Received Date : 20-Mar-2015
Revised Date : 22-Dec-2015
Accepted Date : 19-Jan-2016
Article type : Systematic Review

Are periodontal diseases really silent? A systematic review of their effect on quality of life.

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Running title: Periodontal diseases and life quality

Keywords [All MeSH Headings]: clinical assessment; diagnosis, oral; gingivitis; oral health; periodontal index; periodontitis; quality of life; questionnaires; self-report

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Conflict of Interest and Source of Funding:
The authors declare there are no conflicts of interest in this study. No external funding was available for this study, apart from the support of the authors' institutions.

Acknowledgements:

The authors would like to thank Asisa Friedman (Witten, Germany) for the translation of studies published in the Russian language, and Martha Lucía Galindo Restrepo (Nijmegen, Netherlands) for translating studies published in Dutch.

Abstract

Aim: Periodontal diseases may play an important role in the effect oral health status has on a person's quality of life. The objective was to investigate the influence of periodontal diseases (gingivitis and periodontitis) on oral health related quality of life by systematically reviewing the literature.

Materials and Methods: Studies using clinical periodontal examinations and validated survey instruments were included. Among 1,134 citations initially identified through electronic and hand searching, 37 were eligible and data were extracted from full texts. A vote counting method was used for synthesis of the results.

Results: Included studies were published between 2001 and 2014 and revealed considerable heterogeneity in participant selection, clinical assessments, and oral health related quality of life measures. A significant association between periodontal diseases and oral health related quality of life was reported in 28 studies, of which eight reported increasing impact with greater disease severity or extent.

Conclusions: Within the limits of the available literature, oral health related quality of life was affected by clinically assessed periodontal diseases. There was evidence for increased impairment with greater severity and extent of periodontal diseases, and the recognition of the association was increased when full mouth recording protocols were applied.

Clinical Relevance

Scientific rationale for study: Periodontal diseases potentially affect quality of life.

Principal findings: There is evidence that quality of life is negatively impacted by periodontal diseases, possibly in a dose-response manner, correlating greater detrimental effects with increasing disease severity or extent.

Practical implications: Recognizing the impact of periodontal diseases on patient-perceived quality of life emphasizes the importance of thorough periodontal assessment and diagnosis, followed by successful therapy. **Introduction**

In 1946, the Word Health Organization defined health as a "*state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*", and three

decades later it was recommended to include patients' perception of impairment in the diagnosis and characterization of diseases (Engel 1977). This shift from a medical, strictly biological model to a socio-environmental model including function, psychological and social well-being was subsequently applied in dentistry (Locker 1988, Locker & Allen 2002). The American Dental Association recently approved a resolution 97H-2014 stating: *"Oral health is a functional, structural, aesthetic, physiologic and psychosocial state of well-being and is essential to an individual's general health and quality of life"* (Glick & Meyer 2014, Williams 2015). The concept of Oral Health Related Quality of Life (OHRQoL) accounts for these subjective evaluations as well as for patients' oral care treatment expectations (Sischo & Broder 2011). Remarkable influence on patients perceived OHRQoL has been linked to different oral pathologies, e.g., caries, tooth loss, malocclusion, and tooth mobility (Bortoluzzi et al. 2012, Christensen et al. 2012, Ramos-Jorge et al. 2013, Ukra et al. 2013), or to different types of restorations, such as complete dentures (Bekiroglu et al. 2012; Jivanescu et al. 2013).

Periodontal diseases (PD) are common and highly prevalent chronic diseases worldwide (Marcenes et al. 2013, Richards 2013, Kassebaum et al. 2014, Eke et al. 2015) and are known to impair systemic health in susceptible individuals with for instance metabolic, atherosclerotic cardiovascular, and rheumatoid diseases, as well as aspiration pneumonia (Chapple & Genco 2013, Linden et al. 2013, Tonetti & Van Dyke 2013, Borgnakke 2015). Despite their high prevalence and evident impact on general health, PD are commonly regarded as "silent diseases" since patients often live with no or few symptoms (i.e., bleeding, swelling, and tooth mobility without sense of pain) for several decades before seeking professional attention. Accordingly, disease progression frequently entails further impairment and impedes tooth preservation (Levin 2011, Chapple & Grant 2013). Regarding the clinical signs of PD and considering patients' impairment of OHRQoL, the question arose whether PD are indeed silent conditions – or, more likely, whether the affected individuals perceive an impact on their OHRQoL. A previous review investigated a possible impact of PD on OHRQoL among a restricted number of studies and documented impairment in six of seven included publications (Al-Harthi et al. 2013).

The aim of the current literature review was to further investigate associations between clinically measured PD (gingivitis and periodontitis) and impairment of OHRQoL, and to analyse a potential influence of disease severity on the degree of perceived impairment.

