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The Association Between Sleep Quality, Fatigue and Periodontal Status: a Pilot Study

La asociación entre la calidad del sueño, la fatiga y el estado periodontal: un estudio piloto

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ABSTRACT: Reduced sleep duration, poor sleep quality and fatigue are related to reduced immunity and increased inflammatory markers. Due to its potential to influence inflammation, poor sleep quality and fatigue could be factors for periodontitis and quality of life. Ninety-three individuals with untreated periodontitis and thirty-one individuals with healthy gingiva were included in the study. The research involved a clinical examination and a questionnaire. Demographic information, information on oral health, oral hygiene habits, the Pittsburgh Sleep Quality Index, Jenkins Sleep Scale, Multidimensional Assessment of Fatigue Scale, and Oral Health Impact Profile-14 were included in the questionnaire. Patients were diagnosed based on the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. No statistically significant difference was revealed between sleep quality, fatigue, oral health related quality of life, and stage-grade of periodontitis ($p<0.05$). However, periodontitis group had higher Oral Health Impact Profile-14 scores ($p<0.05$). A statistically significantly lower sleep duration was observed in stage IV periodontitis group than the other groups ($p<0.05$). A statistically significant positive correlation was observed between the Pittsburgh Sleep Quality Index and the scores of the other questionnaires ($p<0.05$). The stage of periodontitis may impact sleep duration.

KEYWORDS: Fatigue; Gingival healthy; Oral health-related quality of life; Periodontal disease; Stage-grade periodontitis; Sleep quality.

RESUMEN: La reducción de la duración del sueño, la mala calidad del sueño y la fatiga están relacionados con una inmunidad reducida y un aumento de los marcadores inflamatorios. Debido a su potencial para influir en la inflamación, la mala calidad del sueño y la fatiga podrían ser factores determinantes en el desarrollo de la periodontitis e incidir en la calidad de vida. Noventa y tres personas con periodontitis no tratada, además de treinta y una personas con encía sana se incluyeron en el estudio. La investigación involucró un examen clínico y un cuestionario. En el cuestionario se incluyeron información demográfica, información sobre salud bucal, hábitos de higiene bucal, el índice de calidad del sueño de Pittsburgh, la escala de sueño de Jenkins, la escala de evaluación multidimensional de la fatiga y el perfil de impacto en la salud bucal-14. Los pacientes fueron diagnosticados en base al Taller Mundial 2017 sobre la Clasificación de Enfermedades y Condiciones Periodontales y Periimplantarias. No se revelaron diferencias estadísticamente significativas entre la calidad del sueño, la fatiga, la calidad de vida relacionada con la salud bucal y el grado de etapa de la periodontitis ($p<0,05$). Sin embargo, el grupo de periodontitis tuvo puntajes más altos en el Perfil de Impacto en la Salud Oral-14 ($p<0.05$). Se observó una duración del sueño significativamente menor desde el punto de vista estadístico en el grupo de periodontitis en estadio IV que en los otros grupos ($p<0,05$). Se observó una correlación positiva estadísticamente significativa entre el Índice de Calidad del Sueño de Pittsburgh y las puntuaciones de los otros cuestionarios ($p<0,05$). La etapa de la periodontitis puede afectar la duración del sueño.

PALABRAS CLAVE: Fatiga; Encías sanas; Calidad de vida relacionada con la salud bucal; Enfermedad periodontal; Periodontitis grado-etapa; Calidad del sueño.

INTRODUCTION

Periodontal diseases represent inflammatory diseases that impact the supporting tissues of the teeth, in which microbial etiological factors induce a number of host responses mediating inflammatory events (1). Inflammatory host response, which accelerates tissue destruction and disease progression, is impacted by risk factors, including genetics, smoking, diabetes mellitus, and poor oral hygiene (2).

Sleep is a biological process, which is crucial for maintaining normal brain functions, health, and well-being and takes a significant part in controlling the functions of many other body systems (3). Inadequate sleep has become a significant and increasingly common problem in modern society (4). In comparison with a few decades ago, significant changes in sleep culture are observed on a global scale due to the trend toward adopting the 24/7 lifestyle, longer shifts, and longer working hours. This situation leads to a considerable decrease in total sleep hours among adults and children (3,5).

There is a significant interaction between sleep and the immune system, and adequate "regenerative" sleep is required for the purpose of maintaining good immunity (3). Reduced sleep duration and poor sleep quality are related to reduced immunity and increased inflammatory markers, which have a profound effect on the emergence and progression of various infectious diseases (6,8).

In everyday speech, fatigue is usually used synonymously with sleepiness, and some rating scales interpret sleep tendency and sleepiness as a dimension of fatigue (9,10). Furthermore, fatigue is associated with proinflammatory cell production and high CRP levels. It is also argued that inflammation makes a potential contribution to the development of fatigue (10).

