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Association of physical activity level and body mass index with periodontal disease severity: A cross-sectional study

Fiziksel aktivite düzeyi ve beden kitle indeksi ile periodontal hastalık şiddeti arasındaki ilişki: Kesitsel bir çalışma

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ABSTRACT

Aim: This cross-sectional study evaluated the relationship of physical activity (PA) level and body mass index (BMI) with periodontal disease severity in adults.

Materials and Methods: The study included 200 patients aged 18-65 years. Demographic data, systemic conditions, smoking status, oral hygiene practices, and dental attendance patterns were recorded. PA level was determined using the Turkish version of the International Physical Activity Questionnaire and categorized as low, moderate, or high. Periodontal status was assessed using clinical periodontal measurements and panoramic radiographs, and participants were classified as having gingivitis, stage I/II periodontitis, or stage III/IV periodontitis. BMI was categorized as underweight/normal weight, overweight, or obese/extremely obese. Statistical analyses included chi-square, Kruskal-Wallis, and Mann-Whitney U tests, as well as correlation analysis. Statistical significance was accepted at $p<0.05$.

Results: The periodontal groups comprised 115 patients with gingivitis, 24 with stage I/II periodontitis, and 61 with stage III/IV periodontitis. Age, education level, cardiovascular disease, dental visit frequency, and BMI were significantly related to periodontal status ($p<0.05$). PA level was not significantly related to periodontal status ($p=0.146$). Age, education level, cardiovascular disease, periodontal status, and PA level varied significantly across BMI categories. Higher BMI categories were linked to more advanced periodontal status and lower PA level ($p<0.05$).

Conclusion: BMI was associated with periodontal disease severity, whereas PA level was not directly associated with periodontal status. Differences in PA level across BMI categories suggest that lifestyle-related factors and body weight status can contribute to periodontal risk assessment.

Keywords: Periodontal diseases, physical activity, body mass index, obesity

Note: *This study was previously presented as an oral presentation at the FDI World Dental Congress (September 2024, Türkiye). The abstract of the presentation was published in a supplement issue of the International Dental Journal [2024;71(Suppl 1):23]. The present manuscript is a full-text article based on that work and has not been published elsewhere.*

ÖZ

Amaç: *Bu kesitsel çalışmada, yetişkin bireylerde fiziksel aktivite düzeyi ve beden kitle indeksinin periodontal hastalık şiddeti ile ilişkisi değerlendirildi.*

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Gereç ve Yöntem: *Çalışmaya 18–65 yaş aralığında 200 hasta dahil edildi. Katılımcıların demografik verileri, sistemik durumları, sigara kullanımı, ağız hijyeni uygulamaları ve diş hekimi ziyaret alışkanlıkları kaydedildi. Fiziksel aktivite düzeyi, Uluslararası Fiziksel Aktivite Anketi'nin Türkçe versiyonu ile belirlendi ve düşük, orta veya yüksek olarak sınıflandırıldı. Periodontal durum, klinik periodontal ölçümler ve panoramik radyografilerle değerlendirildi; katılımcılar gingivitis, evre I/II periodontitis veya evre III/IV periodontitis olarak gruplandırıldı. Beden kitle indeksi düşük kilolu/normal kilolu, fazla kilolu ve obez/aşırı obez olarak sınıflandırıldı. Veriler ki-kare, Kruskal-Wallis ve Mann-Whitney U testleri ile korelasyon analizi kullanılarak değerlendirildi. İstatistiksel anlamlılık düzeyi p<0,05 olarak kabul edildi.*

Bulgular: *Periodontal gruplar 115 gingivitisli, 24 evre I/II periodontitisli ve 61 evre III/IV periodontitisli hastadan oluştu. Yaş, eğitim düzeyi, kardiyovasküler hastalık, diş hekimi ziyaret sıklığı ve beden kitle indeksi periodontal durum ile anlamlı ilişki gösterdi (p<0,05). Fiziksel aktivite düzeyi periodontal durum ile anlamlı ilişkili değildi (p=0,146). Yaş, eğitim düzeyi, kardiyovasküler hastalık, periodontal durum ve fiziksel aktivite düzeyi beden kitle indeksi kategorilerine göre anlamlı farklılık gösterdi. Daha yüksek beden kitle indeksi kategorileri daha ileri periodontal durum ve daha düşük fiziksel aktivite düzeyi ile ilişkiliydi (p<0,05).*