Materials and Methods

This review was conducted according to the MOOSE statement (Stroup et al. 2000) (Appendix 1). The electronic databases MEDLINE, EMBASE, and OpenGrey (for unpublished reports, http://www.opengrey.eu/) were searched until October 17th, 2014, and supplemented by manual search of the bibliographies of retrieved publications, and two journals (Journal of Clinical Periodontology, Journal of Periodontology). The search contained the terms "Periodontal Diseases", "Periodontitis", "Chronic Periodontitis", "Periodontal Pocket", "Aggressive Periodontitis," and "Quality of Life" without language restrictions. Based on the screening of 1,134 titles and abstracts by two reviewers (SB, CW), 109 publications were deemed potentially eligible by at least one of the two investigators. After full text analyses, both reviewers agreed on inclusion of 37 reports, which met the inclusion criteria.

Data were extracted, addressing general characteristics of the studies and according to a focused question applying the PECO format: In adults [P=population], what is the effect of periodontal diseases of various degrees [E=exposure] on oral health related quality of life [O=outcome]? Comparative data from control groups with periodontally healthy subjects or from participant groups with different disease severity were extracted and labeled as comparisons [C=comparison].

Inclusion criteria and data extraction

The search was limited to original studies (observational, epidemiological studies and clinical trials) investigating a possible correlation between OHRQoL and PD. Inclusion criteria were: adults aged ≥16 years; standardized and validated baseline OHRQoL questionnaires (with clinically evaluated reproducibility and representativeness, Appendix 4); clinical periodontal parameters (periodontal probing depth [PPD] and/or clinical attachment loss [CAL]) assessed during baseline; and statistical analysis for possible correlation between OHRQoL and PD. Studies were excluded for the following reasons: not original studies (e.g., reviews), case reports, and OHRQoL measures reported by a third person (relatives, medical staff, etc.), or by children up to 15 years (to avoid mixing of data reported by children and adults). Data on the following parameters were collected: participant characteristics (sex, age, source population, sample size), definition and measurement of PD (periodontal parameters and recording protocol, i.e., full or partial mouth), measurement of OHRQoL, correlation of OHRQoL and PD, as well as correlation of OHRQoL and PD severity (e.g., mild, moderate, or severe) or PD extent (e.g., localized or generalized; proportion of sites or teeth affected). The methodological and reporting quality was evaluated by modified items recommended by

the Newcastle Ottawa Scale (NOS; Chambrone et al. 2011, Wells et al. 2011, Shanbhag et al. 2012) for observational studies, and according to modified items from the methodological index for non-randomized studies (MINORS) (Slim et al. 2003). A score was assigned to each study according to the percentages of possible items considered, with 100% representing the highest possible score (Appendix 2). The level of evidence and the strength of recommendations of the included studies were evaluated according to the patient-centered Strength of Grading Taxonomy (SORT) (Ebell et al. 2004).

In an attempt to reduce the risk of overestimating the reported impacts of PD on OHRQoL, any adjustments for confounders were recorded and adjusted data extracted as indicated in the studies (Table 1). The pronounced heterogeneity among the studies prohibited conducting a conventional meta-analysis, so a synthesis of results using a vote counting method was applied instead (Deeks et al. 2011).

Results

Screening of the 1,134 titles initially identified yielded an inter-examiner agreement of kappa = 0.670 between the two reviewers. Full text examination of the 109 reports potentially eligible led to final inclusion of 37 publications. Study characteristics and outcomes were summarized in Table 1. According to the methodological indices applied (NOS and MINORS), the risk of bias within the studies was found to be moderate with most studies considering between 50% and 83% of the possible items to be recognized (Appendix 2). According to the SORT grading, a level B for the strength of recommendation (patient-oriented evidence from moderate quality studies) and level 2 for quality of evidence (meta-analyses of moderate quality studies) was applicable for the association between clinically diagnosed PD and OHRQoL. The evidence level appeared consistent across the majority of the studies.

Population (P)

OHRQoL was reported among a total of 14,219 study participants aged between 16 (Aslund et al. 2008, Bernabé & Marcenes 2010) and "≥80" (Bianco et al. 2010) years, with a maximum age of 93 years (Bernabé & Marcenes 2010). Most studies included both sexes, although three studies involved female subjects only (Acharya et al. 2009, Mulligan et al. 2008, Wandera et al. 2009) (Table 1). Nineteen of the 37 studies examined distinct population groups with respect to diagnosis of systemic conditions (e.g., type 1 and type 2 diabetes, pregnancy, hemodialysis, HIV), socioeconomic status (e.g., low income),

demographic background (e.g., rural *versus* urban), periodontal diagnosis (e.g., aggressive periodontitis; Acharya et al. 2009, Acharya & Pentapati 2012, Cohen-Carneiro et al. 2010, de Pinho et al. 2012, Durham et al. 2013, Eltas & Uslu 2013, Guzeldemir et al. 2009, Li et al. 2011, Marino et al. 2008, Mulligan et al. 2008, Wandera et al. 2009), or patients receiving periodontal treatment in specialized institutions (Al Habashneh et al. 2012, Aslund et al. 2008, Jowett et al. 2009, Needleman et al. 2004, Palma et al. 2013, Patel et al. 2008, Saito et al. 2010 Saito et al. 2011).

