

**Malocclusion, orthodontic treatment, and the Oral Health Impact Profile (OHIP-14):
Systematic review and meta-analysis**

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ABSTRACT

Objective: To synthesize evidence on the impact of malocclusion and its associated treatment on people's quality of life across studies that used the Oral Health Impact Profile (OHIP-14) questionnaire in the adult population.

Materials and Methods: A systematic search of the English literature using Medline, PubMed, and EMBASE yielded 98 unique citations. Studies using OHIP-14 with individuals 15 years of age and older were included. After initial screening, 64 citations were excluded and another 9 were excluded after reading full text reports; the remaining 25 were included in the review. All studies were observational and used one of three study designs: 11 compared the same group before and after treatment (pre-post design), 10 compared groups with and without malocclusion (independent groups design) and four compared an orthodontically treated group with an independent group requiring treatment (treated-untreated groups design). Only three studies using the pre-post design and four using the independent groups design reported comparable OHIP-14 data and were combined in separate meta-analyses. Meta-analysis was carried out using *metan* command in Stata.

Results: The standardized mean difference (SMD) in OHIP-14 total score was 1.29 (95% CI: 0.67 to 1.92) for the three studies using the pre-post design. Similarly, the SMD score was 0.84 (95% CI: 0.25 to 1.43) for the four studies using the independent groups design. There was evidence of high heterogeneity and publication bias among the studies included.

Conclusions: This meta-analysis revealed that OHIP-14 scores were significantly lower after receiving treatment for malocclusion and in individuals without malocclusion/orthodontic treatment need compared to those with such condition (independent groups). (*Angle Orthod.* 2015;85:493–500.)

KEY WORDS: Malocclusion; Orthodontic treatment; Oral health related quality of life; Review

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INTRODUCTION

Evidence on the physical, psychological, and social consequences of malocclusion and its associated treatment as they relate to quality of life is still conflicting.^{1–3} Although studies generally report an association between malocclusion/orthodontic treatment need and oral health-related quality of life (OHRQoL) scores, the strength of evidence is relatively low, and there is a need for using standardized methods to enhance comparability.^{1,3} Focusing on studies that used the same OHRQoL instrument may

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help in comparing findings across studies and even synthesizing the evidence quantitatively.

Though various instruments are available to measure people's OHRQoL, the Oral Health Impact Profile (OHIP) has been widely used due to its good psychometric properties.⁴ As the original version of the OHIP questionnaire has 49 questions (OHIP-49), it was later considered time-consuming to complete. To overcome this shortcoming, a shorter version with 14 items was derived from the original questionnaire (OHIP-14).⁵ The OHIP-14 is considered a more practical instrument in clinical practice and epidemiological surveys and has also shown good reliability and validity.⁶ Each of the 14 items contained in the instrument can be scored with the scale of 0 to 5. The score 0 refers to good quality of life and 5 refers to worst. Hence, the total score ranges from 0 to 70.

The aim of this study was to synthesize the evidence on the impact of malocclusion and its associated treatment on people's quality of life using studies that used the OHIP-14 questionnaire among the individuals of 15 years of age and above.

MATERIALS AND METHODS

Search Strategy for Identification of Studies

We sought to identify all studies exploring the impact of malocclusion and its associated treatment on people's quality of life, published until November 2013. To identify relevant English studies, MEDLINE and EMBASE via OVID and PubMed were electronically searched. The search strategies included a combination of medical subject heading (MeSH) terms and text words around two main subjects: the exposure (malocclusion or its associated treatment) and outcome (OHRQoL). The MeSH terms were "Malocclusion," "Orthodontics," "Orthognathic Surgery," and "quality of life" and the keywords were orthod*, orthogn*, malocclus*, Oral Health Impact Profile, OHIP, and quality of life. Electronic search strategies were supplemented by hand search of the reference lists of all relevant publications and the most recent related review articles in order to identify additional undetected published studies.

Criteria for Inclusion of Studies

Predefined criteria were applied to select the final list of intervention and/or observational studies to be included in the review. The inclusion criteria used for this review were:

- population: individuals aged 15 years and above;
- intervention/exposure: either malocclusion (determined via clinical examination) or its associated treatment (ie, orthodontic therapy or orthognathic surgery);

- comparison: a control group of individuals without malocclusion (for assessing the impact of malocclusion) or a control group of individuals requiring either orthodontic treatment or orthognathic surgery (for assessing the impact of the treatment of malocclusion, before and after treatment); and
- outcome: OHRQoL measured using the short-version of the OHIP, OHIP-14.