Sonuç: *Beden kitle indeksi periodontal hastalık şiddeti ile ilişkili bulunurken, fiziksel aktivite düzeyi periodontal durum ile doğrudan ilişkili bulunmadı. Beden kitle indeksi kategorilerine göre fiziksel aktivite düzeyindeki farklılık, yaşam tarzı ile ilişkili özelliklerin ve vücut ağırlığı durumunun periodontal risk değerlendirmesine katkı sağlayabileceğini düşündürmektedir.*

Anahtar Sözcükler: *Periodontal hastalıklar; fiziksel aktivite; beden kitle indeksi; obezite*

Not: *Bu çalışma daha önce FDI World Dental Congress'te sözlü bildiri olarak sunulmuştur (Eylül 2024, Türkiye). Sunuma ait özet International Dental Journal'ın ek sayısında yayımlanmıştır [2024;71(Suppl 1):23]. Mevcut makale, bu çalışmaya dayanan tam metin makale olup daha önce başka bir yerde yayımlanmamıştır.*

INTRODUCTION

Periodontal diseases are highly prevalent inflammatory conditions that can affect individuals throughout adulthood (1,2). Gingivitis primarily affects the gingival tissues, whereas periodontitis involves irreversible destruction of the periodontal ligament and alveolar bone and can ultimately lead to tooth loss (3). Although dental biofilm plays a central role in disease initiation, periodontal breakdown is influenced by the host response as well as systemic and lifestyle-related factors (3,4). Thus, periodontal disease can be interpreted within a wider biological framework involving oral inflammation, metabolic health, and individual risk characteristics.

Excess body weight is one of the systemic factors repeatedly linked to periodontal disease. Body mass index (BMI) is widely used in clinical and epidemiological studies to define body weight status. Adipose tissue can promote chronic low-grade inflammation through cytokine release and adipokine imbalance, thereby increasing susceptibility to periodontal tissue breakdown (5). Previous systematic reviews and population-based investigations have shown that higher BMI is associated with periodontitis, although this relationship can differ according to study population, diagnostic criteria, and adjustment for confounders (6,7).

Physical activity is another lifestyle-related factor that can influence periodontal health. Several observational studies have suggested that individuals with higher physical activity levels have lower odds or prevalence of periodontitis (8-10). Nevertheless, the available evidence remains inconsistent. Recent studies indicate that the relationship between physical activity and periodontitis can depend on the type and context of activity (4). In addition, the clinical practice guideline includes risk factor control in the first step of periodontal therapy, while stating that it is still unclear whether increasing physical activity or reducing weight through lifestyle modification has a direct positive effect on periodontal health (11).

Recent evidence suggests that the association between physical activity and periodontitis can be more complex than a simple direct protective effect. This complexity can partly arise from differences in the type and context of physical activity, as leisure-time and occupational physical activity have been reported to show divergent associations with periodontitis (12). In addition, studies using different methodological approaches

have raised questions about whether the observed associations reflect a direct effect of physical activity itself or are influenced by related factors such as BMI, systemic inflammation and general health behaviors (13). Therefore, physical activity can be more meaningfully evaluated together with body weight status rather than as an isolated behavioral factor. This approach is also supported by recent evidence showing that adults with overweight or obesity and low physical activity can have a higher prevalence of severe periodontitis (7). Because physical activity is closely related to body weight regulation and metabolic health, evaluating physical activity and BMI together can help distinguish their independent and combined associations with periodontal disease (7, 13). This combined assessment can also clarify whether the relationship between physical activity and periodontal status is direct or partly mediated by body weight and related systemic factors.

The present cross-sectional study aimed to evaluate the associations of physical activity level and BMI with periodontal disease severity in adults, together with selected demographic, behavioral, and systemic characteristics. It was hypothesized that lower physical activity levels and higher BMI would be associated with more severe periodontal disease, while the relationship between physical activity and periodontal status could also vary according to body weight and other health-related factors.

MATERIALS and METHODS

Study design and population

This clinic-based cross-sectional study was carried out in the Department of Periodontology, Faculty of Dentistry, Trakya University, from March to May 2024. The study sample consisted of 200 consecutive first-time patients who met the eligibility criteria and agreed to participate.

Participants were considered eligible when they were between 18 and 65 years of age, had no fewer than 20 natural teeth other than third molars, had no known systemic condition with a potential effect on periodontal tissues, had not undergone periodontal therapy within the previous six months, were capable of completing both the periodontal examination and the physical activity assessment, and agreed to participate by providing written informed consent. Individuals outside the specified age range, those with diabetes mellitus, disabilities that prevented completion of the study procedures, or systemic diseases or medication use that could alter periodontal health were excluded.

