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# Oral health-related quality of life after prosthodontic treatment for patients with partial edentulism: A systematic review and meta-analysis


## ABSTRACT

**Statement of problem.** Clinicians are currently unable to quantify the psychosocial, functional, and esthetic effects of prosthetic interventions to replace teeth. Understanding the effects of treatment to replace teeth on oral health-related quality of life (OHRQoL) is important for informed consent. A systematic review of the evidence of OHRQoL improvements with prosthodontic tooth replacement and a comparison of outcomes between treatment modalities is therefore indicated.

**Purpose.** The purpose of this systematic review was to examine the OHRQoL of patients with partial edentulism after different dental prosthetic treatments.

**Material and methods.** Electronic database and manual searches were conducted to identify cohort studies and clinical trials reporting on the OHRQoL of individuals receiving implant-supported crowns (ISCs), implant-supported fixed dental prostheses (IFDPs), implant-supported removable dental prostheses (IRDPs), tooth-supported fixed dental prostheses (TFDPs), and removable partial dentures (RPDs). Two reviewers independently conducted article selection, data extraction, and quality assessment. Random-effects models were used to compare OHRQoL change scores (standardised mean change [SMC], 95% confidence intervals [CI]).

**Results.** Of the 2147 identified studies, 2 randomized controlled trials and 21 cohort studies met the inclusion criteria. Overall, studies were of low or moderate risk of bias. Pooled mean OHRQoL change ≤9 months was 15.3 for TFDP, 11.9 for RPD, and 14.9 for IFDP. Pooled SMC

OHRQoL change >9 months was 13.2 for TFDP and 15.8 for IFDP. Direct comparisons ≤9 months between TFDP against IFDP and RPD against IFDP significantly favored IFDP in both cases.

**Conclusions.** TFDP and IFDP had short- and long-term positive effects on OHRQoL. RPDs positively affected OHRQoL in the short-term. IFDP showed greater short-term improvement in OHRQoL than RPD and TFDP.

## CLINICAL IMPLICATIONS

Clinicians may advise patients with multiple missing teeth that implant-supported FDPs make greater improvements to OHRQoL than tooth-supported FDPs or RPDs. They should also inform patients that, while RPDs improve OHRQoL in the short term, these effects may be less noticeable in the medium term.

## INTRODUCTION

Despite declines in edentulism, particularly in developed countries, tooth loss remains prevalent globally and leads to functional and esthetic disabilities with negative psychosocial impacts.[1-3] Patients with fewer than 20 natural teeth have worse OHRQoL than those with 20 teeth or more.[4] Replacing missing teeth improves appearance, function, and prevents undesirable tooth movements.[5] Variables such as number of missing teeth and position of missing teeth can influence how patients perceive treatment to replace missing teeth.[6] Extent of tooth loss, local factors, and systemic factors are important considerations in the planning of prosthodontic treatment.[7] Prosthodontic options for replacing missing teeth in patients with partial edentulism include implant-supported crowns (ISCs), implant-supported fixed dental prostheses (IFDPs),

implant-supported removable dental prostheses (IRDPs), tooth-supported fixed dental prostheses (TFDPs), and removable partial dentures (RPDs).[8]

Outcome measures of prosthetic replacement of missing teeth include masticatory efficiency, continued prosthesis use, technical failure, and biological failure.[9-13] While the importance of these measures is indisputable, they fail to consider the patient's subjective perceptions. The use of patient-reported outcome measures (PROMs) has increased in dental research.[14] PROMs allow assessment of oral health-related quality of life (OHRQoL), a multidimensional construct assessing the impact of oral problems on subjective esthetic, functional, and psychosocial well being.[15] OHRQoL measures include: Oral Health Impact Profile (OHIP), Global Oral Health Assessment Index (GOHAI), Oral Impacts of Daily Performance (OIDP), and UK Oral Health-related Quality of Life Measure (OHQoL-UK).[16-19]

OHRQoL measures are used to evaluate the effect of oral conditions on quality of life and assess the effect of dental interventions.[20,21] OHRQoL may be improved with prosthodontic rehabilitation in patients with partial edentulism, demonstrated by improvements in OHIP scores between baseline and follow-up.[22-24] Previous systematic reviews suggest that rehabilitation with dental implants in edentulous and partially edentulous patients can improve OHRQoL, but comparisons of different prostheses in patients with partial edentulism has not yet been comprehensively reviewed.[25-31] Given the range of different scales to measure OHRQoL, each with different scoring methods and scoring ranges, any synthesis of data is challenging; different scales may be combined for meta-analysis provided that scales measure similar constructs and that researchers are mindful of the increased risk of heterogeneity.[32-35]

The purpose of this systematic review was to assess the impact of treatment with ISCs, IFDPs, IRDPs, RPDs, and TFDPs on quantifiable measures of OHRQoL in patients with partial

edentulism. The following research question was posed: “What is the effect of different dental prosthetic interventions for replacing missing teeth in partially dentate patients with respect to the changes in oral health-related quality of life?” The null hypothesis was that no difference between prosthodontic treatments to replace teeth would be found in their impact on OHRQoL.

## MATERIAL AND METHODS

This systematic review was conducted in compliance with principles proposed by the PRISMA statement.[36] For inclusion in the review, studies had to include partially edentulous adults of either sex and treated with ISCs, IFDPs, IRDPs, RPDs, or TFDPs reporting OHRQoL outcomes using validated OHRQoL measures such as OHIP, GOHAI, or OIDP.[16-18] Only studies measuring pretreatment to post-treatment change in OHRQoL score were included. Single or multiple group prospective randomized controlled trials (RCTs), non-RCTs, and cohort studies were included. Studies reporting interventions on edentulous participants were excluded, as were descriptive studies, cross-sectional studies, case reports, reviews, and review protocols.

A comprehensive literature search was conducted. The electronic libraries, MeSH terms, and keywords used are presented in Table 1. Searches were restricted to English language articles from January 1979 to April 2016. Additional literature was sought from systematic reviews identified in the electronic search and from the references of the included papers. Grey literature was identified from the abstracts of conference proceedings for International Association for Dental Research (IADR) meetings published online.

Duplicated studies were removed, and 2 reviewers (SS and ZA) independently screened titles and abstracts of all articles to select those suitable for full reading, which were also independently reviewed according to inclusion and exclusion criteria. Interreviewer reliability of

inclusion was assessed in 10% of articles. A Cohen kappa score of $\kappa$=0.70 was set as the accepted standard.[37] Disagreements were resolved through discussion with a supervising reviewer (NM). Data concerning publication year, country, setting, study design, participants' characteristics (age, sample size), follow-up, OHRQoL instrument, and prosthodontic interventions were extracted independently by 2 reviewers (SS and ZA). Results were grouped qualitatively according to the type of prosthodontic interventions analyzed: studies investigating conventional tooth- and mucosa-supported prostheses only, studies investigating implant-supported prostheses only, and studies investigating both conventional and implant-supported prostheses.

