seem to have a greater agreement.

The relationship between the need for orthodontic treatment and OHRQoL appears to be influenced by gender and self-esteem. OHRQoL is often poorer in girls (Ashari and Mohamed, 2016; Ghijselings *et al*., 2014). However, the relationship between subjective orthodontic treatment need and OHRQoL was stronger in girls, while the association between borderline subjective need and OHRQoL was stronger in boys. This may suggest that girls are more conscious of their appearance, but in boys functional limitations have a greater impact (Ashari and Mohamed, 2016). Furthermore, self-esteem was found to moderate the association between the need for orthodontic treatment and OHRQoL, although other studies could not confirm this finding (Clijmans *et al*., 2015; De Baets *et al*., 2012).

From these results it can be seen that each person perceives his/her quality of life differently, which may be affected by malocclusion, and since OHRQoL is not only about function, the psychosocial background of each patient should be taken into account before providing treatment. Thus, the goal of treatment should be to promote oral health and OHRQoL in terms of functional as well as social and emotional aspects.

In the context of a public health system, knowledge about the need for orthodontic treatment both from the patients' and from the clinicians' perspectives facilitates better orthodontic treatment planning and contributes to a better quality of life, as the appearance of the teeth and face of the patients has reported to be a more important reason for orthodontic treatment compared to function (Abu *et al*., 2005; De Oliveira and Sheiham, 2003). Orthodontic treatment carries a high cost for patients and the community, thus, it should be evaluated whether or not the need for orthodontic treatment improves the quality of life of patients, for the best possible prioritisation, and for not becoming an excessive burden on global health care resources, especially when they are covered by public government funds.

To our knowledge, this is the first systematic review of the relationship between the need for orthodontic treatment and OHRQoL, in children and adolescents, grouping the results in terms of subjective and/or normative need. However, there are limitations that should be taken into account. Almost all the included studies were cross-sectional, and as a result, the level of evidence is relatively low. We should mention that two studies (Kragt *et al*., 2017; Kragt *et al*., 2018) have similar sample

sizes, recruited from the same birth cohort, and present similar results, which could lead to an overestimation of the results but, at the same time, it would be remiss not to include both studies, as they met all the inclusion criteria. In addition, Kragt et al. (2018) investigated the possible influence of self-esteem on orthodontic treatment need. The limited databases searched in the literature should also be noted, which may mean that some studies were not identified. However, for this reason, the references of the included systematic reviews were also searched. The strength of evidence in a systematic review also depends on the assessment of the quality of the included studies (Egger *et al*., 2003). Finally, the indices of orthodontic need included in this study have also been used to measure malocclusion in other studies of the relationship between malocclusion and oral health related quality of life.

In conclusion, this systematic review revealed that need for orthodontic treatment was associated with the poorer the OHRQoL children and adolescents. Gender and self-esteem may modify this relationship. The need for orthodontic treatment should be prioritised considering not only normative need but patients' and parents' percpectives in terms of OHRQoL of patients, so that orthodontic treatment does not become an excessive burden on health care resources.

Registration and protocol

The review was not registered. Protocol of the review is available from the corresponding author upon reasonable request.

Availability of data and materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests

Funding

None

Authors' contributions

MZT and DL formulated the hypothesis and the design of the study protocol. MZT and DL performed the literature search, the selection of eligible articles, the data extraction and the risk of bias assessment. All authors (MZT, DL, AH) were involved in data interpretation. MZT and DL drafted the manuscript, and AH was involved in its revision. All authors (MZT, DL, AH) approved the final version and agree to be accountable for all aspects of the work. MZT is the corresponding author.

References

Abreu, L.G., Melgaço, C.A., Lages, E.M.B. and Paiva, S.M. (2013): Impact of orthodontic treatment on oral health-related quality of life: a critical review. *Open Access Dentistry* **1**, 3.

Abu Alhaija, E.S., Al-Khateeb, S.N. and Al-Nimri, K.S. (2005): Prevalence of malocclusion in 13-15 year-old North Jordanian school children. *Community Dental Health* **22**, 266-271.

Almeida, A.B., Leite, I.C., Melgaço, C.A. and Marques, L.S. (2014): Dissatisfaction with dentofacial appearance and the normative need for orthodontic treatment: determinant factors. *Dental Press Journal of Orthodontics* **19**, 120-126.

Amir-Behghadami, M. and Janati, A. (2020): Population, Intervention, Comparison, Outcomes and Study (PICOS) design as a framework to formulate eligibility criteria in systematic reviews. *Emergency Medicine Journal* **37**, 387.

Ashari, A. and Mohamed, A.M. (2016): Relationship of the Dental Aesthetic Index to the oral health-related quality of life. *The Angle Orthodontist* **86**, 337-342.

Barbosa, T.S. and Gavião, M.B. (2008): Oral health-related quality of life in children: part II. Effects of clinical oral health status. A systematic review. *International Journal of Dental Hygiene* 6, 100-107.