All participants were informed verbally and in writing about the study procedures, and written informed consent was obtained before data collection. The study was performed in accordance with the 2013 revision of the Declaration of Helsinki and was approved by the Trakya University Non-Interventional Scientific Research Ethics Committee (approval number: TÜTF-GOBAEK 2024/201).

Questionnaire and physical activity assessment

Participants completed a structured questionnaire covering demographic, medical, and oral hygiene-related information. The recorded variables included age, sex, education level, chronic disease status, medication use, smoking status, use of dental floss and/or interdental brushes, and frequency of dental visits.

Physical activity (PA) level was determined using the Turkish short form of the International Physical Activity Questionnaire (IPAQ-SF), a self-report tool developed for assessing physical activity across diverse cultural and socio-economic settings (14). This seven-item questionnaire records activity during the preceding seven days, including vigorous-intensity activity, moderate-intensity activity, walking, and sitting. Total PA was calculated in metabolic equivalent task minutes per week (MET-min/week) using the standard MET coefficients for walking, moderate-intensity activity, and vigorous-intensity activity. Participants were then assigned to low, moderate, or high PA groups according to the IPAQ scoring protocol (10,14,15).

Periodontal examination

All participants received a clinical periodontal examination during their first visit. Before periodontal measurements, the number of teeth and history of periodontal disease were recorded.

Periodontal evaluation included probing depth (PD), clinical attachment level (CAL), and bleeding on probing (BoP). All measurements were performed by the same periodontist (E.A.A.) using a manual periodontal probe (Williams probe, Hu-Friedy; Chicago, IL, USA). Measurements were obtained from six sites per tooth (distobuccal, mid-buccal, mesiobuccal, distolingual/palatal, mid-lingual/palatal, and mesiolingual/palatal) on all teeth except third molars. PD was defined as the

distance from the gingival margin to the base of the periodontal pocket, and CAL was defined as the distance from the cementoenamel junction to the base of the pocket. BoP was recorded according to the presence or absence of bleeding after gentle probing (16).

Clinical periodontal findings and panoramic radiographs obtained for routine diagnostic purposes were used to assign participants to one of three periodontal status groups: gingivitis, Stage I/II periodontitis, or Stage III/IV periodontitis, according to the 2017 Classification of Periodontal and Peri-Implant Diseases and Conditions (3). Participants were assigned to the gingivitis group when gingival inflammation and BoP were present in the absence of CAL or radiographic evidence of bone loss related to periodontitis. Periodontitis was identified when CAL was observed interdentally at a minimum of two non-adjacent teeth. The diagnosis was also accepted when CAL of 3 mm or more on the buccal or oral surface, together with PD exceeding 3 mm, was detected at no fewer than two teeth, after excluding non-periodontal causes for these findings. Participants with periodontitis were subsequently grouped as Stage I/II or Stage III/IV based on the overall severity and extent of periodontal destruction, the amount of radiographic bone loss, tooth loss resulting from periodontitis, and the complexity features specified in the classification system. Because the sample consisted of patients attending a periodontology clinic, a separate periodontal health group was not created.

Body mass index

The same examiner (D.G.) measured each participant's body weight and height under standardized conditions, with participants wearing light clothing and no shoes. BMI was calculated as weight in kilograms divided by height squared in meters (kg/m²). Participants were initially assigned to standard BMI categories: underweight (<18.5 kg/m²), normal weight (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²), obese (30.0–39.9 kg/m²), and extremely obese (≥40.0 kg/m²) (17). For the statistical analyses, these categories were regrouped as underweight/normal weight, overweight, and obese/extremely obese.

Statistical analysis

Data analysis was performed with IBM SPSS Statistics Software (version 31.0.1.0; IBM Corp., Armonk, NY, USA). Demographic, clinical, and questionnaire-derived variables were summarized descriptively. Categorical data were expressed as n (%), while age was expressed as mean ± standard deviation.

Age distribution was checked using the Shapiro–Wilk test. Categorical variables were compared using the chi-square test. The Kruskal-Wallis test was used to compare age among periodontal status and BMI groups. Significant overall differences were followed by pairwise Mann-Whitney U tests. Correlations among BMI category, physical activity level, and periodontal status were evaluated using Spearman's rank correlation analysis. Statistical significance was accepted at $p<0.05$.