Exposure (E): Measurement, Definition, and Reporting of PD in Studies Included

Definition of PD were based on PPD, CAL, and affected number of teeth and/or sites and differed among the studies included (Appendix 3). Full mouth recording (FMR) of PPD and/or CAL at 2 to 6 sites per tooth was performed in 23 studies (Al Habashneh et al. 2012, Aslund et al. 2008, Bernabé & Marcenes 2010, Brennan et al. 2007, de Pinho et al. 2012, Deshmukh & Radke 2012, Durham et al. 2013, Eltas & Uslu 2013, Fotedar et al. 2014, Jansson et al. 2014, Jowett et al. 2009, Lawrence et al. 2008, Li et al. 2011, Ng & Leung 2006, Palma et al. 2013, Patel et al. 2008, Saito et al. 2010, Saito et al. 2011, Saletu etal. 2005, Srisilapanan & Sheiham 2001, Swoboda et al. 2006, Zaitsu et al. 2011, Zhao et al. 2011). Twelve studies used partial mouth recording (PMR) with the Community Periodontal Index for Treatment Needs (CPITN) or its derivative, i.e. the Community Periodontal Index (CPI) (Acharya et al. 2009, Acharya & Pentapati 2012, Andersson et al. 2010, Bandéca et al. 2011, Bianco et al. 2010, Brauchle et al. 2013, Cohen-Carneiro et al. 2010, Cornejo et al. 2013, Marino et al. 2008, Montero-Martin et al. 2009, Mulligan et al. 2008, Wandera et al. 2009) (Table 1; Appendix 3). The clinical periodontal parameters PPD and CAL were expressed as means or number of teeth or sites with defined PPD or CAL (Appendix 3).

Comparison

In several studies, the associations between PD and OHRQoL were compared between patient groups with different extent or severity of PD (Al Habashneh et al. 2012, Bernabé & Marcenes 2010, Eltas & Uslu 2013, Jansson et al. 2014, Marino et al. 2008, Mulligan et al. 2008, Palma et al. 2013, Saito et al. 2010, Saletu etal. 2005, Zhao et al. 2011), while 11 studies compared participants diagnosed with PD with periodontally healthy subjects (Bernabé & Marcenes 2010, Brauchle et al. 2013, Deshmukh & Radke 2012, Durham et al. 2013, Jansson et al. 2014, Jowett et al. 2009, Li et al. 2011, Ng & Leung 2006, Saletu et al. 2005, Srisilapanan & Sheiham 2001, Wandera et al. 2009).

Outcome (O): Measurement, Definition, and Reporting of OHRQoL in Studies Included

Eight different, in part culturally adapted, questionnaires were used to assess OHRQoL (Table 1). The shortened version of the Oral Health Impact Profile (OHIP), OHIP–14, was applied most frequently (19 of 37 studies) and seemd to have the highest detection rate of associations between PD and OHRQoL with 15 of 19 studies showing an impairment in OHRQoL from PD (Table 1). Most questionnaires contained few aspects regarding symptoms specifically related to PD such as "receding gums", "loose tooth", or "bleeding gums" (for example OIDP). Findings regarding OHRQoL were expressed as an overall score and reported as the sum, mean, or median number of impacts, or as a score indicating categorization below or above a defined threshold. Thirteen studies analyzed distinct subdomains of the OHRQoL questionnaires (Tables 1 and 2), which were related to functional (e.g., mastication, speech) or psychosocial aspects (e.g., appearance, self-esteem, intimacy, communication) or to facets of pain and discomfort (e.g., acute or chronic; Acharya et al. 2009, Acharya & Pentapati 2012, Al Habashneh et al. 2012, Bianco et al. 2010, Brennan et al. 2007, de Pinho et al. 2012, Durham et al. 2013, Eltas & Uslu 2013, Jansson et al. 2014, Li et al. 2011, Ng & Leung 2006, Palma et al. 2013, Swoboda et al. 2006, Wandera et al. 2009). Analyses within these subdomains revealed that the impairment perceived in physical aspects was most pronounced, impairment in psychosocial aspects was second most frequently mentioned, while impairment within the pain and discomfort subdomain was less frequent (Table 2).

Associations between PPD and OHRQoL

Overall, 28 of the 37 studies documented a significant association between PD and OHRQoL or OHRQoL subdomains (Acharya et al. 2009, Al Habashneh et al. 2012, Aslund et al. 2008, Bernabé & Marcenes 2010, Bianco et al. 2010, Brauchle et al. 2013, Brennan et al. 2007, Cohen-Carneiro et al. 2010, de Pinho et al. 2012, Deshmukh & Radke 2012, Durham et al. 2013, Eltas & Uslu 2013, Fotedar et al. 2014, Jansson et al. 2014, Jowett et al. 2009, Lawrence et al. 2008, Li et al. 2011, Mulligan et al. 2008, Needleman et al. 2004, Ng & Leung 2006, Palma et al. 2013, Patel et al. 2008, Saletu etal. 2005, Srisilapanan & Sheiham 2001, Swoboda et al. 2006, Wandera et al. 2009, Zhao et al. 2011) (Table 1). In all 11 studies which had a periodontally healthy control group included, impairment in OHRQoL was significantly greater in subjects diagnosed with PD compared to healthy participants. The

observed correlations between PD and OHRQoL indicated a possible influence of the mode of periodontal recording, and the following findings were therefore presented separately for PMR and FMR:

Seven of the twelve studies using PMR detected an association between OHRQoL and PD (Acharya et al. 2009, Acharya & Pentapati 2012, Bianco et al. 2010, Brauchle et al. 2013, Cohen-Carneiro et al. 2010, Mulligan et al. 2008, Wandera et al. 2009), and three documented a significant impairment in OHRQoL subdomains (Acharya et al. 2009, Bianco et al. 2010, Wandera et al. 2009). In the two studies involving a periodontally healthy control group, a significantly higher frequency of impact on the OHRQoL subdomain "eating" (Wandera et al. 2009), or higher mean OHRQoL scores in diseased subjects were reported (Brauchle et al. 2013). With regard to disease severity, one study revealed a significant increase in OHRQoL impairment with increasing mean PPD or CAL (Mulligan et al. 2008), while another study showed no association with PD severity (Marino et al. 2008).

Among the 23 studies using full mouth recording (FMR), 20 reported significant associations between PD and OHRQoL parameters and/or OHRQoL subdomains (Al Habashneh et al. 2012, Aslund et al. 2008, Bernabé & Marcenes 2010, Brennan et al. 2007, de Pinho et al. 2012, Deshmukh & Radke 2012, Durham et al. 2013, Eltas & Uslu 2013, Fotedar et al. 2014, Jansson et al. 2014, Jowett et al. 2009, Lawrence et al. 2008, Li et al. 2011, Ng & Leung 2006, Palma et al. 2013, Patel et al. 2008, Saletu etal. 2005, Srisilapanan & Sheiham 2001, Swoboda et al. 2006, Zhao et al. 2011; Table 1 and 2). Conflicting data between OHRQoL and clinical measures were reported in three studies: associations were demonstrated between OHRQoL and CAL, but not with PPD (Srisilapanan & Sheiham 2001); between OHRQoL and the number of teeth with PPD 4-6 mm, but not with PPD ≥6 mm (Patel et al. 2008); between PD and OHRQoL severity (i.e., severity of impact), but not with OHRQoL extent (i.e., impacts fairly/very often; Lawrence et al. 2008). All nine studies, in which the impact of PD was compared to a periodontally healthy group and FMR was applied, a stronger impairment in diseased subjects was documented (Bernabé & Marcenes 2010, Deshmukh & Radke 2012, Durham et al. 2013, Jansson et al. 2014, Jowett et al. 2009, Li et al. 2011, Ng & Leung 2006, Saletu et al. 2005, Srisilapanan & Sheiham 2001). Eight studies explored a possible correlation between PD severity/extent and OHRQoL parameters or OHRQoL subdomains (Al Habashneh et al. 2012, Bernabé & Marcenes 2010, Eltas & Uslu 2013, Jansson et al. 2014, Palma et al. 2013, Saito et al. 2010, Saletu et al. 2005, Zhao et al. 2011), and seven of those studies found a significant association between PD extent/severity and OHRQoL or OHRQoL subdomains (Al Habashneh et al. 2012, Bernabé & Marcenes 2010,

Eltas & Uslu 2013, Jansson et al. 2014, Palma et al. 2013, Saletu etal. 2005, Zhao et al. 2011) (Tables 1 and 2). In 17 studies, statistical adjustments for confounding variables were explicitly mentioned. Following these adjustments, a significant association between OHRQoL and PD (14 studies) and between OHRQoL and PD severity (7 studies) was documented, while in 3 studies no such association was found (Table 1).

Discussion

This systematic review investigated the role of PD in OHRQoL and demonstrated that an association between PD and OHRQoL was evident, and the impact by PD on quality of life (QoL) was more pronounced with greater severity or extent of PD. A comprehensive clinical assessment of periodontal parameters using full mouth recording protocols seemed to enhance the detectability of the impairment in OHRQoL.

While the current review investigated the correlation between presence of PD and impairment of OHRQoL, a recent review focused on changes of OHRQoL following periodontal therapy (Shanbhag et al. 2012). The latter also documented impaired OHRQoL in periodontally diseased subjects before treatment. Furthermore, non-surgical periodontal therapy had a greater impact on OHRQoL than surgical therapy, and poor clinical response to therapy was correlated to poor OHRQoL outcomes (Shanbhag et al. 2012). While a previous review detected OHRQoL impairment in periodontally compromised participants in a limited number of studies (Al Harthi et al. 2013), confirmation of these findings and identification of possible correlations was attempted in the current review by extending the literature search and inclusion criteria, and considering correlated data on PD and OHRQoL from both epidemiological studies as well as clinical trials.

In accord with the limitations identified by Al-Harthi et al. (2013), interpretation of the results of reviews of this body of literature are restricted due to the great diversity in socioeconomic, demographic, and methodological aspects among the study participants. An impact on perception of OHRQoL was reported for several factors, e.g., lower social class and rurality (Espinoza et al. 2013, Ulinski et al. 2013), age (Slade & Sanders 2011, Enoki et al. 2013), and sex (Pattussi et al. 2010, Ulinski et al. 2013). In addition, compromised medical conditions with their co-morbidities and medication use were found to enhance the effect the oral conditions might have on OHRQoL, as seen for instance in diabetes patients (Miksch et al. 2009, Jivanescu et al. 2013). However, when considering the 17 studies in

which adjustments were made for several confounders, the correlation between PD and OHRQoL was still statistically and clinically significant.