Many studies have reported the correlation between sleep duration, sleep quality, and periodontal diseases. However, the inconsistency in the results is remarkable (11). Although some research on the subject has revealed a significant correlation between short sleep duration and periodontitis (12,13) and between short sleep duration and gingival health (14,15), other studies have found no significant relationship (11,16-18). Among the studies investigating the correlation between sleep quality and periodontitis, there are studies that found (5,19,20) or did not find a significant correlation between poor sleep quality and periodontitis (16,21). Epidemiological studies on fatigue-related factors, e.g., age, physical and psychological stress, and blood oxygen levels, indicated a strong effect of sleep disorder on fatigue (22,23). Although the effect of fatigue was investigated in various fields and the correlation between disease and fatigue was reported, there are very limited studies on the correlation between fatigue and periodontitis (24,25).

Oral health-related quality of life (OHRQoL) simply describes the impact of oral conditions on daily functioning (26) and is an important component of overall health and well-being (27). Bleeding, redness, swelling, tooth mobility, bad breath, and tooth loss caused by periodontitis adversely influence self-esteem and quality of life (28).

In the literature review, the periodontal condition was diagnosed by employing the current method in a very limited number of studies examining the association between sleep and periodontitis (29). Despite this deep relationship between fatigue and sleep, there is no study examining the relationship between the two and periodontitis, as far as we know.

The present research aimed to evaluate whether there was a correlation between sleep quality, fatigue, stage-grade of periodontitis, and oral health-related quality of life, and the demographic factors (age, sex, education) affecting this condition.

MATERIALS AND METHODS

STUDY SAMPLE

The participants in this research were randomly selected from among individuals who presented to Necmettin Erbakan University Faculty of Dentistry Department of Periodontology between October and December 2022 and met the inclusion criteria. Written and verbal consent was acquired from all participants who agreed to participate in the study. This research, which was approved by the Ethics Committee for Non-Pharmaceutical and Medical Device Clinical Research of Necmettin Erbakan University Faculty of Dentistry (Decision no: 2022/15-107), was carried out in line with the guidelines of the 1975 Declaration of Helsinki, which was revised in 2013. The study protocol was registered on ClinicalTrials.gov (NCT05622019).

Prior to the study, the required number of patients for every group was found by calculating the power (G*Power 3.1 software; Heinrich Heine University, Düsseldorf, Germany). According to the power analysis results for the one-way ANOVA test, a power of 90% and an effect size of 0.37 were provided for a total of 115 samples in the research conducted on 5 groups. However, consi-

dering that there might be patients who could not continue the study, it was decided to include 124 individuals in the study.

INCLUSION AND EXCLUSION CRITERIA

Individuals who were aged between 18-65 years, were diagnosed with healthy gingiva or periodontitis based on the results of the "World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions" were enrolled in the research (29).

Exclusion criteria were as follows: (i) sleep apnea; (ii) <20 teeth (excluding third molars and retained roots); (iii) periodontal treatment in the last year; (iv) acute dental conditions that required urgent care, including abscesses and cellulitis, or diseases impacting the jawbones, such as cysts and neoplasms ; (v) concomitant medical conditions (e.g., diabetes, cardiovascular diseases, hypertension, or hypercholesterolemia) or active infectious/inflammatory diseases (e.g., HIV, hepatitis, tuberculosis, rheumatoid arthritis, allergies, or asthma); (vi) pregnant or lactating females; (vii) malignancy; (viii) treatment with systemic antibiotics, corticosteroids and/or immunosuppressive agents within 3 months prior to periodontal examination; (ix) psychiatric, mental or physical disability; (x) depression and accordingly used antidepressants.

CLINICAL EXAMINATION AND STUDY DESIGN

A comprehensive clinical and radiographic periodontal examination was conducted on each patient participating in the research by a single trained and calibrated periodontist (FA). The clinician received calibration training at the beginning of the study and examined fifteen volunteer participants unrelated to the current research in two separate sessions every 24 hours.

Plaque index (PI), gingival index (GI), periodontal pocket depths (PD), and clinical attachment losses (CAL) were recorded (30,31). Clinical measurements were made by utilizing the Williams periodontal probe (Hu-Friedy, Chicago, IL). PD and CAL were evaluated at six sites per tooth in all teeth except for the third molars. For a PD measurement with a periodontal probe, the probe was placed parallel to the vertical axis of the tooth to achieve the deepest point of pocket, and the nearest millimeter mark was manually recorded to the distance between the base of the pocket and the gingival margin. Likewise, CAL was measured as the distance between the cementoenamel junction and the base of the pocket and recorded manually. CAL was defined by tactile sense at points where the cementoenamel junction was not visible. Patients were diagnosed based on the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions (32,33). Clinical gingival health was defined as ≤3mm probing depth and <10% bleeding site (33). The participants were diagnosed with periodontitis at the detection of interdental clinical attachment loss (CAL) in ≥2 non-adjacent teeth or buccal CAL of more than 3mm with a probing depth of ≥3mm in ≥2 teeth. The diagnosed periodontitis was classified on the basis of the stage and grade system (32).

