

Impact of periodontitis on the Oral Health Impact Profile: A systematic review and meta-analysis

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Abstract

Background. Periodontitis, being a chronic and multifactorial disease, affects oral health, and consequently, the patient's quality of life (QoL). The assessment of the oral health-related quality of life (OHRQoL) is possible with the Oral Health Impact Profile-14 (OHIP-14) questionnaire comprising 7 subdomains: functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap.

Objectives. The aim of this study was to conduct a systematic review of cross-sectional or case–control studies concerning the impact of periodontitis on QoL measured with OHIP-14. The outcomes of the studies were subjected to a meta-analysis.

Material and methods. On the basis of a survey of databases (MEDLINE, Scopus, Google Scholar, and Polish Medical Bibliography – PBL), 1,346 titles related thematically to the impact of periodontitis on QoL were obtained and analyzed. Ten studies were considered eligible for evaluation (8 cross-sectional ones and 2 case–control ones).

Results. All studies indicated a significant influence of periodontitis on the deterioration of the OHIP-14 values. This relationship was shown to be directly modified in proportion to the degree of the advancement of the periodontal disease and to the extent of periodontal tissue damage. Our own meta-analysis confirmed the correlation between the prevalence of periodontitis and increased OHIP-14 scores with a cumulative odds ratio (OR) of 1.33, demonstrated a moderately significant deterioration of the OHIP-14 scores by 4.2 points in the group with periodontitis as compared to the control group, and assessed the probability of OHIP-14 deterioration to be 3.5 times greater in severe periodontitis.

Conclusions. The impact of periodontitis on the deterioration of OHRQoL is quite clearly explained by the clinical symptoms of periodontitis. According to patients, the most important problems that periodontitis may cause include psychological discomfort, stress, problems in interpersonal relations, or even difficulties in daily activities. This indicates the need for more of a holistic approach in planning the goals of the periodontal therapy, taking into account the psychological and social aspects of the patient's perception of the disease.

Key words: periodontitis, meta-analysis, oral health, quality of life

Introduction

Periodontitis is a chronic, multifactorial inflammatory disease associated with the dysbiosis of the bacterial biofilm in periodontal pockets, which leads to damage to the attachment apparatus through an inappropriate, usually excessive, host immune inflammatory response.¹ Risk factors affecting the initiation and progression of periodontitis can be divided into 2 categories: non-modifiable (age, gender, race, and genotype) and modifiable (poor oral hygiene, presence of periopathogens in the biocenosis of the oral cavity, nicotine dependence syndrome, selected general diseases – uncontrolled diabetes, obesity or osteoporosis – low socioeconomic status, poor dietary quality, and stress).² The clinical consequences of this progressive damage to periodontal tissues have an impact on the health of the oral cavity in the physiological, psychological and social aspects, which affects the patient's quality of life (QoL).³

The current definition of oral health stresses the interaction between 3 basic elements: the impact of the extent and severity of the disease on the patient's health; the physiological functions of speaking, smiling, chewing, and swallowing; and the social functions enabling unhindered social coexistence.⁴ It also draws attention to the need to determine the impact of oral health on QoL (oral health-related quality of life – OHRQoL).^{4,5}

The ability to measure OHRQoL allows oral health to be linked to both the subjective assessment of the patient's wellbeing and potential limitations in social life. The assessment of OHRQoL enables patient-centered care and helps to identify the needs for health promotion and prevention programs.⁶ It is important, therefore, to demonstrate whether and to what extent periodontitis and its severity affects the QoL of the population exposed to it, since it is second only to caries in terms of prevalence.

A psychometric test of QoL involves the patient filling out a questionnaire, which has been analyzed and validated beforehand. In modern dental epidemiology, it is possible to make the overall assessment of OHRQoL through such multiple indicators and indices as the Oral Impact on Daily Performance (OIDP), the Oral Health Index (OHX), the Geriatric Oral Health Assessment Index (GOHAI), the Liverpool Oral Rehabilitation Questionnaire (LORQ), and the Subjective Oral Health Status Indicators (SOHSI). Another group consists of indicators that estimate the impact of specific conditions affecting the sensation of oral health, such as the Xerostomia-Related Quality of Life Scale (XeQoLS), the Dentin Hypersensitivity Experience Questionnaire (DHEQ) and the Quality of Life With Implant Prosthesis (QoLIP-10). In addition, there are health-related quality of life (HRQoL) indicators that assess the physical, psychological and social impact of health conditions on an individual's wellbeing, e.g., the European Quality of Life (EuroQol) instrument, the 36-Item Short-Form Survey (SF-36), the World Health Organization's Quality

of Life (WHOQOL) instrument, and the Sickness Impact Profile (SIP).⁷ One of the most popular questionnaires for the overall OHRQoL assessment is the Oral Health Impact Profile (OHIP-49)⁸ and its shortened version – OHIP-14.⁹ It is based on Locker's model, which assumes a hierarchical impact of the effects of the disease and a sequential association with 7 dimensions of QoL. This questionnaire assesses the patient's perception of the impact of oral health on the social aspect of their wellbeing.⁸ In the shortened version of OHIP, 14 questions are divided into 7 subdomains: functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap.⁹ The answers are structured on the basis of a 5-point Likert scale, indicating how often the oral cavity problems described in the questions have occurred (from 0 – never to 4 – very often). The score is the total of the answers to all questions, ranging from 0 to 56; the higher the score, the more negative the perception of the impact of oral health on the patient's QoL. The OHIP-14 questionnaire has been validated and translated into many languages, allowing its scores to be compared between specific populations. The Oral Health Impact Profile makes it possible to relate the scores to the clinical parameters of an oral health examination or sociodemographic factors. Based on the original OHIP questionnaire, attempts have been made to create specialized questionnaires on specific conditions that affect oral health, including OHIP-Esthetics, OHIP-EDENT (for edentulous patients), OHIP-TMDs (for patients with temporomandibular disorders), OHIP-PD (for patients with the periodontal disease),¹⁰ and OHIP-CP (for patients with chronic periodontitis).¹¹ The last 2 questionnaires are designed for people with periodontitis, and the questions included in them concern the most common symptoms and their impact on the patient's wellbeing.

The aim of the study was to conduct a literature review on the impact periodontitis has on the most frequently used OHRQoL assessment indicator, which is the shortened OHIP-14. The review includes the best studies that assessed the impact of periodontitis along with its severity and extent on the scores of this profile as well as the relationship between the subdomains of this indicator and the diagnosis of periodontitis. The combined effect of these studies was assessed in a meta-analysis.

Methods

The following databases were thoroughly surveyed for articles published through May 1, 2020: MEDLINE; Scopus; Google Scholar; and the Polish Medical Bibliography (PBL). Bibliographic lists were searched after the following terms had been entered: 'periodontitis', 'periodontal disease', 'quality of life', 'oral-health-related quality of life', and 'oral health impact profile', which corresponds to the Medical Subject Headings (MeSH) key word database.