Two reviewers (SS and ZA) assessed the quality of the included studies independently. The Cochrane Collaboration's risk of bias tool was used to assess the risk of bias in RCTs.[38] The performance bias item was not assessed, since blinding participants and clinicians to prosthodontic interventions is not possible. The quality of nonrandomised trials was evaluated with the Newcastle-Ottawa scale, consisting of 3 categories: group selection (four items); comparability (one item), andoutcome assessment (three items).[39] If an item did not apply to the study, it was labelled 'not applicable', an example being "definition of control group" not applicable for single group studies.

Meta-analysis was carried out to estimate pooled mean changes for OHRQoL scores involving mean and standard deviation or variance data, where available. Total scores of OHRQoL instruments were standardised from 0 to 100 in the same direction to obtain a standardised mean change (SMC) before and after each individual prosthodontic treatment. Positive differences of SMC indicated better OHRQoL after dental prosthesis intervention to replace missing teeth. The mean differences for OHRQoL between 2 or more prosthodontic

interventions were calculated as the difference of SMC between groups. Subgroup analyses were performed according to follow-up periods: ≤9 months (short-term) and >9 months (medium/long-term).

Pooled mean changes for OHRQoL scores (95% confidence interval [CI 95%]) for each type of dental prosthesis treatment (indirect comparisons) and between dental prosthetic treatments (direct comparisons) were estimated using the inverse variance method. Indirect comparisons were considered to be valid based on the following aspects: OHRQoL scores were assessed using validated instruments; OHRQoL measures were standardised from 0 to 100; only studies involving partially dentate patients were included; and unique dental prosthetic treatments (ISCs, IFDPs, IRDPs, RPDs, and TFDPs) were assessed. Meta-analyses were conducted using a random effects model, appropriate as the purpose of the review was to draw general conclusions about the role of prosthesis type on OHRQoL. The random effects model accounts for variability in study design, follow-up periods, research sites, and the variety of potential clinical confounders, including the number of teeth being replaced and the different regions of tooth replacement.[40]

Homogeneity was tested with the Cochran Q test and the proportion of variance between studies due to heterogeneity was assessed by using $I^2$. Where heterogeneity was detected, a meta-analysis was considered inappropriate. All statistical analyses were performed using statistical software (Stata 14; StataCorp LLC) ($\alpha$=.05 for all analyses).

## RESULTS

Initially 882 studies were identified from the electronic database and 42 studies from grey literature searches. A further 1223 articles were included from the reference lists of included

papers. Of the 2147 articles initially screened, 1993 studies were excluded based on the assessment of study titles and abstracts (interreviewer agreement $\kappa$=0.80). The full text of the remaining 154 studies was analyzed and a further 131 papers were excluded ($\kappa$=0.77). Of the 23 articles included for quality assessment, 17 were selected for meta-analysis (Fig. 1).

Supplementary Tables 1to 3 summarize the characteristics of the 2 randomized controlled clinical trials and 21 nonrandomized clinical studies and the effects on OHRQoL, grouped according to the type of prosthodontic treatment being investigated.[23,24,41-61] Of the 21 nonrandomized clinical studies, 20 were prospective studies with 1 or more groups of dental prosthetic treatments, and 1 study was a crossover controlled clinical study. The sample sizes varied considerably amongst the studies. Twelve studies had 9 months or less of follow-up, whereas 11 studies had more than 9 months of follow-up. OHRQoL was assessed using OHIP-14 in 11 studies and OHIP-49 in 9 studies. Two studies used OHIP-20 and 1 study used GOHAI. Eight studies investigated ISCs, 10 studies IFDPs, 9 studies TFDPs, 10 studies RPDs, and 2 studies IRDPs.

The two RCTs were considered to be of low risk of bias except with regard to the blinding of participants and assessors (Table 2). Both studies presented details about random sequence generation and showed no risk of selective reporting bias. Risk of assessment or measurement bias was considered low as validated OHRQoL instruments were used.

The results of quality assessment of the 21 nonrandomized studies with the Newcastle-Ottawa scale are presented in Table 3. Thirteen reported on only 1 intervention; therefore, the item “selection of the non exposed cohort” was not applicable. All studies used representative samples of the partially dentate participants, reported clearly on the type of dental prosthesis

used, and explained the outcome used and the scoring method. Variability was found in the level of accounting of confounders such as age, tooth position, and number of teeth being replaced.

Two studies investigated IRDPs and represented only 32 participants, 17 of whom were involved in a crossover study. Data for this group were insufficient to conduct a meta-analysis.[44,46] Two studies combined the effect of ISCs and IFDPs into one 'implant-supported' intervention and were also excluded.[50,60] Two studies were excluded from meta-analysis because mean data were unavailable or were not supplied on request.[23,61] Two studies reporting on unrepresentative samples or uncommon treatments deemed heterogeneous compared with conventional practice were excluded. These were Yu et al[55] who reported on participants treated in a military hospital and Persic et al,[43] who reported on the use of mini-implants ranging from 1.9 mm to 2.5-mm in diameter.

Seventeen papers provided quantitative data for meta-analysis. The pooled SMC scores of the OHRQoL measure for each prosthodontic treatment is presented in Figure 2. The pooled SMC scores of OHRQoL at ≤9 months follow-up were statistically significant for TFDPs (322 participants; SMC=15.3 points, 95% CI 7.4 to 22.3, P<.001), IFDPs (196 participants; SMC=14.9 points, 95% CI 6.7 to19.6; P<.001) and for RPDs (503 participants; SMC=11.9 points, 95% CI 4.1 to 19.6; P=.003). These changes represented improvements in OHRQoL (Fig. 2A). The pooled SMC scores of OHRQoL at >9 months follow-up were statistically significant for the TFDPs (176 participants; SMC=13.2 points, 95% CI 3.0 to 23.4; P=.011) and IFDPs (158 participants SMC=15.8 points, 95% CI 6.6 to 25.0; P=.001). These changes represented improvements in OHRQoL (Fig. 2B. The Cochran Q test suggested no heterogeneity in the meta-analyses of indirect comparisons. Only 3 studies provided data for meta-analysis of direct comparisons of the OHRQoL scores between 2 different dental prosthetic treatments. The

standardizeded mean difference in OHRQoL change was assessed between TFDPs and IFDPs (SMD=0.42 in favor of IFDPs, 95%CI, -0.75 to -0.10, P=.018) (Fig. 3A) and between RPDs and IFDPs (SMD=0.40 in favor of IFDPs, 95%CI, -0.40 to -0.15, P=.002) (Fig. 3B) at ≤9 months follow-up. Evidence of heterogeneity was detected in the direct comparisons of OHRQoL scores between TFDPs and RPDs at ≤9 months follow-up (Cochran Q test=12.20, P=.032, $I^2$=59.0%), and >9 month follow-up (Cochran Q test=4.46, P=.035, $I^2$=77.6%); therefore, these meta-analyses were not performed.