The groups were designed according to the periodontal conditions of participants. The evaluations were performed by grouping the participants in different ways. In the first comparison, the participants were divided into the (1) Healthy gingiva and (2) Periodontitis groups. In the second comparison, the periodontitis group was divided into 4 subgroups according to their stages, and there were five groups, such as (1) Healthy gingiva, (2) Stage I Periodontitis, (3) Stage II Periodontitis, (4) Stage III Periodontitis, and (5) Stage IV Periodonti-

tis. Finally, the periodontitis group was divided into 3 subgroups according to their grades, and four groups were formed as follows, (1) Healthy gingival, (2) Grade A Periodontitis, (3) Grade B Periodontitis, and (4) Grade C Periodontitis.

QUESTIONNAIRE SURVEYS

All participants in the study were asked to fill out a questionnaire. The questionnaire consisted of the following three main parts: (i) demographic characteristics (age, education level) and (ii) teeth cleaning habits.

In addition to this socio-demographic questionnaire, the sleep duration of all participants was examined. While the Pittsburgh Sleep Quality Index (PSQI) and the Jenkins Sleep Scale (JSS) were applied to all participants to evaluate their sleep quality, the Multidimensional Assessment of Fatigue Scale (MAF) was applied to assess fatigue, and the Oral Health Impact Profile-14 (OHIP-14) was applied to evaluate OHRQoL.

SLEEP DURATION

Each participant was asked to report the average hours of sleep (1-24) per whole day in response to the question, "How many hours do you usually sleep a day?" For the present analyses, sleep duration was categorized into five groups (≤5, 6, 7, 8, and ≥9 hours/day) based on previous studies (34, 35).

THE PITTSBURGH SLEEP QUALITY INDEX (PSQI)

The PSQI is a reliable, valid and standardized effective tool employed with the objective of measuring sleep quality and patterns in adults. It distinguishes "poor" sleep from "good" sleep by measuring seven domains, including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction in the past month.

The scoring of the responses was based on a scale from 0 to 3.3 reflected the negative endpoint on the Likert scale. The component scores were summed to obtain an overall score (in the range of 0 to 21). A global total of "5" or greater was defined as "poor" sleep. Higher PSQI scores indicated poorer sleep quality (37).

THE JENKINS SLEEP SCALE (JSS)

The JSS is a research tool whose Turkish validity and reliability studies have been performed and which evaluates sleep disorders for multiple diseases. Participants answer the questions on a six-point Likert scale (0=never, 1=1-3 days, 2=4-7 days, 3=8-14 days, 4=15-21 days, 5=22 to 31 days). Total scores vary between 0 and 20, and higher scores demonstrate a higher number of sleep problems. Sleep disorders are considered when the average score is greater than or equal to 2, corresponding to a minimum of one problem night per week (36).

MULTIDIMENSIONAL ASSESSMENT OF FATIGUE (MAF) SCALE

The MAF scale was employed to assess the fatigue of the patients participating in the study. The scale, whose Turkish validity and reliability study was carried out by Yıldırım and Ergin, was developed by Belza to evaluate the fatigue of rheumatic patients (37,38). The MAF scale is a four-point Likert scale consisting of 16 questions. While the degree of fatigue is assessed using question 1, the severity of fatigue is assessed using question 2, distress is assessed using question 3, the degree of its impact on activities of daily living is assessed using questions 4-14, and the duration dimensions and the fatigue experienced in the previous weeks are assessed using questions 15-16. Question 16

was not included in the calculation since it was not included in the general fatigue index. The questions on the scale are scored between 1 and 10, and the minimum and maximum scores are between 1 and 50, respectively. A higher score obtained from the scale indicates higher fatigue.

ORAL HEALTH IMPACT PROFILE-14 (OHIP-14)

The OHIP-14 was utilized to determine the effect of periodontitis on QoL. The patients indicated their negative experiences on a scale of 0 to 4. The OHIP-14 score represents the total score of responses (0 to 56), and higher scores indicate poorer OHRQoL. Any score above 14 was considered an indicator of poor OHRQoL (39). The OHIP-14 questionnaire was translated into Turkish, and its validity and reliability were approved by Mumcu *et al*. (40).

STATISTICAL ANALYSIS

Statistical analysis was performed by means of the SPSS 26.0 package program. The normality of the distribution was checked by the Kolmogorov-Smirnov test. In the study, the one-way ANOVA test and the Bonferroni test were used as post hoc tests in comparison by stage, class, age and education level, and the independent sample t-test was conducted in comparison by sex. The Pearson correlation analysis was performed to test the relationship between the scales. Chi-square analysis was used to evaluate the classification according to sleep quality and the stage-grade relationship. Chi-square analysis was carried out to evaluate the relationship between demographic characteristics and stage-grade. Statistical significance was assessed when p was $p<0.05$.