The initial identification included the titles and abstracts of articles on the impact of periodontitis on QoL. This resulted in 1,346 titles. Selection was then made by rejecting the titles of articles not related to the literature review. Subsequently, the number of titles was reduced by selecting original observational studies published in English, German, Russian, or Polish. Further selection required both reviewers (BPC and TK) to read the full text of a given article and take into account the following criteria:

- the use of the shortened OHIP-14 version in a national language;
- the application of the definition of periodontitis based on the measurements of pocket depth (PD) and clinical attachment loss (CAL) or bone loss (BL) in radiographs;
- a control group, defined as individuals with a clinically healthy periodontium or with gingivitis, not with periodontitis;
- a full periodontal examination of all teeth with at least 4 measurement points;
- observations among adults aged 18–70 years;
- a cross-sectional or case–control study including confounding variables;
- the estimation of the strength of the relationship between periodontitis and OHIP-14 with the mean difference (*MD*), relative risk (*RR*) or odds ratio (*OR*); alternatively, available data to calculate one of these measures; and
- for studies from the same country, the later one was taken into account, with a preference for data from a national survey.

The following information was gathered about the studies eligible for the final analysis: the authors; the country and year of publication; the number and age of the participants; the definition of periodontitis; the estimation of the link along with the confounding variables taken into consideration; a significant demonstration of the relationship between the OHIP-14 subdomains and periodontitis; and the authors' final conclusions.

To determine the combined effect of studies reporting on the impact of periodontitis on the assessed Quality of Life Index (QLI), a model with a variable effect was chosen (the DerSimonian and Lard method). For the combined studies, the total *RR* or raw mean difference (*RMD*) was determined along with the corresponding confidence interval (*CI*). A significance level of $p < 0.05$ was adopted. The heterogeneity of the selected studies was assessed using the *Q* test and I^2 statistics, assuming a significance level of $p < 0.05$. The cumulative impact of the severity of periodontitis (mild, moderate or severe) on the OHIP-14 values was analyzed as well. The publication bias was assessed with Egger's test (with a significance level of $p < 0.05$) and by creating a funnel plot. All analyses were carried out using the analysis kit of Statistica, v. 13.1 (StatSoft, Kraków, Poland).

Results

There were 53 original observational studies with the assessment of the OHIP-14 index in individuals with the periodontal disease (Fig. 1). They were conducted from 2006 to 2020 in the following countries: Brazil ($n = 11$; Haye Biazevic et al.,¹² da Silva Araújo et al.,¹³ Cohen-Carneiro et al.,¹⁴ Bandéca et al.,¹⁵ de Freitas Borges et al.,¹⁶ Palma et al.,¹⁷ Batista et al.,¹⁸ Meusel et al.,¹⁹ de Vasconcelos Maia et al.,²⁰ Llanos et al.,²¹ and de Santana Passos-Soares et al.²²); India ($n = 5$; Acharya,²³ Fotedar et al.,²⁴ Sanadhya et al.,²⁵ Grover et al.,²⁶ and Yadav et al.²⁷); the UK ($n = 5$; Jowett et al.,²⁸ Bernabé and Marcenés,²⁹ White et al.,³⁰ Masood et al.,³¹ and Fuller et al.³²); Turkey ($n = 4$; Eltas et al.,³³ Balci et al.,³⁴ Ustaoglu et al.,³⁵ and Beşiroğlu and Lütfoğlu³⁶); China ($n = 1$; He et al.³⁷); Hong Kong ($n = 1$; Ng and Leung³⁸); New Zealand ($n = 1$; Lawrence et al.³⁹); Australia ($n = 2$; Mariño et al.⁴⁰ and Slade and Sanders⁴¹); Sweden ($n = 2$; Jansson et al.⁴² and Kato et al.⁴³); Germany ($n = 2$; Brauchle et al.⁴⁴ and Sonnenschein et al.⁴⁵); Norway ($n = 1$; Holde et al.⁴⁶); Spain ($n = 2$; Montero-Martín et al.⁴⁷ and Montero et al.⁴⁸); Belgium ($n = 1$; Carvalho et al.⁴⁹); the USA ($n = 2$; Cunha-Cruz et al.⁵⁰ and Wright et al.⁵¹); Mexico ($n = 1$; Rodríguez Franco and de la Rubia⁵²); Israel ($n = 1$; Levin et al.⁵³); Jordan ($n = 1$; Al Habashneh et al.⁵⁴); Sudan ($n = 1$; Khalifa et al.⁵⁵); Nigeria ($n = 1$; Lawal et al.⁵⁶); Jamaica, the Dominican Republic and Puerto Rico ($n = 1$; Collins et al.⁵⁷); Malaysia ($n = 1$; Sulaiman et al.⁵⁸); Nepal ($n = 1$; Goel and Baral⁵⁹); Sri Lanka ($n = 1$; Wellapuli and Ekanayake⁶⁰); Taiwan ($n = 1$; Wang et al.⁶¹); Poland ($n = 1$; Wąsacz et al.⁶²); Romania ($n = 1$; Grigoras et al.⁶³); and

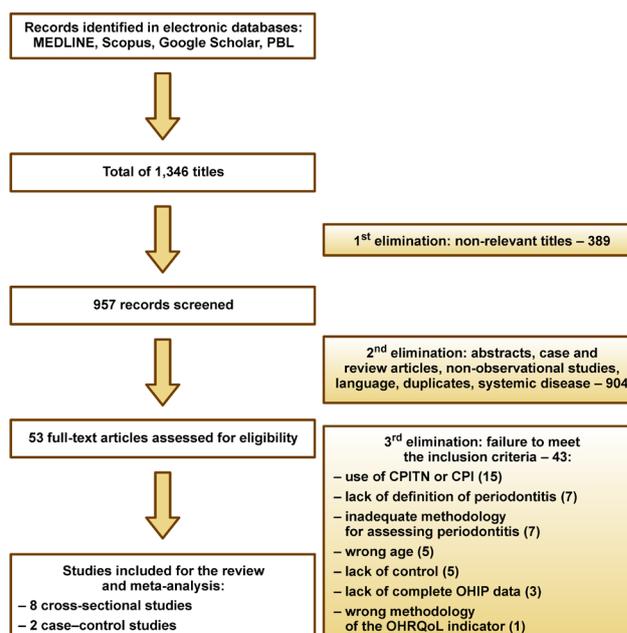


Fig. 1. Flow chart of the study selection process for the systematic review
PBL – Polish Medical Bibliography; CPITN – Community Periodontal Index of Treatment Needs; CPI – Community Periodontal Index; OHIP – Oral Health Impact Profile; OHRQoL – oral health-related quality of life.

