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ORIGINAL ARTICLE / ОРИГИНАЛНИ РАД

Possible association between COVID-19-caused stress and periodontal health – a pilot study

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SUMMARY

Introduction/Objective Stress is proposed as one of the risk factors linked to periodontal disease. The COVID-19 pandemic has a significant negative impact in population on mental and somatic health. This study aimed to examine the possible association between COVID-19 resultant stress and periodontal health.

Methods An observational pilot study was conducted from March 2020 to October 2021 and included 202 participants. Participants graded their stress level using the Perceived Stress Scale (PSS). Periodontal Disease Index and Clinical Attachment Level were determined. Participants were categorized into following groups: Ia (low stress), IIa (moderate stress), IIIa (high stress) and Ib (healthy parodontium), IIb (mild periodontal disease), IIIb (severe periodontal disease). The cause/effect relationship between stress and health was measured.

Results The results indicated a statistically significant difference between the groups classified according to the stress level concerning values of all the measured parameters. The Poisson regression analysis showed that in both models, crude and adjusted, periodontal health-related covariables were higher in subjects perceiving greater stress (Periodontal Disease Index – Pradjusted = 1.042, 95% CI [1.030–1.055] and Clinical Attachment Level – PRadjusted = 1.108, 95% CI [1.094–1.122]).

Conslusion During COVID-19 pandemic increased stress has a negative impact on mental health and may result in the deterioration of the entire oral cavity's health, including the periodontium.

Keywords: COVID-19; pandemic; stress; periodontal disease

INTRODUCTION

The COVID-19 pandemic is a global health emergency that so far affected more than 290 million people worldwide, including the 5.4 million death toll [1]. Rapid transmission has called for compulsory measures such as quarantine and community containment, which led to psychological disorders like stress, anxiety, and depression [2]. Findings of the study conducted in China showed that almost one-half of the participants deemed the impact of COVID-19 on mental health as moderate or severe, with a third of them experiencing anxiety symptoms [3]. Some studies suggest that oral conditions such as periodontal disease could be a risk factor for serious form of COVID-19, considering its mutual inflammatory pathways [4].

Periodontal disease is a multifactorial disease of the supporting tissues of the teeth [5]. It is characterized by progressive destruction of epithelial attachment and resorption of alveolar bone, resulting in luxation, migration, and, eventually, tooth loss [6]. The main etiological factor is dental plaque [7]. Clinical manifestations of the disease are determined by the nature of the immune response to microorganisms clustered in biofilm [8]. In addition to oral plaque, the onset and progression of the disease are influenced by other local and systemic factors, such as tobacco consumption, viral infections, and diabetes mellitus [9]. However, more attention has been paid to the role of psychological determinants in this disease's pathogenesis [10].

In the course of the current pandemic, people worldwide are put under severe psychological stress whose extent to the mental and oral health is yet to be determined [2]. During stressful events, significant changes occur on biological, physiological, and behavioral levels [11]. It is hypothesized that chronic stress can alter the host's immune response, increasing the patient's susceptibility to disease and causing severe periodontal destruction [12]. Also, anxiety and fear of the unknown, extensively present during this pandemic, often lead to adopting detrimental behavioral changes that affect oral and general health [13]. Studies have shown that people under stress tend to neglect their oral health, which manifests in visiting their dentist less often, having a comfort diet, and brushing their teeth less frequently [14].

This study aims to establish whether a significant clinical correlation exists between stress levels and the severity of the manifestations of

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Table 1. Participants' characteristics according to the stress level

