



## Effect of Stress on Periodontium and Oral Health in Covid-19 Positive Patients: An Online Questionnaire-Based Survey

Bushra Iftikhar<sup>1\*</sup>, Suhail Majid Jan<sup>2</sup>, Roobal Behal<sup>3</sup>

<sup>1</sup>Postgraduate Student, Department of Periodontics, Govt. Dental College and Hospital, Shireen Bagh, Srinagar, India. Email: bushra.iftikhar11@gmail.com. Orcid ID: 0000-0002-3518-2954.

<sup>2</sup>Professor and Head, Department of Periodontics, Govt. Dental College and Hospital, Shireen Bagh, Srinagar, India. Email: suhail38182@gmail.com. Orcid ID: 0000-0002-9025-894X.

<sup>3</sup>Associate Professor, Department of Periodontics, Govt. Dental College and Hospital, Shireen Bagh, Srinagar, India. Email: roobalbehal0@gmail.com. Orcid ID: 0000-0002-5292-7460

\*Corresponding author

Received: 14 May 2022

Revised: 05 July 2022

Accepted: 16 July 2022

Published: 22 August 2022

### Abstract

**Background:** Emergence of Covid-19 pandemic resulted in stressful living conditions throughout the world leading to an alteration of habits and detrimental effects on overall health particularly oral health and hygiene of people throughout the world. The aim was to assess perceived stress and its impact on periodontium and oral health in Covid-19 positive patients. **Material & Methods:** An online health questionnaire was submitted by Covid-19 positive patients over a period of six months with answers regarding their systemic health, perceived stress, existing habits and their alteration, oral hygiene maintenance and symptoms of oral and periodontal diseases during covid positivity. **Results:** Results showed that there was increase in stress levels of Covid-19 positive patients with alteration of habits and increased incidence of negative effects on oral and periodontal health. **Conclusions:** Although Covid-19 positive patients experienced more stress and higher incidence of oral and periodontal diseases but no direct relation could be established.

**Keywords:-** Covid -19 and Stress, Periodontium, Oral Health.

## INTRODUCTION

In December 2019, an outbreak of the novel strain severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) emerged in China, and rapidly spread worldwide. The new condition was named coronavirus disease 2019 (COVID-19) by the World Health Organization (WHO) and was subsequently declared a pandemic on the 11<sup>th</sup> of March 2020.<sup>[1]</sup> Millions of cases were confirmed with hundreds of thousands of deaths. This unprecedented situation and the finding that the virus was highly contagious (person-to-

person transmission) required the adoption of non-vaccination public health measures aiming to reduce further spreading of SARS-CoV-2.<sup>[2]</sup> These measures included track-and-tracing, self-isolation, quarantine, social distancing and community containment, as well as nationwide lockdowns.<sup>[3]</sup>

Stress is a specific human reaction in response to a trigger and is characterized by three successive phases: alarm, resistance, and general coping syndrome.<sup>[4]</sup> The stress response corresponds to the activation of the catabolic mechanisms: activating the

adrenocorticotrophic axis and the sympathetic autonomic nervous system (ANS), and withdrawal of the parasympathetic ANS. Recovery involves anabolic pathways including sleep and activation of a wave tone. These regulatory pathways allow the human body to react in a coordinated and adjusted manner for re-establishing homeostasis (eustress).<sup>[5]</sup>

Stress during an infectious disease outbreak can include fear and worry about one's health, worsening of chronic health problems, and increased use of substances.<sup>[6]</sup> Most people infected with the virus causing COVID-19 experience mild to moderate respiratory illness and recover without requiring special treatment. However, older people and those with underlying medical problems, such as cardiovascular disease, diabetes, chronic respiratory disease, and cancer, are more likely to develop severe illness, which may lead to death.<sup>[7]</sup> People at higher risk for severe illness are at increased risk of stress due to COVID-19 outbreaks. Chronic exposure to stressful conditions is associated with a failure to comply with medical regimens, resulting in disease exacerbation<sup>[8]</sup> and leading to comorbid serious health problems such as hypertension, heart attack and stroke, diabetes mellitus, and obesity.<sup>[9]</sup> Patients with chronic disease face lifestyle disruptions due to the COVID-19 outbreaks, to their physical activity, sleep, stress, and mental health, which need to be better addressed.<sup>[10]</sup> The mental health and psychosocial consequences of the COVID-19 pandemic may be more severe among people with chronic illness.<sup>[11]</sup>

The stressor characterizes any situation that activates the pathways of stress, irrespective of

its nature, intensity, and duration.<sup>[4]</sup> Despite numerous experimental, clinical and epidemiological studies on the relationship between stress and periodontal disease, the exact mechanisms linking these two phenomena remain largely unknown.<sup>[12,13,14,15]</sup> As a first step, these studies have shown the indirect impact of stress on the periodontium through changes in behavior and lifestyle (food and oral hygiene, smoking, parafunctions, etc.).<sup>[16]</sup>

## MATERIAL AND METHODS

An online cross-sectional design was done. A google form was circulated amongst the subjects who tested positive for covid-19 during the year 2021/2022. The data was collected between October 2021 to March 2022 through emails and online social networking platforms. The survey was delivered via Google Forms through web link (<https://forms.gle/uRr9BqF8TMntMZMT9>). Participants were informed that participation was anonymous and voluntary.