Russia ($n = 1$; Drachev et al.⁶⁴). Forty-three studies did not meet the inclusion criteria and were not part of the review and meta-analysis. The reasons for eliminating these studies were as follows: the use of the Community Periodontal Index of Treatment Needs (CPITN) or the Community Periodontal Index (CPI) to assess the clinical condition of periodontitis ($n = 15$)^{13–15,18,20,24,25,28,31,33,44,47,48,55,56}; no adopted definition of periodontitis ($n = 7$)^{21,26,34,45,57,62,63}; the use of an outdated definition of periodontitis from 1999 or before ($n = 7$)^{16,17,23,38,40,51,52}; the assessment of individuals who were too old or too young ($n = 5$)^{12,30,43,49,64}; no control group ($n = 5$)^{19,27,58,60,61}; a lack of complete OHIP data ($n = 3$)^{36,46,59}; and an inadequate methodology of the OHRQoL indicator.⁵⁰

Ten studies (8 cross-sectional and 2 case-control; 8 local and 2 national) were eligible for the review and meta-analysis (Table 1).^{22,29,32,35,37,39,41,42,53,54} All of them showed a significant impact of the diagnosis of periodontitis (defined by the measurements of PD and CAL) on the deterioration of OHIP-14. In addition, the studies indicated that the association between the prevalence of periodontitis and OHRQoL was directly modified by the stage and extent of periodontal tissue damage^{32,37,54} relative to the number of preserved teeth.⁴² The quality of the selected articles is evidenced by the number of variables taken into account, related to both periodontitis and OHRQoL, which distorted these observations. The most frequently assessed confounding factors were age ($n = 8$), gender ($n = 8$), the markers of the socioeconomic status ($n = 7$), nicotine use ($n = 6$), and the number of teeth ($n = 6$). Eight observations recorded the effect of periodontitis on the OHIP-14 subdomains.^{22,32,35,37,39,42,53,54} Seven of them showed a significant impact on psychological and physical disability, 6 of them showed an impact on psychological discomfort, social disability and handicap, and 5 on functional limitation and physical pain.

In 5 of the studies eligible for the meta-analysis, in which the relationship between periodontitis and OHIP-14 was expressed with the adjusted odds ratio (*aOR*), a statistically significant relationship was shown, although not a very strong one.^{22,29,32,37,39} The strongest correlation was in the Chinese report – *aOR* for severe periodontitis was 1.63 with 95% *CI* ranging from 1.41 to 1.98.³⁷ The relatively weakest correlation, although also statistically significant, was found in the New Zealand study, in which *OR*, adjusted by only 3 confounding variables, was 1.49 with a fairly wide 95% *CI*: 1.01–2.19.³⁹ In our own meta-analysis of these 5 studies, involving a total of 1,869 individuals with periodontitis and 2,805 individuals in the control group from 4 countries (New Zealand, the UK, Brazil, and China), the relationship between the prevalence of periodontitis and an increase in the OHIP-14 index had a cumulative *OR* of 1.33 (95% *CI*: 1.25–1.43); $p < 0.001$ (Fig. 2). The analysis of heterogeneity of these 5 studies did not confirm this relationship ($Q = 3.66$; $p = 0.45$; $I^2 = 0\%$; 95% *CI*: 0–78.6).

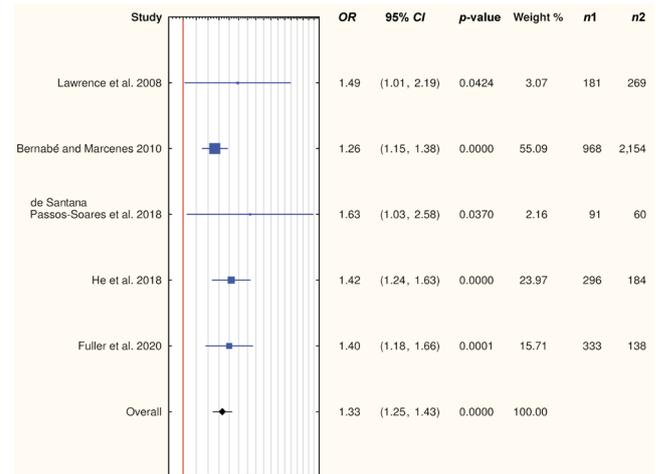


Fig. 2. Forest plot of the adjusted odds ratio (*aOR*) of the Oral Health Impact Profile-14 (OHIP-14) in periodontitis

$n1$ – size of the periodontitis group; $n2$ – size of the control group.

In the case of 7 studies eligible for the meta-analysis in which the difference between the periodontitis group and the control group was assessed through a difference in the mean values of the OHIP-14 index, in each study, the mean OHIP-14 value was significantly higher with exposure to periodontitis.^{22,32,35,41,42,53,54} These differences were quite diverse, ranging from 9.7 points for severe periodontitis in a recent English study³² to only 2.8 points in an Australian study.⁴¹ The meta-analysis of these 7 studies, including a total of 1,981 individuals with periodontitis and 3,472 individuals in the control group from 7 countries (Australia, Jordan, Sweden, Brazil, Israel, Turkey, and the UK) showed a moderately significant deterioration of the OHIP-14 index by 4.2 points (95% *CI*: 3.10–5.31); $p < 0.0001$ (Fig. 3). The results were heterogeneous ($Q = 36.95$; $p < 0.001$; $I^2 = 83.76\%$; 95% *CI*: 68.1–91.7).

