

WITHDRAWN: The Effects of Mask Usage During the COVID-19 Pandemic on Temporomandibular Joint

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The full text of this preprint has been withdrawn by the authors while they make corrections to the work. Therefore, the authors do not wish this work to be cited as a reference. Questions should be directed to the corresponding author.

Abstract

Objectives: To evaluate possible temporomandibular joint disorder (TMD) symptoms that may occur due to mask use in dentists during the COVID-19 pandemic period and reveal the potentially effective factors.

Materials and Methods: An online questionnaire, consisting of three parts, was sent to dentists and clinical dental students. The first part included questions for sociodemographic information. In the second part, questions were asked to evaluate stress levels, TMD symptoms, and treatment of TMD if any for before (T0) and during the pandemic (T1). In the last part, professional mask choice, mask-related parafunctional movements, and breathing pattern while wearing a mask were evaluated.

Results: TMD symptoms and stress level were found significantly higher at T1. An increase in mouth breathing and mask-related parafunctional movements was reported during the use of N95 masks compared to daily life in dentists whose professional mask selection was N95 respirator. The change in TMJ pain and muscle pain at rest between the T0 and T1 was higher in those whose professional mask choice was N95 respirators than those who chose to wear one surgical mask.

Conclusion: The increase in mouth breathing and mask-related parafunctional movements during the use of N95 respirators may cause an increase in TMD.

Clinical Relevance: During the use of N95 respirator masks, an increase in mouth breathing and mask-related parafunctional movements can be observed. It should be considered that this situation may cause an increase in the TMD symptoms.

Introduction

The novel coronavirus disease 2019 (COVID-19) was first detected in Wuhan City, China, and the World Health Organization (WHO) China Country Office was informed of cases of pneumonia with unknown etiology on 31 December 2019 [1]. WHO announced COVID-19 to be a pandemic on 11 March 2020 [2].

Studies have shown that interpersonal transmission of the coronavirus causing COVID-19 (SARS-CoV-2) occurs through respiratory droplets, contact, airborne, and fomite transmission, and thus, governments have either recommended or made compulsory that facemasks are used in public areas [3]. Wearing facemasks in public areas has been compulsory in the Turkey since 8 September 2020 [4]. Researchers have reported that while standard surgical masks are sufficient during daily activities, FFP2 or more protective masks are necessary in occupations that involve exposure to respiratory droplets [5].

An article titled “the Workers Who Face the Greatest Coronavirus Risk” was published by the New York Times in March 2020 with a chart which demonstrated that dentists and other dental care workers who face the most risk of getting infected by the new coronavirus highlighted their frequency of exposure to the disease and physical proximity to others, in this case, patients [6].

The report of WHO science briefing in July 2020 mentioned that transmission through aerosols has brought upon the necessity of using filtering facepiece respirators (FFRs), such as FFP2/N95 or FFP3/N99 respirators, during aerosol generating procedures in the field of healthcare [3]. Additionally, it was reported that healthcare workers should use personal protective equipment such as face shields/goggles and gowns during these procedures [7].

Ong et al.[8] noticed that the prolonged usage of masks increased the prevalence of headaches, especially for individuals with a history of headaches, yet they also found that long-term mask usage does not reduce the oxygen saturation level in the blood. In addition to headaches, other discomforts reported while wearing a mask include nasal bridge scarring [9], facial itching [9], rash/irritation [10], and discomfort related to increased facial temperatures [11, 12]. In the study conducted by Luximon et al. [13] participants reported an increase in humidity, breathing difficulty, and overall discomfort while wearing facemasks, especially while wearing the N95 mask and situations that required speaking.

The increase in the number of patients with temporomandibular joint disorder (TMD) who presented to our clinic during the pandemic period and the reporting that parafunctional habits such as clenching, mouth breathing, and those to keep the mask in place or fix it became more frequent among our colleagues, especially during the use of N95 respirators, led us to conduct this study. The aim of this study is to evaluate possible TMD symptoms that may occur due to mask use among dentists during the COVID-19 pandemic period and reveal the potentially effective factors.

Materials And Methods

This study was approved by the XXX Ministry of Health (2021-04-07T11_42_33) and XXX University Non-Invasive Ethics Committee (2021/168).

A questionnaire was created online through Google Forms (Google LLC, Mountain View, CA, USA) and sent to dentists and clinical dental students via e-mail, WhatsApp, and social media platforms (Instagram, Twitter). Dentists who were not working during the pandemic period and preclinical dental students were excluded from the study.