RESULTS

This study was conducted with ninety-three patients with periodontitis and thirty-one individuals with healthy gingiva. The mean clinical values of the patients in the present research were AL=3.84± .52mm and PD= .92±2.35mm.

Table 1 presents the distribution of the participants' demographic characteristics by the groups. No statistically significant difference was detected between the groups in the comparison made according to the participants' sex ($p>0.05$). Upon comparing the participants' ages, there was a statistically significant difference between the groups ($p<0.05$). While there were no participants over the age of 50 in gingival healthy group, it was observed that the incidence of stage III and stage IV periodontitis increased with age. The education level of the individuals differed significantly according to gingival health status ($p<0.05$). The education level of the participants with healthy gingiva was significantly higher. The number of individuals with low education increased as the stage of periodontitis increased.

The oral health-related conditions of the participants and the distribution of their brushing habits by groups are presented in Table 2. There was a significant difference between the groups in terms of tooth brushing habits ($p<0.05$). It was observed that the habit of brushing twice a day was higher in individuals in the gingival healthy and stage I periodontitis groups. Brushing habit less than once a day was more common in Stage III and Stage IV groups. No statistically significant difference was identified between the groups in terms of previous dental treatment, interface brushing and mouthwash use habits ($p>0.05$). A statistically significant difference was detected between the groups according to the answers to the questions on gingival bleeding and mobility. There was a significant difference between the groups in terms of gingival bleeding ($p<0.05$). The number of individuals who answered positively to the question "Do you have gingival bleeding?" was the lowest in the gingival healthy group. As the stage of periodontitis increased, the number

of participants who stated that they had bleeding gums also increased. There was a significant difference between the groups in terms of tooth mobility ($p<0.05$). No one gave a positive answer to the question "Do you have any loosening teeth?" in the gingival healthy and stage I periodontitis groups. As the stage of periodontitis increased, the probability of tooth mobility increased.

Upon examining the association between the participants' sleep duration and the stage of periodontitis, statistically significantly shorter sleep duration was observed in the group with stage IV periodontitis ($p<0.05$). There was a significant relationship between sleep duration and the grade of periodontitis ($p>0.05$) (Table 3). However, it was revealed that sleep duration decreased as the stage and grade increased, and the shortest sleep duration was in the group with periodontitis grade C.

The mean global scores and Cronbach's alpha values of the scales employed in the study are presented in Table 4. Reliability analysis was conducted on all scales, and Cronbach's alpha values were found to be above 0.7, indicating that the result of the scales' reliability analysis was appropriate.

When the PSQI, JSS, and MAF scores of the participants were compared, no significant difference was determined between the individuals with periodontitis and healthy gingiva ($p>0.05$). Nevertheless, individuals with periodontitis had higher PSQI scores. The OHIP-14 scores were revealed to be statistically significantly higher in individuals with periodontitis ($p<0.05$) (Table 5).

In the evaluation of the participants' PSQI, MAF, JSS, and OHIP-14, no significant difference was detected between different stages and individuals with healthy gingiva ($p>0.05$). The lowest evaluation in the PSQI scale was in stage I periodontitis and gingival healthy groups, and the highest evaluation was in stage IV periodontitis group. In the evaluation of OHIP-14, the lowest score was in the group with healthy gingiva, whereas the highest score was in stage IV periodontitis group (Table 6).

In the evaluation of the participants' PSQI, MAF, JSS, and OHIP-14, there was no statistically significant difference according to the grade of periodontitis ($p>0.05$). In the evaluation of the PSQI, the lowest mean score and the highest mean score were observed in the group with healthy gingiva and the grade C periodontitis group, respectively (Table 7).

Upon examining the differences in the PSQI, JSS, MAF, and OHIP-14 survey results between sexes, the mean scores of females were observed to be statistically significantly higher compared to males (Table 8).

It was calculated that individuals had sufficient or insufficient sleep levels according to their responses to the PSQI and JSS. No significant difference was detected between the groups for both scales ($p<0.05$). However, it was observed that the majority of individuals with stage IV periodontitis consisted of individuals with insufficient sleep (Table 9).

The correlation analysis of the PSQI, JSS, MAF, and OHIP-14 is shown in Table 10. A statistically significant positive relationship was identified between the PSQI and JSS, MAF and OHIP-14 ($p<0.05$). There was a statistically significant positive relationship between the JSS and MAF ($p<0.05$).

Table 1. The distribution of the participants' brushing habits and demographic characteristics by the groups.

