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Original article

The Impact of COVID-19 on the Incidence of Temporomandibular Disorders

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SUMMARY

Introduction/Aim. Various psychological factors that arose during the COVID-19 pandemic could contribute to the development of chronic emotional stress which is the biggest contributor to the development of temporomandibular disorders (TMDs). This research aimed to evaluate the corellation between TMD and COVID-19 pandemic among students.
Methods. The authors conducted the study at the Faculty of Medicine in Niš, using an anonymous online survey, during two different periods, in 2022 at the peak of the pandemic and in 2023 after the WHO declared the end of the pandemic.The questionnaire consisted of questions that evaluate the influence of COVID-19 on patients' life as well as the questions from the Fonseca questionnaire.
Results. The sample consisted of 363 (2022) and 212 (2023) examinees. Statistical significance was determined using the χ^2 test. Students with TMDs were more prevalent in 2023 than in 2022 (83% vs 76%). TMDs were significantly more present among the female examinees ($p < 0.001$). Significance was not determined among examinees based on the study group, vaccination status, or based on whether they or their loved ones were affected by COVID-19.
Conclusion. Evidence of significantlly high number of TMDs was found among students. It could be linked to COVID-19 pandemic due to a large number of stresogenic factors that affect the students.

Keywords: **temporomandibular disorders, COVID-19, stress**

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INTRODUCTION

The mandible and cranium are connected by a complex joint that is unique in many aspects within the human body. It differs from other joints in the body in terms of morphology, function, range of motion, and its close relationship with vital organs. The joint surfaces are covered by a special type of the fibrous tissue (1).

Temporomandibular disorders (TMDs) encompass various clinical diagnoses of orofacial pain originating in the chewing muscles, temporomandibular joint, and the surrounding structures. TMDs are the most common cause of orofacial pain after dental caries and periodontal disease (2). It is estimated that 75% of the population experience some symptoms at least once in their lifetime, but only 10% of them meet the diagnostic criteria. It affects women more frequently than men. The etiology is multifactorial, with a particular focus on occlusal disturbances, bad habits, and emotional stress. Numerous studies have demonstrated a connection between the development of TMDs, depression, and anxiety (3 - 6). Various psychological factors that arise in individuals dealing with COVID-19 infection, particularly during their own or their loved ones' treatment, can initiate and trigger a cascade of sympathetic activity in our bodies. Increased sympathetic activity leads to the release of adrenocorticotropic hormone, representing the autonomic nervous system's response to stress (7). Additionally, bruxism is six times more prevalent in patients under greater stress. Prolonged contraction of head and neck muscles is associated with a forced body position induced by stressful events. Therefore, muscle contraction in bruxism could be a part of defensive behavior linked to anxiety and stress (8). Anxiety-related processes occur in the central nervous system, involving interactions between the prefrontal cortex, limbic and paralimbic structures, and the motor region of the brainstem, resulting in motor and physiological responses not only to stress but also increased alertness and attention (9). Over time, all these feelings lead to psychological overload and constant emotional stress, one of the most significant etiological factors in the development of temporomandibular disorders.

The period of the pandemic and the subsequent quarantine imposed due to COVID-19 in all European countries can be considered a major life event affecting millions. In Serbia, a state of emergency was declared on March 15, 2020, lasting until May 6 of the same year. During this period, people were instructed to stay at home and socially isolate themselves to reduce the spread of the virus. It is important to note that the initial lockdowns came as a complete surprise to most of the population in all countries. Therefore, restrictions in everyday life and behavior were not equally tolerated by every individual (10). Preliminary recent research indicates that the coronavirus epidemic is associated with moderate to severe psychological impact on most individuals (11). Specific physical symptoms (e.g. myalgia, dizziness, colds, and respiratory inflammation) and self-perceived poor health have been significantly associated with greater psychological impact and higher levels of stress, anxiety, and depression. The psychosocial impact of COVID-19 may influence musculoskeletal pain, especially stress-related pain conditions such as temporomandibular disorders (12 - 15). Several studies explored the connection between stress and temporomandibular disorders, providing evidence that psychological distress is linked to high levels of pain and disability related to TMDs (16). Case-control stu-dies observed that stress levels, anxiety, depression, and catastrophizing are significantly higher in individuals with TMD compared to the asympto-matic population (17, 18). Furthermore, individuals with orofacial pain report that stress contributes to the onset, development, and maintenance of their pain (19 - 22). During quarantine, people had to isolate themselves and suddenly experienced a change in their personal, social, and professional lives, which can be considered a major life change (23). We assumed that the coronavirus pandemic might have caused "loss and interpersonal relationship problems" in people. Lockdown due to the coronavirus, concerns about personal health, as well as the health of people in our environment during the pandemic, can be considered social stressors that similarly affected the lives of all people in quarantine and in the subsequent period until the end of the pandemic was declared (24 - 26).