The questionnaire consisted of three parts. The first part included questions on demographic information, including age, sex, status, institution, and weekly working hours. In the second part, questions were asked to evaluate stress levels and TMD symptoms (limitation of mouth opening, TMJ and masticatory muscle pain at rest and function, alteration during function, TMJ sounds, jaw locking, or luxation), and treatment of TMD if any of individuals for before (T0) and during the COVID-19 pandemic period (T1). Individuals were requested to score their stress levels, pain levels, and levels of limitation of mouth opening on a scale of 0 to 10. In the last part, professional mask choice, mask-related parafunctional jaw movements (lateral or protrusive positioning of the mandible, grinding, repetitive mouth opening and closing, involuntary mouth opening) and breathing pattern while wearing a mask were evaluated. The last two

criteria were also questioned for mask usage in their routine life. The data were collected from May 25 to August 15, 2021.

Statistical Analysis

A total of 554 individuals filled out the questionnaire. 49 of them stated that they were not actively working, and thus, these individuals were excluded from the analyses, and the statistical analyses were conducted on the data collected from 505 individuals.

The analyses were performed in the IBM SPSS Statistics software (version 22.0; IBM Corp., Armonk, NY). The data are expressed as mean and standard deviation or frequency with percentage values for the variables. Data normality was assessed using Shapiro–Wilk test.

The comparison of limitation of mouth opening, TMJ, and masticatory muscle pain during rest and function in different periods (T0: before the COVID-19 pandemic, T1: during the pandemic) was performed with the Wilcoxon Signed-Rank test. Changes in terms of TMD symptoms between the periods ($\Delta T0/T1$) in the groups formed according to their mask preferences while performing dental procedures (Group 1: one surgical mask, Group 2: two surgical masks, Group 3: N95/FFP2 or N95/FFP2 + surgical mask) were analyzed with the Kruskal-Wallis test. The Bonferroni post-hoc test was used to determine the source of the differences that were found significant.

McNemar's test was used to compare breathing patterns and parafunctional movements (keeping mouth open, teeth clenching, lateral or protrusive movement of the mandible, opening and closing the mouth repeatedly to adjust the mask) while performing dental procedures and in daily life between the groups. Spearman's rank correlation coefficient was used to examine the correlation between weekly working hours and TMD symptoms. The level of statistical significance was accepted as $p < 0.05$.

Results

The distributions of the demographic characteristics of the participants, including age, sex, status, institution, weekly working hours, and professional mask choice, are given in Table 1.

Table 1
Sociodemographic characteristics of the participants (n = 505)

Age (Years)	n	Percentage
20–25	175	34.7%
25–30	141	27.9%
30–40	86	17%
40–50	46	9.1%
50–60	37	7.3%
60+	20	4%
Gender		
Female	346	68.5%
Male	159	31.5%
Type of Institution		
Governmental oral and dental health center	47	9.3%
Private dental office	103	20.4%
Private dental polyclinic/hospital	114	22.6%
University	241	47.7%
Profession		
Clinical dental student	139	27,5%
Postgraduate student	71	14,1%
Dentist	194	38,4%
Dental specialist	101	20%
Weekly Working Time		
< 10 hours	100	29.8%
10–20 hours	89	17.6%
20–30 hours	63	12.5%
30–40 hours	123	24.4%
40 < hours	130	25.7%
Professional Mask Choice		
One surgical mask	44	8.7%

Age (Years)	n	Percentage
Two surgical masks	80	15.8%
N95/FFP2 or N95/FFP2 + surgical mask	381	75.5%

The results of the comparison of TMD symptoms, including limitation of mouth opening, TMD and masticatory muscle pain during rest and function, and stress levels between T0 and T1 are shown in Table 2. All these symptoms and stress levels were found significantly higher at T1 compared to T0 ($p < 0.001$).

Table 2
Comparison of TMD symptoms and stress levels between T0 and T1

	T0		T1		p-value
	Mean	SD	Mean	SD	
Limitation of Mouth Opening	0.37	0.81	0,64	1,05	< 0.001***
TMJ Pain at Rest	0.77	1.45	1.21	1.83	< 0.001***
TMJ Pain in Function	0.76	1.31	1.36	2.00	< 0.001***
Muscle Pain at Rest	0.87	1.46	1.49	2.07	< 0.001***
Muscle Pain in Function	0.96	1.56	1.62	2.24	< 0.001***
Stress level	4,3	2,22	6,03	2,32	< 0.001***
*P < .05; ** P < .01; *** P < .001					

While the number of participants reporting no alteration in function decreased during the COVID-19 pandemic period, an increase was observed in the number of individuals who reported functional alterations (TMJ sounds, locking, or luxation). Furthermore, the number of participants with painless function decreased, and those who experienced pain during one or more movements (opening or closing the mouth, lateral or protrusive movement of the mandible) increased from T0 to T1. While 52 of the participants reported that they had received treatment for TMD (pain killers, anti-inflammatory drugs, muscle relaxants, oral splints, physical therapy, surgical approaches, or Botox injections) before the pandemic, 53 participants reported that they began treatment during the pandemic period (Table 3).

