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Influence of physical exercise on periodontal disease: A meta-analysis

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Abstract

Background: Some studies indicate that physical exercise is associated with a lower prevalence of the periodontal disease. Similarly, subjects with a higher maximum oxygen consumption (VO_2max) are less likely to develop periodontal disease.

Objective: To assess the influence of physical exercise on periodontal disease.

Search and Selection Methods: A search for studies on physical exercise and periodontal disease was conducted in the following databases: PubMed (MEDLINE, Cochrane Library), Web of Science (WoS), and Scopus.

Data Analysis: For dichotomous outcomes, the estimates of effects of an intervention were expressed as odds ratios (OR) using Mantel-Haenszel (M-H) method, and for continuous outcomes, the estimates of effects of an intervention were expressed as mean differences (MD) using the inverse variance (IV) method, both with 95% confidence intervals.

Results: 20 studies were included in this meta-analysis. Regular physical exercise reduced by 23% the periodontitis risk (OR:0.77; p=0.001). Overweight-obese patients were 1.86 times more likely to have periodontitis (OR:1.86; p<0.01). Regarding periodontal parameters, subjects who performed regular physical exercise had significantly lower levels (p<0.05) of probing depth (PD), bleeding on probing (BOP), and clinical attachment loss (CAL). In contrast, the gingival (GI) and plaque (PI) indices did not vary markedly due to physical exercise, with no statistical significance (p>0.05).

Conclusions: Regular physical exercise improves periodontal status and reduces the risk of periodontitis.

Keywords: exercise, obesity, periodontitis, risk factors

Introduction

Periodontal disease is the second most prevalent oral disease in humans, affecting approximately 70% of the world population to varying degrees of involvement of tooth-supporting tissues (gingiva, periodontal ligament, and alveolar bone) [1]. Periodontal disease is an inflammatory disease of multifactorial etiology due to the interaction between bacterial pathogens, the host response, and both oral to general health habits [2].

Regular exercise improves cognitive activity, increases proprioception and total lung capacity, favors the maintenance of the cardiovascular system, enhances its function and prevents related pathologies, as well as reduces body fat [3]. Periodontal disease is an inflammatory oral disorder that may be positively influenced by physical activity. Although a clear relationship between exercise and periodontal disease has not been confirmed, several findings point to a potential protective role of physical exercise, mainly an anti-inflammatory effect, by modulating the immunological markers of various systemic inflammatory diseases [4]. Some studies indicate that exercise is associated with a lower prevalence of the periodontal disease. Similarly, subjects with higher maximum oxygen consumption (VO_2max) are less likely to develop periodontal disease [5]. This study aimed to assess the influence of physical exercise on periodontal disease.

Material and Methods

The two authors (ARA and DAPC) independently performed all the investigation stages (search, study selection, data extraction, and evaluation). Later, both authors jointly selected the articles to consider in this study.

Search strategy

The following databases PubMed (MEDLINE, Cochrane Library), Web of Science (WoS), and Scopus were searched for studies on exercise and periodontal disease up to October 2021. The search strategy included the combination of Medical Subjects Headings (MeSH) and free-text terms. The search terms were: ("exercise"[MeSH Terms] OR "physical activity") AND ("periodontal diseases"[MeSH Terms] OR “periodontitis”[MeSH Terms]); ("exercise" OR "physical activity") AND ("periodontitis"); KEY (("exercise" OR "physical activity") AND ("periodontitis")). No restrictions about the date or publication language of the articles were established. The exclusion criteria were: a) articles with a relevant risk of bias (score <4 points on

the Joanna Briggs Institute -JBI- checklist for analytical cross-sectional studies) [6], b) articles with no full-text availability, c) articles without clinical data, and d) studies with non-usable data.

Risk of bias assessment

The methodological quality of the studies and the risk of bias were assessed using the checklist for analytical cross-sectional studies developed by the Joanna Briggs Institute (JBI) that contains eight items [6]. It was based on study design, study conduct, and analysis of the outcome of interest. Studies with 7-8 positive replies (points) were categorized as low risk of bias (high quality); a score between 4 and 6 points as moderate risk of bias (moderate quality), and studies with less than 4 points, as high risk of bias (low quality). Articles with a high risk of bias were excluded from the study.

Statistic analysis

RevMan 5.4 program (The Cochrane Collaboration, Oxford, UK) was used to perform the meta-analysis. For dichotomous variables, the odds ratio (OR) was applied with the Mantel-Haenszel (MH) Chi-square formula and, for continuous variables, the inverse variance (IV) for the mean difference (MD) was used, both statistics with 95% confidence intervals (95% CI). Heterogeneity was established according to the Higgins statistic (I^2) expressed as percentages. When the heterogeneity was high (I^2>50%), the random-effects model was used. P-values below 0.05 were considered statistically significant.