The exclusion criteria were:

- studies carried out with children or adolescents (below the age of 15);
- letters to editors, unpublished articles, case reports, case series, and reviews;
- studies published in languages other than English;
- duplicate studies (studies originating from the same subjects by the same investigators but published in different journals); and
- articles providing no information on sample size, mean, or standard deviation for the OHIP-14 total score, or insufficient information for their calculation.

Data Extraction and Validity Assessment Procedure

Two reviewers performed independent searches, assessed the quality of the included studies, and extracted the data in duplicate. Records of all references were combined in EndNote X4 (Thomas Reuters, Philadelphia, Pa). Differences were resolved by discussion and/or rereading. The titles and abstracts obtained from initial electronic searches were screened for relevance. For studies meeting the inclusion criteria, or for which there was insufficient data in the title and abstract to make a clear decision, the full report was obtained and assessed to establish whether they met the inclusion criteria. Studies rejected at this or subsequent stages were recorded in the table of excluded studies, and reasons for exclusion were noted. The full text of all topic-related studies was assessed for methodologic quality using the STROBE checklists.^{7,8}

General bibliographic information as well as key methodologic characteristics (author, year of publication, study design, and methods used) and relevant results (number of samples used, mean score, and standard deviation for the two groups—with and without malocclusion or with and without treatment) were extracted from all included studies.

Statistical Methods

Descriptive statistics were used to summarize the study characteristics. A meta-analysis was performed using the *metan* command in Stata version 11.2

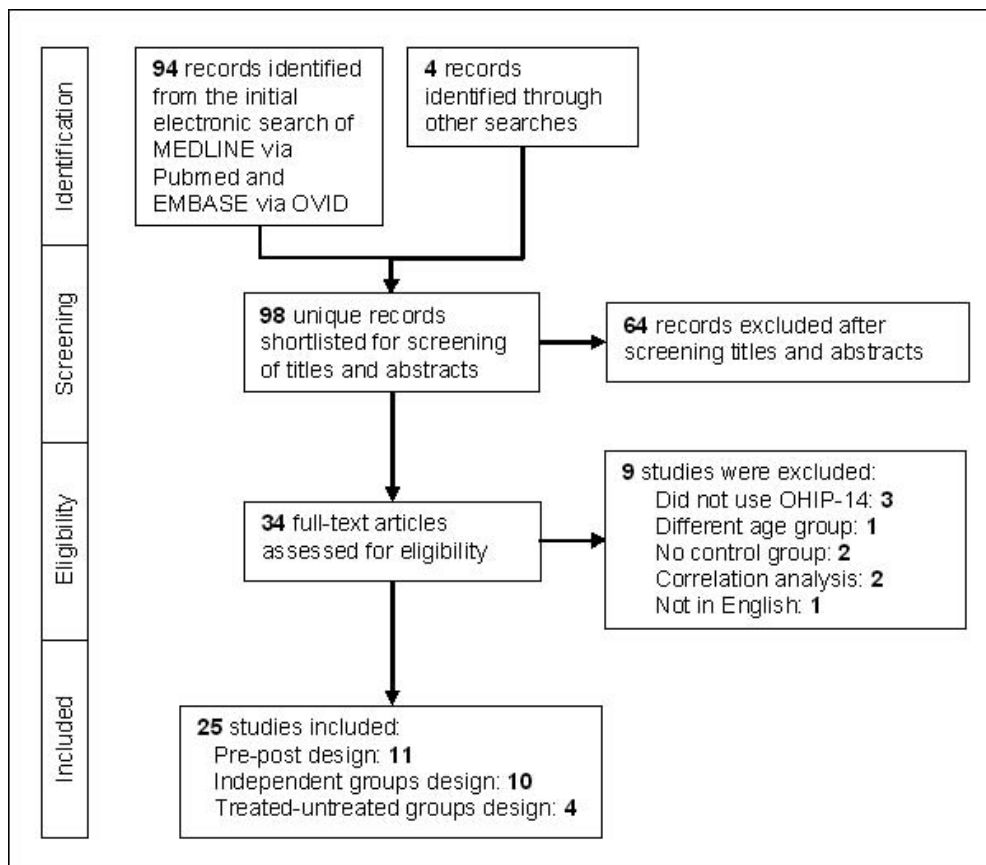


Figure 1. Flowchart of the selection of studies for the review.