RESULTS

A total of 200 participants were included in the study. Of these, 115 participants (57.5%) were classified as having gingivitis, 24 (12.0%) as stage I/II periodontitis, and 61 (30.5%) as stage III/IV periodontitis. The mean age of the study population was 37.53 ± 13.57 years, and 103 participants (51.5%) were female.

The distribution of demographic, behavioral and systemic variables according to periodontal status is presented in Table-1. Age, education level, cardiovascular disease, dental visit frequency and BMI category were significantly associated with periodontal status ($p<0.001$, $p<0.001$, $p<0.001$, $p=0.028$ and $p<0.001$, respectively). Participants with stage III/IV periodontitis were older and more frequently had lower education level, cardiovascular disease, symptom-based dental attendance and overweight or obesity/extreme obesity. In contrast, PA level was not significantly associated with periodontal status ($p=0.146$).

The distribution of variables according to BMI category is shown in Table-2. Age, education level, cardiovascular disease, periodontal status and PA level differed significantly according to BMI category ($p<0.001$, $p<0.001$, $p=0.002$, $p<0.001$ and $p<0.001$, respectively). Higher BMI categories were associated with older age, lower education level, higher prevalence of cardiovascular disease, more advanced periodontal status and lower PA level.

Correlation analysis demonstrated a significant negative correlation between BMI category and PA level ($r=-0.377$, $p<0.001$), and a significant positive correlation between BMI category and periodontal status ($r=0.432$, $p<0.001$). No statistically significant correlation was observed between PA level and periodontal status ($r=-0.116$, $p=0.101$).

Table-1. Comparison of demographic, behavioral and systemic variables according to periodontal status

Variable	Total n=200	Gingivitis n=115	Stage I/II periodontitis n=24	Stage III/IV periodontitis n=61	p-value
Age [mean ± SD]	37.53 ± 13.57	31.60 ± 12.32[a]	39.79 ± 9.68[b]	47.82 ± 10.49[c]	**<0.001***
Sex [n (%)]					
Female	103 (51.5)	62 (53.9)	14 (58.3)	27 (44.3)	0.369
Male	97 (48.5)	53 (46.1)	10 (41.7)	34 (55.7)	
Education level [n (%)]					
Primary/secondary school	48 (24.0)	16 (13.9)	4 (16.7)	28 (45.9)	**<0.001***
High school	48 (24.0)	21 (18.3)	7 (29.2)	20 (32.8)	
University/higher education	104 (52.0)	78 (67.8)	13 (54.2)	13 (21.3)	
Smoking status [n (%)]					
Non-smoker	83 (41.5)	50 (43.5)	13 (54.2)	20 (32.8)	0.271
Former smoker	35 (17.5)	17 (14.8)	5 (20.8)	13 (21.3)	
Smoker	82 (41.0)	48 (41.7)	6 (25.0)	28 (45.9)	
Cardiovascular disease [n (%)]					
No	171 (85.5)	106 (92.2)	22 (91.7)	43 (70.5)	**<0.001***
Yes	29 (14.5)	9 (7.8)	2 (8.3)	18 (29.5)	
Interproximal cleaning [n (%)]					
No	150 (75.0)	82 (71.3)	16 (66.7)	52 (85.2)	0.076
Yes	50 (25.0)	33 (28.7)	8 (33.3)	9 (14.8)	
Dental visit frequency [n (%)]					
Every 6 months	20 (10.0)	18 (15.7)	2 (8.3)	0 (0.0)	**0.028***
Once a year	33 (16.5)	21 (18.3)	5 (20.8)	7 (11.5)	
Less often	32 (16.0)	17 (14.8)	4 (16.7)	11 (18.0)	
Only when symptomatic	115 (57.5)	59 (51.3)	13 (54.2)	43 (70.5)	
BMI category [n (%)]					
Underweight/normal weight	88 (44.0)	68 (59.1)	12 (50.0)	8 (13.1)	**<0.001***
Overweight	78 (39.0)	39 (33.9)	6 (25.0)	33 (54.1)	
Obese/extremely obese	34 (17.0)	8 (7.0)	6 (25.0)	20 (32.8)	
Physical activity level (IPAQ) [n (%)]					
Low	67 (33.5)	37 (32.2)	8 (33.3)	22 (36.1)	0.146
Moderate	82 (41.0)	41 (35.7)	12 (50.0)	29 (47.5)	
High	51 (25.5)	37 (32.2)	4 (16.7)	10 (16.4)	

*p<0.05. BMI, body mass index; IPAQ, International Physical Activity Questionnaire; SD, standard deviation. Categorical variables were evaluated with the chi-square test. Age was compared among groups using the Kruskal–Wallis test. Superscript lowercase letters denote significant pairwise differences based on post hoc Mann–Whitney U tests.