In the current review, eight different culturally adapted and translated oral health assessment tools were utilized, and the OHIP-14 was the rating scale most frequently applied. It is important to consider the limits of comparability between different OHRQoL measures due to differences in values, expectations, and perceptions of health and disease or impairment in different cultures (Hunt et al. 1991, Alghadeer et al. 2010). In addition, not all questionnaires comprise the same domains or the same scoring systems (Bernabé et al. 2009), and the majority of questions are not directed specifically at symptoms arising from PD, but are rather aiming at discovering impairment related to teeth and gums in general. To compensate for these limitations, only studies providing a correlation between periodontal parameters and OHRQoL scores were included and associations between PD and both overall OHRQoL as well as each of the subdomains (i.e., function, pain/ discomfort and psychosocial impairment) were considered in the present data analysis (Table 2, Appendix 4). One of the studies demonstrated that increasing disease severity led to an increased impairment in already affected items of OHRQoL, but not to the designation of additional numbers of items (Lawrence et al. 2008). This observation indicated that progression of periodontal disease affected the quality of impairment, while the quantity of impeded OHRQoL domains remained unchanged.

The variety of clinical periodontal parameters applied and the diversity of PD extent and/or severity within the investigated populations constituted a potential bias and emphasize the need for standard definitions (Eke et al. 2012). While PPD measures generally disclose the current disease status, CAL represents the life-long, cumulative destruction including previous loss of supporting periodontal tissues. Although not inevitably associated with an inflammatory disease status, gingival recession has been found to be a significant factor for OHRQoL impairment. Due to the exposed root surfaces, subjects tend to avoid exposing gingival recessions during smiling (Patel et al. 2008), or experience hypersensitivity. Thus, it is likely that attachment loss recognized by gingival recession led to stronger impairment in QoL, while periodontal pockets were overlooked. The current review documented an enhanced detectability of OHRQoL impairment by applying FMR protocols, which is to be expected since periodontitis is clinically manifested through breakdown of periodontal tissue unevenly distributed around each tooth and is a site-specific disease. It has been shown that

any partial mouth periodontal examination protocol invariably miss a significant proportion of diseased sites (Eke et al. 2010).

Recommendations for future research

The following aspects should be considered for future research in this field: 1) applying full mouth recording protocols for measurement of PPD and CAL; 2) applying consistent, globally accepted, definitions of PD and OHRQoL; 3) using questionnaires that specifically address symptoms of PD; 4) including adequate sample sizes and a periodontally healthy control group; and 5) accounting for possible confounding factors and for an additive effect of different oral diseases.

Clinical Significance

There is evidence for an association between clinically diagnosed PD and subjectively assessed OHRQoL, with greater impact on OHRQoL with increasing severity or extent of PD, a dose-response relationship. Hence, PD play an important role in the impact of oral health on the quality of life in affected individuals – and consequently should not be considered silent diseases. Since recognition of this association was enhanced when full mouth recording of PPD was performed, clinical implementation of a comprehensive periodontal examination is recommended, in combination with completion of a survey on OHRQoL.

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Supporting Information

Additional supporting information may be found in the online version of this article:

Appendix 1. MOOSE checklist

Appendix 2. Scores for assessment of methodological and reporting quality

Quality assessment (methodological and reporting scores) of included studies

Appendix 3. Periodontal assessment (PPD, CAL), PD case definitions used, and detailed study outcomes

Appendix 4. OHRQoL instruments applied

Figure Legend:

Figure 1: Selection process for study inclusion

Table 1. Main findings from the 37 included studies (details are displayed in Appendix 2).