Results

Study selection

In the initial search, 550 articles were found (141 in PubMed, 231 in WoS, and 178 in Scopus) between the years 1993 and 2021, 137 of them duplicates, leaving 413 articles to evaluate. The exclusion criteria were: a) articles with a high risk of bias (<4 points) according to the Joanna Briggs Institute (JBI) checklist for analytical cross-sectional studies [6] (n=103), b) articles with no full-text availability (n=94), c) articles without clinical data (n=71), and d) studies with non-usable data (n=125). After applying these criteria, 20 studies were included in this meta-analysis (figure 1).

Table 1 shows the main descriptive characteristics and the risk of bias according to the JBI checklist of the twenty studies included in this meta-analysis [7-26]. A total of 314 487 participants, 157 542 males (50.1%) and 156 945 females (49.9%) were considered in these articles. Considering the JBI checklist [6], ten articles (50%) had high methodological quality (++), and the other ten (50%) showed moderate methodological quality (+).

Exercise and periodontitis risk

The evaluation of the influence of physical exercise on periodontitis risk is presented in figure 2. Seventeen studies [7-15, 17-24] analyzed physical exercise, observing that it reduced by 23% the probability of developing periodontitis, with highly statistically significant differences (OR=0.77; CI95%: 0.66 to 0.90; p=0.001).

Other parameters (obesity and periodontal parameters)

The analysis of other parameters in periodontitis patients according to obesity and physical exercise is shown in table 2.

Four studies [13, 15, 18, 23] examined the possible relationship between obesity and periodontitis, finding that subjects with overweight-obesity increased 1.86-times the probability of having periodontal disease compared to individuals with normal weight. A statistically significant association between these two variables was observed (OR=1.86; 95%CI: 1.16 to 2.98; p<0.01).

Two studies [13, 25] evaluated the gingival index (GI), finding a GI reduction of 0.16 units in subjects who did physical exercise, although the results were not statistically significant (MD=-0.16; 95%CI: -0.37 to 0.04; p=0.11). Three studies [13, 25, 26] reviewed the plaque index (PI) also finding a PI lower by 0.09 units in individuals who exercised regularly. However, statistical significance was not reached either (MD=-0.09; 95%CI: -0.44 to 0.01; p=0.25). Four studies [13, 16, 25, 26] examined the probing depth (PD), showing that subjects with habitual physical activity had a PD 0.23 mm. lower than individuals without regular physical activity. After statistical analysis, significant differences were found (MD=-0.23; 95%CI: -0.44 to -0.01; p=0.04).

Three studies [16, 25, 26] inspected the bleeding on probing (BOP), noting a BOP reduction of 4.69 units in subjects who did physical exercise, with a highly statistically significant relationship (MD=-4.69; 95%CI: -7.74 to - 1.64; p<0.01). Other three studies [13, 16, 25] were focused on the clinical attachment loss (CAL), observing a mean decrease of 0.36 mm. among individuals who performed habitual physical exercise, with a highly statistically significant association (MD=-0.36; 95%CI: -0.56 to -0.16; p<0.001).