Covariables	1) Low-stress level (n = 55)	2) Moderate stress level (n = 87)	3) High-stress level (n = 60)	p
	n (%)			
Gender				
male female	19 (22.4) 36 (30.8)	36 (42.4) 51 (43.6)	30 (35.3) 30 (25.6)	[a]0.094
Age (in years)				
X ± SD; med (min–max)	28.1 ± 6.8; 26.0 (22–54)	43.3 ± 18.6; 41.0 (19–82)	56.9 ± 12.2; 60.0 (25–72)	[b]0.000* [c](1 *vs.* 2) 0.000* [c](1 *vs.* 3) 0.000* [c](2 *vs.* 3) 0.000*
Marital status				
single in a relationship married divorced widowed	14 (30.4) 21 (38.2) 14 (23.7) 5 (17.9) 1 (7.1)	18 (39.1) 21 (38.2) 30 (50) 13 (46.4) 5 (35.7)	14 (30.4) 13 (23.6) 15 (25.4) 10 (35.7) 8 (57.1)	[a]0.137
Household status				
living alone living with up to five housemates living with more than five housemates	22 (56.8) 29 (24.2) 4 (11.4)	15 (31.9) 55 (45.8) 17 (48.6)	10 (31.3) 36 (20) 14 (40)	[a]0.006* [a](1 *vs.* 2) 0.005* [a](1 *vs.* 3) 0.005* [a](2 *vs.* 3) 0.647
Property ownership				
owner tenant	38 (26.6) 17 (28.8)	59 (41.3) 28 (47.5)	46 (32.2) 14 (23.7)	[a]0.484
Employment				
student employed unemployed retired	26 (59.1) 24 (28.2) 5 (12.2) 0 (0)	18 (40.9) 44 (51.8) 14 (34.1) 11 (34.4)	0 (0) 17 (20) 22 (53.7) 21 (65.6)	[a]0.000* [a](1 *vs.* 2) 0.001* [a](1 *vs.* 3) 0.000* [a](2 *vs.* 3) 0.000*
Education				
elementary school high school degree university degree	2 (100) 14 (13.9) 39 (39.4)	0 (0) 41 (40.6) 46 (46.5)	0 (0) 46 (45.5) 14 (14.1)	[a]0.000* [a](1 *vs.* 2) 0.011* [a](1 *vs.* 3) 0.000* [a](2 *vs.* 3) 0.000*
Smoker				
yes no	22 (24.7) 33 (29.2)	36 (40.4%) 51 (45.1%)	31 (34.8) 29 (25.7)	[a]0.203
Body Mass Index				
underweight normal overweight obesity	0 (0) 39 (31.2) 14 (23.7) 2 (14.3)	0 (0) 52 (41.6) 28 (47.5) 7 (50)	4 (100) 34 (27.2) 17 (28.8) 5 (35.7)	[a]0.057

X – mean value; SD – standard deviation; Med – mediana; min – minimum; max – maximum; [a]χ^2 test; [b]Kruskal–Wallis test; [c]Mann–Whitney test; *statistically significant

periodontal disease during the COVID-19 pandemic, one of the potential major stressful factors.

METHODS

The study was designed as an observational clinical pilot study; it was conducted in accordance with the Helsinki Declaration. Approval was obtained from the Ethics committee of Faculty of Medical Sciences, University of Kragujevac, Kragujevac, Serbia (No. 01-2925). The study included all patients who came for a regular dental examination or intervention, starting from March 2020 to October 2021.

To estimate the sample size for the study, the following formula was used: $n = (1.96)^2 \times 4 \times SD^2/d^2$ (SD – standard deviation of the measured loss of clinical attachment and d-the desired width of the confidence interval) and data-based on the study by Coelho et al. [15]. According to the available data, the calculated sample size was 72 patients and the researchers included 202 patients in this study.

Including factors for entering the study were that person gave written consent to participate in the study and was older than 18 years. Excluding factors were less than three teeth present, pregnancy, life-threatening conditions, uncontrolled diseases, mental disorders, and refusal of patients to participate.

Before participating in the study, the procedure and aim of the research were explained to all patients. After signing the information form and signing consent to participate in the study, all patients completed the survey, thus providing socio-epidemiological data of age, marital status, housing status, employment status, education, smoking status, body weight, and height and potential systemic diseases. After that, the patients filled the Perceived Stress Scale (PSS) [16, 17], with the note of the examiner to fill the scale with special reference to the current situation, i.e., primarily considering the pandemic's impact. This scale consisted of 10 questions, each being scored from 0 to 4, depending on the answer. The score of the PSS was obtained, based on which the patients were categorized into three groups – group Ia: low stress (0–13), group IIa: moderate stress (14–26), and group IIIa: high perceived-stress (27–40).