STUDY	POPULATION	MEASUREMENT	COMPARISON			OUTCOME		
Authors Year Country	**Number, Sex (%); Age: Mean(± SD; Range) Population Characteristic**	**OHRQoL Instrument**	**PD Proto-col**	**PD-Free Con-trol**	**Adjusted for Confound-ers**	**1 PD & OHRQoL** **2 PD Severity/ Extent & OHRQoL**	**stat. sign. association between: PD~ OHRQoL**	**PD~ OHRQoL Subdo-mains**
Acharya et al. 2009 India	259, 100 % F; 26yrs (±5.5)20-37 pregnant, low income	OHIP-14; Indian	PMR	No	n/a	**1**	+	A,B,D
						2	n/a	n/a
Acharya & Pentapati 2012 India	134,28.4 % F[a]; 25.9yrs (±4.7) employees, software companies	OIDP Indian	PMR	No	2, 3	**1**	+	n/a
						2	n/a	n/a
Al Habashneh et al. 2012 Jordan	400, 59 % F[a]; 36.7yrs (±11.9;18-60) periodontology department	OHIP-14; Arabic	FMR	No	2, 3 ,4, 5, 9	**1**	n/a	n/a
						2	+	B, C, D, E, F, G
Andersson et al. 2010 Sweden	204, 56.2% F[a]; 47.2yrs (±16.9) n/a	OIDP; Swedish	PMR	No	1, 2, 6, 9	**1**	-	n/a
						2	n/a	n/a
Aslund et al. 2008 Switzerland	215, 54% F[a]; 53yrs (±12.3; 16-86) periodontology department	OHQoL-UK; German	FMR	No	n/a	**1**	+	n/a
						2	n/a	n/a
Bandéca et al. 2011 Brazil	100, 71% F[a]; 40.7yrs (18-68) n/a	OHIP-14; Portuguese	PMR	No	1, 2, 7, 8, 9, 12	**1**	-	n/a
						2	n/a	n/a
Bernabé & Marcenes 2010 United Kingdom	3,122, 54.3% F[a]; 41.2yrs (±16.2; 16-93) 1998 Adult Dental Health Survey (ADHS)	OHIP-14	FMR	Yes	2, 3, 8, 9, 10, 12	**1**	+	n/a
						2	+	n/a
Bianco et al. 2010 Brazil	224, 70.53% F; F: 30.3% 50-59yrs, 33.3% 60-69yrs, 31.8% 70-79yrs, 4.5%	OHIP-49	PMR	No	1, 2, 8, 9, 10, 12	**1**	n/a	A, B, G
						2	n/a	n/a

	≥80yrs; M: 31.6% 50-59yrs, 34.8% 60-69yrs, 27.2% 70-79yrs, 6.3% ≥80yrs n/a							
Brauchle et al. 2013 Germany	93, 62.4% F; 51yrs (27-74)	OHIP-14; German	PMR	Yes	n/a	**1** **2**	+ n/a	n/a n/a
Brennan et al. 2007 Australia	709, 70.9% F; n/a n/a	EuroQoL	FMR	No	n/a	**1** **2**	n/a n/a	δ, γ, **ε** n/a
Cohen-Carneiro et al. 2010 Brazil	126, Isodoro: 59.6% F; 30.5yrs (±12.6); Lauro Sodré: 59.5% F; 35.7yrs (±12.6) 2 rural riverine communities, Amazonas	OHIP-14; Portugese	PMR	No	n/a	**1** **2**	+ n/a	n/a n/a
Cornejo et al. 2013 Spain	194, 71.1% F[a]; 26.8% M & 24.6% F: 65-74yrs; 73.2% M & 75.4% F: ≥75yrs n/a	GOHAI; Spanish	PMR	No	n/a	**1** **2**	- n/a	n/a n/a
de Pinho et al. 2012 Brazil	300, 60% F; 50.7% ≥55yrs diabetes types 1 & 2	OHIP-14; Brazilian	FMR	No	n/a	**1** **2**	n/a n/a	A, B n/a
Deshmukh & Radke 2012 India	385, 34.3% F[a]; 62yrs (±11.2) n/a	GOHAI; Hindi	FMR	Yes	n/a	**1** **2**	+ n/a	n/a n/a
Durham et al. 2013 United Kingdom	89, 56.2% F[a]; 47yrs (±9) chronic periodontitis	OHIP-49 OHQoL-UK	FMR	Yes	n/a	**1** **2**	+ n/a	A, B, C, E, F; a, b, c n/a
Eltas & Uslu 2013 Turkey	53, 47.2% F[a]; 31.3yrs (21-48) general aggressive periodontitis	OHQoL-UK; Turkish	FMR	No	n/a	**1** **2**	n/a +	a, b b
Fotedar et al. 2014 India	351, 54.98% F; 35.7yrs (±9.3; 21-64)	OHIP-14; GOHAI English/ Hindi	FMR	No	1, 9, 13	**1** **2**	+ n/a	n/a n/a
Guzeldemir et al. 2009 Turkey	43 (out of 47), 48.9% F[a]; 46.4yrs (±15.1; 18-75) hemodialysis	OHIP-14; Turkish	n/a	No	n/a	**1** **2**	- n/a	n/a n/a