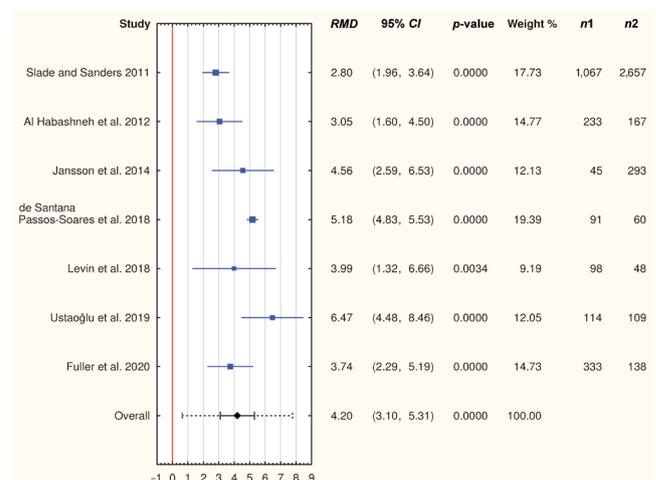


Fig. 3. Forest plot of the raw mean difference (RMD) in OHIP-14 in periodontitis

Table 1. Characteristics of the selected studies

Author, year, country	Number (age [years]) of the participants	Definition of periodontitis	Confounding variables assessed	Effect of periodontitis on OHIP-14	Subdomains relevant for periodontitis	Main conclusion
Lawrence et al. ³⁹ 2008, New Zealand cross-sectional, local study	PG – 181 (32) C (no P) – 269 (32)	1 site with PD ≥ 4 mm and 2 sites with CAL ≥ 4 mm	– age – gender – socioeconomic status	PG – OR: 1.49 (95% CI: 1.01–2.19) <i>p</i> = 0.0424	– physical pain – psychological discomfort – physical disability	a significant impact of periodontitis on the deterioration of OHRQoL
Bernabé and Marcenes ²⁹ 2010, the UK cross-sectional, national study	PG – 968 C (no P) – 2,154 average age for the whole group – 41.2 years	1 interdental site with PD ≥ 4 mm and 2 interdental sites with CAL ≥ 4 mm	– age – gender – number of teeth – education – income – place of residence	PG – RR: 1.26 (95% CI: 1.15–1.38) <i>p</i> < 0.001	NR	a significant impact of periodontitis on the deterioration of OHRQoL
Slade and Sanders ⁴¹ 2011, Australia cross-sectional, national study	PG – 1,067 (54.6) C (no P) – 2,657 (39.4)	2 sites with PD ≥ 5 mm or 2 sites with CAL ≥ 4 mm	– number of teeth	average OHIP-14 score: 9.5 ± 13.1 vs 6.7 ± 11.3 <i>p</i> < 0.001	NR	a significant impact of moderate and severe periodontitis on the deterioration of OHRQoL
Al Habashneh et al. ⁵⁴ 2012, Jordan cross-sectional, local study	PG – 233 (18–60) C (G) – 167 (18–60)	4 teeth with 1 site with PD ≥ 4 mm and CAL ≥ 3 mm	– age – gender – number of teeth – education – income – general diseases – nicotine	sP: 15.57 ± 7.5 vs 9.50 ± 7.1 <i>p</i> < 0.001 mP: 12.55 ± 7.4 vs 9.50 ± 7.1 <i>p</i> < 0.050 mP: NS	– physical pain – physical disability – psychological disability – social disability – handicap	a significant impact of periodontitis on the deterioration of OHRQoL; the more severe periodontitis, the greater the impact
Jansson et al. ⁴² 2014, Sweden cross-sectional, local study	IP – 83 (59.9) gP – 45 (64.4) C (no P) – 293 (42.5)	PD ≥ 4 mm and BL ≥ 33% of the root length; IP < 30% of the teeth with BL ≥ 33% of the root length, gP ≥ 30% of the teeth with BL ≥ 33% of the root length	– age – gender – number of teeth – education – nicotine	average OHIP-14 score: gP: 8.47 ± 10.4 vs 3.91 ± 5.4 <i>p</i> < 0.001 IP vs C: NS	– functional limitation – psychological discomfort – physical disability – psychological disability – social disability – handicap	a significant impact of severe and generalized periodontitis on the deterioration of OHRQoL
de Santana Passos- Soares et al. ²² 2018, Brazil cross-sectional, local study	PG – 91 (NA) C (no P) – 60 (NA)	4 teeth with at least 1 site with PD ≥ 4 mm and CAL ≥ 3 mm	– age – gender – education – nicotine	average OHIP-14 score: 13.15 ± 1.1 vs 7.97 ± 1.0 <i>p</i> < 0.010 PG – OR: 1.63 (95% CI: 1.03–2.58) <i>p</i> = 0.0370	– psychological discomfort – psychological disability	a significant impact of the co-occurrence of periodontitis and caries on the deterioration of OHRQoL
Levin et al. ⁵³ 2018, Israel case–control, local study	PG – 98 (38.8) C (no P) – 48 (37.7)	PD ≥ 4 mm and BL ≥ 3 mm	– age – gender – nicotine	average OHIP-14 score: 10.65 ± 8.5 vs 6.66 ± 5.8 <i>p</i> = 0.004	– functional limitation – physical disability – psychological disability – social disability – handicap	a significant impact of periodontitis on the deterioration of OHRQoL
He et al. ³⁷ 2018, China cross-sectional, local study	PG – 296 (35–74) C (no P) – 184 (35–74)	at least 2 interdental sites with PD ≥ 4 mm and CAL ≥ 3 mm or 1 site with PD ≥ 5 mm; def. acc. CDC/AAP	– age – gender – number of teeth – education – income – place of birth – nicotine	sP – OR: 1.63 (95% CI: 1.41–1.98) <i>p</i> < 0.010 mP – OR: 1.42 (95% CI: 1.24–1.63) <i>p</i> < 0.010 mP: NS	– functional limitation – physical pain – psychological discomfort – physical disability – psychological disability – social disability – handicap	a significant impact of periodontitis on the deterioration of OHRQoL; the more severe periodontitis, the greater the impact
Ustaoglu et al. ³⁵ 2019, Turkey cross-sectional, local study	PG – 114 (39.2) C (G) – 109 (23.7)	4 teeth in the mandible and maxilla with at least 1 site with PD ≥ 5 mm and CAL ≥ 4 mm	– general diseases	average OHIP-14 score: 13.53 ± 9.4 vs 7.06 ± 5.0 <i>p</i> < 0.001	– functional limitation – physical pain – psychological discomfort – physical disability – psychological disability – social disability – handicap	a significant impact of generalized periodontitis on the deterioration of OHRQoL
Fuller et al. ³² 2020, the UK case–control, local study	PG – 333 (25–50) C (no P) – 138 (24–64)	at least 1 site with PD ≥ 5 mm and CAL > 0 mm	– age – gender – race – number of teeth – socioeconomic status – BMI – general diseases – nicotine	average OHIP-14 score: sP: 14.89 ± 10.8 vs 5.20 ± 6.6 <i>p</i> < 0.001 mP: 8.94 ± 7.6 vs 5.20 ± 6.6 <i>p</i> < 0.05 PG – OR: 1.40 (95% CI: 1.18–1.66) <i>p</i> < 0.001	– functional limitation – physical pain – psychological discomfort – physical disability – psychological disability – social disability – handicap	a significant impact of periodontitis (classification from 1999 and 2007) on the deterioration of OHRQoL; the more severe periodontitis, the greater the impact

PG – periodontitis group; C – control; P – periodontitis; G – gingivitis; IP – localized periodontitis; gP – generalized periodontitis; NA – not available; PD – pocket depth; CAL – clinical attachment loss; BL – bone loss; CDC/AAP – the Centers for Disease Control/American Academy of Periodontology; BMI – body mass index; CI – confidence interval; RR – relative risk; sP – severe periodontitis; mP – moderate periodontitis; mP – mild periodontitis; NS – nonsignificant; OR – odds ratio; NR – not reported.

The meta-analysis of 3 studies in which the impact of the severity of periodontitis on the probability of OHIP-14 deterioration was assessed was also carried out (Fig. 4).^{32,37,54} Mild periodontitis did not change the likelihood of OHRQoL deterioration, while moderate periodontitis significantly increased this probability by 64% (95% CI: 1.12–2.40); $p = 0.012$, and severe periodontitis increased the probability by approx. 3.5 times (95% CI: 1.32–9.73); $p = 0.012$. The higher OR values in this meta-analysis in relation to the one shown in Fig. 2 result from combining the unadjusted and converted measures of MD for 2 observations.^{32,54}

The visual analysis of the funnel plot (Fig. 5), the noticeable symmetry of the distribution of the 7 points representing the results of the meta-analysis shown in the forest plot in Fig. 3 and the insignificance of Egger's test ($b_0: -1.6$; 95% CI: $-5.28-2.08$; $p = 0.31$) indicate an insignificant publication bias. Out of the 7 studies analyzed with the funnel plot, 3 of them are outside 95% CI, which indicates a large variety of these results.