All patients were examined by a single examiner from the Department of Periodontology and Oral Medicine. Faculty of Medical Sciences, University of Kragujevac, due to gaining objectivity and consistency of the obtained results. The doctor had all the protective equipment during the examination. The following parameters were established during the examination: Periodontal Disease Index and Clinical Attachment Level. A dental mirror and a periodontal probe (Williams probe, Hu-Friedy, Chicago, IL, USA) were used for the examination.

The Periodontal Disease Index (PDI, Ramfjord, 1959) was an instrument used to assess the entire periodontal health [18]. Numerical values 1–3 indicated the severity of gingivitis, and 4–6 indicated loss of attachment, while 0 indicated healthy periodontium [18]. The tooth's mesial and vestibular sites were examined, and the representative teeth were: first upper right molar, left upper central incisor, left

Table 2. Participants' characteristics according to the periodontal health

Covariables	1) Healthy periodontium (n = 41)	2) Mild periodontal disease (n = 83)	3) Severe periodontal disease (n = 78)	p
	n (%)			
Gender				
male female	14 (16.5) 27 (23.1)	28 (32.9) 55 (47)	43 (50.6) 35 (29.9)	[a]0.012* [a](1 *vs.* 2) 0.964 [a](1 *vs.* 3) 0.030* [a](2 *vs.* 3) 0.006*
Age (in years)				
X ± SD; med (min–max)	46.6 ± 19.6; 54 (19–72)	41.8 ± 17.1; 39 (20–77)	42.9 ± 18; 40 (20–82)	[b]0.348
Marital status				
single in a relationship married divorced widowed	6 (13) 9 (16.4) 15 (25.4) 6 (21.4) 5 (35.7)	15 (32.6) 23 (41.8) 31 (52.5) 9 (32.1) 7 (35.7)	25 (54.3) 23 (41.8) 13 (22) 13 (46.4) 4 (28.6)	[a]0.016* [a](1 *vs.* 2) 0.185 [a](1 *vs.* 3) 0.024* [a](2 *vs.* 3)0.163
Household status				
living alone living with up to 5 housemates living with more than 5 housemates	7 (14.9) 28 (23.3) 6 (17.1)	13 (27.7) 54 (45) 16 (45.7)	27 (57.4) 38 (31.7) 13 (37.1)	[a]0.042* [a](1 *vs.* 2) 0.587 [a](1 *vs.* 3) 0.222* [a](2 *vs.* 3) 0.036*
Property ownership				
owner tenant	37 (25.9) 4 (6.8)	60 (42) 23 (39)	46 (32.2) 32 (54.2)	[a]0.000* [a](1 *vs.* 2) 0.023* [a](1 *vs.* 3) 0.000* [a](2 *vs.* 3) 0.076
Employment				
student employed unemployed retired	13 (29.5) 16 (18.8) 2 (4.9) 10 (31.3)	19 (43.2) 42 (49.4) 15 (36.6) 7 (21.9)	12 (27.3) 27 (31.28) 24 (58.5) 15 (46.9)	[a]0.002* [a](1 *vs.* 2) 0.556 [a](1 *vs.* 3) 0.937 [a](2 *vs.* 3) 0.021*
Education				
elementary school high school degree university degree	2 (100) 19 (18.8) 20 (20.2)	0 (0) 43 (42.6) 40 (40.4)	0 (0) 39 (38.6) 39 (39.4)	[a]0.090
Smoker				
yes no	8 (9) 33 (29.2)	49 (55.1) 34 (30.1)	32 (36) 46 (40.7)	[a] 0.000* [a](1 *vs.* 2) 0.000* [a](1 *vs.* 3) 0.019* [a](2 *vs.* 3) 0.023*
Body Mass Index				
underweight normal overweight obesity	0 (0) 26 (20.8) 12 (20.3) 3 (21.4)	2 (50) 50 (40.4) 24 (40.7) 7 (50)	2 (50) 49 (39.2) 23 (39) 4 (28.6)	[a]0.790