Jansson et al. 2014 Sweden	443, 48% F; 42.5yrs (±15.4), 59.9yrs (±11.4), 64.4yrs (±11.8) n/a	OHIP-14; Swedish	FMR	Yes	1, 2, 5, 9, 10	**1** **2**	+ +	n/a A, C, D, E, F, G
Jowett et al. 2009 United Kingdom	27 (13 test(T)+14 control(C), n/a; C:41yrs (26-53); T:39.5yrs (27-61) referred to periodontist	OHIP-14	FMR	Yes	n/a	**1** **2**	+ n/a	n/a n/a
Lawrence et al. 2008 New Zealand	924, 48.9% F[a]; 32yrs Dunedin Multidisciplinary Health and Development Study	OHIP-14	FMR	No	1, 8, 9	**1** **2**	+ (sev) - (ext) n/a	n/a n/a
Li et al. 2011 China	80, 60 % F[a]; 62.6yrs diabetes type 2; chronic PD	GOHAI	FMR	Yes	n/a	**1** **2**	+ n/a	I, III n/a
Mariño et al. 2008 Australia	603, 63.7% F; 67.7yrs (±6.2) senior citizens' ethnic social club	OHIP-14	PMR	No	n/a	**1** **2**	n/a -	n/a n/a
Montero-Martin et al. 2009 Spain	270, 54.4% F[a]; 45.2yrs (±9.5) n/a	OHIP-14; Spanish	PMR	No	n/a	**1** **2**	- n/a	n/a n/a
Mulligan et al. 2008 USA	689, 100% F; 38.6yrs (19-64) HIV, OHRQoL study	OHIP-14; English & Spanish	PMR	No	5, 8, 10, 11, 13	**1** **2**	+ +	n/a n/a
Needleman et al. 2004 United Kingdom	205, n/a; n/a periodontist clinic	OHQoL-UK	n/a	No	n/a	**1** **2**	+ n/a	n/a n/a
Ng & Leung 2006 China	727, 53% F; 25-64yrs (31.5% 25-34, 35.2% 35-44, 22.1% 45-54, 11.2% 55-64) n/a	OHIP-14; Chinese	FMR	Yes	2, 9, 10	**1** **2**	+ n/a	A, B, C, D, E n/a
Palma et al. 2013 Brazil	150, 62% F; 47yrs (±13.5) Periodontics section	OHIP-14; Portuguese	FMR	No	2, 7, 8, 9	**1** **2**	+ +	n/a C, D
Patel et al. 2008 USA	21, 81% F[a]; 50.4yrs (±18.7; 24-82) graduate periodontal	Michigan OHRQoL Scale	FMR	No	n/a	**1** **2**	+ n/a	n/a n/a

	clinic							
Saito et al. 2010 Japan	58, 60.3% F[a]; 53.6yrs (±13.2; 20-75) two periodontal clinics	OHRQL instrument; Japanese	FMR	No	n/a	**1** **2**	- -	n/a n/a
Saito et al. 2011 Japan	21, 76.2% F[a]; 56.4yrs (±9.7; 31-71) two periodontal clinics	OHRQL instrument; Japanese	FMR	No	n/a	**1** **2**	- n/a	n/a n/a
Saletu et al. 2005 n/a	40, 40% F[a]; 32-64yrs n/a	QLI; German	FMR	Yes	2, 5, 8	**1** **2**	+ +	n/a n/a
Srisilapanan & Sheiham 2001 Thailand	623, n/a; 60-74yrs 88.1% dentate n/a	OIDP; Thai	FMR	Yes	n/a	**1** **2**	- (PPD) + (CAL) n/a	n/a n/a
Swoboda et al. 2006 USA	733, 55.6% F[a]; 72.7yrs (±4.7) Trials to Enhance Elder's Teeth&Oral Health (TEETH)	GOHAI	FMR	No	1, 2, 6, 8, 9, 10	**1** **2**	+ n/a	II n/a
Wandera et al. 2009 Uganda	713, 100% F; 25.6yrs (±6.4) pregnant; urban & rural; multi-center randomized community trial	OIDP; in Lumasaaba, adapted	PMR	Yes	2, 8, 9, 10	**1** **2**	- n/a	i n/a
Zaitsu et al. 2011 Japan	459, 66.4%F[a]; 48.8yrs (±4.3) n/a	GOHAI; Japanese	FMR	No	1, 2, 8, 10	**1** **2**	- n/a	n/a n/a
Zhao et al. 2011 China	300, 51.3% F[a]; 67.7yrs n/a	GOHAI; Chinese Putonghua	FMR	No	2, 8, 10	**1** **2**	n/a + (CAL)	n/a n/a

Abbreviation OHRQoL questionnaires and corresponding subdomains

OHIP: Oral Health Impact Profile: subdomains: A=functional limitation, B=physical pain, C=psychological discomfort, D=physical disability, E=psychological disability, F=social disability, G=Handicap;

GOHAI: General/Geriatric Oral Health Assessment Index: subdomains: I=physical function, II=psychosocial function, III=pain & discomfort;

OHQoL-UK: United Kingdom Oral Health Related Quality of Life: subdomains: a=physical Domain, b=social Domain, c=psychosocial Domain;

OIDP: Oral Impact on Daily Performances: subdomains: i=eating, ii= speaking, iii=cleaning, iv=sleeping, v=smiling, vi=carry out work, vii=enjoy social contact;

OHRQL instrument: Oral Health Related Quality of Life instrument: subdomains 1 =pain, 2=dry mouth, 3=eating and chewing function, 4=speech function, 5=social function, 6=psychological function, 7=health perception;

EuroQoL/EQ-5D: subdomains: α=Mobility, β=self-care, γ=usual activities, δ=pain / discomfort, ε=anxiety / depression, ζ=cognition;

F=female, FMR=full mouth recording, M=male, n/a=not available, PD=periodontal disease, PMR=partial mouth recording, PPD= periodontal probing depth, OHRQoL=Oral Health Related Quality of Life, QLI=Quality of Life Index, sev=severity, ext=extent, CAL=clinical attachment loss

Confounders: 1=sex, 2=age, 3=sex, 4=medical illnesses, 5=smoking, 6=ethnic origin, 7=self-assessment, 8=dental status and oral hygiene, 9=SES, 10=number of teeth, 11=study visit number, 12=dental prosthesis, 13=other

Footnotes:

[a] percentages calculated by the authors

Table 2 Oral Health Related Quality of Life (OHRQoL) subdomains and their associations with periodontal disease.