Table 3

Distribution and frequency of the treatment of TMD, functional alterations, and pain status in T0 and T1

		T0		T1	
		n	%	n	%
Functional Alterations	Normal Function	386	%76.4	348	%68.9
	TMJ sounds (clicking or crepitus)	119	%23.6	150	%29.7
	Jaw locking or luxation	0	%0	7	%1.4
Pain During Function	Painless Function	462	%91.5	404	%80
	Pain during one movement*	36	%7.1	76	%15
	Pain during at least 2 movements*	7	%1.4	25	%5
Treatment of TMD	Presence	52	%10.3	53	%10.5
	Absence	453	%89.7	452	%89.5
*Opening the mouth, closing the mouth, lateral or protrusive movements of the mandible					

Changes in TMD symptoms between the periods ($\Delta T0/T1$) in the groups that were formed according to their mask preferences while performing dental procedures are demonstrated in Table 4. The results revealed a statistically significant difference in the change in TMJ pain at rest ($p = 0.01$) and masticatory muscle pain at rest ($p = 0.008$) only between Group 1 and Group 3. The results of the comparison of breathing patterns and parafunctional activities while performing dental procedures and in daily life within the groups are shown in Table 5. Statistically significant differences in breathing patterns and the presence of parafunctional activities were detected only in Group 3 ($p < 0.001$). No correlation was found between working hours and TMD symptoms ($p < 0.05$).

Table 4
Intergroup comparison of the change in TMD symptoms between the periods ($\Delta T0-T1$)

$(\Delta T0-T1)$	Group 1		Group 2		Group 3		p-value	Post hoc p-value	
	(n = 44)		(n = 80)		(n = 381)				
	Mean	SD	Mean	SD	Mean	SD			
Δ Limitation of Mouth Opening	0.06	1.06	0.2	0.8	0.3	0.9	0.19		
Δ TMJ Pain at Rest	-0.02	1.48	0.27	0.01	0.52	1.35	0.01**	Grup 1-3	0.02*
Δ TMJ Pain in Function	0.34	2.03	0.46	1.01	0.65	1.47	0.23		
Δ Muscle Pain at Rest	0.04	0.65	0.32	0.91	0.74	1.61	0.008**	Grup 1-3	0.04*
Δ Muscle Pain in Function	0.18	2.03	0.47	1.00	0.76	1.50	0.05		
*P < .05; ** P < .01; *** P < .001									
T0; Before the pandemic, T1; During the pandemic									

Table 5

Intragroup comparison of breathing patterns and parafunctional movements while performing dental procedures and in daily life

			Daily Life		Performing Dental Procedure		p-value
			n	%	n	%	
Group 1 (n = 44)	Breathing pattern	Nasal breath	21	48%	20	45%	0.51
		Mouth breath	4	9,09%	3	7%	
		Nasal and mouth breath	19	43,18%	21	48%	
	Parafunctional movement	Presence	29	66%	29	66%	1
		Absence	15	34%	15	34%	
Group 2 (n = 80)	Breathing pattern	Nasal breath	37	46,25%	39	49%	0.47
		Mouth breath	12	15,00%	13	16%	
		Nasal and mouth breath	31	38,75%	28	35%	
	Parafunctional movement	Presence	50	63%	55	69%	0.33
		Absence	30	38%	25	31%	
Group 3 (n = 381)	Breathing pattern	Nasal breath	195	51,18%	145	38%	< 0.001***
		Mouth breath	25	6,56%	55	14%	
		Nasal and mouth breath	161	42,26%	181	48%	
	Parafunctional movement	Presence	234	61%	297	78%	< 0.001***
		Absence	147	39%	84	22%	

*P < .05; ** P < .01; *** P < .001

Discussion

Temporomandibular disorders are multifactorial conditions, in which soft or hard tissue could be affected. Trauma [14], emotional state [15, 16], malocclusion [17, 18] and oral parafunctions [19–21] can be counted among the known etiological factors for TMD. Oral, masticatory, and facial behaviors that do not serve any functional purpose are called oral parafunctions in general [22]. These behaviors are usually harmless, but when their frequency or the forces induced by them exceed some physiological tolerance, they seem to cause harmful effects on joints and muscles. Oral parafunctions such as teeth

clenching and grinding, nail biting, and gum chewing are the most commonly reported ones [23, 24]. In the present study, it was aimed to reveal the parafunctional movements that may develop due to mask usage and evaluate the possible effects of these movements on temporomandibular joint dysfunction.

TMD presents with bilateral or unilateral symptoms such as muscle pain, headaches, TMJ sounds, jaw locking or luxation, tinnitus, and restricted mouth opening [25–27]. Some conditions such as toothaches, earaches, maxillary sinusitis, some carcinomas, neuralgias, salivary gland diseases, acromegaly, Eagle syndrome, migraine, and high blood pressure mimic the symptoms of TMD [28]. This study did not include clinical examination, whereas it is based on the self-reports of the participants. To prevent the confusion of TMD symptoms with the other conditions mentioned above, the questionnaire was administered only to dentists and clinical dental students. The participants were asked to evaluate their TMD signs and symptoms in one certain period (before and during the COVID-19 pandemic period).