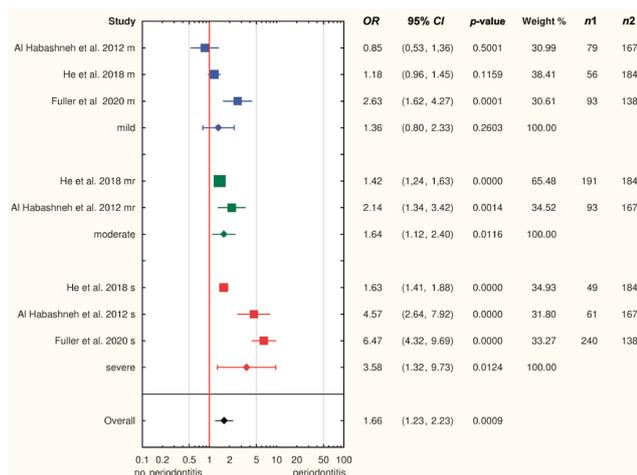


Fig. 4. Forest plot of OR of OHIP-14 in mild, moderate or severe periodontitis

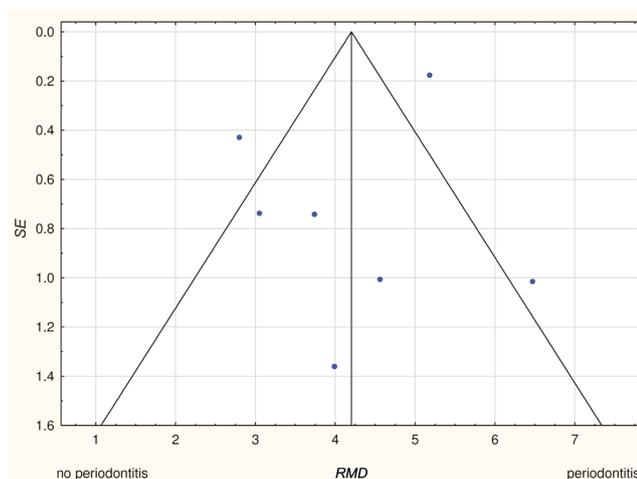


Fig. 5. Funnel plot with pseudo 95% CIs

SE – standard error.

Discussion

For the review and meta-analysis of studies on the link between periodontitis and QoL assessed with the most commonly used OHIP-14 index, articles of the best possible methodological quality were selected. The quality assessment of the 2 included case–control studies^{32,53} according to the Newcastle–Ottawa Scale (NOS)⁶⁵ indicated an average quality (7 stars). An important inclusion criterion was the definition of periodontitis using the measurements of PD and CAL, which is consistent with the current views on the assessment of the periodontal status for epidemiological and clinical purposes. Studies that considered the impact of confounding variables by applying multiple or logistic regression were also included. The introduction of a range limit for age in which periodontitis is one of the most common oral diseases, while minimizing the impact of tooth loss, was of great importance as well.

In all of these studies, a significant deterioration of OHRQoL under the influence of periodontitis was found, and this impact increased with the severity and extent of periodontopathy. This was reflected in the meta-analysis – periodontitis increased the probability of OHRQoL deterioration by 33%, and a significant impact of moderate and severe periodontitis was 64% and 358%, respectively. No reference was found in the available literature for our own meta-analysis. The unambiguity of these findings is distorted only by the heterogeneity of studies in which the correlation measure was expressed with MD (Fig. 3). This was probably due to the type of research conducted as well as to subjective differences in emotional patterns for experiencing discomfort, disability and pain among populations from different continents (East and West Asia, Oceania, Europe, and South America). Three systematic literature reviews (SLRs) on the impact of periodontitis on OHRQoL are not as unambiguous as our review.^{66–68} In the first one, Al-Harathi et al. indicated that 3 out of 4 studies showed a significant relationship between periodontitis and OHIP-14.⁶⁶ This was not confirmed in the Australian study by Marinõ et al.⁴⁰ In another review, Buset et al. selected 15 studies on this relationship and its significance was confirmed in 12 of them.⁶⁷ No such relationship was found by Marinõ et al.,⁴⁰ Montero-Martín et al.⁴⁷ or Bandéca et al.¹⁵ In the latest available SLR on the impact of periodontitis on OHIP-14, a significant relationship was found in 18 out of 22 of the selected observational studies.⁶⁸ This was not confirmed in the study by Bandéca et al.,¹⁵ another Brazilian study by Batista et al.,¹⁸ an Indian study by Sanadhya et al.,²⁵ or the study in our own review, regarding the observations among homeless people in Hong Kong (the study was excluded on the 3rd stage of selection).⁶⁹ All of those observations, in which this significant relationship was not found, combined 2 methodological characteristics – the assessment of the condition of the

periodontium and a definition of the periodontal disease based on CPI as well as a partial protocol for oral health testing. It seems that an incorrect determination of the rate of prevalence for periodontitis and a lack of the assessment of the periodontal status for all teeth may interfere with observations regarding the impact of periodontitis on OHRQoL.

The impact of periodontitis on the deterioration of OHRQoL is quite clearly explained by the influence of clinical symptoms such as gingival redness and swelling, bleeding while brushing the teeth, gingival recessions, often associated with the excessive sensitivity of the exposed dentin, tooth mobility, pathological tooth migration (PTM), or recurrent halitosis on the dysfunctions of the stomatognathic system, red complex esthetics and self-assessment. These symptoms should be associated only with the periodontal disease; thus, in observational studies, they should be controlled for by taking into account many local factors that may distort them, e.g., caries, mouth and facial pain, an increased tooth sensitivity, or the loss of tooth functionality (less than 10 interdental contact points) and severe tooth loss (less than 10 teeth).

In the last 3 studies included in the final part of our literature review,^{32,35,37} a significant relationship was confirmed between all subdomains of the OHIP-14 index and periodontitis. The consideration of earlier studies indicated psychological limitation (embarrassment, difficulty in being relaxed) and physical limitation (difficulty in toothbrushing and eating) as subdomains most frequently associated with periodontitis. In turn, pain, discomfort and functional limitation were indicated relatively rarely. The predominance of the impact of periodontitis on the psychological and social subdomains of OHRQoL was also noted by Buset et al. in their literature review.⁶⁷ This indicates the predominance of problems experienced by periodontal patients which very often go unnoticed during treatment, which is usually provided only to inhibit functional limitation, eliminate pain and improve an esthetic effect. However, in the patients' perception, the most important problems that periodontitis may cause are psychological discomfort, embarrassment, stress, problems in interpersonal relations, and even difficulties in everyday activities. This shows the need for even greater holistic planning as regards periodontal therapy goals. Lawrence et al. found that the severity of periodontitis led to an increase in the values of only some subdomains, not to an increase in all subdomains that showed incorrect values.³⁹ This may indicate that the progression of periodontitis affects the quality of particular OHRQoL subdomains and does not affect them all. He et al., on the other hand, showed that with an increase in the severity of periodontitis, there is a significant increase in the highest-scoring answers to the questions in all subdomains.³⁷ These differences may be caused by national, racial or socioeconomic discrepancies.