(StataCorp, College Station, Tex). As the studies selected in this analysis were carried out in different countries and populations, between-study variations were assumed a priori. Hence, random effect models were used in the meta-analysis, which takes into account both within- and between-study variations in effect sizes. To test whether there was more heterogeneity in the data than the chance, Q test was used. The heterogeneity measure I^2 was also calculated to measure the percentage of heterogeneity in the data. Both the Begg and Egger tests were used to measure the bias due to small study effects in our data. Funnel plots were used to assess the publication bias visually.

RESULTS

Study Characteristics

A flowchart describing the systematic review search results is presented in Figure 1. The search yielded 98 unique citations. After screening titles and abstracts, 64 citations were excluded as clearly not relevant to this systematic review, leaving 34 for full-text review. Nine studies were further excluded after reading their full text reports; the remaining 25 were assessed for their methodologic quality. Table 1 summarizes the

key methodological aspects and findings of the 25 studies included in this review. All 25 studies were observational and were organized into three groups according to the type of comparisons made: (1) 11 studies⁹⁻¹⁹ comparing groups with and without malocclusion/orthodontic treatment need (independent groups design), (2) 10 studies²⁰⁻²⁹ comparing the same group of individuals before and after treatment (labelled as pre-post design), and (3) four studies³⁰⁻³³ comparing an orthodontically treated group with an independent group requiring treatment (treated-untreated groups design).

Findings From Meta-analysis

Among the studies that used OHIP-14, only a few used the same type and details of reporting. Only eight of the 25 studies included in the review (32%) provided information on the OHIP-14 mean and standard deviation as well as the sample size of the groups compared, namely three of the 11 using the pre-post design, four of the 10 using the independent groups design, and one of the four using the treated-untreated groups design (Table 1). The three and four studies in the first and second study designs were amenable to meta-analysis. The remaining 18 studies were

Table 1. Characteristics of the Studies on the Association of Malocclusion and Its Associated Treatment With OHIP-14^{a,b}

Author, y	Study Design ^a	Sample Characteristics	Exposure ^b	Outcome	Statistical Analysis ^c	Main Findings
Anosike et al. (2010) ¹⁶	Type 1	805 Schoolchildren, Nigeria, 12–16 y	DAI	Prevalence	Chi-square	No association
Bernabé et al. (2008) ⁹	Type 1	200 Schoolchildren, UK, 16–17 y	DAI, IOTN	Mean (SD), prevalence	Nonparametric	Differences in total score and prevalence by DAI but not IOTN
Caglayan et al. (2009) ¹⁷	Type 1	1090 Patients, Turkey, 18+ y	Complaints	Median	Nonparametric	Orthodontic/aesthetic patients had higher total scores than controls
de Oliveira and Sheiham (2003) ¹³	Type 1	1675 Schoolchildren, Brazil, 15–16 y	IOTN	Prevalence	Logistic regression	Prevalence of impacts increased with IOTN severity
Frejman et al. (2013) ¹⁵	Type 1	68 Patients, Brazil, 27.6 y	Class II/III malocclusion	Median	Nonparametric	Higher total score in patients with malocclusion
Hassan and Amin (2010) ¹⁴	Type 1	366 Patients, Egypt, 21–25 y	IOTN	Prevalence	Chi-square	Higher prevalence as IOTN severity increased but not in all domains
Lee et al. (2007) ¹⁹	Type 1	154 Patients, Hong Kong, 16–45 y	Dentofacial deformity	Mean (SD), prevalence	Nonparametric	Higher total score in cases than controls
Liu et al. (2011) ¹²	Type 1	273 Patients, Hong Kong, 16–30 y	DAI, IOTN	Median	Nonparametric	Higher total scores among patients with orthodontic need
Manjith et al. (2012) ¹⁸	Type 1	200 Patients, India, 11–15 y	IOTN	Prevalence	Chi-square	Prevalence of impacts increased with IOTN severity
Masood et al. (2013) ¹⁰	Type 1	323 Patients, Malaysia, 15–25 y	IOTN	Mean (SD)	Linear regression	Total and domain scores increased with IOTN severity
Sutinen et al. (2007) ¹¹	Type 1	215 Patients, Finland, 16–60 y	Indication for orthognathic surgery	Mean (SD)	t-Test	Patients waiting for surgery had higher total scores than controls
Chen et al. (2010) ²⁰	Type 2	222 Patients, China, 15.7 y	Fixed orthodontic therapy	Mean	RM-ANOVA	Total and domain scores decreased after completion of treatment
Choi et al. (2010) ²¹	Type 2	60 Patients, Hong Kong, 23.9 y	Bimaxillary surgery and orthodontic therapy	Mean (SD)	Friedman ANOVA	Reduction in total score 6 mo after completion of treatment
Feu et al. (2013) ²⁸	Type 2	284 Patients, Brazil, 12–15 y	IOTN	Median	GEE	Reduction in total score after 2 y (treatment completed)
Kavin et al. (2012) ²²	Type 2	14 Patients, India, 22–34 y	Anterior maxillary osteotomy and orthodontic treatment	Mean (SD)	Descriptive only	Reduction in total score 8 wk after surgery
Lee et al. (2008) ²³	Type 2	36 Patients, China, 23.3 y	Orthognathic surgery	Mean (SD)	Paired t-test	Reduction in total score 6 mo after surgery
Liu et al. (2011) ²⁴	Type 2	232 Patients, Hong Kong, 16+ y	Fixed orthodontic treatment	Median (IQR)	Paired t-test	No difference in total score between baseline and 18 mo after bonding and banding
Rustemeyer and Gregersen (2012) ²⁶	Type 2	50 Patients, Germany, 18–52 y	Orthognathic surgery for Class II/III malocclusion	Mean (SD)	Paired t-test	Reduction in total scores 12 mo after surgery
Rustemeyer Gregerson (2012) ²⁹	Type 2	30 Patients, Germany, 24.3 ± 4.5 y	Orthognathic surgery for Class III malocclusion	Mean (SD)	Paired t-test	Reductions in some but not all domains 8 mo after surgery
Rustemeyer Lehmann (2013) ²⁷	Type 2	60 Patients, Germany, 23.1 ± 4.8 y	Surgical correction of prognathism and maxillary hypoplasia	Mean (SD)	Paired t-test	Reductions in some but not all domains 6 mo after surgery
Silvola et al. (2012) ²⁵	Type 2	51 Patients, Finland, 36.4 y	Orthodontic and surgical treatment	Mean, median	Paired t-test	Reductions in severity, extent and prevalence 3 y after treatment