X – mean value; SD – standard deviation; Med – mediana; min – minimum; max – maximum; [a]χ^2 test; [b]Kruskal–Wallis test; [c]Mann–Whitney test; *statistically significant

Table 3. Periodontal health-related covariables according to the stress level

Oral parameters	Low-stress level (n = 55)	Moderate stress level (n = 87)	High-stress level (n = 60)	[a]p
	n (%)			
PDI				
healthy mild severe	37 (63.8) 17 (31.5) 1 (1.1)	21 (36.2) 30 (55.6) 36 (40)	0 (0) 17 (11.7) 53 (58.9)	0.000* (1 *vs.* 2) 0.000* (1 *vs.* 3) 0.000* (2 *vs.* 3) 0.000*
CAL				
healthy mild severe	52 (58.4) 0 (0) 3 (3.8)	37 (41.6) 17 (51.5) 33 (41.3)	0 (0) 16 (48.5) 44 (55)	0.000* (1 *vs.* 2) 0.000* (1 *vs.* 3) 0.000* (2 *vs.* 3) 0.000*

PDI – Periodontal Disease Index; CAL – Clinical Attachment Level

upper first premolar, left lower first molar, right lower central incisor, and right lower first premolar [18]. Based on the PDI, patients were categorized into the following groups: patients with healthy periodontium (PDI = 0–3; no periodontal involvement), patients with mild periodontal disease (PDI = 4; the loss of attachment is 3 mm or less), and patients with severe periodontal disease (PDI = 5–6; the loss of attachment is more than 3 mm) [18].

Clinical Attachment Level (CAL) represented the distance from the enamel-cement border to the bottom of the periodontal sulcus/pocket [18]. Measurement of this value was performed with a Williams-graded periodontal probe (Hu-Friedy) at four points on each tooth present, the middle of the oral tooth surface, mesial, distal, and vestibular. Values were expressed in millimeters [18]. The mean values of each subject's clinical attachment levels were obtained by summing the measured values and dividing the obtained sum by the number of examined teeth and the number of examined surfaces [18]. Based on the size of the loss of clinical attachment, patients were divided into the following groups: patients with healthy periodontium (who do not have a loss of clinical attachment), patients with mild periodontal disease (loss of the clinical attachment leveled up to 3 mm) and patients with severe periodontal disease (loss of the clinical attachment higher than 3 mm) [18].

After determining all oral clinical parameters and based on the groups assigned to participants within these parameters, patients were cathegorized into final groups that reflected the health of the entire periodontal tissue (Group Ib: patients with healthy periodontium, Group IIb: patients with mild periodontal disease, and Group IIIb: patients with severe periodontal disease).

ll data were processed in the SPSS statistical program, version 21. Descriptive methods were used for statistical data processing. Differences in values of a categorical variable among the groups were tested for significance by χ^2 test or by Fisher's exact test if assumptions for the χ^2 test were not met. The measurement of association between periodontal health covariables and stress was performed by univariate and multivariate Poisson regression analysis. In the multivariate model, socio-epidemiological variables entered the model. A p-value < 0.05 was considered to be a measure of statistical significance for all statistical tests used.

Table 4. Prevalence ratio for the association of periodontal health covariables and stress