## DISCUSSION

The present study reviewed the evidence on the impact of prosthodontic treatments to replace missing teeth on the OHRQoL in patients with partial edentulism. Improvements in OHRQoL were observed after IFDPs, TFDPs, and RPDs at short-term follow-up (≤9 months). In addition, TFDPs and IFDPs resulted in positive changes of OHRQoL at longer follow-up (>9 months). The largest effect sizes were observed for IFDPs >9 months follow-up and TFDPs ≤9 months follow-up, resulting in 15.8% and 15.3% improvement in the OHRQoL score after treatment. However, ISCs in both follow-up periods and RPDs at >9 months did not improve OHRQoL. Direct comparisons suggested that the influence of IFDPs on OHRQoL was significantly higher than TFDPs or RPDs. IFDPs improved OHRQoL score 42% more than TFDPs and 40% more than RPDs at ≤9 months follow-up.

This review reveals a significant increase in the number of studies on the influence of dental prosthesis treatments on OHRQoL in patients with partial edentulism. Eighteen of the 23 studies included were published during the last 5 years. However, the quality of evidence of individual

studies is a limitation since only 2 RCTs were identified (level of evidence 1b) and the remaining 21 studies were clinical follow-up studies (level of evidence 2b).[62]

Previous well-conducted systematic reviews of the OHRQoL impacts of prosthetic replacement of missing teeth have found insufficient data to determine which treatment is "better or worse" than another and tended to focus on the management of the edentulous patient.[28-30] More recent reviews have investigated partially dentate patients, though the focus of these reviews has either been on the narrow area of the shortened dental arch versus RPDs, or has restricted analysis only to implant-supported prostheses.[26,27] Hutlin et al[25] reviewed this topic covering articles up to 2010 and demonstrated that oral rehabilitation to replace missing teeth in edentulous and partially edentulous patients can improve OHRQoL. However, this review included only 5 studies and grouped edentulous and partially dentate patients.[25] Thomason et al[31] provided a thorough qualitative review of the existing literature on the role of implants in the management of the edentulous patient, though they found sparse information on the impact on the OHRQoL in partially dentate patients. Recent review articles focused on the impact of dental implants on OHRQoL in edentulous or partially dentate patients,[27] and on the comparison of OHRQoL between 2 modalities of tooth replacement in patients with a shortened dental arch.[26] Having broader inclusion criteria has allowed this review to focus on a wider range of interventions to manage the partially dentate patient.

While this approach allows for general conclusions to be drawn, it has its limitations. The review found that particular clinical confounders such as number of missing teeth and position of missing teeth,were rarely controlled for or adequately described. These confounders in patients with partial edentulism can affect prosthodontic treatment. Therefore, a limitation in this review is a lack of RCTs controlling for significant confounders. Future studies should consider both the

use of validated OHRQoL measures and appropriate research designs to reduce confounding by stratifying for tooth position, occlusal stability, and number of missing teeth. This approach will both reduce the risks of bias and allow meaningful conclusions to be drawn.[21]

Direct comparison between IFDPs and RPDs provides insight into the benefits of fixed implant support in edentulous spans where TFDPs may have been inappropriate. The impact of IRDPs on OHRQoL could not be similarly evaluated due to the limited numbers of participants. However, data from both studies investigating IRDPs and OHRQoL are encouraging, with a suggested 41-point improvement in OHIP-49 and 29-point improvement in OHIP-14 at 3-months follow-up.[44,46] The findings that RPDs had no significant effect on OHRQoL at follow-up of >9 months was interesting. Whether this was due to issues concerning maintenance, distortions in fit over time, negative effects on periodontal health, or changes in outcome expectation, is uncertain from this review. Previous studies have demonstrated that success with RPDs is greater where they replace anterior teeth and that effective maintenance is crucial to longer-term success.[10] Patient outcome expectations and response shift may account for some changes in OHRQoL outcome with RPDs. Clinicians should make patients aware that that their expectations of treatment may change with time. While some may be happy just to restore a space initially for esthetic concerns, over time the importance of functional performance and ease of maintenance may become more of a priority.

The suggestion that an IFDP is better than a TFDP should be treated with caution. The number of teeth replaced by TFDPs is limited by the availability of stable abutment teeth. With IFDPs, if more support is needed another implant can be placed. To restore an edentulous space with TFDPs, however, one must work with what remains of the dentition. In patients where a TFDP is too high a risk to the remaining teeth, this option may be discounted. In such patients,

an RPD or the use of an implant-supported prosthesis would be considered more appropriate. While the cohort of patients treated with RPDs may be similar to that treated with IFDPs, the same cannot be said for patients with TFDPs.

Intervention with ISCs did not show statistically significant improvement at either ≤9 months and >9 months follow-up. Subgroup analysis was not possible for the effect of ISCs placed in anterior versus posterior areas. though the esthetic importance of tooth replacement may account for variation in impact on OHRQoL.[6]

In the current review, 22 studies used the OHIP questionnaire and 1 used GOHAI. The similarity in construct of these scales may explain the low heterogeneity in the analysis. Although indirect meta-analysis is not a consensus because of possible bias, no statistically significant heterogeneity was found in any of the 8 indirect meta-analyses, with 6 demonstrating null variability in point estimates because of heterogeneity ($I^2$=0); this suggests reliable findings.

## CONCLUSIONS

Based on the findings of this systematic review and meta-analysis, the following conclusions were drawn:

1. Both fixed tooth-supported and implant-supported dental prostheses demonstrably improved OHRQoL in the short (≤9 months) and medium (>9 months) term.
2. The extent of improvement was approximately 15% to 16% for IFDPs, and 13% to 15% for TFDPs.
3. RPDs improved OHRQoL at a follow-up of less than 9 months by approximately 12% of the score range but showed no measurable improvement at a follow-up of more than 9 months.

4. When directly compared, IFDPs provided an approximately 40% improvement in OHRQoL compared with both RPDs and TFDPs.

**REFERENCES**

1. White DA, Tsakos G, Pitts NB, Fuller E, Douglas GV, Murray JJ, et al. Adult Dental Health Survey 2009: common oral health conditions and their impact on the population. Br Dent J 2012;213:567-72.

2. Marcenes W, Kassebaum NJ, Bernabe E, Flaxman A, Naghavi M, Lopez A, et al. Global burden of oral conditions in 1990-2010: a systematic analysis. J Dent Res 2013;92:592-7.