The literature review and the resulting meta-analysis have a number of limitations. Firstly, there is a risk of selection bias. Only in 5 of the selected studies was randomized sampling performed.^{29,37,41,42,54} A lack of the random selection of individuals for an epidemiological inquiry runs the risk of it being unrepresentative of the general or local population. This particularly concerns surveying individuals in academic centers. Secondly, not all confounding variables can be controlled for. In 4 studies, only 1–3 confounding variables were taken into account.^{35,39,41,53} Many of these studies show that general diseases associated with periodontitis and OHRQoL, such as diabetes, metabolic syndrome, osteoporosis, and local clinical conditions, e.g., caries, odontogenic pain and discomfort associated with prosthetic restorations, are not controlled for. Thirdly, the nature of an observational study in the form of a cross-sectional or case–control study does not unequivocally establish that exposure to periodontitis results in a reduced sense of QoL, since OHRQoL before periodontopathy is unknown. In addition, cross-sectional studies are highly exposed to the risk of selection bias. Fourthly, there is a possibility of observer bias. This is often the case when there is no process of calibrating examiners, or assessing inter- or intra-examiner reproducibility, especially in the clinical assessment of CAL. In the studies included in our review, such a procedure was performed only in 5 of them.^{22,29,35,37,54} The possibility of making a diagnostic error can come from adopting different definitions of periodontitis based on PD and CAL measurements. Currently, the definition of periodontitis by Eke et al.,⁷⁰ subsequently adopted by the Centers for Disease Control/American Academy of Periodontology (CDC/AAP), is considered to be the gold standard for epidemiological periodontal research. This literal definition was used only in the study by He et al.³⁷ Finally, there are limitations due to the use of the OHIP-14 index and varying methodologies for a subjective psychometric test. The questions contained in this questionnaire do not relate directly to the condition of the periodontium, which may lead to incorrect answers, especially when the questionnaire is self-administered. To reduce memory bias, one should limit the timeframe of the events being asked about. The best solution is to appoint a second examiner for a psychometric test who is blinded to the clinical condition of the periodontium, or to conduct such tests before the clinical examination. In the vast majority of studies eligible for this review, the psychometric test process was not described in sufficient detail.

This literature review and innovative meta-analysis provides further evidence on the relationship between periodontitis and OHRQoL, with a strong influence of the severity and extent of periodontopathy of a dose-effect type. The impact of periodontitis on the psychological and social aspects of the patient's perception of the disease has been shown, which should be taken into account for treatment purposes. Recommendations for further studies on

the relationship between periodontitis and OHRQoL indicators include conducting more high-quality European (including Polish) studies in this area, using QoL indicators profiled for periodontitis, using a comprehensive protocol for oral health testing as well as defining the prevalence rate, severity and extent of periodontitis according to CDC/AAP, controlling for the widest possible spectrum of local and general confounding factors, and conducting randomized, controlled studies on the impact of non-surgical and/or surgical treatment on OHRQoL indicators.