AIM

The aim of the study was to investigate the association between the COVID-19 pandemic and temporomandibular disorder symptoms among students at the Faculty of Medicine in Niš.

MATERIALS AND METHODS

The research was conducted among students of both genders enrolled in integrated academic programs at the Faculty of Medicine in Niš. Ethical approval for the study was obtained from the Ethics Committee of the Faculty of Medicine, University of Niš, under the protocol number 12-3588-2/3. The examined sample at the peak of the pandemic consisted of 363 students, while the sample after the WHO declared the end of the pandemic was comprised of 212 students from the Faculty of Medicine in Niš.

Due to the COVID-19 pandemic, clinical confirmation of TMD symptoms was not possible. Surveys were conducted using Google Forms, and students were informed through student organizations on social media.

The first survey was conducted during the period of the highest increase in the number of newly infected individuals, from January 22, 2022 to February 2, 2022. The second survey was conducted five days after the WHO declared the global pandemic over, from May 10, 2023 to May 22, 2023. The surveys were anonymous.

Students were asked to provide answers to the following questions, in addition to general information such as gender and study group:

- Whether the student had a COVID-19 infection in the last six months.
- Whether the student had been vaccinated against COVID-19.

In addition to these data, questions related to the temporomandibular joint were included within the Fonseca questionnaire, which contained the following questions:

1. Do you experience difficulty in opening your mouth?
2. Do you feel difficulty when moving your lower jaw to the side?
3. Do you experience fatigue or pain in your jaw muscles while chewing?
4. Do you have headaches?
5. Do you have a stiff neck or neck pain?
6. Do you have ear pain or pain around the ear (temporomandibular joint)?
7. Have you ever noticed any sounds in the temporomandibular joint when chewing or opening your mouth?
8. Do you have habits such as teeth clenching or grinding?
9. Do you feel that the contacts between your teeth have changed?
10. Do you consider yourself a person under pressure (nervous)?

Statistical methods

Frequencies and percentages for categorical data were computed. Descriptive statistics also included mean, standard deviation, median, minimum and maximum of Fonseca score values. To compare distributions of a categorical variables levels, the Chi-square test was used. The Mann-Whitney U test was used to compare the Fonseca score values for 2022 and 2023. To assess the association between Fonseca score values and other variables, univariate and multivariate linear regression analyses using enter method were performed. Regression coefficients (B) and 95% confidence intervals (95% CI) were calculated.

A statistical software package (PASW Statistics 18, Release Version 18.0.0, SPSS, Inc., 2009, Chicago, IL) was used. The level of significance was set at $p < 0.05$.

RESULTS

The percentage of students who received the vaccine in the last six months was significantly higher in 2022 than in 2023 (68.3% vs. 16.2%; Chi-square test: $P < 0.001$). Also, the percentage of students who had contracted Covid-19 in the last six months was significantly higher in 2022 than in 2023 (26.7% vs. 12.4%; Chi-square test: $p < 0.001$).

The average Fonseca score for the examined students in 2022 was 31.57 ± 18.04, with a median of 30, ranging from 0 to 85. In 2023, the average Fonseca score was 36.53 ± 20.1, with a median of 35, ranging from 0 to 90. Fonseca scores in 2023 were significantly higher than in 2022 (Mann-Whitney U test: $p = 0.008$) (Table 1).