3. Batista MJ, Lawrence HP, de Sousa ML. Impact of tooth loss related to number and position on oral health quality of life among adults. Health Qual Life Outcomes 2014;12:165.

4. McGrath C, Bedi R. Can dentures improve the quality of life of those who have experienced considerable tooth loss? J Dent 2001;29:243-6.

5. Davenport JC, Basker RM, Heath JR, Ralph JP, Glantz PO. The removable partial denture equation. Br Dent J 2000;189:414-24.

6. Oosterhaven SP, Westert GP, Schaub RM. Perception and significance of dental appearance: the case of missing teeth. Community Dent Oral Epidemiol 1989;17:123-6.

7. Ali Z, Eliyas S, Vere JW. Choosing the right dental material and making sense of the options: evidence and clinical recommendations. Eur J Prosthodont Restor Dent 2015;23:150-62.

8. Pjetursson BE, Lang NP. Prosthetic treatment planning on the basis of scientific evidence. J Oral Rehabil 2008;35 Suppl 1:72-9.

9. Gunne HS. The effect of removable partial dentures on mastication and dietary intake. Acta Odontol Scand 1985;43:269-78.

10. Jepson NJ, Thomason JM, Steele JG. The influence of denture design on patient acceptance of partial dentures. Br Dent J 1995;178:296-300.

11. Kern M, Wagner B. Periodontal findings in patients 10 years after insertion of removable partial dentures. J Oral Rehabil 2001;28:991-7.

12. Papaspyridakos P, Chen CJ, Singh M, Weber HP, Gallucci GO. Success criteria in implant dentistry: a systematic review. J Dent Res 2012;91:242-8.

13. Sailer I, Pjetursson BE, Zwahlen M, Hammerle CH. A systematic review of the survival and complication rates of all-ceramic and metal-ceramic reconstructions after an observation period of at least 3 years. Part II: Fixed dental prostheses. Clin Oral Implants Res 2007;18 Suppl 3:86-96.

14. Black N. Patient reported outcome measures could help transform healthcare. BMJ 2013;346:f167.

15. Locker D. Measuring oral health: a conceptual framework. Community Dent Health 1988;5:3-18.

16. Slade GD, Spencer AJ. Development and evaluation of the Oral Health Impact Profile. Community Dent Health 1994;11:3-11.

17. Atchison KA, Dolan TA. Development of the Geriatric Oral Health Assessment Index. J Dent Educ 1990;54:680-7.

18. Adulyanon S, Vourapukjaru J, Sheiham A. Oral impacts affecting daily performance in a low dental disease Thai population. Community Dent Oral Epidemiol 1996;24:385-9.

19. McGrath C, Bedi R. An evaluation of a new measure of oral health related quality of life--OHQoL-UK(W). Community Dent Health 2001;18:138-43.

20. Allen PF. Assessment of oral health related quality of life. Health Qual Life Outcomes 2003;1:40.

21. Robinson PG. Choosing a measure of Health Related Quality of Life. Community Dent Health 2016;33:107-15.

22. Gerritsen AE, Allen PF, Witter DJ, Bronkhorst EM, Creugers NH. Tooth loss and oral health-related quality of life: a systematic review and meta-analysis. Health Qual Life Outcomes 2010;8:126.

23. Anweigi L, Finbarr Allen P, Ziada H. Impact of resin bonded bridgework on quality of life of patients with hypodontia. J Dent 2013;41:683-8.

24. McKenna G, Allen PF, O'Mahony D, Cronin M, DaMata C, Woods N. The impact of rehabilitation using removable partial dentures and functionally orientated treatment on oral health-related quality of life: a randomised controlled clinical trial. J Dent 2015;43:66-71.

25. Hultin M, Davidson T, Gynther G, Helgesson G, Jemt T, Lekholm U, et al. Oral rehabilitation of tooth loss: a systematic review of quantitative studies of OHRQoL. Int J Prosthodont 2012;25:543-52.

26. Fueki K, Baba K. Shortened dental arch and prosthetic effect on oral health-related quality of life: a systematic review and meta-analysis. J Oral Rehabil 2017;44:563-72.

27. Reissmann DR, Dard M, Lamprecht R, Struppek J, Heydecke G. Oral health-related quality of life in subjects with implant-supported prostheses: A systematic review. J Dent 2017;65:22-40.

28. Abt E, Carr AB, Worthington HV. Interventions for replacing missing teeth: partially absent dentition. Cochrane Database Syst Rev 2012:CD003814.

29. Strassburger C, Kerschbaum T, Heydecke G. Influence of implant and conventional prostheses on satisfaction and quality of life: A literature review. Part 2: Qualitative analysis and evaluation of the studies. Int J Prosthodont 2006;19:339-48.

30. Naito M, Yuasa H, Nomura Y, Nakayama T, Hamajima N, Hanada N. Oral health status and health-related quality of life: a systematic review. J Oral Sci 2006;48:1-7.

31. Thomason JM, Heydecke G, Feine JS, Ellis JS. How do patients perceive the benefit of reconstructive dentistry with regard to oral health-related quality of life and patient satisfaction? A systematic review. Clin Oral Implants Res 2007;18 Suppl 3:168-88.

32. Puhan MA, Soesilo I, Guyatt GH, Schunemann HJ. Combining scores from different patient reported outcome measures in meta-analyses: when is it justified? Health Qual Life Outcomes 2006;4:94.

33. Johnston BC, Patrick DL, Busse JW, Schunemann HJ, Agarwal A, Guyatt GH. Patient-reported outcomes in meta-analyses--Part 1: assessing risk of bias and combining outcomes. Health Qual Life Outcomes 2013;11:109.

34. Johnston BC, Patrick DL, Thorlund K, Busse JW, da Costa BR, Schunemann HJ et al. Patient-reported outcomes in meta-analyses-part 2: methods for improving interpretability for decision-makers. Health Qual Life Outcomes 2013;11:211.

35. da Costa BR, Nuesch E, Rutjes AW, Johnston BC, Reichenbach S, Trelle S, et al. Combining follow-up and change data is valid in meta-analyses of continuous outcomes: a meta-epidemiological study. J Clin Epidemiol 2013;66:847-55.

36. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ 2009;339:b2535.

37. Landis JR, Koch GG. An application of hierarchical kappa-type statistics in the assessment of majority agreement among multiple observers. Biometrics 1977;33:363-74.

38. Higgins JP, Altman DG, Gotzsche PC, Juni P, Moher D, Oxman AD, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ 2011;343:d5928.

39. Lo CK-L, Mertz D and Loeb M. Newcastle-Ottawa Scale: comparing reviewers' to authors' assessments. BMC Med Res Methodol 2014;14:45-49.

