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Original Article

# Does the guideline-based physical activity level for cardiovascular health also benefit periodontal health?

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## KEYWORDS

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**Abstract Background/purpose:** It is unclear about whether the guideline-based physical activity (PA) level for cardiovascular health also benefits periodontal health. Therefore, this study aimed to clarify the association between guideline-based PA levels and periodontitis in young adults.

**Materials and methods:** This was a cross-sectional study which included 334 military participants, aged 18–44 years in Taiwan. The PA level was assessed by total running time per week (wk) in the past 6 months from a self-reported questionnaire, and was classified as moderate intensity PA <150, 150–299, and ≥300 min/wk according to the American guideline for cardiovascular health. Periodontitis was defined based on the 2017 World Workshop. Multiple logistic regression analysis was used to determine the association with adjustment for age, sex, educational level, tobacco smoking, alcohol intake, body mass index, waist circumference, blood pressure and teeth brushing frequency.

**Results:** As compared to the PA: 150–299 min/wk, the PA <150 min/wk was associated with a greater possibility of periodontitis (odds ratio (OR): 2.45 (95% confidence interval (CI):

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1.24–4.82), whereas the PA  $\geq 300$  min/wk was not associated with periodontitis (OR: 0.98 (95% CI: 0.13–1.09)) in young adults.

**Conclusion:** The guideline-based moderate intensity PA level  $\geq 150$  min/wk is found to have superior periodontal health in young adults. However, there is no additional benefit in more exercise time to obtain better periodontal health when the suggested PA level has been achieved.

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## Introduction

Periodontitis is a long lasting low-grade inflammatory disease and featured by a dysbiosis of microorganisms in oral cavity.<sup>1</sup> Periodontal pathogens affect systemic health by directly invading bloodstream or indirectly by increasing systemic levels of inflammatory mediators.<sup>2</sup> However, periodontitis tends to be a “silent” disease until the periodontium destruction resulting in symptoms. This phenomenon makes it easy for most people to be unaware of potential infection in the oral cavity.

Periodontitis is the sixth most common disease in the general population,<sup>3</sup> and is associated with several modifiable risk factors, e.g., metabolic syndrome, obesity, active tobacco smoking and poor oral hygiene.<sup>4–7</sup> With regard to physical activity (PA), which is related to metabolic syndrome and obesity, the results for the periodontitis association were inconsistent in the existing literature. Greater levels of PA have been demonstrated as a protective factor of periodontitis<sup>8</sup> or not as a predictor of periodontitis<sup>9,10</sup> in the general populations, and in contrast as a risk factor of periodontitis in elite athletes.<sup>11</sup>

In 2018, the American guideline suggested moderate intensity PA, e.g., running  $\geq 150$  min/week (wk) for cardiovascular health in adults.<sup>12</sup> However, it is unclear about whether the guideline-based PA level also benefits periodontal health. Therefore, this study aimed to investigate the association of moderate intensity PA levels with periodontitis in young adults.

## Materials and methods

### Study population

This was a cross-sectional study from the ancillary cardio-respiratory fitness and health in eastern armed forces (CHIEF) -oral health study.<sup>12–15</sup> Participants were recruited from the military for their regular annual whole-body health examinations in the Hualien Armed Forces General Hospital, the only military referral hospital in Eastern Taiwan, in 2018–2020. Participants who received an oral examination and an assessment of the PA levels were eligible in this study. Participants were excluded if their relevant data were not reported in detail, e.g., uncertain PA levels per week.

### Clinical and demographic measures

The whole-body health examinations included measurements of body height, body weight, body mass index, defined as the body weight (kg) divided by the body height

squared ( $m^2$ ) and waist circumference in a standing position. The hemodynamic parameters, i.e., blood pressure (BP) and pulse rate were measured over right upper arm at rest, using an automatic device (Parama-Tech Co Ltd, Fukuoka, Japan). A questionnaire was utilized to assess each participant’s education level (up to senior high school, college/university degree, and postgraduate degree), tobacco smoking status and alcohol intake status (active vs. former or never) and daily tooth brushing times (1, 2 and  $\geq 3$ ).

### Moderate intensity physical activity levels

The self-reported moderate intensity PA levels were assessed by weekly total running time (<150, 150–299 and  $\geq 300$  min/wk) on average during leisure time in the past 6 months according to the 2018 American guideline<sup>16</sup> as low, adequate and high levels.