Students without symptoms and signs of TMD were more prevalent in 2022 than in 2023 (24.0% vs. 17.0%), as well as students with mild degrees of disorder (51.2% vs. 48.1%), while students with moderate degrees of disorder were more prevalent in 2023 than in 2022 (24.1% vs. 21.2%), as were those with severe disorder (10.8% vs. 3.6%). The distribution of students with various degrees of dis-

Table 1. *Characteristics of participants by the year of study*

Feature	Year		Total (N = 575)	*P*
	2022 (N = 363)	2023 (N = 212)		
Gender				
Male	76 (20.9%)	50 (23.6%)	126 (21.9%)	0.459
Female	287 (79.1%)	162 (76.4%)	449 (78.1%)	
Year of study				
1	41 (11.3%)	29 (13.8%)	70 (12.2%)	0.331
2	43 (11.9%)	25 (11.9%)	68 (11.9%)	
3	51 (14.1%)	22 (10.5%)	73 (12.8%)	
4	62 (17.1%)	25 (11.9%)	87 (15.2%)	
5	115 (31.8%)	73 (34.8%)	188 (32.9%)	
6	50 (13.8%)	36 (17.1%)	86 (15.0%)	
Have you received the Covid19 vaccine in the last 6 months?				
No	115 (31.7%)	176 (83.8%)	291 (50.8%)	**< 0.001**
Yes	248 (68.3%)	34 (16.2%)	282 (49.2%)	
Have you had Covid19 in the last 6 months?				
No	266 (73.3%)	184 (87.6%)	450 (78.5%)	**< 0.001**
Yes	97 (26.7%)	26 (12.4%)	123 (21.5%)	
Did you experience death in the family or among friends during the pandemic?				
No	243 (66.9%)	144 (68.6%)	387 (67.5%)	0.688
Yes	120 (33.1%)	66 (31.4%)	186 (32.5%)	
Do you have difficulty opening your mouth?				
No	289 (79.6%)	152 (71.7%)	441 (76.7%)	**< 0.001**
Yes	67 (18.5%)	51 (24.1%)	118 (20.5%)	
Do you feel difficulty moving your lower jaw sideways?				
No	286 (79%)	160 (75.8%)	446 (77.8%)	0.373
Sometimes	60 (16.6%)	36 (17.1%)	96 (16.8%)	
Yes	16 (4.4%)	15 (7.1%)	31 (5.4%)	
Do you feel fatigue or pain in the jaw muscles while chewing?				
No	238 (65.6%)	81 (38.4%)	319 (55.6%)	**< 0.001**
Sometimes	96 (26.4%)	95 (45.0%)	191 (33.3%)	
Yes	29 (8.0%)	35 (16.6%)	64 (11.1%)	
Do you have headaches?				
No	90 (24.9%)	44 (20.8%)	134 (23.3%)	0.465
Sometimes	160 (44.2%)	103 (48.6%)	263 (45.8%)	
Yes	112 (30.9%)	65 (30.7%)	177 (30.8%)	
Do you have a stiff neck or neck pains				
No	119 (32.8%)	63 (29.7%)	182 (31.7%)	0.720
Sometimes	144 (39.7%)	90 (42.5%)	234 (40.7%)	
Yes	100 (27.5%)	59 (27.8%)	159 (27.7%)	
Do you have ear pain or pain around the ear?				
No	263 (72.5%)	150 (70.8%)	413 (71.8%)	0.811
Sometimes	79 (21.8%)	47 (22.2%)	126 (21.9%)	
Yes	21 (5.8%)	15 (7.1%)	36 (6.3%)	
Have you ever noticed any sounds in the temporomandibular joint during chewing or opening your mouth?				
No	144 (39.7%)	66 (31.1%)	210 (36.5%)	0.111
Sometimes	95 (26.2%)	60 (28.3%)	155 (27.0%)	
Yes	124 (34.2%)	86 (40.6%)	210 (36.5%)	
Do you have any habits like grinding or clenching your teeth?				
No	224 (61.7%)	124 (58.8%)	348 (60.6%)	0.280