Covariables	Periodontal Disease Index		Clinical Attachment Level	
	Crude (95% CI)	Adjusted (95% CI)	Crude (95% CI)	Adjusted (95% CI)
Stress score	**1.052** (1.043–1.061)	**1.042** (1.030–1.055)	**1.104** (1.093–1.116)	**1.108** (1.094–1.122)
Gender				
male	**1.269** (1.076–1.496)	1.125 (0.942–1.345)	1.104 (0.926–1.317)	-
female	Ref.	Ref.		
Marital status				
single	Ref.	Ref.	Ref	Ref.
in a relationship	0.769 (0.589–1.005)	0.791 (0.592–1.055)	1.042 (0.744–1.460)	0.865 (0.604–1.239)
married	**1.337** (1.059–1.687)	1.151 (0.901–1.471)	**2.403** (1.800–3.207)	**2.074** (1.548–2.778)
divorced	**1.408** (1.072–1.849)	1.069 (0.799–1.431)	**2.532** (1.834–3.494)	**1.747** (1.257–2.429)
widowed	**1.819** (1.334–2.481)	1.016 (0.923–1.325)	**4.417** (3.171–6.152)	**1.565** (1.101–2.224)
Household status				
living alone	Ref.	Ref.	Ref.	Ref.
living with up to 5 housemates	1.218 (0.982–1.510)	0.958 (0.712–1.273)	**1.820** (1.401–2.365)	1.331 (1.007–1.760)
living with more than 5 housemates	**1.379** (1.061–1.794)	0.952 (0.712–1.273)	**2.311** (1.714–3.115)	**1.444** (1.047–1.990)
Property ownership				
owner	1.044 (0.870–1.254)	-	1.033 (0.851–1.254)	-
tenant	Ref.			
Employment				
student	Ref.	Ref.	N/A	N/A
employed	**2.865** (2.071–3.965)	**1.720** (1.202–2.462)		
unemployed	**3.494** (2.483–4.917)	**1.688** (1.117–2.549)		
retired	**4.605** (3.275–6.473)	**1.795** (1.172–2.748)		
Education				
elementary school	Ref.	-	Ref.	-
high school degree	3.574 (0.890–14.346		3.443 (0.990–9.575)	
university degree	2.040 (0.507–8.214)		4.834 (0.157–14.832)	
Smoker				
yes	1.162 (0.958–1.371)	-	1.186 (0.996–1.414)	-
no	Ref.		Ref.	
Body Mass Index				
normal	Ref.	Ref.	Ref.	Ref.
underweight	**1.725** (1.074–2.773)	1.325 (0.779–2.253)	**2.429** (1.574–3.749)	1.398 (0.870–2.246)
overweight	1.170 (0.975–1.403)	1.101 (0.905–1.340)	**1.228** (1.013–1.488)	1.222 (0.992–1.504)
obesity	1.123 (0.812–1.1554)	0.961 (0.672–1.374)	1.010 (0.700–1.455)	1.051 (0.710–1.554)

RESULTS

The study included 202 participants (85 males and 117 females, aged 19–82 years; mean age 43.19 years). Analyzing the subjects in relation to the stress, a statistically significant difference was registered between the observed groups in terms of age (between all three groups), household status (between group with low-stress level and group with moderate stress level, and between group with low-stress level and group with high-stress level), employment (between all three groups) and education (between all three groups) shown in Table 1. In terms of age, the youngest group was group with low-stress level (28.1 ± 6.8 years), while the oldest group was the group with high-stress level (56.9 ± 12.2 years) as shown in Table 1.

Similar results were registered between the groups according to the periodontal health (Table 2). A statistically significant difference was registered between the observed groups in terms of gender (between group with low-stress level and group with high-stress level, and between group with moderate stress level and group with high-stress level), marital status (between group with low-stress level and group with high-stress level), household status (between the same groups as for gender), property ownership (between group with low-stress level and group with moderate stress level, and between group with low-stress level and group with high-stress level), employment (between group with moderate stress level and group with high-stress level) and smoking status (between all three observed groups) shown in Table 2.

Table 3 represents periodontal health-related covariables in relation to the level of stress of the subjects. A statistical significance was registered between all three groups of patients according to the stress level in terms of periodontal health parameters. The participants from the healthy group experienced the lowest levels of stress, while subjects with severe form of periodontal disease, according to the measured indices, encountered the highest stress.

The results of the univariate and multivariate Poisson regression analysis with adjustment for potential confounders are shown in Table 4. The Poisson regression analysis showed that in both models, crude and adjusted, periodontal health-related covariables were higher in subjects perceiving greater stress (Table 4).

DISCUSSION

This study aimed to examine the possible impact of stress during the COVID-19 pandemic on periodontal health. Given to the study's findings, it was shown that there was a statistically significant correlation between the level of stress during the COVID-19 pandemic and the status of the health of the entire periodontium. Patients with a higher level of stress had a more severe form of

periodontal disease, in contrast to patients whose scores on the Perceived Stress Scale were lower, which was in agreement with previous studies that also researched this topic [12, 19]. Since the COVID-19 outbreak represents a major stressful event, the impact on mental health in the form of elevated levels of stress, anxiety, and depression was noted among the global population [3]. Periodontal disease is a chronic condition that shares similar pathogenesis like stress, so it could be said that the COVID-19 pandemic has an indirect impact on the periodontial overall health [20].