Table-2. Distribution of demographic, behavioral, and periodontal variables according to BMI category

Variable	Underweight/ normal n=88	Overweight n=78	Obese/ extremely obese n=34	p-value
Age [mean ± SD]	30.10 ± 10.34[a]	40.79 ± 13.12[b]	49.00 ± 11.17[c]	**<0.001***
Sex [n (%)]				
Female	46 (52.3)	40 (51.3)	17 (50.0)	0.974
Male	42 (47.7)	38 (48.7)	17 (50.0)	
Education level [n (%)]				
Primary/secondary school	10 (11.4)	21 (26.9)	17 (50.0)	**<0.001***
High school	17 (19.3)	23 (29.5)	8 (23.5)	
University/higher education	61 (69.3)	34 (43.6)	9 (26.5)	
Smoking status [n (%)]				
Non-smoker	35 (39.8)	30 (38.5)	18 (52.9)	0.286
Former smoker	12 (13.6)	18 (23.1)	5 (14.7)	
Smoker	41 (46.6)	30 (38.5)	11 (32.4)	
Cardiovascular disease [n (%)]				

No	84 (95.5)	61 (78.2)	26 (76.5)	**0.002***
Yes	4 (4.5)	17 (21.8)	8 (23.5)	
Periodontal status [n (%)]				
Gingivitis	68 (77.3)	39 (50.0)	8 (23.5)	**<0.001***
Stage I/II periodontitis	12 (13.6)	6 (7.7)	6 (17.6)	
Stage III/IV periodontitis	8 (9.1)	33 (42.3)	20 (58.8)	
Physical activity level (IPAQ), [n (%)]				
Low	16 (18.2)	31 (39.7)	20 (58.8)	**<0.001***
Moderate	35 (39.8)	37 (47.4)	10 (29.4)	
High	37 (42.0)	10 (12.8)	4 (11.8)	

*p<0.05. BMI, body mass index; IPAQ, International Physical Activity Questionnaire; SD, standard deviation. Categorical variables were evaluated with the chi-square test. Age was compared among groups using the Kruskal–Wallis test. Superscript lowercase letters denote significant pairwise differences based on post hoc Mann–Whitney U tests.

DISCUSSION

This cross-sectional study investigated the relationships among PA level, BMI, and periodontal disease severity in adults. The principal finding was that BMI category was significantly related to periodontal status, whereas PA level was not directly associated with periodontal disease severity. However, PA level differed according to BMI category, and an inverse correlation was observed between BMI category and PA level. These findings suggest that body weight status can have a more evident relationship with periodontal disease severity in this study population, while PA may be relevant mainly as part of a broader lifestyle and metabolic profile.

Periodontitis is a chronic inflammatory disease with a substantial global burden, and its clinical expression is shaped by interactions among microbial biofilm, host response, systemic status, and lifestyle-related characteristics (1-3). In the present study, stage III/IV periodontitis was more frequent among participants with overweight and obesity/extreme obesity. This finding is consistent with previous evidence supporting a relationship between excess body weight and periodontitis. Suvan et al. (6) reported an association between overweight/obesity and periodontitis in adults, and more recent evidence has supported this relationship (18,19). In addition, Liu et al. (20) reported significant associations of both BMI and waist circumference with periodontitis in adults. Biologically, this relationship can be explained by systemic low-grade inflammation, oxidative stress, adipokine dysregulation, and altered immune-inflammatory responses (5,21). Although the cross-sectional nature of the present study does not allow causal conclusions, the greater frequency of advanced periodontitis in higher BMI categories supports the relevance of body weight status in periodontal risk assessment.

The present BMI-related findings are also compatible with the study by Reda et al. (7), who evaluated BMI and PA together and reported that individuals with overweight or obesity and low physical activity had a higher prevalence of severe periodontitis. In our study, BMI category was positively correlated with periodontal status and negatively correlated with PA level. However, the present study did not demonstrate a significant direct association between PA level and periodontal status. Differences in study design, periodontal case definition, sample size, participant characteristics, and physical activity assessment can explain this discrepancy.