Sometimes	79 (21.8%)	41 (19.4%)	120 (20.9%)	
Yes	60 (16.5%)	46 (21.8%)	106 (18.5%)	
Do you feel that the contacts between your teeth have changed?				
No	299 (82.6%)	153 (72.9%)	452 (79.0%)	**0.008**
Sometimes	22 (6.1%)	27 (12.9%)	49 (8.6%)	
Yes	41 (11.3%)	30 (14.3%)	71 (12.4%)	
Do you consider yourself as a stressed or nervous person?				
No	50 (13.8%)	22 (10.4%)	72 (12.5%)	0.380
Sometimes	156 (43%)	101 (47.6%)	257 (44.7%)	
Yes	157 (43.3%)	89 (42.0%)	246 (42.8%)	
Severity of disorder				
No symptoms and signs 0 do 15	87 (24.0%)	36 (17.0%)	123 (21.4%)	**0.002**
Mild disorder 20 do 40	186 (51.2%)	102 (48.1%)	288 (50.1%)	
Moderate disorder 45 do 65	77 (21.2%)	51 (24.1%)	128 (22.3%)	
Severe disorder 70 do 100	13 (3.6%)	23 (10.8%)	36 (6.3%)	
Fonseca score	31.57±18.04 30 (0 – 85)	36.53±20.12 35 (0 – 90)	33.40±18.97 30 (0 – 90)	**0.008**

NOTE: Values are presented as number (percentage) or as mean ± standard deviation and median (minimum – maximum).

Table 2. *Distribution of different degrees of temporomandibular disorders by investigated factors*

Feature	Fonseca classification				*P*
	No symptoms and signs 0 do 15 (N = 123)	Mild disorder 20 do 40 (N = 288)	Moderate disorder 45 do 65 (N = 128)	Severe disorder 70 do 100 (N = 36)	
Gender					
Male	48 (38.1%)	61 (48.4%)	13 (10.3%)	4 (3.2%)	**< 0.001**
Female	75 (16.7%)	227 (50.6%)	115 (25.6%)	32 (7.1%)	
Year of study					
1	11 (15.7%)	34 (48.6%)	22 (31.4%)	3 (4.3%)	0.057
2	7 (10.3%)	37 (54.4%)	18 (26.5%)	6 (8.8%)	
3	13 (17.8%)	3 (53.4%)	19 (26.0%)	2 (2.7%)	
4	17 (19.5%)	51 (58.6%)	16 (18.4%)	3 (3.4%)	
5	55 (29.3%)	86 (45.7%)	34 (18.1%)	13 (6.9%)	
6	19 (22.1%)	41 (47.7%)	18 (20.9%)	8 (9.3%)	
Have you received the Covid19 vaccine in the last 6 months?					
No	56 (19.2%)	146 (50.2%)	65 (22.3%)	24 (8.2%)	0.187
Yes	66 (23.4%)	142 (50.4%)	62 (22.0%)	12 (4.3%)	
Have you had Covid-19 in the last 6 months?					
No	91 (20.2%)	228 (50.7%)	103 (22.9%)	28 (6.2%)	0.763
Yes	30 (24.4%)	60 (48.8%)	25 (20.3%)	8 (6.5%)	
During the pandemic, have you experienced death in your family or among friends?					
No	89 (23.0%)	18 (51.2%)	78 (20.2%)	22 (5.7%)	0.144
Yes	32 (17.2%)	0 (48.4%)	50 (26,9%)	14 (7.5%)	

order was significantly different in 2022 and 2023 (Chi-square test: p = 0.002) (Table 2).

In 2023, a significantly higher percentage of students reported sometimes having difficulty opening their mouths compared to 2022 (24.1% vs. 18.5%; Chi-square test: p < 0.001).

In 2023, a significantly higher percentage of students reported sometimes or always experiencing fatigue or pain in their jaw muscles while chewing compared to 2022 (45.0% vs. 26.4% and 16.6% vs. 8.0%; Chi-square test: p < 0.001).

In 2023, a significantly higher percentage of students reported sometimes or always feeling that the contacts between their teeth had changed compared to 2022 (12.9% vs. 6.1% and 14.3% vs. 11.3%; Chi-square test: p = 0.008).

Differences in the distribution of individual categories of other characteristics were not significant among the examined students in 2022 and 2023.

Among the female students, all degrees of temporomandibular disorders were significantly more prevalent compared to male students, with mild disorders at 50.6% vs. 48.4%, moderate at 25.6% vs. 10.3%, and severe disorders at 7.1% vs. 3.2% (Chi-square test: P < 0.001).