Table 1. Continued.

Author, y	Study Design ^a	Sample Characteristics	Exposure ^b	Outcome	Statistical Analysis ^c	Main Findings
de Oliveira and Sheiham (2004) ³⁰	Type 3	1675 Schoolchildren, Brazil, 15–16 y	IOTN	Prevalence	Logistic regression	Prevalence was lower in treated than in never treated
Esperao et al. (2010) ³¹	Type 3	117 Patients, Brazil, 24.5 y	Orthognathic surgery	Prevalence	Logistic regression	Patients in the postsurgical phase experienced fewer impacts than those waiting for surgery
Navabi et al. (2012) ³²	Type 3	302 Patients, Iran, 21.7 y	Fixed orthodontic treatment	Prevalence	Chi-square	Differences in prevalence between treated and untreated
Palomares et al. (2012) ³³	Type 3	200 Patients, Brazil, 18–30 y	Orthodontic treatment	Mean	Negative binomial regression	Treated patients had lower scores than those waiting for treatment

^a Type 1 refers to independent groups design; type 2 refers to pre-post design; and type 3 refers to treated-untreated design.

^b DAI indicates dental aesthetic index; IOTN, index for orthodontic treatment need; GEE, generalized estimation equations; and IQR, interquartile range.

excluded from the meta-analysis. Figure 2 depicts the results of the two meta-analyses. The contribution of each study to the meta-analysis is given as a percentage of weight. For the four studies that used the pre-post study design, the standardized mean difference (SMD) was 1.29 (95% CI: 0.67 to 1.92), indicating that the OHIP-14 score decreased after treatment. Similarly, for the three studies that used the independent groups study design, the SMD was 0.84 (95% CI: 0.25 to 1.43), indicating that people without malocclusion had lower OHIP-14 scores compared with their counterparts. The mean SMD score was significantly different from 0 in both cases ($P < .001$ and $.005$, respectively). The studies involved in each meta-analysis were heterogeneous and the heterogeneity was statistically significant ($P = .047$ and $<.001$ for the first and second meta-analysis, respectively). The variations in SMD measured as a percentage (I^2) were 67.2% (pre-post study design) and 91.6% (independent group study design). The between-study variance was 0.20 and 0.34 for the pre-post and independent-group study designs, respectively.