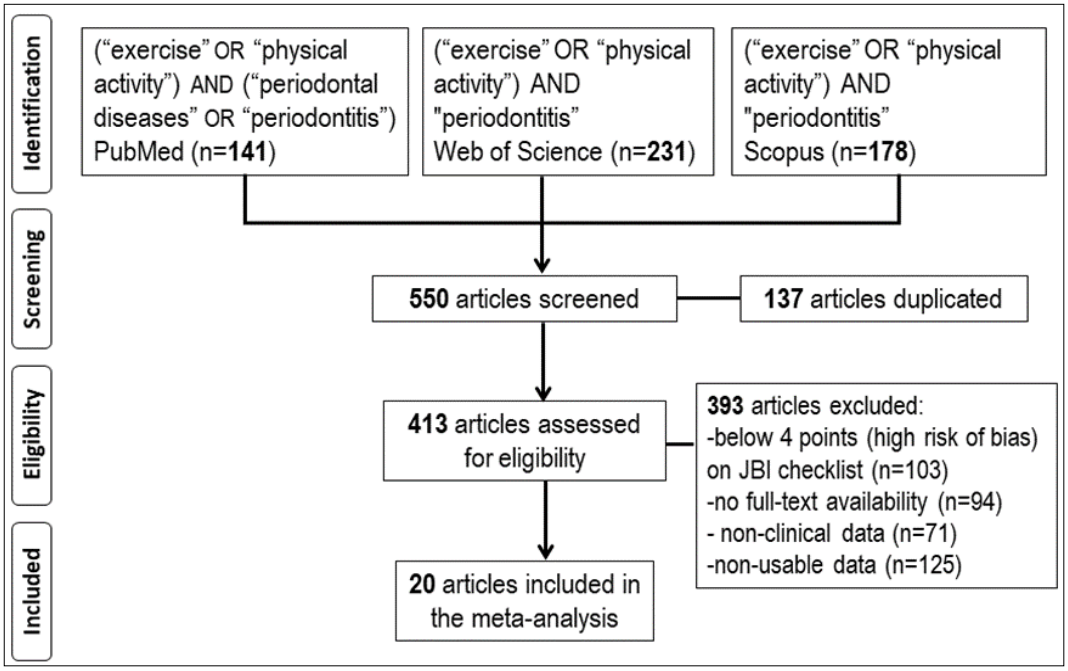

Fig 1: Flow diagram of study selection.

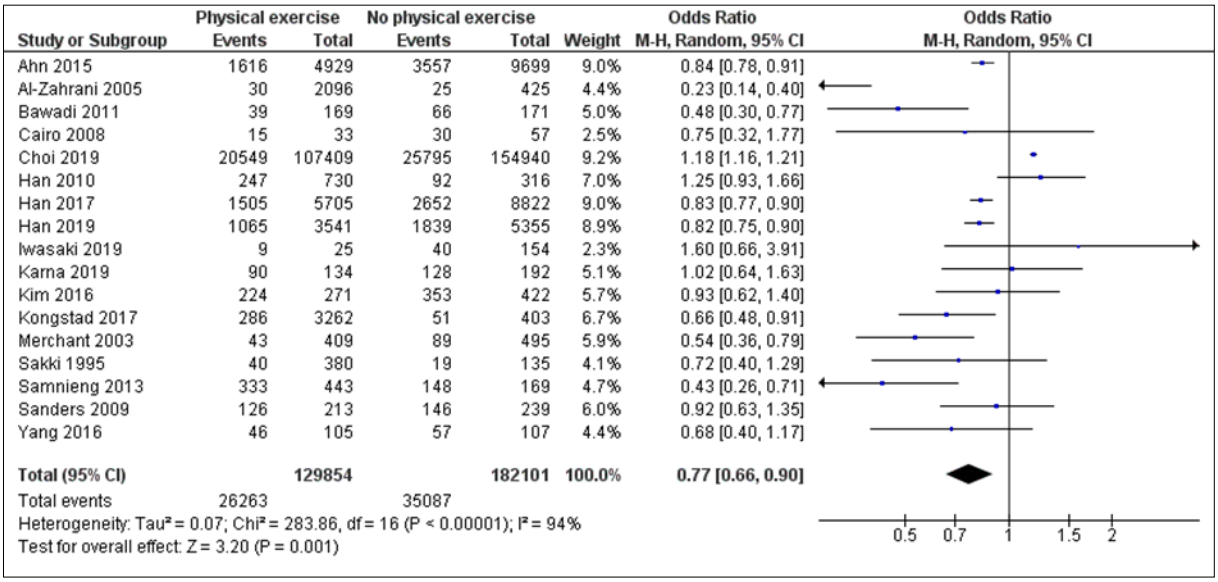

Fig 2: Study data and forest plot graph for the presence of periodontitis in subjects with and without regular physical exercise.

Table 1: Descriptive characteristics and methodological quality evaluation of the twenty studies included in this meta-analysis.

Study, year	Study population	Parameters analyzed	MSQ
Sakki, 1995 [7]	527 (266M, 261F; 55.0y)	Periodontal status, exercise, oral health, dietary, smoking, drinking, family income.	+
Merchant, 2003 [8]	2123 (2123M, 0F; na)	Periodontal status, exercise, smoking, drinking, diabetes, BMI.	+
Al-Zahrani, 2005 [9]	2521 (1245M, 1276F; 48.8y)	Periodontal status, exercise, smoking, dietary, vitamin intake, educational level.	++
Cairo, 2008 [10]	90 (48M, 42F; 35.1y)	Periodontal status, exercise, smoking, cardiovascular disease, blood pressure, BMI, educational level.	+
Sanders, 2009 [11]	751 (310M, 441F; na)	Periodontal status, exercise, smoking, BMI, diabetes, interleukin 1-β, C-reactive protein.	++
Han, 2010 [12]	1046 (476M, 570F; na)	Periodontal status, exercise, smoking, drinking, family income, oral health.	++
Bawadi, 2011 [13]	340 (168M, 172F; na)	Periodontal status, exercise, smoking, family income, educational level, BMI, oral health.	+