There were no significant differences in the distribution of various degrees of temporomandibular disorders among other investigated factors.

Univariate regression analysis revealed that an increase in Fonseca score values was significantly associated with female gender (B = 10.706; 95% CI: 7.051 to 14.362; P < 0.001) and the occurrence of death in the family or among friends during the pandemic (B = 3.786; 95% CI: 0.474 to 7.099; P = 0.025), while a decrease in Fonseca score values was significantly associated with the year 2022 (B = -4.963; 95% CI: -8.160 to -1.765; P = 0.002) and the year of study (B = -1.195; 95% CI: -2.147 to -0.243; P = 0.014).

Multivariate regression analysis, controlling for the influence of other factors, showed that changes in Fonseca score values were significantly associated with the year 2022 (B = -5.797; 95% CI: -9.584 to -2.009; P = 0.003), female gender (B = 10.221; 95% CI: 6.544 to 13.898; P < 0.001), and the occurrence of death in the family or among friends during the pandemic (B = 3.788; 95% CI: 0.572 to 7.004; P = 0.021) (Table 3).

Table 3. *The association between Fonseca score values and investigated characteristics, linear regression analysis results*

Type of analysis/Variable	B	95% CL Bounds		*P*
		Lower	Upper	
Univariate analysis				
Year 2022	-4.963	-8.160	-1.765	**0.002**
Female gender	10.706	7.051	14.362	**< 0.001**
Year of study	-1.195	-2.147	-0.243	**0.014**
Received COVID-19 vaccine in the last 6 months	-2.721	-5.830	0.388	0.086
Had COVID-19 in the last 6 months	-1.150	-4.943	2.643	0.552
Death in the family or among friends during the pandemic	3.786	0.474	7.099	**0.025**
Multivariate analysis				
Year 2022	-5.797	-9.584	-2.009	**0.003**
Female gender	10.221	6.544	13.898	**< 0.001**
Year of study	-0.735	-1.691	0.220	0.131
Received COVID-19 vaccine in the last 6 months	-0.141	-3.788	3.505	0.939
Had COVID-19 in the last 6 months	0.081	-3.682	3.843	0.966
Death in the family or among friends during the pandemic	3.788	0.572	7.004	**0.021**
Study group - Medicine	1.968	-1.303	5.239	0.238
Study group - Pharmacy	1.646	-4.006	7.297	0.568
Study group - Dentistry	-1.968	-5.239	1.303	0.238

DISCUSSION

The results of our study indicate a high percentage of temporomandibular disorders (TMDs) with a prevalence of 76% in 2022 and 83% in the study conducted in 2023. Furthermore, students with moderate degrees of disorder were more prevalent in 2023 than in 2022 (24.1% vs. 21.2%), as were those with severe disorder (10.8% vs. 3.6%).

In a similar epidemiological study conducted among dental students, the authors reported a 53.21% prevalence of TMDs in a sample of similar size and age (27). Considering the association of psychosomatic stressors with TMDs and the significant role attributed to chronic stress, depression, and anxiety in its etiology (3 - 6), this difference can be explained by the timing of patient interviews when there was no COVID-19 pandemic. Similar studies conducted before the pandemic also reported lower percentages of TMDs (28, 29).

Other earlier studies reported lower prevalence rates of TMDs in the population (30). The explanation for these differences includes variations in sample size, age, and gender distribution of patients. Therefore, we compared the results of our study with studies conducted in groups of students with similar sample sizes.

Similar to our 2022 study, a group of authors who conducted research in the context of the pandemic reported a 77.5% prevalence of TMD among dental students and noted an increased index of anxiety, depression, and stress among students (31).

In addition to the obvious reasons for a stressful environment, the increased prevalence of depression, anxiety, and chronic stress during the COVID-19 pandemic can also be attributed to changes in sleep patterns, time perception, and social media use (32, 33). The authors noted that during quarantine, people go to bed and wake up later, affecting circadian rhythms and mental health, leading to stress, anxiety, and depression. Previous research has reported a correlation between sleep disorders and the development of TMD (34 - 36).

In many studies, the student population and individuals under 30 years of age show a higher level of anxiety and depression, which may affect the overall number of individuals affected by TMDs in research (37). However, as mentioned earlier, compared to studies conducted before the pandemic, the prevalence is higher.