Beller, E.M., Glasziou, P.P., Altman, D.G., Hopewell, S., Bastian, H., Chalmers, I., Gøtzsche, P.C., Lasserson, T. and Tovey, D. (2013): PRISMA for Abstracts Group. PRISMA for Abstracts: reporting systematic reviews in journal and conference abstracts. *PLoS Medicine* **10**, e1001419.

Bellot-Arcís, C., Montiel-Company, J.M., Almerich-Silla, J.M., Paredes-Gallardo, V. and Gandía-Franco, J.L. (2012): The use of occlusal indices in high-impact literature. *Community Dental Health* **29**, 45-48.

Bhatia, R., Winnier, J.J. and Mehta, N. (2016): Impact of malocclusion on oral health-related quality of life in 10-14-year-old children of Mumbai, India. *Contemporary Clinical Dentistry* **7**, 445-450.

Choi, E.S., Ryu, J.I., Patton, L.L. and Kim, H.Y. (2019): Item-level analysis of the relationship between orthodontic treatment need and oral health-related quality of life in Korean schoolchildren. *American Journal of Orthodontics and Dentofacial Orthopedics* **155**, 355-361.

Clijmans, M., Lemiere, J., Fieuws, S. and Willems, G. (2015): Impact of self-esteem and personality traits on the association between orthodontic treatment need and oral health-related quality of life in adults seeking orthodontic treatment. *European Journal of Orthodontics* **37**, 643-650.

De Baets, E., Lambrechts, H., Lemiere, J., Diya, L. and Willems, G. (2012): Impact of self-esteem on the relationship between orthodontic treatment need and oral health-related quality of life in 11- to 16-year-old children. *European Journal of Orthodontics* **34**, 731-737.

De Oliveira, C.M., Sheiham, A., Tsakos, G. and O'Brien, K.D. (2008): Oral health-related quality of life and the IOTN index as predictors of children's perceived needs and acceptance for orthodontic treatment. *British Dental Journal* **204**, 1-5

De Oliveira, C.M. and Sheiham, A. (2003): The relationship between normative orthodontic treatment need and oral health-related quality of life. *Community Dentistry and Oral Epidemiology* **31**, 426-436.

Dimberg, L., Lennartsson, B., Bondemark, L. and Arnrup, K. (2016): Oral health-related quality-of-life among children in Swedish dental care: The impact from malocclusions or orthodontic treatment need. *Acta Odontologica Scandinavica* **74**, 127-133.

Egger, M., Juni, P., Bartlett, C., Holenstein, F. and Sterne, J. (2003): How important are comprehensive literature searches and the assessment of trial quality in systematic reviews? Empirical study. *Health Technology Assessment* **7**, 1-76.

Eslamipour, F., Asgari, I. and Tabesh, A. (2014): Orthodontic Treatment Need and Oral Health Related Quality of Life in Students in Isfahan. *Journal of Dental School, Shahid Beheshti University of Medical Sciences* **32**, 187-196.

Gatto, R.C.J., Garbin, A.J.Í., Corrente, J.E. and Garbin, C.A.S. (2019): The relationship between oral health-related quality of life, the need for orthodontic treatment and bullying, among Brazilian teenagers. *Dental Press Journal of Orthodontics* **24**, 73-80.

Gherunpong, S., Tsakos, G. and Sheiham, A. (2006): A socio-dental approach to assessing children's orthodontic needs. *European Journal of Orthodontics* **28,** 393-399.

Ghijselings, I., Brosens, V., Willems, G., Fieuws, S., Clijmans, M. and Lemiere, J. (2014): Normative and self-perceived orthodontic treatment need in 11- to 16-year-old children. *European Journal of Orthodontics* **36**, 179-185.

Hassan, A.H., Hassan, M.H. and Linjawi, A.I. (2014): Association of orthodontic treatment needs and oral health-related quality of life in Saudi children seeking orthodontic treatment. *Patient Prefer Adherence* **13**, 1571-1579.

Herkrath, A.P.C.Q., Vettore, M.V., de Queiroz, A.C., Alves, P.L.N., Leite, S.D.C., Pereira, J.V., Rebelo, M.A.B. and Herkrath, F.J. (2019): Orthodontic treatment need, self-esteem, and oral health-related quality of life among 12-yr-old schoolchildren. *European Journal Oral Sciences* **127**, 254-260.

Johal, A., Cheung, M.Y. and Marcenes, W. (2007): The impact of two different malocclusion traits on quality of life. *British Dental Journal* **202**, E2.

Kavaliauskienė, A., Šidlauskas, A. and Zaborskis, A. (2018): Relationship Between Orthodontic Treatment Need and Oral Health-Related Quality of Life among 11-18-Year-Old Adolescents in Lithuania. *International Journal of Environmental Research and Public Health* **15**, 1012.

Kok, Y.V., Mageson, P., Harradine, N.W. and Sprod, A.J. (2004): Comparing a quality of life measure and the Aesthetic Component of the Index of Orthodontic Treatment Need (IOTN) in assessing orthodontic treatment need and concern. *Journal of Orthodontics* **31**, 312-318.