The participants in this study reported an increase in TMD symptoms during the pandemic compared to before the pandemic. Etiological factors such as professional mask preferences, duration of mask use, parafunctional habits that could be formed due to wearing a mask, and stress were investigated in this study.

75.5% of the participants reported that their choice of professional mask was N95/FFP2 or N95/FFP2 + surgical mask, while 15.8% chose to wear two surgical masks on top of each other, and 8.7% preferred one surgical mask. In the comparison of the TMD symptoms of the groups that were created according to their professional mask choices, while there was no significant difference in terms of limitation of mouth opening or TMJ and masticatory muscle pain at function, the difference in the change of TMJ pain and masticatory muscle pain at rest was higher in Group 3 than in Group 1.

The participants in Group 3 stated that their mouth breathing and mask-related parafunctional movements (lateral or protrusive positioning of the mandible, grinding, repetitive mouth opening and closing, involuntary mouth opening) increased compared to daily life during the use of N95 masks. Neither of the other groups reported a significant difference, and this result also indicated the impact of FFP2/N95 use on breathing patterns and parafunctions. This may explain the increase in TMJ and masticatory muscle pain at rest during the pandemic period among individuals with N95 respirators as their mask preference (Group 3) compared to individuals with one surgical mask as their mask preference (Group 1). Supporting the findings of the study, there are studies reporting a significant relationships between parafunctional habits, mouth breathing, and TMD [29, 30]. Besides, Kojima et al. [31] reported that involuntary mouth opening, like bruxism, may play a role in the development of TMDs.

Scheid et al. [25] found that the sustained use of masks increased the prevalence of headaches for individuals with a history of headaches but also noticed that long-term mask usage does not reduce the oxygen saturation levels in the blood. This finding led to suspicion of other causes of headaches that could be related to mask use. In addition to this suspicion, the increasing number of patients who consulted our clinic with TMJ complaints during the COVID-19 pandemic and our colleagues reporting

that they have adopted parafunctional behavior during mask use have brought upon the need to investigate the effects of facemask use on TMJ.

One of the objectives of the present study was to explore the possible effects of prolonged mask usage on TMD during the COVID-19 pandemic. To evaluate the relationship between professional mask wearing duration and TMD signs and symptoms, the participants were asked about their weekly working hours. No significant correlation was found between weekly working hours and TMD symptoms. Even though the weekly working hours of the participants were expected to provide information about the duration of their professional mask usage, this period may not completely reflect the time worked with the mask or long-term use of masks in daily life, although limited working hours may explain the lack of correlation.

The association between depression and stress and different physical symptoms of TMD is widely acknowledged [32, 33]. A study on TMD patients revealed that increased stress levels during the pandemic led to an increase in parafunctional habits (awake and sleep bruxism, clenching) and sleeping disorders (variation in the quality and duration of sleep, fatigue) [34]. A recent meta-analysis with 13 studies showed that depression, anxiety, and insomnia were highly prevalent among healthcare professionals [35]. Considering this information, it should be noted that stress is a significant factor for TMD. According to the self-reports of the participants in this study, their stress levels increased during the pandemic period compared to the pre-pandemic period.

Although the purpose of this study was to investigate the effects of mask usage on TMD, it was a limitation of our study that the etiology of TMD is multifactorial, and one factor cannot be evaluated alone. Another limitation was that in this study, TMD symptom data were not based on clinical examinations, but they were recorded according to the self-reports of the participants, and information about the pre-pandemic period was also collected during the pandemic period.

Conclusion

The results of this study indicated that an increase in TMD was observed in dentists during the pandemic period. The degree of change in TMJ pain and masticatory muscle pain at rest between the periods ($\Delta T_0/T_1$) was higher in the participants whose professional mask choice was N95 respirator or N95 respirator use with a surgical mask cover in comparison to those who chose to wear one surgical mask. An increase in mouth breathing and mask-related parafunctional movements was reported during the use of N95 respirator masks compared to daily life in the dentists whose professional mask selection was N95 respirators.

Declarations

Ethical approval: This study was approved by the XXX University Non-Invasive Ethics Committee (2021/168).

Informed consent: Informed consent was obtained from all individual participants included in the study.

Conflict of interest: The authors declare that they have no conflict of interest.

Author Contribution:

E.S.A: Design of the study, Data collection, Writing - Original Draft, Writing - Review & Editing

I.A: Design of the study, Data collection, Writing - Original Draft

E.D.S: Design of the study, Statistical analysis, Interpretation of results

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