40. Tufanaru C, Munn Z, Stephenson M, Aromataris E. Fixed or random effects meta-analysis? Common methodological issues in systematic reviews of effectiveness. Int J Evid Based Healthc 2015;13:196-207.

41. van Eekeren PJ, Aartman IH, Tahmaseb A, Wismeijer D. The effect of implant placement in patients with either Kennedy class II and III on oral health-related quality of life: a prospective clinical trial. J Oral Rehabil 2016;43:291-6.

42. Fueki K, Igarashi Y, Maeda Y, Baba K, Koyano K, Sasaki K, et al. Effect of prosthetic restoration on oral health-related quality of life in patients with shortened dental arches: a multicentre study. J Oral Rehabil 2015;42:701-8.

43. Persic S, Palac A, Vojvodic D, Celebic A. Initial effects of a treatment by fixed partial dentures supported by mini dental implants from a patient's point of view. Coll Antropol 2014;38:275-8.

44. Persic S, Celebic A. Influence of different prosthodontic rehabilitation options on oral health-related quality of life, orofacial esthetics and chewing function based on patient-reported outcomes. Qual Life Res 2015;24:919-26.

45. Yunus N, Masood M, Saub R, Al-Hashedi AA, Taiyeb Ali TB, Thomason JM. Impact of mandibular implant prostheses on the oral health-related quality of life in partially and completely edentulous patients. Clin Oral Implants Res 2016;27:904-9.

46. Gates WD, 3rd, Cooper LF, Sanders AE, Reside GJ, De Kok IJ. The effect of implant-supported removable partial dentures on oral health quality of life. Clin Oral Implants Res 2014;25:207-13.

47. Swelem AA, Gurevich KG, Fabrikant EG, Hassan MH, Aqou S. Oral health-related quality of life in partially edentulous patients treated with removable, fixed, fixed-removable, and implant-supported prostheses. Int J Prosthodont 2014;27:338-47.

48. Wickert M, John MT, Schierz O, Hirsch C, Aarabi G, Reissmann DR. Sensitivity to change of oral and general health-related quality of life during prosthodontic treatment. Eur J Oral Sci 2014;122:70-7.

49. Wolfart S, Muller F, Gerss J, Heyedcke G, Marre B, Boning K, et al. The randomized shortened dental arch study: oral health-related quality of life. Clin Oral Investig 2014;18:525-33.

50. Bramanti E, Matacena G, Cecchetti F, Arcuri C, Cicciu M. Oral health-related quality of life in partially edentulous patients before and after implant therapy: a 2-year longitudinal study. Oral Implantol (Rome) 2013;6:37-42.

51. Fillion M, Aubazac D, Bessadet M, Allegre M, Nicolas E. The impact of implant treatment on oral health related quality of life in a private dental practice: a prospective cohort study. Health Qual Life Outcomes 2013;11:197.

52. Hosseini M, Worsaae N, Schiodt M, Gotfredsen K. A 3-year prospective study of implant-supported, single-tooth restorations of all-ceramic and metal-ceramic materials in patients with tooth agenesis. Clin Oral Implants Res 2013;24:1078-87.

53. Montero J, Castillo-Oyague R, Lynch CD, Albaladejo A, Castano A. Self-perceived changes in oral health-related quality of life after receiving different types of conventional prosthetic treatments: a cohort follow-up study. J Dent 2013;41:493-503.

54. Raes F, Cosyn J, De Bruyn H. Clinical, aesthetic, and patient-related outcome of immediately loaded single implants in the anterior maxilla: a prospective study in extraction sockets, healed ridges, and grafted sites. Clin Implant Dent Relat Res 2013;15:819-35.

55. Yu SJ, Chen P, Zhu GX. Relationship between implantation of missing anterior teeth and oral health-related quality of life. Qual Life Res 2013;22:1613-20.

56. Petricevic N, Celebic A, Rener-Sitar K. A 3-year longitudinal study of quality-of-life outcomes of elderly patients with implant- and tooth-supported fixed partial dentures in posterior dental regions. Gerodontology 2012;29:e956-63.

57. Ponsi J, Lahti S, Rissanen H, Oikarinen K. Change in subjective oral health after single dental implant treatment. Int J Oral Maxillofac Implants 2011;26:571-7.

58. Goshima K, Lexner MO, Thomsen CE, Miura H, Gotfredsen K, Bakke M. Functional aspects of treatment with implant-supported single crowns: a quality control study in subjects with tooth agenesis. Clin Oral Implants Res 2010;21:108-14.

59. Allen PF, O'Sullivan M, Locker D. Determining the minimally important difference for the Oral Health Impact Profile-20. Eur J Oral Sci 2009;117:129-34.

60. Nickenig HJ, Wichmann M, Andreas SK, Eitner S. Oral health-related quality of life in partially edentulous patients: assessments before and after implant therapy. J Craniomaxillofac Surg 2008;36:477-80.

61. John MT, Slade GD, Szentpetery A, Setz JM. Oral health-related quality of life in patients treated with fixed, removable, and complete dentures 1 month and 6 to 12 months after treatment. Int J Prosthodont 2004;17:503-11.

62. Howick J, Chalmers I, Glasziou P, Greenhalgh T, Heneghan C, Liberati A, et al. The Oxford Levels of Evidence 2. Oxford Centre for Evidence-Based Medicine. 2016.

https://www.cebm.net/2016/05/ocebm-levels-of-evidence/

Table 1. Systematic review search strategy

| Electronic Databases and Libraries | MeSH search terms and Keywords |
|---|---|
| MEDLINE-PubMed, MEDLINE-Ovid, Cochrane-CENTRAL, Cochrane Database of Systematic Reviews, National Health Service Economic Evaluation Database, Health Technology Assessment Database and Web of Science. | (Jaw, Edentulous, Partially [Mesh] OR Jaw, Edentulous [Mesh] OR Mouth, Edentulous [Mesh] OR Anodontia [Mesh] OR Tooth Loss [Mesh] OR Partially Dentate OR Edentulous OR Missing Teeth OR Absent Teeth OR Edentate OR Partial Edentulous OR Hypodontia OR Tooth loss)<br>AND<br>(Dentures [Mesh] OR Denture, Partial [Mesh] OR Denture, Partial, Removable [Mesh] OR Denture, Partial, Fixed [Mesh] OR Dental-Prosthesis, Implant-Supported [Mesh] OR Dental Implants [Mesh] OR Denture OR Partial Denture OR Bridge OR Dental Bridge OR Implant)<br>AND<br>(Oral Health Impact Profile OR OHIP OR Oral Impacts on Daily Performance OR OIDP OR Global Oral Health Assessment Index OR Geriatric Oral Health Assessment Index OR GOHAI OR OHQoL-UK) |