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References

- Meyle J, Chapple I. Molecular aspects of the pathogenesis of periodontitis. *Periodontol 2000*. 2015;69(1):7–17. doi:10.1111/prd.12104
- Genco RJ, Borgnakke WS. Risk factors for periodontal disease. *Periodontol 2000*. 2013;62(1):59–94. doi:10.1111/j.1600-0757.2012.00457.x
- Needleman I, McGrath C, Floyd P, Biddle A. Impact of oral health on the life quality of periodontal patients. *J Clin Periodontol*. 2004;31(6):454–457. doi:10.1111/j.1600-051X.2004.00498.x
- Hescot P. The new definition of oral health and relationship between oral health and quality of life. *Chin J Dent Res*. 2017;20(4):189–192. doi:10.3290/j.cjdr.a39217
- Glick M, Williams DM, Kleinman DV, Vujicic M, Watt RG, Weyant RJ. A new definition for oral health developed by the FDI World Dental Federation opens the door to a universal definition of oral health. *J Am Dent Assoc*. 2016;147(12):915–917. doi:10.1016/j.adaj.2016.10.001
- Sischo L, Broder HL. Oral health-related quality of life: What, why, how, and future implications. *J Dent Res*. 2011;90(11):1264–1270. doi:10.1177/0022034511399918
- Haag DG, Peres KG, Balasubramanian M, Brennan DS. Oral conditions and health-related quality of life: A systematic review. *J Dent Res*. 2017;96(8):864–874. doi:10.1177/0022034517709737
- Slade GD, Spencer AJ. Development and evaluation of the Oral Health Impact Profile. *Community Dent Health*. 1994;11(1):3–11.
- Slade GD. Derivation and validation of a short-form Oral Health Impact Profile. *Community Dent Oral Epidemiol*. 1997;25(4):284–290. doi:10.1111/j.1600-0528.1997.tb00941.x
- Rodríguez NI, Moral J. Adaptation and content validity by expert judgment of the Oral Health Impact Profile applied to Periodontal Disease. *J Oral Res*. 2017;6(4):92–96. doi:10.17126/joralres.2017.029
- He S, Wang J, Wei S, Ji P. Development and validation of a condition-specific measure for chronic periodontitis: Oral Health Impact Profile for Chronic Periodontitis. *J Clin Periodontol*. 2017;44(6):591–600. doi:10.1111/jcpe.12716
- Haye Biazevic MG, Rissotto RR, Michel-Crosato E, Amorim Mendes LA, Amorim Mendes MO. Relationship between oral health and its impact on quality of life among adolescents. *Braz Oral Res*. 2008;22(1):36–42. doi:10.1590/s1806-83242008000100007
- da Silva Araújo AC, Gusmão ES, Mazza Batista JE, Cimões R. Impact of periodontal disease on quality of life. *Quintessence Int*. 2010;41(6):e111–e118.
- Cohen-Carneiro F, Bessa Rebelo MA, Souza-Santos R, Bovi Ambrosano GM, Salino AV, Pontes DG. Psychometric properties of the OHIP-14 and prevalence and severity of oral health impacts in a rural riverine population in Amazonas State, Brazil. *Cad Saude Publica*. 2010;26(6):1122–1130. doi:10.1590/S0102-311X2010000600006
- Bandéca MC, Nadalin MR, Calixto LR, Saad JRC, da Silva SRC. Correlation between oral health perception and clinical factors in a Brazilian community. *Community Dent Health*. 2011;28(1):64–68.
- de Freitas Borges T, Regalo SC, Taba M Jr, Siéssere S, Mestriner W Jr, Semprini M. Changes in masticatory performance and quality of life in individuals with chronic periodontitis. *J Periodontol*. 2013;84(3):325–331. doi:10.1902/jop.2012.120069
- Palma PV, Caetano PL, Gonçalves Leite IC. Impact of periodontal diseases on health-related quality of life of users of the Brazilian Unified Health System. *Int J Dent*. 2013;2013:150357. doi:10.1155/2013/150357
- Batista MJ, Rihs Perianes LB, Hilgert JB, Hugo FN, de Sousa MdLR. The impacts of oral health on quality of life in working adults. *Braz Oral Res*. 2014;28(1):1–6. doi:10.1590/1807-3107BOR-2014.vol28.0040
- Meusel DRDZ, Ramacciato JC, Motta RHL, Brito RB Jr, Flório FM. Impact of the severity of chronic periodontal disease on quality of life. *J Oral Sci*. 2015;57(2):87–94. doi:10.2334/josnusd.5787
- de Vasconcellos Maia C, Mendes FM, Normando D. The impact of oral health on quality of life of urban and riverine populations of the Amazon: A multilevel analysis. *PLoS One*. 2018;13(11):e0208096. doi:10.1371/journal.pone.0208096
- Llanos AH, Benítez Silva CG, Ichimura KT, et al. Impact of aggressive periodontitis and chronic periodontitis on oral health-related quality of life. *Braz Oral Res*. 2018;32:e006. doi:10.1590/1807-3107bor-2018.vol32.0006
- de Santana Passos-Soares J, de Souza Santos LP, da Cruz SS, et al. The impact of caries in combination with periodontitis on oral health-related quality of life in Bahia, Brazil. *J Periodontol*. 2018;89(12):1407–1417. doi:10.1002/JPER.18-0047
- Acharya S. Oral health-related quality of life and its associated factors in an Indian adult population. *Oral Health Prev Dent*. 2008;6(3):175–184.
- Fotedar S, Sharma KR, Fotedar V, Bhardwaj V, Chauhan A, Manchanda K. Relationship between oral health status and oral health related quality of life in adults attending H.P. Government Dental College, Shimla, Himachal Pradesh – India. *Oral Health Dent Manag*. 2014;13(3):661–665.
- Sanadhya S, Aapaliya P, Jain S, Sharma N, Choudhary G, Dobaría N. Assessment and comparison of clinical dental status and its impact on oral health-related quality of life among rural and urban adults of Udaipur, India: A cross-sectional study. *J Basic Clin Pharm*. 2015;6(2):50–58. doi:10.4103/0976-0105.152091
- Grover V, Malhotra R, Dhawan S, Kaur G, Kapoor A. Comparative assessment of oral health related quality-of-life between rural and urban chronic periodontitis patients. *Saudi J Oral Sci*. 2015;2(1):19–24. doi:10.4103/1658-6816.150587
- Yadav T, Chopra P, Kapoor S. Association between chronic periodontitis and oral health-related quality of life in Indian adults. *J Int Oral Health*. 2019;11(5):280–286. doi:10.4103/jioh.jioh_50_19
- Jowett AK, Orr MTS, Rawlinson A, Robinson PG. Psychosocial impact of periodontal disease and its treatment with 24-h root surface debridement. *J Clin Periodontol*. 2009;36(5):413–418. doi:10.1111/j.1600-051X.2009.01384.x
- Bernabé E, Marcenes W. Periodontal disease and quality of life in British adults. *J Clin Periodontol*. 2010;37(11):968–972. doi:10.1111/j.1600-051X.2010.01627.x
- White DA, Tsakos G, Pitts NB, et al. Adult Dental Health Survey 2009: Common oral health conditions and their impact on the population. *Br Dent J*. 2012;213(11):567–572. doi:10.1038/sj.bdj.2012.1088
- Masood M, Younis LT, Masood Y, Bakri NN, Christian B. Relationship of periodontal disease and domains of oral health-related quality of life. *J Clin Periodontol*. 2019;46(2):170–180. doi:10.1111/jcpe.13072
- Fuller J, Donos N, Suvan J, Tsakos G, Nibali L. Association of oral health-related quality of life measures with aggressive and chronic periodontitis. *J Periodontol Res*. 2020;55(4):574–580. doi: 10.1111/jre.12745
- Eltas A, Uslu MO, Eltas SD. Association of oral health-related quality of life with periodontal status and treatment needs. *Oral Health Prev Dent*. 2016;14(4):339–347. doi:10.3290/j.ohpd.a35613
- Balci N, Alkan N, Gurgan CA. Psychometric properties of a Turkish version of the Oral Health Impact Profile-14. *Niger J Clin Pract*. 2017;20(1):19–24. doi:10.4103/1119-3077.164353
- Ustaoglu G, Bulut DG, Gümüş KÇ, Ankaralı H. Evaluation of the effects of different forms of periodontal diseases on quality of life with OHIP-14 and SF-36 questionnaires: A cross-sectional study. *Int J Dent Hyg*. 2019;17(4):343–349. doi:10.1111/idh.12409
- Beşiroğlu E, Lütfioğlu M. Relations between periodontal status, oral health-related quality of life and perceived oral health and oral health consciousness levels in a Turkish population. *Int J Dent Hyg*. 2020;18(3):251–260. doi: 0.1111/idh.12443