Several observational studies have reported favorable relationships between physical activity and periodontal health. Merchant et al. (8) found that increased physical activity was associated with lower periodontitis risk in men, while Al-Zahrani et al. (9) reported a lower prevalence of periodontitis among physically active individuals. Similar associations were also reported by Bawadi et al. (10), and systematic reviews have suggested that physical activity can be associated with a reduced prevalence of periodontal disease (4,22). In the present study, high physical activity was numerically more frequent in the gingivitis group than in the periodontitis groups, but this difference did not reach statistical significance. Therefore, the present findings do not provide clear evidence for a direct relationship between self-reported PA level and periodontal disease severity.

The absence of a significant direct association should be interpreted in relation to the method used to measure PA. Although the short form of the IPAQ is a validated and widely used tool, it relies on self-reported activity during the previous

seven days and provides a general activity category rather than detailed information on long-term behavior patterns (14,15). Different domains of PA may also have different relationships with periodontal outcomes. Marruganti et al. (12) reported divergent associations between leisure-time and occupational physical activity and periodontitis, while Fu et al. (23) suggested that leisure-time physical activity and smoking exposure can interact in relation to periodontitis risk. Sedentary behavior can add relevant information beyond total PA level, as suggested by Almohamad et al. (24) and Şen et al. (25). Findings related to regular walking and structured PA intervention in metabolically vulnerable patients further suggest that the type and clinical context of PA can be important when evaluating its relationship with periodontal health (26,27). Thus, the lack of a significant association in the present study may reflect the complexity of PA-related behaviors rather than the absence of any relationship with periodontal health.

The relationship between physical activity and periodontitis can therefore be indirect or mediated through other health-related factors. Chan et al. (28) described physical activity as a potentially modifiable behavioral factor for periodontal disease but noted that causality has not been established and that its effects can be mediated through obesity, metabolic health, stress, inflammatory pathways, and other health-related behaviors. Regular physical activity can also improve psychological well-being and influence neuroactive mediators, including endorphins, serotonin, and dopamine (29). Through interactions among the nervous, endocrine, and immune systems, these responses could contribute to improved immune regulation and attenuation of systemic inflammation, thereby indirectly affecting periodontal health (29, 30). Nevertheless, this psychoneuroimmunological pathway remains a plausible hypothesis and requires further investigation. Similarly, Baumeister et al. (13) found no clear evidence for a causal effect of physical activity on periodontitis risk. This interpretation is consistent with the present study, in which PA level was associated with BMI category but was not directly associated with periodontal status.

Age, education level, and cardiovascular disease frequency were also related to periodontal status and/or BMI category. Participants with stage III/IV periodontitis were older, and mean age increased across BMI categories. This pattern is compatible with the cumulative nature of periodontal tissue loss and the possible role of age-related systemic changes in periodontal susceptibility (31). Lower education level was more frequent among participants with advanced periodontitis and higher BMI, which is in line with previous evidence linking lower educational attainment with increased periodontitis risk (32). This association may reflect differences in health literacy, preventive care, oral hygiene practices, dietary habits, and general health awareness. Cardiovascular disease was also more frequent among participants with stage III/IV periodontitis and among those with higher BMI. Although no causal inference can be made, this finding is consistent with evidence connecting severe periodontitis and cardiovascular disease and can reflect shared inflammatory and lifestyle-related risk profiles (33). In addition, symptom-based dental attendance was more common in the stage III/IV periodontitis group, suggesting that delayed or problem-oriented dental care can accompany more advanced periodontal conditions. However, the direction of these associations cannot be determined from cross-sectional data.

This study has several limitations. The cross-sectional design prevents causal interpretation. Because participants were recruited from a periodontology clinic, the findings may not be generalizable to the broader population. Physical activity was assessed by self-report and reflected a short recall period, which can have introduced reporting bias. Another limitation is that leisure-time, occupational, transportation-related, and sedentary behaviors were not analyzed separately. Finally, although demographic, behavioral, systemic, and BMI-related variables were evaluated, residual confounding remains possible. Further longitudinal studies with more detailed assessment of PA, including activity type, intensity, duration, sedentary behavior, and metabolic status, are needed to clarify its relationship with periodontal disease development and progression.

CONCLUSION

Within the limitations of this study, BMI category was related to periodontal disease severity, while self-reported PA level was not directly associated with periodontal status. However, PA level differed according to BMI category. These findings indicate that body weight status can be an

important component of periodontal risk assessment and that PA should be interpreted together with BMI and lifestyle-related health characteristics.