Table 2. Risk of bias: findings for included randomized studies

| | | | | | |
|---|---|---|---|---|---|
| McKenna et al 2015 | + | ? | + | + | + |
| Wolfart et al 2014 | + | + | + | + | + |
| | Random sequence generation | Allocation concealment | Selective reporting | Attrition bias | Other bias |

Key:

+ : Low risk of bias

? : Unclear risk of bias

– : High risk of bias

Table 3. Newcastle-Ottawa Quality Assessment Scale: findings for included nonrandomized studies

| Study | Selection | | | | Comparability | Outcome | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Item 1 | Item 2 | Item 3 | Item 4 | Item 1 (2 stars available) | Item 1 | Item 2 | Item 3 | |
| Swelem et al | ★ | ★ | ★ | ★ | ★ | ★ | ★ | ★ | 8/9 stars |
| Van Eekeren et al | ★ | N/A | ★ | ★ | ★★ | ★ | ★ | ★ | 8/8 stars |
| Persic & Celebic | ★ | ★ | ★ | ★ | ★ | ★ | ★ | - | 7/9 stars |
| Fueki et al | ★ | ★ | ★ | ★ | ★★ | ★ | ★ | - | 8/9 stars |
| Yunus et al | ★ | N/A | ★ | ★ | ★ | ★ | ★ | - | 6/8 stars |
| Gates et al | ★ | ★ | ★ | ★ | ★★ | ★ | ★ | ★ | 9/9 stars |
| Persic et al | ★ | N/A | ★ | ★ | ★ | ★ | ★ | ★ | 7/8 stars |
| Wickert et al | ★ | ★ | ★ | ★ | ★ | ★ | ★ | - | 7/9 stars |
| Anweigi et al | ★ | N/A | ★ | ★ | ★★ | ★ | ★ | - | 7/8 stars |
| Bramanti et al | ★ | N/A | ★ | ★ | ★ | ★ | ★ | - | 6/8 stars |
| Hosseini et al | ★ | N/A | ★ | ★ | ★ | ★ | ★ | ★ | 7/8 stars |
| Fillion et al | ★ | N/A | ★ | ★ | ★ | ★ | ★ | - | 6/8 stars |
| Raes et al | ★ | N/A | ★ | ★ | ★★ | ★ | ★ | ★ | 8/8 stars |
| Montero et al | ★ | ★ | ★ | ★ | ★ | ★ | ★ | ★ | 8/9 stars |
| Yu et al | ★ | N/A | ★ | ★ | ★★ | ★ | ★ | ★ | 8/8 stars |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Petrecievic et al | ★ | ★ | ★ | ★ | ★★ | ★ | ★ | - | 8/9 stars |
| Ponsi et al | ★ | N/A | ★ | ★ | ★ | ★ | ★ | - | 6/8 stars |
| Goshima et al | ★ | N/A | ★ | ★ | ★★ | ★ | ★ | - | 7/8 stars |
| Allen et al | ★ | N/A | ★ | ★ | ★ | ★ | ★ | - | 6/8 stars |
| Nickenig et al | ★ | N/A | ★ | ★ | - | ★ | ★ | - | 5/8 stars |
| John et al | ★ | ★ | ★ | ★ | - | ★ | ★ | ★ | 7/9 stars |

★: point received for item N/A: item was not relevant for this study -: no point received for item

Supplementary Table 1. Characteristics of included studies comparing conventional tooth- or mucosa-supported prostheses only

| Study | Study design | Country | Setting | Participants | Follow-up period (months) | OHRQoL Instrument | Dental prosthetic treatment |
|---|---|---|---|---|---|---|---|
| Allen et al 2009 | PCS | Ireland | University Teaching Hospital | Baseline sample, N= 51<br>Follow-up sample, N = 44<br>Mean age, 23.6 (SD, 14.8) | 1 | OHIP-20 | RPD |
| Anweigi et al 2013 | PCS | Ireland | University Teaching Hospital | Baseline sample, N=40<br>Follow-up sample, N=40<br>Median age, 20 (IQR, 18-22) | 6 | OHIP-49 | TFDP |
| John et al 2004 | PCS | Germany | University Teaching Hospital & General Dental Practice | TFDP<br>Baseline sample, N=42<br>Follow-up sample, not stated<br>Mean age, 43.8 (SD, 12.5) | 1 | OHIP-49 | TFDP (included single crowns) |
| | | | | RPD<br>Baseline sample, N=31<br>Follow-up sample, not stated<br>Mean age, 60.5 (SD, 7.1) | 6-12 | | RPD (included telescopic crown-retained RPDs) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| McKenna et al 2015 | RCT | Ireland | University Teaching Hospital & Geriatric Day Hospital | RPD<br>Baseline sample, N=65 (>65yrs only)<br>Follow-up sample1-month, N=53<br>Follow-up sample 6-months, N=45<br>Follow-up sample 12-months, N=45<br>TFDP<br>Baseline sample, N=67 (>65yrs only)<br>Follow-up sample 1-months, N=52<br>Follow-up sample 6-months, N=47<br>Follow-up sample 12-months, N=47 | 1<br>6<br>12 | OHIP-14 | TFDP<br>RPD |
| Montero et al 2013 | PCS | Spain | University Teaching Hospital | RPD<br>Baseline sample, N=59<br>Follow-up sample, not stated<br>TFDP<br>Baseline sample, N=46<br>Follow-up sample, not stated<br>Mean age, 64.9 (SD, 10.7) (complete cohort) | 1 | OHIP-14 | RPDs (metal)<br>TFDP |
| Wickert et al 2014 | PCS | Germany | University Teaching Hospital | RPD<br>Baseline sample, N=75 | 1 | OHIP-49 | TFDP<br>RPD |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | Follow-up sample, N=75<br>Mean age, 60.7 (SD, 12.4) | | | |
| | | | | TFDP<br>Baseline sample, N=81<br>Follow-up sample, N=81<br>Mean age, 49.6 (SD, 17.1) | | | |
| Wolfart et al 2014 | RCT | Multi-centre: Germany, Switzerland | University Teaching Hospitals | RPD<br>Baseline sample, N=79<br>Follow-up sample 6-weeks, N=76<br>Follow-up sample 12 months, N=73<br>Follow-up sample 5-years, N=68<br>Mean age, 59.7 (SD, 10.7) | 1.5<br>12<br>60 | OHIP-49 | RPD<br>TFDP |
| | | | | TFDP<br>Baseline sample, N=66<br>Follow-up sample 6-weeks, N=65<br>Follow-up sample 12 months, N=65<br>Follow-up sample 5-years, N=57<br>Mean age, 58.9 (SD, 10.6) | | | |

PCS, Prospective clinical study. RCT, Randomised controlled trial. RPD, Removable partial denture. TFDP, Tooth-supported fixed dental prosthesis. OHIP, Oral Health Impact Profile.