37. He S, Wei S, Wang J, Ji P. Chronic periodontitis and oral health-related quality of life in Chinese adults: A population-based, cross-sectional study. *J Periodontol*. 2018;89(3):275–284. doi:10.1002/JPER.16-0752
38. Ng SKS, Leung WK. Oral health-related quality of life and periodontal status. *Community Dent Oral Epidemiol*. 2006;34(2):114–122. doi:10.1111/j.1600-0528.2006.00267.x
39. Lawrence HP, Thomson WM, Broadbent JM, Poulton R. Oral health-related quality of life in a birth cohort of 32-year olds. *Community Dent Oral Epidemiol*. 2008;36(4):305–316. doi:10.1111/j.1600-0528.2007.00395.x
40. Mariño R, Schofield M, Wright C, Calache H, Minichiello V. Self-reported and clinically determined oral health status predictors for quality of life in dentate older migrant adults. *Community Oral Dent Epidemiol*. 2008;36(1):85–94. doi:10.1111/j.1600-0528.2007.00378.x
41. Slade GD, Sanders AE. The paradox of better subjective oral health in older age. *J Dent Res*. 2011;90(11):1279–1285. doi:10.1177/0022034511421931
42. Jansson H, Wahlin Å, Johansson V, et al. Impact of periodontal disease experience on oral health-related quality of life. *J Periodontol*. 2014;85(3):438–445. doi:10.1902/jop.2013.130188
43. Kato T, Abrahamsson I, Wide U, Hakeberg M. Periodontal disease among older people and its impact on oral health-related quality of life. *Gerodontology*. 2018;35(4):382–390. doi:10.1111/ger.12363
44. Brauchle F, Noack M, Reich E. Impact of periodontal disease and periodontal therapy on oral health-related quality of life. *Int Dent J*. 2013;63(6):306–311. doi:10.1111/idj.12042
45. Sonnenschein SK, Betzler C, Kohnen R, Krisam J, Kim TS. Oral health-related quality of life in patients under supportive periodontal therapy. *Acta Odontol Scand*. 2018;76(8):572–579. doi:10.1080/00016357.2018.1483528
46. Holde GE, Baker SR, Jönsson B. Periodontitis and quality of life: What is the role of socioeconomic status, sense of coherence, dental service use and oral health practices? An exploratory theory-guided analysis on a Norwegian population. *J Clin Periodontol*. 2018;45(7):768–779. doi:10.1111/jcpe.12906
47. Montero-Martin J, Bravo-Pérez M, Albaladejo-Martínez A, Hernández-Martín LA, Rosel-Gallardo EM. Validation the Oral Health Impact Profile (OHIP-14sp) for adults in Spain. *Med Oral Patol Oral Cir Bucal*. 2009;14(1):E44–E50.
48. Montero J, Albaladejo A, Zalba JI. Influence of the usual motivation for dental attendance on dental status and oral health-related quality of life. *Med Oral Patol Oral Cir Bucal*. 2014;19(3):e225–e231. doi:10.4317/medoral.19366
49. Carvalho JC, Mestrinho HD, Stevens S, van Wijk AJ. Do oral health conditions adversely impact young adults? *Caries Res*. 2015;49(3):266–274. doi:10.1159/000375377
50. Cunha-Cruz J, Hujuel PP, Kressin NR. Oral health-related quality of life of periodontal patients. *J Periodontol Res*. 2007;42(2):169–176. doi:10.1111/j.1600-0765.2006.00930.x
51. Wright CD, McNeil DW, Edwards CB, et al. Periodontal status and quality of life: Impact of fear of pain and dental fear. *Pain Res Manag*. 2017;2017:5491923. doi:10.1155/2017/5491923
52. Rodríguez Franco NI, de la Rubia JM. Oral Health Impact Profile scale applied to Periodontal Disease: Relationship with sociodemographic variables in general population and clinic samples from Monterrey, Mexico. *Open Dent J*. 2018;12:1152–1161. doi:10.2174/1874210601812011152
53. Levin L, Zini A, Levine J, et al. Demographic profile, Oral Health Impact Profile and Dental Anxiety Scale in patients with chronic periodontitis: A case-control study. *Int Dent J*. 2018;68(4):269–278. doi:10.1111/idj.12381
54. Al Habashneh R, Khader YS, Salameh S. Use of the Arabic version of Oral Health Impact Profile-14 to evaluate the impact of periodontal disease on oral health-related quality of life among Jordanian adults. *J Oral Sci*. 2012;54(1):113–120. doi:10.2334/josnusd.54.113
55. Khalifa N, Allen PF, Abu-bakr NH, Abdel-Rahman ME. Psychometric properties and performance of the Oral Health Impact Profile (OHIP-14s-ar) among Sudanese adults. *J Oral Sci*. 2013;55(2):123–132. doi:10.2334/josnusd.55.123
56. Lawal FB, Taiwo JO, Arowojolu MO. How valid are the psychometric properties of the Oral Health Impact Profile-14 measure in adult dental patients in Ibadan, Nigeria? *Ethiop J Health Sci*. 2014;24(3):235–242. doi:10.4314/ejhs.v24i3.7
57. Collins JR, Elías AR, Brache M, et al. Association between gingival parameters and oral health-related quality of life in Caribbean adults: A population-based cross-sectional study. *BMC Oral Health*. 2019;19(1):234. doi:10.1186/s12903-019-0931-1
58. Sulaiman L, Saub R, Baharuddin NA, et al. Impact of severe chronic periodontitis on oral health-related quality of life. *Oral Health Prev Dent*. 2019;17(4):365–373. doi:10.3290/j.ohpd.a42502
59. Goel K, Baral D. A comparison of impact of chronic periodontal diseases and nonsurgical periodontal therapy on oral health-related quality of life. *Int J Dent*. 2017;2017:9352562. doi:10.1155/2017/9352562
60. Wellapuli N, Ekanayake L. Association between chronic periodontitis and oral health-related quality of life in Sri Lankan adults. *Int Dent J*. 2016;66(6):337–343. doi:10.1111/idj.12255
61. Wang TF, Fang CH, Hsiao KJ, Chou C. Effect of a comprehensive plan for periodontal disease care on oral health-related quality of life in patients with periodontal disease in Taiwan. *Medicine (Baltimore)*. 2018;97(5):e9749. doi:10.1097/MD.00000000000009749
62. Wąsacz K, Pac A, Darczuk D, Chomyszyn-Gajewska M. Validation of a modified Oral Health Impact Profile scale (OHIP-14) in patients with oral mucosa lesions or periodontal disease. *Dent Med Probl*. 2019;56(3):231–237. doi:10.17219/dmp/109388
63. Grigoras S, Mărtu S, Balcos C. Quality of life regarding patients with periodontal disease in Iasi, Romania. *Procedia Soc Behav Sci*. 2014;127:15–20. doi:10.1016/j.sbspro.2014.03.204
64. Drachev SN, Brenn T, Trovik TA. Oral health-related quality of life in young adults: A survey of Russian undergraduate students. *Int J Environ Res Public Health*. 2019;15(4):719. doi:10.1016/j.sbspro.2014.03.204
65. Wells GA, Shea B, O'Connell D, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp. Accessed May 20, 2020.
66. Al-Harthi LS, Cullinan MP, Leichter JW, Thomson WM. The impact of periodontitis on oral health-related quality of life: A review of the evidence from observational study. *Aust Dent J*. 2013;58(3):274–277; quiz 384. doi:10.1111/adj.12076
67. Buset SL, Walter C, Friedmann A, Weiger R, Borgnakke WS, Zitzmann NU. Are periodontal diseases really silent? A systematic review of their effect on quality of life. *J Clin Periodontol*. 2016;43(3):333–344. doi:10.1111/jcpe.12517
68. Ferreira MC, Dias-Pereira AC, Branco-de-Almeida LS, Martins CC, Paiva SM. Impact of periodontal disease on quality of life: A systematic review. *J Periodontol Res*. 2017;54(4):651–665. doi:10.1111/jre.12436
69. Luo Y, McGrath C. Oral health and its impact on the life quality of homeless people in Hong Kong. *Community Dent Health*. 2008;25(2):137–142.
70. Eke PI, Dye BA, Wei L, et al. Prevalence of periodontitis in adults in the United States: 2009 and 2010. *J Dent Res*. 2012;91(10):914–920. doi:10.1177/0022034512457373