Periodontitis classification		Gingival healthy	Stage I Periodontitis	Stage II Periodontitis	Stage III Periodontitis	Stage IV Periodontitis	P value
		n (%)	n (%)	n (%)	n (%)	n (%)	
Sex	Male	9 (29.0)	6 (46.2)	11 (35.5)	21 (56.8)	5 (41.7)	0.157
	Female	22 (71.0)	7 (53.8)	20 (64.5)	16 (43.2)	7 (58.3)	
Age	<30	25 (80.6)	1 (7.7)	2 (6.5)	0 (0.0)	1 (8.3)	0.001*
	31-40	5 (16.1)	6 (46.2)	9 (29.0)	13 (35.1)	2 (16.7)	
	41-50	1 (3.2)	6 (46.2)	11 (35.5)	14 (37.8)	5 (41.7)	
	51-60	0 (0.0)	0 (0.0)	7 (22.6)	6 (16.2)	1 (8.3)	
	60+	0 (0.0)	0 (0.0)	2 (6.5)	3 (8.1)	3 (25.0)	
Education level	Primary school	1 (3.2)	4 (30.8)	12 (38.7)	14 (37.8)	6 (50.0)	0.006*
	Secondary school	0 (0.0)	4 (30.8)	1 (3.2)	4 (10.8)	4 (33.3)	
	High school	8 (25.8)	3 (23.1)	7 (22.6)	10 (27.0)	1 (8.3)	
	University	20 (64.5)	2 (15.4)	10 (32.3)	8 (21.6)	1 (8.3)	
	Graduate	2 (6.5)	0 (0.0)	1 (3.2)	0 (0.0)	0 (0.0)	

*p<0.05.
† chi-square test.

Table 2. The distribution of the oral hygiene habits and oral health features of the participants by the groups.

Periodontal classification		Gingival healthy	Stage I Periodontitis	Stage II Periodontitis	Stage III Periodontitis	Stage IV Periodontitis	p
		n (%)	n (%)	n (%)	n (%)	n (%)	
Frequency of Tooth Brushing	1	8 (25.8)	3 (23.1)	7 (22.6)	14 (37.8)	2 (16.7)	0.002*
	2	21(67.7)	8 (61.5)	15 (48.4)	10 (27.0)	2 (16.7)	
	3 and more	2 (6.5)	1 (7.7)	5 (16.1)	1 (2.7)	0 (0.0)	
	Once in a Few Days	0 (0.0)	1 (7.7)	3 (9.7)	8 (21.6)	4 (33.3)	
	Once or less in a Week	0 (0.0)	0 (0.0)	1 (3.2)	3 (8.1)	3 (25.0)	
Frequency of Using an Interface Brush	1	4 (12.9)	2 (15.4)	3 (9.7)	2 (5.4)	1 (8.3)	0.559
	2 and more	2 (6.5)	2 (15.4)	4 (12.9)	5 (13.5)	0 (0.0)	
	2-6 per week	3 (9.7)	0 (0.0)	1 (3.2)	2 (5.4)	0 (0.0)	
	Once per week	3 (9.7)	1 (7.7)	3 (9.7)	3 (8.1)	0 (0.0)	
	Rarely	9 (29.0)	6 (46.2)	6 (19.4)	7 (18.9)	2 (16.7)	
	Never	6 (19.4)	1 (7.7)	13 (41.9)	15 (40.5)	5 (41.7)	
Frequency of Mouthwash Use	1		2 (15.4)	1 (3.2)	4 (10.8)	1 (8.3)	0.653
	2 and more	1 (3.2)	1 (7.7)	3 (9.7)	0 (0.0)	1 (8.3)	
	2-6 per week	2 (6.5)	0 (0.0)	2 (6.5)	2 (5.4)	0 (0.0)	
	Once per week	4 (12.9)	1 (7.7)	3 (9.7)	1 (2.7)	0 (0.0)	
	Rarely	10(32.3)	1 (7.7)	6 (19.4)	8 (21.6)	2 (16.7)	
	Never	14 (45.2)	7 (53.8)	13 (41.9)	20 (54.1)	7 (58.3)	
Gingival Bleeding	I do not know	3 (9.7)	1 (7.7)	1 (3.2)	3 (8.1)	0 (0.0)	0.001*
	Yes	7 (22.6)	8 (61.5)	21 (67.7)	29 (78.4)	7 (58.3)	
	No	21 (67.7)	4 (30.8)	8 (25.8)	4 (10.8)	4 (33.3)	
Mobility	I do not know	2 (6.5)	2 (15.4)	2 (6.5)	2 (5.4)	2 (16.7)	0.001*
	Yes	0 (0.0)	0 (0.0)	8 (25.8)	17 (45.9)	5 (41.7)	
	No	29 (93.5)	11 (84.6)	20 (64.5)	16 (43.2)	4 (33.3)	
Previous Dental Treatment	I do not know	0 (0.0)	1 (7.7)	0 (0.0)	0 (0.0)	0 (0.0)	0.211
	Yes	4 (12.9)	4 (30.8)	11 (35.5)	16 (43.2)	3 (25.0)	
	No	26 (83.9)	8 (61.5)	19 (61.3)	20 (54.1)	8 (66.7)	

*p<0.05.
† chi-square test.

Table 3. The correlation between sleep durations and periodontitis stage-grade.