### Periodontal health measures

The European Federation of Periodontology (EFP)/American Academy of Periodontology (AAP) joint workshop in 2017 on the periodontal diseases was utilized to define the presence of periodontitis.<sup>17</sup> Since participants were young adults, the extension of periodontitis was localized in the present study (<30% of teeth involved).<sup>17</sup> Full mouth examination of each participant was performed by the same dentist at the enrollment and the status of periodontitis was rechecked and treated at the outpatient department within one month. The inter observer agreement (kappa coefficient) for verifying the periodontitis was estimated 96.3%.

### Statistical analysis

The participants were divided to those with and without periodontitis. To evaluate differences between the two groups, analysis of variance (ANOVA) was used for continuous variables and chi-square test was used for categorical variables. Multiple logistic regression analysis with adjustments for sex, age, education level, tobacco smoking status, alcohol intake status, body mass index, waist circumference, systolic BP and diastolic BP, was used to determine the association between moderate intensity PA levels and periodontitis in Model 1. Teeth brushing frequency was further adjusted in Model 2. All statistical analyses were performed with SPSS version 26.0 (IBM Corp., Chicago, IL, USA). A  $P$ -value  $< 0.05$  was considered statistically significant. This study protocol has been approved by

the Ethics Committee of the Mennonite Christian Hospital (No. 16-05-008) in Taiwan, and all participants written an informed consent.

## Results

In total, 361 subjects were eligible in this study, and 27 with incomplete PA information were excluded, leaving a sample of 334 participants for the final analysis. Since the participants were relatively young, no one had diabetes. Of them, the age averaged 32.61 years and the prevalence of periodontitis was 49.10%. The demographics and characteristics are shown in Table 1. There was a higher prevalence of male sex, active smokers, active alcohol consumers, and greater age and waist circumference were seen in those with periodontitis. On the contrary, those with periodontitis had a lower tooth brushing frequency.

Table 2 shows the multiple logistic regression analysis results for the presence of periodontitis with moderate intensity PA levels. As compared to those with PA: 150–299 min/wk, those with PA <150 min/wk had a greater possibility of periodontitis in Model 1 and Model 2 [odds ratios (ORs) and 95% confidence intervals (CIs): 1.71 (0.90–3.23) and 2.45 (1.24–4.82), respectively]. However, the possibility of periodontitis presence in those with PA ≥300 min/wk was not significantly higher than those with PA: 150–299 min/wk in Model 1 and Model 2 (ORs: 0.85 (0.50–1.42) and 0.98 (0.13–1.09), respectively).

## Discussion

To our best of knowledge, the present study is the first report to reveal an association of PA levels with periodontitis in young adults. We found that the possibility of periodontitis was higher in young adults with moderate intensity PA levels <150 min/wk, which is below the level suggested by the American guideline for cardiovascular health.<sup>11</sup> In addition, there were no additional benefits for the lower prevalence of periodontitis if the moderate intensity PA levels were over 300 min/wk. The benefits of PA on periodontitis may be offset by an increased risk of periodontitis in highly fit individuals, i.e., athletes.<sup>11</sup>

The National Health and Nutrition Examination Survey (NHANES) indicated those with insufficient PA had higher prevalence of periodontitis.<sup>18</sup> The NHANES study further identified that leisure-time rather than occupational PA could protect from periodontitis.<sup>19</sup> Occupational PA may relate to heavy physical labor, which, in turn, is associated with socioeconomic disadvantage, an established risk factor of periodontitis.<sup>20</sup> Sufficient PA has shown as an effective way to improve oral and systemic health through reducing inflammation and boosting immune system.<sup>21–23</sup>

The higher PA levels may not necessarily reduce the periodontitis risk. Athletes, particularly long-distance runners, would experience dry mouth due to mouth breathing and fluid loss, which increase periodontitis burden.<sup>11</sup> In addition, higher PA levels also decrease immunoglobulin A (IgA) concentration in saliva and increase serum pro-inflammatory markers, such as tumor necrosis factor