**The survey questionnaire consisted of 28 questions of the following instruments:**

1. Demographics and personal characteristics
2. Perceived stress scale - It is a 10-item scale widely used to assess the perception of stress. It is a measure of the degree to which situations in one's life are appraised as stressful.
3. Stress and diet
4. Stress and habits
5. Personal habits in covid-19 positive subjects



6. Covid-19 symptoms related to oral cavity
7. Periodontal and oral problems in covid-19 positive subjects

The study was approved by the Ethics Committee of Government Dental College, Srinagar. During the survey, a total of 356 responses were collected of which only 335 responses were included in the study that were answered completely. Descriptive statistics were applied and the data collected was analyzed using SPSS 20.0 version.

## RESULTS

Results of the survey showed that most of the survey participants were young with only 6.2% above the age of 44 years [Table 1] with almost equal participation of males and females. Most of the participants were systemically healthy with only about 17% reporting to suffer from one or more medical conditions.

Among the participants only 7.8% subjects experienced most severe stress, who rated their stress during covid-19 infection as 10. Almost half of the subjects (52.2%) reported their diet being affected by stress and 8.3% subjects reported consumption of junk food many times during covid pandemic. About 18.5 % of the subjects were nail biters and 7.2% of them reported an increase in the habit. Also, 11.2%

of the subjects reported an increase in teeth grinding during covid-19 infection and 11.8% experienced pain and clicking sound during eating or mouth opening during covid-19 infection [Table 2].

**Covid-19 symptoms related to oral cavity and oral health:** most of the subjects (48%) reported mild symptoms and only 2% reported to be hospitalized. Almost one fourth subjects (25.4%) reported pain in muscles of mouth and about half (54.4%) of the subjects reported loss of taste. Three fifth (60.4%) of the subjects reported shortening of breath. 88.5% subjects reported brushing and among them more than half (58.7%) reported brushing once. 13.6% subjects reported increased deposits, 8.7% subjects reported an increase in previous gum problem with 8.1% reporting painful gums, 5.6% with swelling of gums and 5.3% with gum bleeding while only 3.3% of subjects reported loosening of teeth. Almost half the subjects (46.6%) reported dry mouth and 10.8% reported burning mouth and tongue during covid-19 infection. 22.3% subjects reported halitosis with 20.3% of the subjects reported having a tongue coating. 11% of subjects reported oral ulcers during the pandemic [Table 3].

**Table 1:** Demographic data and medical history

Age (years)		Frequency (%) / number
1	15-24	25.1 / 84
2	25-34	54.4 / 182
3	35-44	14.3 / 48
4	>44	6.2 / 21
Gender		
1	Females	51.1 / 171



2	Males	48.9 / 164
<b>Any medical/systemic problem</b>		
1	Nil	83.3 / 279
2	Diabetes	7.9 / 27
3	Hypertension	7.6 / 25
4	Others	1.2 / 4

**Table 2:** Stress and its perceived effects

<b>Perceived stress scale:</b>	<b>Frequency (%) / number</b>
Under 3	32.8 / 110
4-6	36.4 / 122
7-9	23 / 77
10	7.8 / 26
<b>Stress and diet</b>	
Was your diet affected by stress during the pandemic?	
Yes	52.2 / 175
No	47.8 / 160
How frequently you ate junk food during covid-19 pandemic?	
Many times daily	8.3 / 28
Once daily	7.1 / 24
Few times weekly	25.6 / 86
Never	58.9 / 197
<b>Stress and coping strategies:</b>	
Are you a nail biter?	
Yes	18.5 / 62
No	81.7 / 273
Did your nail-biting habit increase during covid?	
Yes	7.2 / 24
No	92.8 / 311
Did you experience teeth grinding during covid-19 infection?	
Yes	11.2 / 38
No	88.8 / 297
Did you experience pain and clicking sound during eating or mouth opening during covid-19 infection?	
Yes	11.8 / 40
No	88.2 / 295