Periodontitis Classification	Sleep Duration										Total
	≤5 hours		6 hours		7 hours		8 hours		≥9 hours		
	n	%	n	%	n	%	n	%	n	%	
Gingival healthy	2	6.5	6	19.4	10	32.3	8	25.8	5	16.1	31
Stage I	0	0.0	1	7.7	9	69.2	3	23.1	0	0.0	13
Stage II	2	6.5	3	9.7	20	64.5	5	16.1	1	3.2	31
Stage III	2	5.4	7	18.9	21	56.8	5	13.5	2	5.4	37
Stage IV	2	16.7	8	66.7	1	8.3	1	8.3	0	0.0	12
Total	8	6.5	25	20.2	61	49.2	22	17.7	8	6.5	124
p value						0.003*					
Gingival healthy	2	6.5	6	19.4	10	32.3	8	25.8	5	16.1	31
Grade A	0	0.0	0	0.0	4	57.1	3	42.9	0	0.0	7
Grade B	3	7.3	6	14.6	27	63.4	6	14.6	0	0.0	42
Grade C	3	6.8	13	29.5	20	45.5	5	11.4	3	6.8	44
Total	8	6.5	25	20.3	61	48.8	22	17.9	8	6.5	124
p value						0.058					

*p<0.05.
† chi-square test.

Table 4. The mean of the global PSQI, JSS, MAF, and OHIP-14 scores and Cronbach's alpha values.

	N	Total Number of Items	Cronbach's Alpha Value	Min.	Max.	Mean
PSQI	124	7	0.765*	0	14	4.61±3.06
JSS	124	4	0.942*	0	19	5.12±4.11
MAF	124	16	0.841*	3.5	47.60	23.16±10.03
OHIP-14	124	14	0.903*	0	56	10.48±12.14

Abbreviations: PSQI, Pittsburgh Sleep Quality Index; JSS, Jenkins Sleep Scale; MAF, Multidimensional Assessment of Fatigue Scale; OHIP-14, Oral Health Impact Profile-14.
*α≥7.

Table 5. The association of the PSQI, JSS, MAF, and OHIP-14 with periodontal status.

		N	Mean±S.D.	P value
PSQI	Gingival healthy	31	4.35±1.94	0.954
	Periodontitis	93	4.70±3.36	
JSS	Gingival healthy	31	5.00±3.42	0.856
	Periodontitis	93	4.67±4.15	
MAF	Gingival healthy	31	22.82±10.66	0.352
	Periodontitis	93	20.65±11.38	
OHIP-14	Gingival healthy	31	7.71±9.01	0.038*
	Periodontitis	93	11.39±13.15	

Abbreviations: PSQI, Pittsburgh Sleep Quality Index; JSS, Jenkins Sleep Scale; MAF, Multidimensional Assessment of Fatigue Scale; OHIP-14, Oral Health Impact Profile-14.
*p<0.05.
† test: independent sample t-test.

Table 6. The relationship between the PSQI, JSS, MAF, and OHIP-14 and periodontitis stage.

	Periodontal status	N	Mean±s.d.	P value
PSQI	Gingival healthy	31	4.35±1.94	0.575
	Stage I	13	4.08±2.47	
	Stage II	31	4.45±3.14	
	Stage III	37	4.73±3.75	
	Stage IV	12	5.92±3.55	
JSS	Gingival healthy	31	5.01±3.43	0.670
	Stage I	13	6.25±4.65	
	Stage II	31	5.10±4.17	
	Stage III	37	4.52±4.16	
	Stage IV	12	6.35±5.20	
MAF	Gingival healthy	29	24.40±9.06	0.747
	Stage I	12	23.05±11.96	
	Stage II	27	24.37±10.76	
	Stage III	33	21.83±9.63	
	Stage IV	10	20.80±10.63	
0HIP-14	Gingival healthy	31	7.71±9.01	0.514
	Stage I	13	13.00±16.51	
	Stage II	31	10.39±12.30	
	Stage III	37	10.78±12.55	
	Stage IV	12	14.17±12.52	

Abbreviations: PSQI, Pittsburgh Sleep Quality Index; JSS, Jenkins Sleep Scale; MAF, Multidimensional Assessment of Fatigue Scale; OHIP-14, Oral Health Impact Profile-14.
*p<0.05.
† One-way ANOVA test.

Table 7. The association of the PSQI, JSS, MAF, and OHIP-14 with periodontitis grade.

	Periodontal status	N	Mean±S.D.	P value
PSQI	Gingival healthy	31	31.00±6.32	0.324
	Grade A	7	35.00±8.43	
	Grade B	42	34.88±12.48	
	Grade C	44	35.52±12.09	
JSS	Gingival healthy	31	4.09±3.41	0.841
	Grade A	7	6.31±4.41	
	Grade B	42	4.75±4.47	
	Grade C	44	5.22±4.25	
MAF	Gingival healthy	31	24.41±9.07	0.512
	Grade A	7	23.52±10.00	
	Grade B	42	23.96±10.71	
	Grade C	44	21.16±10.40	
0HIP-14	Gingival healthy	31	7.71±9.01	0.306
	Grade A	7	15.14±18.99	
	Grade B	42	10.05±13.33	
	Grade C	44	12.27±11.63	

Abbreviations: PSQI, Pittsburgh Sleep Quality Index; JSS, Jenkins Sleep Scale; MAF, Multidimensional Assessment of Fatigue Scale; OHIP-14, Oral Health Impact Profile-14.
*p<0.05.
† One-way ANOVA test.