**Table 1** Clinical characteristics of the study military young population (n = 334).

	Without Periodontitis (N = 170)	With Periodontitis (N = 164)	P-value
Moderate intensity PA (%)			
<150 min/wk	28 (16.5)	37 (22.6)	0.36
150–299 min/wk	76 (44.7)	69 (42.1)	
≥300 min/wk	66 (38.8)	58 (35.4)	
Sex (%)			
Men	144 (84.7)	158 (96.3)	<0.01
Women	26 (15.3)	6 (3.7)	
Age (years)	31.88 ± 5.30	33.37 ± 4.09	<0.01
Education level (%)			
Up to senior high school	11 (6.5)	5 (3.0)	0.08
College or University degree	154 (90.6)	158 (96.3)	
Postgraduate degree	5 (2.9)	1 (0.6)	
Unhealthy behavior (%)			
Cigarette smoking, active	46 (27.1)	66 (40.2)	0.01
Alcohol intake, active	62 (36.5)	82 (50.0)	0.01
Systolic blood pressure (mmHg)	120.39 ± 12.64	122.19 ± 11.65	0.17
Diastolic blood pressure (mmHg)	72.88 ± 10.08	74.28 ± 9.45	0.19
Body mass index (kg/m <sup>2</sup> )	25.44 ± 3.24	26.08 ± 3.03	0.06
Waist circumference (cm)	84.36 ± 8.45	87.31 ± 8.10	<0.01
Tooth brushing frequency (%)			
1 time/day	2 (1.2)	12 (7.3)	<0.01
2 times/day	20 (11.8)	10 (6.1)	
≥3 times/day	148 (87.1)	142 (86.6)	

Continuous variables are expressed as mean ± SD (standard deviation), and categorical variables as N (%).

Abbreviations: PA, physical activity.

**Table 2** Association of moderate intensity physical activity levels with presence of periodontitis in military young adults.

Physical activity	Univariate			Multivariate					
	Crude model			Model 1			Model 2		
	ORs	95% CIs	P-value	ORs	95% CIs	P-value	ORs	95% CIs	P-value
<150 min/wk	1.44	0.80–2.59	0.22	1.71	0.90–3.23	0.10	2.45	1.24–4.82	0.01
150–299 min/wk	1.00			1.00			1.00		
≥300 min/wk	0.94	0.58–1.52	0.79	0.85	0.50–1.42	0.53	0.98	0.13–1.09	0.93
p-value for trend			0.20			0.04			0.02

Data are presented as odds ratios and 95% confidence intervals (CI) using multiple logistic regression analysis for.

Model 1: sex, age, smoking, alcohol intake, education level, systolic blood pressure, diastolic blood pressure, body mass index and waist circumference.

Model 2: Model 1 covariates plus teeth brushing frequency.

alpha (TNF- $\alpha$ ), interleukin (IL)-1 $\beta$ , IL-6, IL-8, IL-10 and C-reactive protein, and stress hormones, e.g., cortisol and adrenaline,<sup>24–28</sup> which will temporarily reduce cellular defense.<sup>29</sup> These negative reactions to intensive physical exercise may favor oral infections (open window theory).<sup>30,31</sup> Furthermore, higher PA levels may be related to psychological stress, which is considered as one of the most critical risk factors for periodontal destruction.<sup>32</sup>

This study has some strengths. First, the population included merely military young adults whose PA level and the initiation of periodontitis can be readily assessed and documented. Second, the high prevalence of periodontitis in our young military subjects is close to a prior epidemiology report for young adults in Taiwan.<sup>33</sup> Third, the military base environment, e.g., diets and lifestyles were similar, which may reduce the influence of unmeasured parameters. However, there are also several limitations in this study. First, the study design is cross-sectional, and the cause-and-effect relationship can't be established. Second, the military training courses involve various kinds of sports, making it difficult to estimate occupational effect of the intensity and aerobic/anaerobic activity on the possibility of periodontitis. Third, our sample is relatively small and could not analyze the association by the periodontitis severity. In addition, the status of periodontitis is usually less severe in young adults, and using a wide range of periodontitis severity as the outcome of interest in young adults may provide more practical evidence for the early prevention. However, the results in this study may not be appropriately applied to the elderly individuals who have a higher prevalence of severe periodontitis. Finally, the PA was self-reported, which may have recall bias.

In conclusion, obtaining the guideline-based moderate intensity PA level for cardiovascular health min/wk was also found to be associated with superior periodontal health in young adults. However, there was no additional benefit in more exercise time ( $\geq 300$  min/wk) to obtain better periodontal health when the minimal suggested PA level has been achieved. Whether this relationship is causal or merely association remains uncertain.

## Declaration of competing interest

The authors declare no conflicts of interest.

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