Bias due to small study effect was tested using Begg's test and Egger's test. The two tests showed no evidence of bias ($P = .30$ and $.43$ for the pre-post study design and 0.31 and 0.32 for the independent group study design, respectively). Publication bias was assessed using funnel plots with 95% pseudo CI (Figure 3). There was no evidence of publication bias in the first meta-analysis, whereas there was evidence of publication bias in the second meta-analysis. Hence, further trimming was performed for the independent-group study design to adjust for publication bias (Table 2). The sensitivity analysis indicated that the omission of any of the studies led to a new estimate of 0.81 (95% CI: 0.25 to 1.43).

DISCUSSION

Our review revealed no high-quality studies on the association of malocclusion (longitudinal studies) or its associated treatment (randomized controlled trials) with

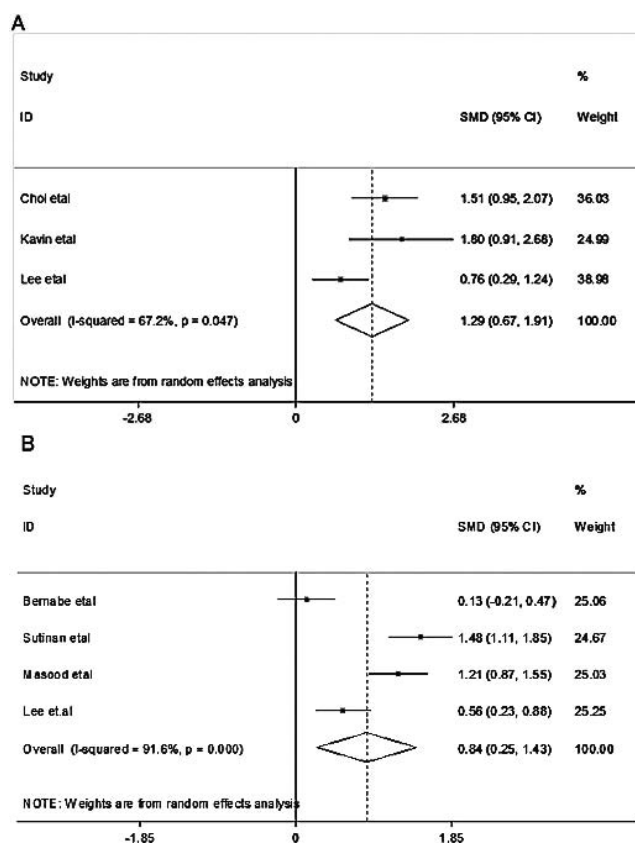


Figure 2. Forest plot depicting the standardized mean difference (SMD) and its 95% confidence interval for (A) studies comparing the same group before and after treatment (pre-post study design) and (B) studies comparing groups with and without malocclusion (independent group study design).

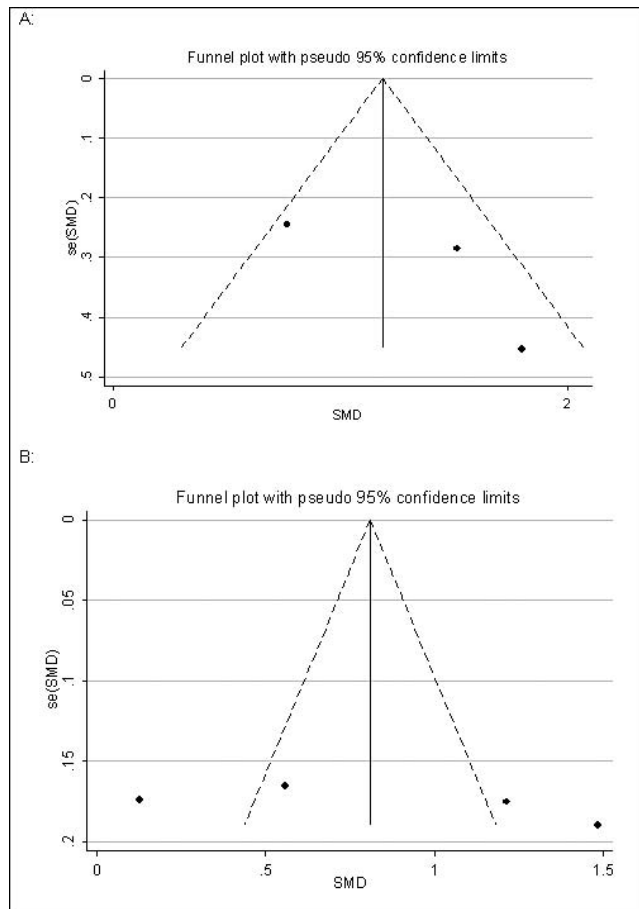


Figure 3. Funnel plot for evaluation of publication bias for (A) studies comparing the same group before and after treatment (pre-post study design) and (B) studies comparing groups with and without malocclusion (independent group study design).