Supplementary Table 2. Characteristics of included studies comparing implant-supported prostheses only

| Study | Study design | Country | Setting | Participants | Recalls (months) | OHRQoL Instrument | Prosthetic treatment |
|---|---|---|---|---|---|---|---|
| Bramanti et al 2013 | PCS | Italy | University Teaching Hospital | Baseline sample, N=50<br>Follow-up sample, N=50<br>Mean age, 51.2 (SD: 12.6) | 24 | OHIP-14 | IFDP and ISC |
| Fillion et al 2013 | PCS | France | Private Practice | ISC baseline sample, N=77<br>ISC follow-up sample, N=77<br>IFDP baseline sample, N= 75<br>IFDP follow-up sample, N=75<br>Mean age 52 (SD, 9.9)<br>(Complete cohort) | A. 6<br>B. 6-9<br>C. >9 | GOHAI | IFPD<br>ISC |
| Goshima et al 2010 | PCS | Denmark | University Teaching Hospital | Baseline sample, N=18<br>Follow-up, N=18<br>Mean age, 32 (SD, 10) | 1 | OHIP-49 | ISC |
| Hosseini et al 2013 | PCS | Denmark | University Teaching Hospital | Baseline sample, N=59<br>Follow-up sample, N=59<br>Mean age, 27.9 (SD, 9.3) | 36 | OHIP-49 | ISC |
| Nickenig et | PCS | Germany | Armed Forces | Baseline, N=219 | 1-2 | OHIP-21 | ISC & |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| al<br>2008 | | | Dental Clinic | Follow-up, N=219<br>Mean age, 44.7 (range, 19.2-67.6) | | | IFDP |
| Persic et al<br>2014 | PCS | Croatia | University Teaching Hospital | Baseline, N=23<br>Follow-up, N=23<br>Mean age, 66, (range 54-78) | 3 | OHIP-14 | IFDP |
| Ponsi et al<br>2011 | PCS | Finland | Private Practice | Baseline sample, N=90<br>Follow-up sample, N=80<br>Mean age, 52 (range, 24-75) | 3 | OHIP-14 | ISC |
| Raes et al<br>2013 | PCS | Belgium | University Teaching Hospital | Immediate loading<br>Baseline sample, N=16<br>Follow-up sample, N=16<br>Mean age, 45 (SD, 14)<br>Delayed loading<br>Baseline sample, N=23<br>Follow-up sample, N=23<br>Mean age, 40 (SD, 19)<br>Grafted sites<br>Baseline sample, N=9<br>Follow-up sample, N=9<br>Mean age, 35 (SD, 15) | 6<br>12 | OHIP-14 | ISC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Van Eekeren et al 2016 | PCS | Netherlands | University Teaching Hospital | Baseline sample, N=35<br>Follow-up sample, N=34<br>Mean age, 61 (Range, 36-85) | 12 | OHIP-14 | IFDP |
| Yu et al 2013 | PCS | China | Military General Hospital | Baseline sample, N=263<br>Follow-up sample, N=238<br>Mean age, 41.5 (SD, 9.5) | 6 | OHIP-14 | ISC and IFDP combined. Anterior teeth only |
| Yunus et al 2015 | PCS | Malaysia | University Teaching Hospital | Baseline sample, N=20<br>Follow-up, not stated<br>Mean age, 47.0 (SD, 12.9) | 3<br>12 | OHIP-14 | IFDP |

PCS, Prospective clinical study. ISC, Implant-supported crown. IFDP, Implant-supported fixed dental prosthesis. OHIP, Oral Health Impact Profile. GOHAI, Global Oral Health Assessment Index.

Supplementary Table 3. Characteristics of included studies comparing conventional and implant-supported prostheses

| Study | Study design | Country | Setting | Participants | Recalls (months) | OHRQoL Instrument | Prosthetic treatment |
|---|---|---|---|---|---|---|---|
| Fueki et al 2015 | PCS | Japan | University Teaching Hospital | RPD baseline sample, N=69<br>RPD follow-up samples:<br>3-months, N=52<br>6-months, N=40<br>12-months, N=33<br>RPD mean age, 63.9 (8.5)<br>IFDP baseline sample, N=30<br>IFDP follow-up samples:<br>3-months, N=12<br>6-months, N=11<br>12-months, N=13<br>IFDP mean age, 56.1 (10.2) | 3<br>6<br>12 | OHIP-49 | RPD<br>IFDP |
| Gates et al 2014 | CCCT | USA | University Teaching Hospital | Baseline sample, N=17<br>RPD follow-up sample, N=17<br>IRDP follow-up sample, N=17<br>Mean age: 61.5, (SD not supplied) | 3 | OHIP-49 | RPD<br>IRDP |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Persic & Celebic 2015 | PCS | Croatia | University Teaching Hospital | TFDP baseline, N=25<br>TFDP follow-up: not stated<br>TFDP mean age, 52.8 (SD, 16.8)<br>IRDP baseline, N=15<br>IRDP follow-up: not stated<br>IRDP mean age, 65.4 (SD, 8.2)<br>IFDP baseline, N=59<br>IFDP follow-up: not stated<br>IFDP mean age, 56.1 (SD, 11.0) | 3 | OHIP-14 | RPD<br>TFDP<br>IRDP<br>IFDP |
| Petrecievic et al 2012 | PCS | Croatia | Not stated | IFDP baseline sample, N=64<br>IFDP follow-up: not stated<br>IFDP mean age, 46.5 (SD, 11.2)<br>TFDP baseline sample, N=38<br>TFDP follow-up: not stated<br>TFDP mean age, 57.6 (SD, 14.4) | 36 | OHIP-49 | IFDP<br>TFDP |
| Swelem et al 2014 | PCS | Russia | University Teaching Hospital | TFDP<br>Baseline sample, N=32<br>Follow-up, N=32<br>Mean age, 44.4 (SD, 6.5) | 1.5<br>6 | OHIP-14 | TFDP<br>RPD<br>IFDP |

| | |
|---|---|
| | RPD |
| | Baseline sample, N=45 |
| | Follow-up, N=45 |
| | Mean age, 44.4 (SD, 6.6) |
| | IFDP |
| | Baseline sample, N=57 |
| | Follow-up, N=57 |
| | Mean age, 35.4 (SD, 5.9) |

PCS, Prospective Clinical Study. CCCT, Crossover Controlled Clinical Trial. ISC, Implant-supported crown. IFDP, Implant-supported fixed dental prosthesis. IRDP, Implant-supported removable dental prosthesis. RPD, Removable partial denture. TFDP, Tooth-supported fixed dental prosthesis. OHIP, Oral Health Impact Profile.

**FIGURES**

Figure 1. PRISMA flowchart of search strategy and outcomes.