Conflict of Interest: The authors declare that they have no conflict of interest related to this study.

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References

1. Chen MX, Zhong YJ, Dong QQ, Wong HM, Wen YF. Global, regional, and national burden of severe periodontitis, 1990–2019: An analysis of the Global Burden of Disease Study 2019. J Clin Periodontol 2021;48(9):1165-88. doi:10.1111/jcpe.13506
2. Tonetti MS, Jepsen S, Jin L, Otomo-Corgel J. Impact of the global burden of periodontal diseases on health, nutrition and wellbeing of mankind: A call for global action. J Clin Periodontol 2017;44(5):456-62. doi:10.1111/jcpe.12732
3. Papapanou PN, Sanz M, Buduneli N, Dietrich T, Feres M, Fine DH, et al. Periodontitis: Consensus report of workgroup 2 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. J Periodontol 2018;89(Suppl 1):S173-82. doi:10.1002/jper.17-0721
4. Ferreira RDO, Corrêa MG, Magno MB, Almeida APCPSC, Fagundes NCF, Rosing CK, et al. Physical activity reduces the prevalence of periodontal disease: Systematic review and meta-analysis. Front Physiol 2019;10:234. doi:10.3389/fphys.2019.00234
5. Reytor-González C, Parise-Vasco JM, González N, Simancas-Racines A, Zambrano-Villacres R, Zambrano AK, et al. Obesity and periodontitis: A comprehensive review of their interconnected pathophysiology and clinical implications. Front Nutr 2024;11:1440216. doi:10.3389/fnut.2024.1440216
6. Suvan J, D'Aiuto F, Moles DR, Petrie A, Donos N. Association between overweight/obesity and periodontitis in adults. A systematic review. Obes Rev 2011;12(5):e381-404. doi:10.1111/j.1467-789X.2010.00808.x
7. Reda M, Koldsland OC, Bhatta L, Sen A. Body mass index, physical activity, and severe periodontitis: A cross-sectional HUNT4 Oral Health Study. BMC Oral Health 2026;26(1):404. doi:10.1186/s12903-026-07882-x
8. Merchant AT, Pitiphat W, Rimm EB, Joshipura K. Increased physical activity decreases periodontitis risk in men. Eur J Epidemiol 2003;18(9):891-8. doi:10.1023/A:1025622815579
9. Al-Zahrani MS, Borawski EA, Bissada NF. Increased physical activity reduces prevalence of periodontitis. J Dent 2005;33(9):703-10. doi:10.1016/j.jdent.2005.01.004
10. Bawadi HA, Khader YS, Haroun TF, Al-Omari M, Tayyem RF. The association between periodontal disease, physical activity and healthy diet among adults in Jordan. J Periodontal Res 2011;46(1):74-81. doi:10.1111/j.1600-0765.2010.01314.x
11. Sanz M, Herrera D, Kebschull M, Chapple I, Jepsen S, Berglundh T, et al. Treatment of stage I–III periodontitis: The EFP S3 level clinical practice guideline. J Clin Periodontol 2020;47(Suppl 22):4-60. doi:10.1111/jcpe.13290
12. Marruganti C, Baima G, Grandini S, Graziani F, Aimetti M, Sanz M, et al. Leisure-time and occupational physical activity demonstrate divergent associations with periodontitis: A population-based study. J Clin Periodontol 2023;50(5):559-70. doi:10.1111/jcpe.13766
13. Baumeister SE, Reckelkamm SL, Ehmke B, Nolde M, Baurecht H. Physical activity and the risk of periodontitis: An instrumental variable study. Clin Oral Investig 2023;27(8):4803-8. doi:10.1007/s00784-023-05109-9
14. Saglam M, Arikan H, Savci S, Inal-Ince D, Bosnak-Guclu M, Karabulut E, et al. International Physical Activity Questionnaire: Reliability and validity of the Turkish version. Percept Mot Skills 2010;111(1):278-84. doi:10.2466/06.08.PMS.111.4.278-284
15. Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, et al. International Physical Activity Questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 2003;35(8):1381-95. doi:10.1249/01.MSS.0000078924.61453.FB
16. Chapple ILC, Mealey BL, Van Dyke TE, Bartold PM, Dommisch H, Eickholz P, et al. Periodontal health and gingival diseases and conditions on an intact and a reduced periodontium: Consensus report of workgroup 1 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. J Periodontol 2018;89(Suppl 1):S74-84. doi:10.1002/JPER.17-0719
17. World Health Organization. Obesity: Preventing and managing the global epidemic. Report of a WHO consultation. World Health Organ Tech Rep Ser 2000;894:1-253. PMID:11234459
18. Kim CM, Lee S, Hwang W, Son E, Kim TW, Kim K, et al. Obesity and periodontitis: A systematic review and updated meta-analysis. Front Endocrinol 2022;13:999455. doi:10.3389/fendo.2022.999455