Kragt, L., Wolvius, E.B., Jaddoe, V.W.V., Tiemeier, H. and Ongkosuwito, E.M. (2018): Influence of self-esteem on perceived orthodontic treatment need and oral health-related quality of life in children: the Generation R Study. *European Journal of Orthodontics* 254-261.

Kragt, L., Jaddoe, V., Wolvius, E. and Ongkosuwito, E. (2017): The association of subjective orthodontic treatment need with oral health-related quality of life. *Community Dentistry Oral Epidemiology* **45**, 365-371.

Kunz, F., Platte, P., Keß, S., Geim, L., Zeman, F., Proff, P., Hirschfelder, U. and Stellzig-Eisenhauer, A. (2018): Correlation between oral health-related quality of life and orthodontic treatment need in children and adolescents-a prospective interdisciplinary multicentre cohort study. *Journal of Orofacial Orthopedics* **79**, 297-308.

Liberati, A., Altman, D.G., Tetzlaff, J., Mulrow, C., Gøtzsche, P.C., Ioannidis, J.P., Clarke, M., Devereaux, P.J., Kleijnen, J. and Moher, D. (2009): The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *PLoS Medicine* **6**, e1000100.

Liu, Z., McGrath, C. and Hägg, U. (2009): The impact of malocclusion/orthodontic treatment need on the quality of life. A systematic review. *The Angle Orthodontist* **79,** 585-591.

Locker, D., Jokovic, A. and Clarke, M. (2004): Assessing the responsiveness of measures of oral health-related quality of life. *Community Dentistry Oral Epidemiology* **32**, 10-18.

Locker, D. (2001) Does dental care improve the oral health of older adults? *Community Dental Health* **18**, 7-15.

Mandall, N.A., McCord, J.F., Blinkhorn, A.S., Worthington, H.V. and O'Brien, K.D. (2000): Perceived aesthetic impact of malocclusion and oral self-perceptions in 14-15-year-old Asian and Caucasian children in greater Manchester. *European Journal of Orthodontics* **22,** 175-183.

Mary, A.V., Mahendra, J., John, J., Moses, J., Ebenezar, A.V.R. and Kesavan, R. (2017): Assessing Quality of Life using the Oral Health Impact Profile (OHIP-14) in Subjects with and without Orthodontic Treatment need in Chennai, Tamil Nadu, India. *Journal of Clinical and Diagnostic Research* **11**, ZC78-ZC81.

Modesti, P.A., Reboldi, G., Cappuccio, F.P., Agyemang, C., Remuzzi, G., Rapi, S., Perruolo, E. and Parati, G. (2016): ESH Working Group on CV Risk in Low Resource Settings. Panethnic Differences in Blood Pressure in Europe: A Systematic Review and Meta-Analysis. *PLoS One* **11**, e0147601.

Naseh, R., Padisar, P., Shojaei-Nejad, H. and Morsaghian, M. (2016): Students' orthodontic treatment needs and oral-health-related quality of life in Qazvin city, Iran. *Journal of Oral Health and Oral Epidemiology* **5**, 154-160.

Nguee, A.A.M., Ongkosuwito, E.M., Jaddoe, V.W.V., Wolvius, E.B. and Kragt, L. (2020): Impact of orthodontic treatment need and deviant occlusal traits on oral health-related quality of life in children: A cross-sectional study in the Generation R cohort. *American Journal of Orthodontics and Dentofacial Orthopedics* **157**, 764-72.e4.

Stang, A. (2010): Critical evaluation of the Newcastle-Ottawa scale for the assessment of the quality of nonrandomized studies in meta-analyses. *European Journal of Epidemiology* **25**, 603-605.

Tsakos, G. (2008): Combining normative and psychosocial perceptions for assessing orthodontic treatment needs. *Journal of Dental Education* **72,** 876-885.

Tsakos, G., Gherunpong, S. and Sheiham, A. (2006): Can oral health-related quality of life measures substitute for normative needs assessments in 11 to 12-year-old children? *Journal of Public Health Dentistry* **66**, 263-268.

Zaror, C., Pardo, Y., Espinoza-Espinoza, G., Pont, À., Muñoz-Millán, P., Martínez-Zapata, M.J., Vilagut, G., Forero, C.G., Garin, O., Alonso, J. and Ferrer, M. (2019): Assessing oral health-related quality of life in children and adolescents: a systematic review and standardized comparison of available instruments. *Clinical Oral Investigations* **23**, 65-79.

Zhang, M., McGrath, C. and Hägg, U. (2006): The impact of malocclusion and its treatment on quality of life: a literature review. *International Journal of Paediatric Dentistry* **16**, 381-387.

Zhang, M., McGrath, C. and Hägg, U. (2009): Orthodontic treatment need and oral health-related quality among children. *Community Dental Health* **26**, 58-61.