Samnieng, 2013 [14]	612 (158M, 454F; 68.8y)	Periodontal status, exercise, smoking, drinking, dietary, sleeping hours.	+
Ahn, 2015 [15]	14625 (6247M, 8378F; na)	periodontal status, exercise, family income, smoking, drinking, obesity, diabetes, hypertension, hypercholesterolemia	++
Oliveira, 2015 [16]	111 (111M, 0F; 34.8y)	Periodontal status, exercise, BMI, oral health.	+
Kim, 2016 [17]	693 (263M, 430F; 62.5y)	Periodontal status, exercise, educational level, smoking, drinking, obesity, metabolic syndrome.	++
Yang, 2016 [18]	212 (165M, 47F; 57.1y)	Periodontal status, exercise, educational level, drinking, BMI, diabetes, *Helicobacter pylori* infection.	+
Han, 2017 [19]	14527 (7183M, 7344F; 47.9y)	Periodontal status, exercise, family income, BMI, smoking, drinking, diabetes, hypertension, metabolic syndrome.	++
Kongstad, 2017 [20]	3665 (1425M, 2240F; 53.7y)	Periodontal status, exercise, smoking, drinking, BMI, C-reactive protein.	+
Choi, 2019 [21]	262349 (133026M, 129323F; 60.3y)	Periodontal status, exercise, smoking, drinking, family income, BMI, blood pressure.	++
Han, 2019 [22]	9728 (4110M, 5618F; 45.9y)	periodontal status, exercise, educational level, family income, smoking, diabetes, oral health	++
Iwasaki, 2019 [23]	179 (62M, 117F; 80.1y)	Periodontal status, exercise, educational level, smoking, oral health, obesity, diabetes, hypertension, depression.	++
Karna, 2019 [24]	326 (141M, 185F; 64.5y)	Periodontal status, exercise, smoking, drinking, educational level, metabolic syndrome.	++
Alkan, 2020 [25]	25 (0M, 25F; 47.5y)	Periodontal status, exercise, educational level, smoking, bruxism, oral health, various cytokines.	+
Wernicke,2021 [26]	37 (15M, 22F; na)	Periodontal status, exercise, smoking, BMI, diabetes, C-reactive protein.	+

MSQ: Methodological study quality according to the Joanna Briggs Institute (JBI) checklist for analytical cross-sectional studies (++: high, +: moderate, −: low); M: male; F: female; y: mean age in years; na: not available; BMI: body mass index.

Table 2: Analysis of different parameters in periodontitis patients according to obesity and physical exercise.

Parameter	Ref.	Outcome	OR/MD	(95% CI)	I^2	P-value
Obesity	[13,15,18,23]	overweight-obesity	OR: 1.86	(1.16 to 2.98)	79%	0.009*
Gingival index (GI)	[13,25]	exercise group	MD: -0.16	(-0.37 to 0.04)	57%	0.11
Plaque index (PI)	[13,25,26]	exercise group	MD: -0.09	(-0.23 to 0.06)	0%	0.25
Probing depth (PD)	[13,16,25,26]	exercise group	MD: -0.23	(-0.44 to -0.01)	89%	0.04*
Bleeding on probing (BOP)	[16,25,26]	exercise group	MD: -4.69	(-7.74 to -1.64)	35%	0.003*
Clinical attachment level (CAL)	[13,16,25]	exercise group	MD: -0.36	(-0.56 to -0.16)	63%	<0.001*

Ref.: references; **OR:** Odds Ratio; **MD:** mean difference; **(95% CI):** 95% confidence interval; I^2**:** Higgins statistic for heterogeneity (percentage); *****statistically significant.

Discussion

Data from 20 studies on the influence of physical exercise on periodontal disease have been included in this meta-analysis.