The limitation of social contacts during quarantine and forced isolation can be an important factor in worsening mental health and the development of stress (38), which can be related to the increased number of respondents with TMDs (39).

Regarding the gender of the participants, female participants reported the symptoms of TMDs significantly more often than male participants in both study periods. Additionally, more severe forms of TMDs were more common in female participants. These data align with numerous previous studies reporting a higher incidence of TMDs in females (40, 41).

Among the participants, there was no statistically significant difference in the prevalence of TMDs based on vaccination status or the direct impact of the pandemic on participants' lives. This data may be related to the equal stressful impact on all participants due to similar changes in living conditions. This is supported by the results of the Fonseca questionnaire in 2022, where 86.3% of respondents considered themselves nervous individuals and 75.1% experienced headaches, while in 2023, 89.6% of respondents considered themselves nervous individuals and 79.3% experienced headaches.

The strength of our study lies in the fact that it covered periods when the pandemic reached its peak in terms of the number of infections. The study was conducted in 2022, as well as the period after the WHO declared the end of the pandemic, which corresponds to the 2023 study. Additionally, the sample size included only students of the same age group with similar study conditions that influenced their life circumstances.

LIMITATIONS

The limitations of our study primarily include the inability to clinically assess TMDs due to the prevention of worsening the epidemiological situation during the COVID-19 pandemic. Additionally, the study was conducted in a limited student population, and the results may not reflect the entire population.

CONCLUSION

The results of our study indicate a high percentage of participants showing the signs of TMDs. The sudden and drastic change in the living environ-

ment of students, their habits, and the large number of stressors during the pandemic, as well as the fact that the studied population belongs to the age group most prone to stress, anxiety, and depression, may be related to the increased incidence of these disorders. Further clinical and psychological studies are necessary to directly confirm the relationship between the COVID-19 pandemic and TMDs.

Data availability statement

The layout of the questionnaire (in Serbian) is available at: https://docs.google.com/forms/d/e/1FAIpQLScrFnyU9TBHpmZ3m1ku8wAzcIiTmvuMrY1WxIAB2LVdQyigUg/viewform?usp=sf_link. The dana sets generated and analyzed during the study are not publicly available; all data from this study are available from the corresponding author on request.

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Uticaj COVID-19 na učestalost javljanja temporomandibularnih poremećaja

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S A Ž E T A K

Uvod/Cilj. Različiti psihološki faktori koji se javljaju tokom pandemije COVID-19 mogu doprineti razvoju hroničnog emocionalnog stresa, koji je najznačajniji faktor u razvoju temporomandibularnih poremećaja (TMP). Ovo istraživanje ima za cilj da proceni korelaciju između TMP-a i pandemije COVID-19 među studentima.
Metode. Autori su sproveli istraživanje na Medicinskom fakultetu u Nišu, koristeći anonimnu onlajn anketu, tokom dva različita perioda – 2022. godine na vrhuncu pandemije i 2023. godine nakon što je Svetska zdravstvena organizacija (SZO) proglasila kraj pandemije. Odgovori na pitanja iz upitnika iskorišćeni su za procenu uticaja COVID-19 na život bolesnika, kao i odgovori na pitanja iz Fonseca upitnika.
Rezultati. Uzorak je obuhvatio 363 (2022) i 212 (2023) ispitanika. Statistička značajnost utvrđena je korišćenjem χ^2 testa. Studenti sa TMP-om bili su zastupljeniji 2023. godine nego 2022. godine (83% naspram 76%). TMP je bio značajno prisutniji među ženskim ispitanicima ($p < 0,001$). Statistički značaj nije utvrđen među ispitanicima na osnovu studijske grupe, statusa vakcinacije ili na osnovu toga da li su oni ili njihovi najbliži bili pogođeni oboljenjem COVID-19.
Zaključak. Dokazi o značajno visokom broju TMP-a pronađeni su među studentima. To bi moglo biti povezano sa pandemijom COVID-19 zbog velikog broja stresogenih faktora koji utiču na studente.

Ključne reči: **poremećaji temporomandibularnih zglobova, COVID-19, stres**