19. Arbildo-Vega HI, Cruzado-Oliva FH, Coronel-Zubiate FT, Aguirre-Ipenza R, Meza-Málaga JM, Luján-Valencia SA, et al. Association between periodontal disease and obesity: Umbrella review. Medicina 2024;60(4):621. doi:10.3390/medicina60040621
20. Liu L, Xia LY, Gao YJ, Dong XH, Gong RG, Xu J. Association between obesity and periodontitis in US adults: NHANES 2011–2014. Obes Facts 2024;17(1):47-58. doi:10.1159/000534751
21. Checa-Ros A, Hsueh WC, Merck B, González-Torres H, Bermúdez V, D'Marco L. Obesity and oral health: The link between adipokines and periodontitis. touchREV Endocrinol 2024;20(1):62-8. doi:10.17925/EE.2024.20.1.7
22. Cao R, Qiu P, Zhou Y, Dong B, Han Y, Fan Z. The underlying relationship between exercise and the prevalence of periodontitis: A systematic review and meta-analysis. BMC Sports Sci Med Rehabil 2023;15(1):161. doi:10.1186/s13102-023-00759-4
23. Fu H, Zhang D, Li Y. NHANES-based analysis of the correlation between leisure-time physical activity, serum cotinine levels and periodontitis risk. BMC Oral Health 2024;24(1):466. doi:10.1186/s12903-024-04141-9
24. Almohamad M, Krall Kaye E, Mofleh D, Spartano NL. The association of sedentary behaviour and physical activity with periodontal disease in NHANES 2011–2012. J Clin Periodontol 2022;49(8):758-67. doi:10.1111/jcpe.13669
25. Şen DÖ, Yarkaç FU, Eroğlu ZT, Yıldız K. The relationship between periodontal status, physical activity, dietary practices, and dental caries. Sci Rep 2024;14(1):29086. doi:10.1038/s41598-024-73690-4
26. Wernicke K, Grischke J, Stiesch M, Zeissler S, Krüger K, Bauer P, et al. Influence of physical activity on periodontal health in patients with type 2 diabetes mellitus. A blinded, randomized, controlled trial. Clin Oral Investig 2021;25(11):6101-7. doi:10.1007/s00784-021-03908-6
27. Han SJ, Bae KH, Lee HJ, Kim SJ, Cho HJ. Association between regular walking and periodontitis according to socioeconomic status: A cross-sectional study. Sci Rep 2019;9(1):12969. doi:10.1038/s41598-019-49505-2
28. Chan CCK, Chan AKY, Chu CH, Tsang YC. Physical activity as a modifiable risk factor for periodontal disease. Front Oral Health 2023;4:1266462. doi:10.3389/froh.2023.1266462
29. Ren J, Xiao H. Exercise for mental well-being: Exploring neurobiological advances and intervention effects in depression. Life (Basel) 2023;13(7):1505. doi:10.3390/life13071505
30. Nimmo MA, Leggate M, Viana JL, King JA. The effect of physical activity on mediators of inflammation. Diabetes Obes Metab 2013;15(Suppl 3):51-60. doi:10.1111/dom.12156
31. Tonetti MS, Bottenberg P, Conrads G, Eickholz P, Heasman P, Huysmans M, et al. Dental caries and periodontal diseases in the ageing population: Call to action to protect and enhance oral health and well-being as an essential component of healthy ageing. J Clin Periodontol 2017;44(Suppl 18):S135-44. doi:10.1111/jcpe.12681
32. Boillot A, El Halabi B, Batty GD, Rangé H, Czernichow S, Bouchard P. Education as a predictor of chronic periodontitis: A systematic review with meta-analysis population-based studies. PLoS One 2011;6(7):e21508. doi:10.1371/journal.pone.0021508
33. Sanz M, Marco Del Castillo A, Jepsen S, Gonzalez-Juanatey JR, D'Aiuto F, Bouchard P, et al. Periodontitis and cardiovascular diseases: Consensus report. J Clin Periodontol 2020;47(3):268-88. doi:10.1111/jcpe.13189