OHIP-14 scores. Most evidence is cross-sectional and based on reduced samples of individuals. However, evidence from these studies suggests that OHIP-14 scores were significantly lower after receiving treatment for malocclusion (pre-post design), indicating that the quality of life has improved and in individuals without malocclusion/orthodontic treatment need compared to those with such condition (independent groups design). The pooled SMD from the three studies that used the pre-post design was 1.29 (95% CI: 0.67 to 1.92,) whereas the pooled SMD from the four studies that used the independent groups design was 0.84 (95% CI: 0.25 to 1.43). The two values indicate large effects according to the Cohen (1988) benchmark values of small (0.20), moderate (0.50), and large (0.80) effects.³⁴ However, they should be taken with certain caution as they came from studies with no parallel control group or follow-up assessment (ie, for the pre-post and independent groups design, respectively).

Furthermore, our two meta-analyses revealed high levels of heterogeneity among the studies, meaning

Table 2. Sensitivity Analysis for the Meta-Analysis of Studies Comparing Groups With and Without Malocclusion (Independent Groups Study Design)

Study Omitted	Estimate	95% Confidence Interval
Bernabé et al. (2008) ⁹	1.04	0.84 to 1.24
Sutinen et al. (2007) ¹¹	0.91	0.71 to 1.11
Masood et al. (2013) ¹⁰	0.68	0.48 to 0.87
Lee et al. (2007) ¹⁹	0.63	0.43 to 0.82
Combined	0.81	0.64 to 0.98

that findings varied widely between the populations and countries where the primary studies were conducted. The meta-analyses also revealed the presence of publication bias in these published papers, which needs to be addressed. All studies but one⁹ included in the meta-analyses reported significant differences in OHIP-14 total scores between groups, but previous reviews (not focusing exclusively on the above instrument) have found conflicting results.¹⁻³

Our review highlights some areas for further improvement in this research field. First, despite identifying 25 studies for this review, none used the best study design (either a randomized controlled trial for the impact of orthodontic/orthognathic treatment or a longitudinal study for the impact of malocclusion). Researchers have used three main types of study designs to assess the impact of malocclusion and its associated treatment on OHIP-14 total scores. Sadly, those choices will not provide the best evidence on this topic. There is, therefore, the necessity for more studies using appropriate designs to be carried out in this field in the future. Second, different studies follow different approaches when reporting OHRQoL using the OHIP-14 instrument. Seven studies using the pre-post design and four in the independent groups design did not report mean and standard deviation for the OHIP-14 total score and could not be used in the corresponding meta-analyses. As meta-analysis requires the summary statistics for each group considered in the study, lack of these statistics restricts the application of a meta-analysis in achieving its objectives.

Some limitations of this review need to be addressed. First, the results of any meta-analysis are highly reliable only if it is based on a large number of studies. However, the results of the present meta-analyses were based on three studies for the pre-post design and four studies for the independent groups design. This review and meta-analysis will need to be updated once more studies have been conducted. Second, our search was restricted to studies published in English only, and as such, some relevant evidence could have been omitted (language bias). Third, although we only combined findings from studies with the two strongest study designs among those

available, they are not the best possible designs to assess the impact of malocclusion and its associated treatment on quality of life. Also, as the impact of malocclusion on quality of life may differ between children and adults as adults look this in context with aesthetics apart from functional, comparison between these two populations will help the policy makers for better planning. However, the strength of this review is that it is the first attempt to use meta-analysis to elucidate the effect of treatment on oral health-related quality of life of patients of different groups by combining studies carried out across the world. The precision of the meta-analysis results could have been improved if the analysis included properly designed studies like clinical trials for the impact of orthodontic treatment and longitudinal studies for the impact of malocclusion.

CONCLUSIONS

This meta-analysis revealed that:

- OHIP-14 scores were significantly lower after receiving treatment (indicating improvement in quality of life) for malocclusion (pre-post study design) and in individuals without malocclusion/orthodontic treatment need compared to those with such condition (independent groups study design).
- There is a lack of standardization among studies in terms of study designs and reporting of OHIP-14 scores; hence, there is poor evidence on this topic.

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