The study results showed that there was a statistically significant difference in the status of periodontal health between the sexes. Possible explication for worse periodontal health in men could be due to the association of sex hormones, specifically testosterone, with periodontal disease [21]. The percentage of unemployed participants was the highest in the group with severely impaired periodontal health, and the employment variable had a statistically significant effect on periodontal health, in terms of PDI, especially in the case of unemployed subjects. However, other similar studies that were conducted before the current pandemic, did not find a significant association [22, 23]. Subjects who were single had the most severe periodontal disease, which was statistically significant and was also consistent with a previous study, performed in 2018 [15]. Nevertheless, regarding each measured periodontal disease indicator, a marital status significantly affected only the clinical attachment level. This study did also show an association between smoking status and periodontal health, confirming the results from earlier studies and the most common clinical expectations [15, 22, 23].

According to the results of this study, and bearing in mind the confounding covariables, the impact of stress on periodontal health was statistically significant. This analysis indicated that if the stress level increased by one unit, on the PDI would deteriorate by 4.2% (PRadjusted = 1.042) and CAL by 10.8% (PRadjusted = 1.108). These results coincided with a previous similar study [15].

The limitations of this study are reflected in relatively short time span of the research, the lack of radiographic monitoring of the periodontal health, and a smaller number of patients who attended the dental examination due to fear of COVID-19 infection. Since there were no other studies researching this topic during the COVID-19 pandemic, researchers could only compare their results with similar studies, performed before the current pandemic, which examined the effects of stress in general. However, these limitations do not affect the relevance of the obtained data.

CONCLUSION

Having in mind all the obtained results of this research, etiological factors and pathogenesis of periodontal disease, multifactorial and various variables considered in this study, and above all, the current global situation, it may be concluded that the increased stress during the COVID-19 pandemic may result in deterioration of the entire oral cavity's health, including the periodontium. However, more studies are necessary to further investigate this relationship and its' long-term implications.

Conflict of interest: None declared.

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Могућа повезаност стреса изазваног пандемијом ковида 19 и пародонталног здравља – пилот-студија

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САЖЕТАК

Увод/Циљ Стрес се наводи као један од фактора ризика повезаних са пародонталним здрављем. Пандемија ковида 19 има значајан негативан утицај на ментално и телесно здравље популације.

Циљ овог истраживања био је да се испита могућа повезаност између стреса изазваног пандемијом ковида 19 и пародонталног здравља.

Методе Опсервационо пилот-истраживање спроведено је од марта 2020. до октобра 2021. године и обухватило је 202 испитаника. Испитаници су оцењививали свој ниво стреса користећи српску верзију упитника Скала перципираног стреса. Индекс пародонталног обољења, индекс крварења гингиве и ниво припојног епитела одређивани су клиничким прегледом. Испитаници су подељени у следеће групе: Ia (низак ниво стреса), IIa (умерен ниво стреса), IIIa (висок ниво стреса), Ib (здрав пародонцијум), IIb (умерена форма обољења) и IIIb (тешка форма обољења). Процењивана је узрочно-последична веза између стреса и пародонталног здравља.

Резултати Резултати указују на статистички значајну разлику између испитиваних група на основу стреса у свим посматраним параметрима. Поасонова регресија је у оба модела показала да су варијабле повезане са пародонталним здрављем биле више код испитаника код којих је регистрован виши ниво стреса (индекс пародонталног обољења – *PRadjusted* = 1,042, 95% *CI* [1,030–1,055] и ниво припојног епитела – *PRadjusted* = 1,108, 95% *CI* [1,094–1,122]).

Закључак Појачан стрес током пандемије ковида 19 негативно утиче на ментално здравље и може довести до погоршања здравља целе усне дупље, укључујући и пародонцијум.

Кључне речи: ковид 19; пандемија; стрес; пародонтитис