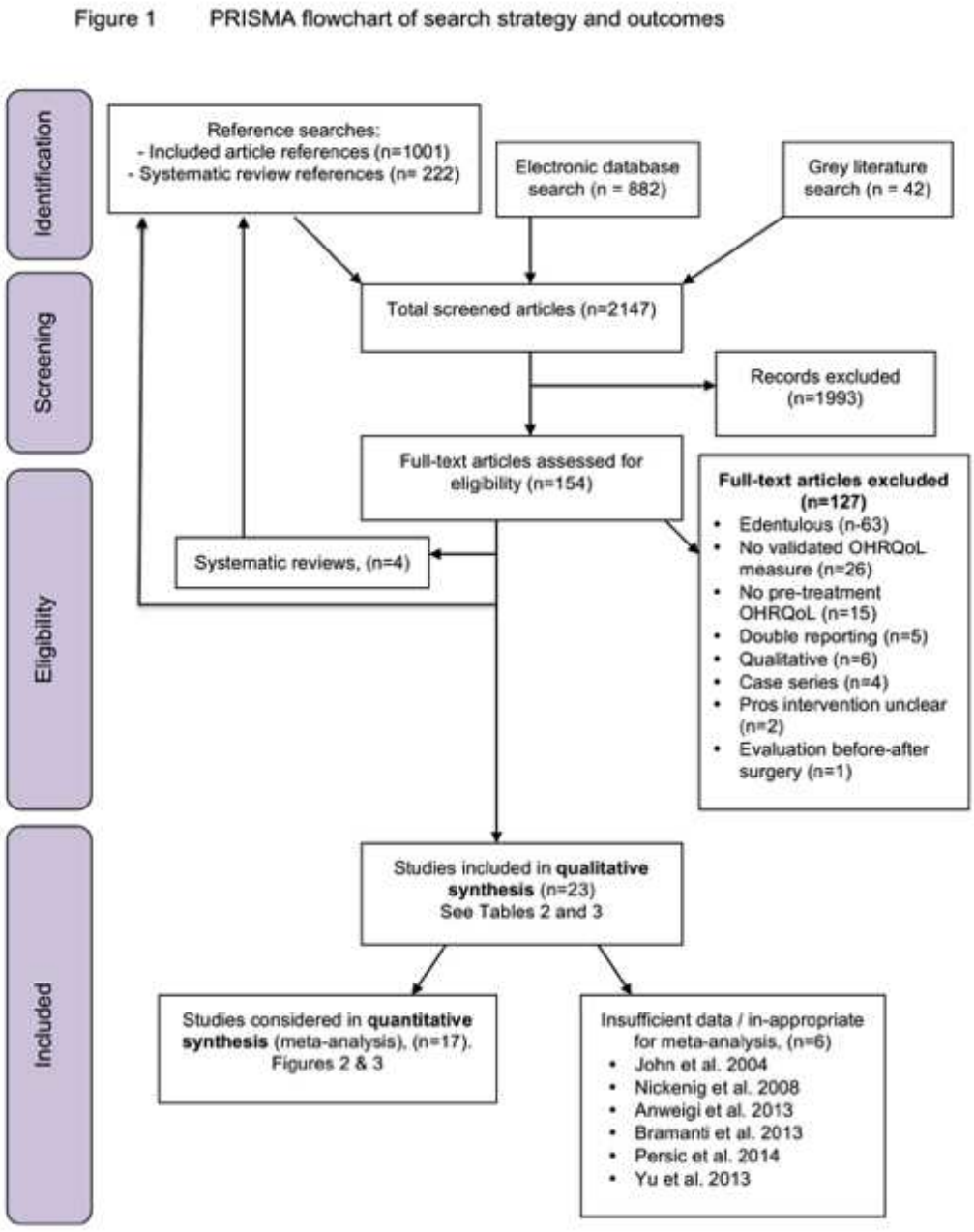
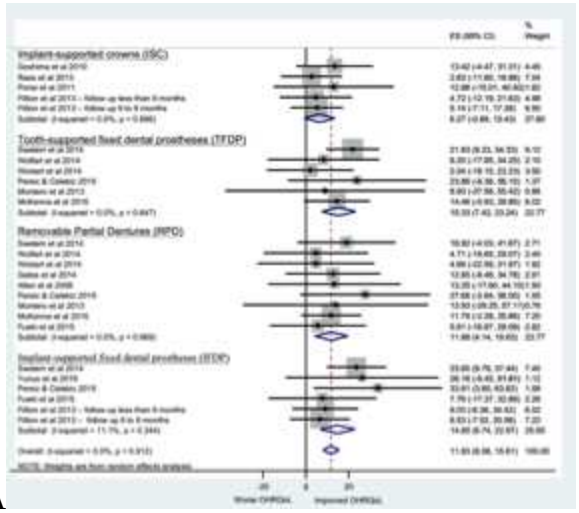



Figure 2. Effect of prosthodontic intervention on OHRQoL in partially dentate patients. A, Indirect meta-analysis at ≤9 month follow-up. B, Indirect meta-analysis at >9 month follow-up.

A 

B

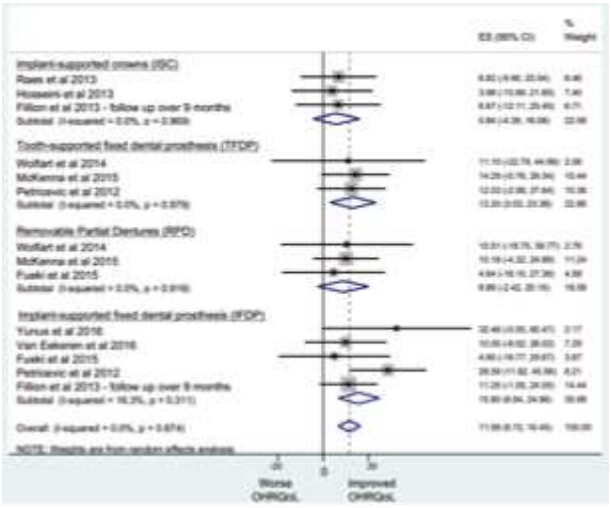
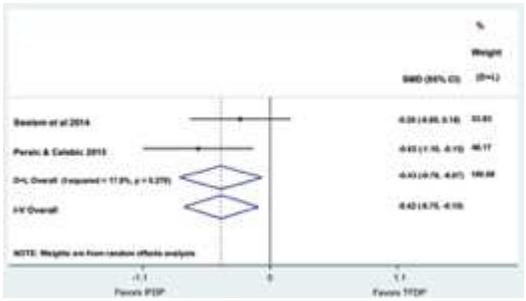



Figure 3. Meta-analysis. A, Direct comparison of TFDP versus IFDP at ≤9 month follow-up. B, Direct comparison of RPD versus IFDP at ≤9 month follow-up.

A 

B