OHRQoL Survey Instrument **Authors Year**	**Functional Domain**			**Pain / Discomfort**	**Psychosocial Domain**		
OHIP	**D**	**A**	**G**	**B**	**C**	**E**	**F**
Acharya et al. 2009	x	x		x			
Al Habashneh et al. 2012	x		x	x	x	x	x
Bianco et al. 2010		x	x	x			
de Pinho et al. 2012		x		x			
Durham et al. 2013		x		x	x	x	x
Jansson et al. 2013	x	x	x		x	x	x
Ng & Leung 2006	x	x		x	x	x	
Palma et al. 2013	x				x		
GOHAI		**I**		**III**		**II**	
Li et al. 2011		x		x			
Swoboda et al. 2006						x	
OHQoL-UK		**a**			**c**		**b**
Durham et al. 2013		x			x		x
Eltas & Uslu 2013		x					x
OIDP	**i**	**ii**	**iii**	**iv**	**v**	**vii**	**vi**
Wandera et al. 2009	x						
EuroQoL	α	β	γ	δ	ε		ζ
Brennan et al. 2007			x	x	x		
Sum		13		8		9	

Abbreviation OHRQoL questionnaires and corresponding subdomains

OHIP: Oral Health Impact Profile: subdomains: A=functional limitation, B=physical pain, C=psychological discomfort, D=physical disability, E=psychological disability, F=social disability, G=Handicap;

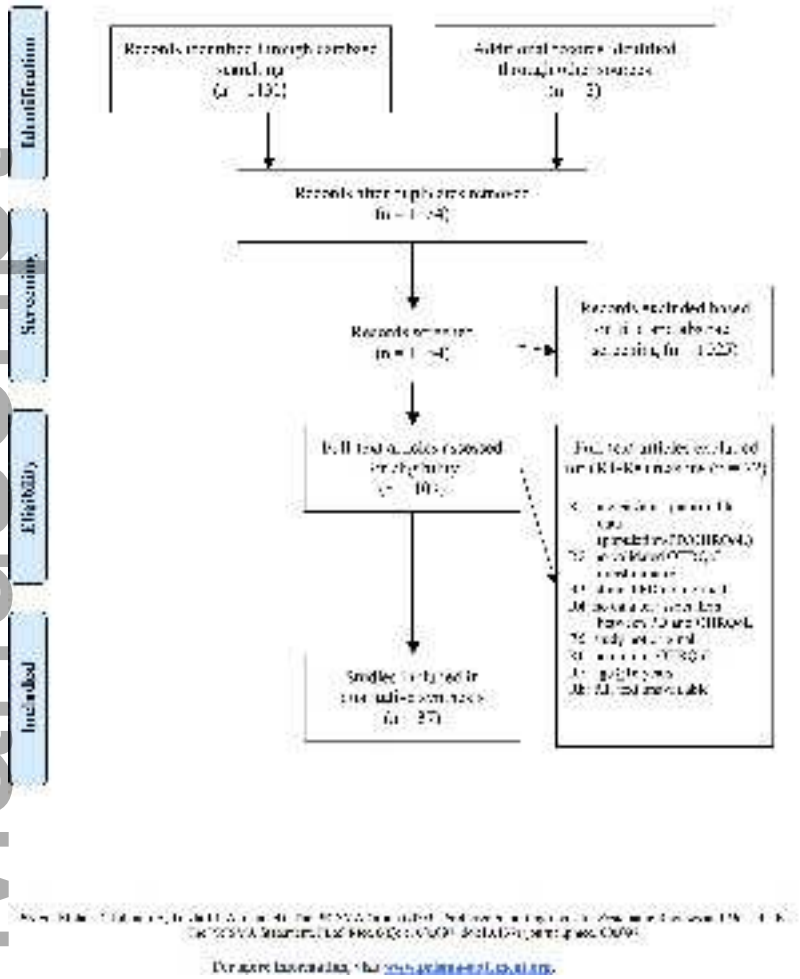
GOHAI: General/Geriatric Oral Health Assessment Index: subdomains: I=physical function, II=psychosocial function, III=pain & discomfort;

OHQoL-UK: United Kingdom Oral Health Related Quality of Life: subdomains: a=physical Domain, b=social Domain, c=psychosocial Domain;

OIDP: Oral Impact on Daily Performances: subdomains: i=eating, ii= speaking, iii=cleaning, iv=sleeping, v=smiling, vi=carry out work, vii=enjoy social contact;

OHRQL instrument: Oral Health Related Quality of Life instrument: subdomains 1 =pain, 2=dry mouth, 3=eating and chewing function, 4=speech function, 5=social function, 6=psychologic function, 7=health perception; EuroQoL/EQ-5D: subdomains: α=Mobility, β=self-care, γ=usual activities, δ=pain / discomfort, ε=anxiety / depression, ζ=cognition.

Durham et al. 2013 (15) applied both OHIP and OHQoL-UK.



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