In the present study, performing physical exercise reduced by 23% the probability of having periodontitis, with a highly statistically significant association (p=0.001). Of the seventeen studies that analyzed the possible relationship between physical exercise and periodontitis, thirteen of them [7-11, 13-15, 17-20, 22, 24] confirmed this protective effect of physical exercise, while only three [12, 21, 23] did not observe a reduction in the periodontitis risk related to physical exercise. It has been seen that healthy lifestyle habits (physical exercise, healthy diet, or maintaining optimal weight) are factors related to a lower probability of periodontitis. Considering only physical exercise, sedentary individuals without physical activity had a prevalence of periodontitis of 25.2%; partially active subjects, 16.9% and decreased to 13% in individuals with regular physical exercise [13]. Although the link between periodontitis and physical exercise is not fully understood, it could result in a reduction in proinflammatory mediators such as tumor necrosis factor-alpha (TNF-α), interleukin 6 (IL-6), protein C reactive, and other mediators. By reducing the levels of inflammatory mediators, the inflammatory response in the periodontium and the probability of periodontitis decrease [9]. Additionally, physical exercise reduces the percentage of intra-abdominal fat, and consequently overweight/obesity, factors associated with various metabolic diseases, and the increase in inflammatory mediators. Physical exercise decreases insulin resistance, facilitating the control of diabetes mellitus and improving the periodontal status of diabetics [4, 9, 13].

Some studies [12, 21, 23] find a lower frequency of periodontitis in subjects who do not exercise. However, these studies do not focus on the possible direct relationship between physical exercise and periodontitis, but rather take into consideration other healthy lifestyle factors aimed at preventing oral diseases. These healthy lifestyle

habits (weight maintenance, balanced diet, staying active, avoiding harmful habits, or good oral hygiene) contribute to good general and oral health in the population [24].

In this study, overweight-obese subjects increased 1.86-times their probability of periodontitis with a statistically significant relationship ($p<0.01$). All the studies [13, 15, 18, 23] that evaluated the weight agreed in pointing out this higher prevalence of periodontitis in overweight-obese individuals. Poor diet and overweight contribute to an increase in adipocytes and intra-abdominal fat, facilitating the release of inflammatory cytokines that promote chronic inflammation as seen in periodontitis [13]. In addition, overweight-obesity affects cardiovascular diseases such as hypertension or metabolic diseases as relevant as diabetes mellitus. All of these systemic diseases are also associated with an increased periodontitis risk [25]. Since periodontitis is a multifactorial disease, when confounding risk factors (smoking, alcohol consumption, lack of exercise, hypercholesterolemia, hypertension, or diabetes mellitus) are excluded, the link between overweight-obesity and periodontitis is highlighted [15].

In the present study, the subjects who did physical exercise regularly presented better periodontal parameters than those who did not practice physical exercise. Physical exercise conditioned lower gingival (GI) and plaque (PI) indices, although the results were not statistically significant ($p>0.05$). In contrast, probing depth (PD), bleeding on probing (BOP), and clinical attachment loss (CAL) were significantly lower in individuals with regular physical activity, reaching statistical significance. All the studies [13, 16, 25, 26] that determined these periodontal variables found better periodontal parameters among those who performed physical exercise. Healthy lifestyle habits together with physical exercise seem to be the factors that most influenced the decrease in GI and PI indices, probably due to the decrease in inflammatory mediators [25].

The link between poorer physical condition and increased probing depth (PD) and clinical attachment loss (CAL) has been revealed. In turn, this higher PD and CAL were associated with increased serum levels of proinflammatory cytokines in the context of periodontal disease. This inflammatory mediators elevation can locally modify muscle metabolism and lead to the development of a feeling of fatigue, as a protective mechanism against muscle damage, and the maintenance of homeostasis and physical integrity. This feeling of increased fatigue induces the reduction or even the cessation of physical exercise, leading to a worse physical condition [16]. Sports activity brings an important decrease in bleeding on probing (BOP) and therefore a relevant improvement in the periodontal disease severity. Regular physical activity could induce a reduction in inflammatory processes in the oral cavity [26].

One of the limitations of this study is that the nature (aerobic, anaerobic), frequency, or intensity of physical exercise could not be adequately established. Either, the effect of increasing the time and/or intensity of physical activity on the periodontal status could not be determined. Stratified analysis was also not possible considering the possible confounding variables. The results of this meta-analysis should be interpreted with caution due to the high heterogeneity observed in some comparisons. Individual differences between studies could be conditioned by the study design, the methods used to collect information, the type of statistical analysis applied, or the characteristics of the study populations.

New studies in larger population samples with a longer follow-up time are required to assess the real role of physical exercise on the prevalence of periodontal disease.

Conclusions

In this meta-analysis, regular physical exercise reduced by 23% the periodontitis risk (OR: 0.77; $p=0.001$). Overweight-obese patients were 1.86 times more likely to have periodontitis (OR: 1.86; $p<0.01$). Regarding periodontal parameters, subjects who performed regular physical exercise had significantly lower levels ($p<0.05$) of probing depth (PD), bleeding on probing (BOP), and clinical attachment loss (CAL). In contrast, the gingival (GI) and plaque (PI) indices did not vary markedly due to physical exercise, with no statistical significance ($p>0.05$).

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