Table 8. Examination of the PSQI, JSS, MAF, and OHIP-14 Evaluations According to the Sex of the Participants.

		N	Mean±s.d.	P
PSQI	Female	72	5.17±3.25	0.017*
	Male	52	3.85±2.62	
JSS	Female	72	5.96±4.36	0.008*
	Male	52	3.98±3.40	
MAF	Female	72	24.79±10.10	0.030*
	Male	52	20.56±9.45	
OHIP-14	Female	72	11.83±12.07	0.044*
	Male	52	8.60±12.10	

Abbreviations: PSQI, Pittsburgh Sleep Quality Index; JSS, Jenkins Sleep Scale; MAF, Multidimensional Assessment of Fatigue scale; OHIP-14, Oral Health Impact Profile-14.
*p<0.05.
† independent sample t-test.

Table 9. The relationship between sleep adequacy and periodontitis stage.

			PSQI		Total	p
			Adequate	Inadequate		
Periodontitis stage	Gingival healthy	n (%)	20 (64.5)	11(35.5)	31	0.636
	I	n (%)	7 (53.8)	6 (46.2)	13	
	II	n (%)	18 (58.1)	13(41.9)	31	
	III	n (%)	24 (64.9)	13(35.1)	37	
	IV	n (%)	5(41.7)	7(53.8)	12	
	Total	n (%)	74(59.7)	50(40.3)	124	

Abbreviations: PSQI, Pittsburgh Sleep Quality Index.
*p<0.05.
† chi-square test

Table 10. Correlation Analysis of the PSQI, JSS, MAF, and OHIP-14.

	PSQI	JSS	MAF	OHIP-14
PSQI	1	0.551*	0.268*	0.214*
JSS		1	0.311*	0.153
MAF			1	0.159
OHIP-14				1

Abbreviations: PSQI, Pittsburgh Sleep Quality Index; JSS, Jenkins Sleep Scale; MAF, Multidimensional Assessment of Fatigue Scale; OHIP-14, Oral Health Impact Profile-14.
*r:0.268, r:0.551, r:0.214, r:0.331 p<0.05.
† Pearson correlation analysis.

DISCUSSION

The main aim of the current research was to evaluate the association between sleep quality, fatigue, OHRQoL, and the stage-grade of periodontitis. As a result of the study, no statistically significant relationship was identified between sleep duration, sleep quality, multidimensional fatigue, OHRQoL, and the stage-grade of periodontitis.

In the study by Han and Park, a higher rate of periodontitis was observed in females sleeping more than 9 hours and between 6 and 8 hours compared to females sleeping less than 5 hours. In women, long sleep duration was determined to be correlated with periodontitis (14). Another study in which a significant relationship was detected between long sleep duration and periodontitis showed that the estimated probability of periodontitis for each hour of more sleep increased by 17% (15). Unlike these studies, the study by Iwasaki et al. determined short sleep duration to be correlated with severe periodontitis (13). In another study, sleep deprivation was revealed to be associated with a high prevalence of periodontitis (12). On the contrary, the research by Beydoun and Wiener, similar to our study, observed no significant relationship between sleep duration and periodontitis (17,18). Likewise, the meta-analysis and Mendelian randomization study conducted by

Zhou *et al*. concluded that short sleep duration did not increase the risk of periodontal disease (11).

Although there was no significant difference between the groups in our research, it was found that sleep duration decreased as the stage-grade of periodontitis increased. The effect of long sleep could not be evaluated since there were not enough individuals who slept more than 9 hours as a subgroup.

There are few studies investigating the association between periodontal conditions and sleep quality. The PSQI was utilized to assess sleep quality in those studies. The JSS was used together with the PSQI in our study. The JSS is easier to fill out for the participant and evaluate for the researcher in comparison with the PSQI. Similar results are obtained with the PSQI in the studies (41). In our research, a positive relationship was observed between the PSQI and JSS. Although no significant results were obtained between the groups in both of them, differences were observed in the changes in the mean group scores.

Aluckal, Grover, and Singh's study evaluating sleep quality found that individuals with periodontitis had significantly poorer sleep quality compared to individuals with gingivitis or periodontally healthy individuals (5,42,43). In other recent studies, no significant difference was detected between the sleep quality of individuals with healthy gingiva, gingivitis, and periodontitis (16,21). Similar to these studies, in our research, there was no significant difference between the groups when sleep quality was assessed by the PSQI.

In one of the few studies in the literature examining the association between sleep quality and the stage-grade of periodontitis, while high PSQI scores were found to be correlated with a high stage of periodontitis, they were not found to be associated with grade (20). Another study determined that there was a correlation between sleep quality and periodontal health, and individuals with Stage IV-Grade C periodontitis had the highest PSQI scores (19). Unlike this study, a group of individuals with healthy gingiva was also included in our research. However, no significant relationship was found between the PSQI and JSS values and the stage-grade of periodontitis.

Although fatigue and sleepiness are usually regarded as different concepts in both research and clinical practice, a number of assessment scales utilize sleepiness as a dimension of fatigue since some tasks that cause mental fatigue lead to sleepiness (10).

There are many studies examining the relationship between fatigue and inflammation in individuals with chronic disease or healthy individuals. In some of these studies, increased circulating concentrations of inflammatory markers, including C-reactive protein (CRP) and interleukin (IL-6), during cancer treatment were associated with the development of a general feeling of fatigue (44,45).

In the study by Nakada *et al.*, one of the limited studies examining the association between fatigue and periodontitis, fatigue was created in mice through insomnia. The study reported that increased serum corticosterone levels and decreased serum albumin levels were related to the progression of periodontal disease. It was indicated that this result revealed that fatigue increased the susceptibility to periodontal disease (24).

The only study in the literature examining the association between fatigue and periodontal condition using the MAF scale found no significant relationship between fatigue and pocket depth and gingival index (25). Unlike this study, our study observed that the periodontal health group was more tired than the other groups, although not in the total amount. It was determined that this result was due to the fact that the mean age of the

periodontal health group was lower than the other groups. The extent of the burden between age and marriage shows that the results of multidimensional dimensional analysis at younger ages are higher than those of the elderly (46). This situation can be explained by various stress loads about life such as the high daily working time, income anxiety, family behaviors, and working life in young individuals.

In the study by Karaaslan and Dikilitaş, regarding the OHIP-14 results, the overall and area scores of Stage IV had significantly higher scores than Stages I, II, and III (19). In another study, similar to our study, the OHIP-14 scores of individuals with periodontitis were found to be significantly higher than the scores of individuals with healthy gingiva (47).

Considering the research examining the association between sleep and periodontal condition, different results were obtained. It can be thought that these differences were due to the community where the studies were conducted and the methodological differences in the studies. Previous studies reported some significant ethnoracial differences in the associations between sleep duration and systemic inflammation. It was indicated that the difference in the findings of the relevant studies could be explained by this situation (48). Moreover, sex and age distribution in the groups may also affect the results. In the study performed by Han and Park, while long sleep duration was found to be correlated with periodontitis in females, this relationship was not observed in males (14). Considering the sex difference in our study, it was remarkable that the PSQI, JSS, MAF, and OHIP-14 results of women were significantly higher.

One of the limitations of our study is that the sex distributions within the groups were equal, but the age distribution was not equal. Another limitation is the inability to identify causality between periodontitis and sleep, fatigue, and OHRQoL due to the study's cross-sectional design. It is considered that the evaluations based on patients' statements may affect the results.

Nevertheless, our study also has strengths. Our study is the first in the literature evaluating sleep, fatigue, OHRQoL, and the stage-grade of periodontitis together. Furthermore, the JSS was used for the first time in studies conducted to investigate the association between sleep quality and the stage-grade of periodontitis. Additionally, the participants' diagnosis of periodontal conditions according to the last workshop, the exclusion of individuals with sleep apnea, known depression and antidepressant use that may affect the results of the sleep and fatigue questionnaires, and the inclusion of only healthy individuals without systemic drug use in terms of the study's homogeneity are other strengths of our study.

In conclusion, in accordance with the results of our research, it was found that the sleep duration decreased as the stage of periodontitis increased, and individuals with periodontitis had lower OHRQoL. No significant association was found between sleep quality and periodontal condition. According to sex, sleep quality, fatigue, and OHRQoL were determined to be lower in females compared to males. Nevertheless, there is a need for prospective and longitudinal research examining the relationship between sleep quality and fatigue and the severity and prognosis of periodontal disease with inflammatory mediators in a larger sample.

AUTHOR CONTRIBUTION STATEMENT

Collected the clinical data: F.A.
Ensured that the questionnaires were applied to patients: D.Ö.Ş.
Analyzed the dat: F.U.Y. and Z.T.E.
Designed the study, supervised all procedures, and wrote the article: Z.T.E.

All authors critically discussed the results, reviewed the draft, and approved the final version.

This study was presented as an oral presentation at the 26th Internatıonal Dental Congress Of TTA (September 8-11, 2022).

CONFLICT OF INTEREST STATEMENT

The authors reported no conflicts of interests related to this study.

ETHICAL APPROVAL

Necmettin Erbakan University Faculty of Dentistry Ethics Committee for Non-Pharmaceutical and Medical Device Clinical Research approved the study (Decision no: 2022/15-107), and informed consent was acquired from all participants.

The study protocol was registered on ClinicalTrials.gov (NCT05622019).

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