**Table 3: Covid-19 and its symptoms and impact on oral cavity and periodontium**

<b>Covid-19 and oral symptoms:</b>	<b>Frequency (%) / number</b>
1. How symptomatic were you during covid?	
<ul style="list-style-type: none"> <li>• Hospitalized</li> <li>• Quarantine at home with severe symptoms</li> <li>• Mild symptoms</li> <li>• No symptoms</li> </ul>	2 / 7 20.5 / 69 48 / 161 29.2 / 98
2. Did you experience pain in muscles of mouth during covid?	
<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	25.4 / 85 74.6 / 250
3. Did you experience loss of taste during covid?	
<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	54.4 / 182 45.6 / 153
4. Did you experience shortening of breath during covid?	
<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	60.4 / 202 39.6 / 133
<b>Covid-19 and oral habits:</b>	
1. Did you brush your teeth during covid?	
<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	88.5 / 296 11.5 / 39
2. How many times you brushed during covid?	
<ul style="list-style-type: none"> <li>• Twice daily</li> <li>• Once daily</li> <li>• Few times a week</li> <li>• Once a week</li> </ul>	26.8 / 90 58.7 / 196 7.7 / 26 6.8 / 23
<b>Covid-19 impact on oral and periodontal problems:</b>	
1. Did you notice increased deposits on teeth during covid?	
<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	13.6 / 46 86.4 / 289
2. Did you have any previous gum or oral problem?	
<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	23.8 / 80 76.2 / 255
3. Did your gum problem increase during covid?	
<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	8.7 / 29 91.3 / 306
4. Did you experience dry mouth during covid?	
<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	46.6 / 156 53.4 / 179
5. Did you experience painful gums during covid?	
<ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>	8.1 / 27 91.9 / 308



6. Did you experience oral ulcers during covid? <ul style="list-style-type: none"><li>• Yes</li><li>• No</li></ul>	11 / 37 89 / 298
7. Did you experience bad smell during covid? <ul style="list-style-type: none"><li>• Yes</li><li>• No</li></ul>	22.3 / 75 77.7 / 260
8. Did you have a white coating on tongue during covid? <ul style="list-style-type: none"><li>• Yes</li><li>• No</li></ul>	20.3 / 68 79.7 / 267
9. Did you experience burning mouth or burning tongue during covid? <ul style="list-style-type: none"><li>• Yes</li><li>• No</li></ul>	10.8 / 36 89.2 / 299
10. Did you experience loosening of teeth during covid? <ul style="list-style-type: none"><li>• Yes</li><li>• No</li></ul>	3.3 / 11 96.7 / 324
11. Did you have swelling of gums during covid? <ul style="list-style-type: none"><li>• Yes</li><li>• No</li></ul>	5.6 / 19 94.4 / 316
12. Did you experience gum bleeding during covid? <ul style="list-style-type: none"><li>• Yes</li><li>• No</li></ul>	5.3 / 18 94.7 / 317

## DISCUSSION

This study aimed to evaluate the impact of stress in Covid-19 positive subjects and the oral and periodontal health of adults with a nationwide online cross-sectional questionnaire survey. The Covid-19 epidemic is a global health crisis, unlike any in modern history,<sup>[17]</sup> which severely affects physical and mental health.<sup>[18,19]</sup>

The results of our survey showed that due to the pandemic there was an increase in perceived stress in Covid-19 positive patients and an overall effect on the periodontal and oral health. As reported by previous studies,<sup>[20,21,22,23]</sup> this survey also shows an increase in perceived stress among Covid-19

positive patients. However, the reason for stress was not asked.

**Stress and Diet:** Stress appears to alter overall food intake in two ways, resulting in under or overeating, which may be influenced by stressor severity.<sup>[24]</sup> Stressed participants prefer more to eat junk foods such as fast foods, snacks and beverages as compared with unstressed participants ( $p < 0.05$ ) and the junk food preference was increased with the increase of stress levels.<sup>[25]</sup> Results of this survey demonstrated that almost one third (30.8%) participants reported stress ranging from 7-10, with more than half of the subjects reporting a change in diet due to stress and 8.3% participants reported intake of junk food many times a day, which is in accordance with the above stated studies.



**Stress and Coping Strategies:** Nail biting is a stress removing habit adopted by many children and adults.<sup>[26]</sup> Stressed individuals show a higher chance of presenting bruxism when compared to healthy individuals,<sup>[27]</sup> also studies have shown an increase in TMJ disorders due to anxiety and stress.<sup>[28]</sup> The results of this survey support these stress induced changes (7.2% participants reported increased nail-biting habit, 11.2% reported increase in teeth grinding and 11.8% reported TMJ clicking).

**Covid and Oral and Periodontal Manifestations:** Documented Covid-19 cases have been associated with dry mouth, oral lesions, and periodontal symptoms in the scientific literature.<sup>[29,30,31,32]</sup> Dry mouth is the most common oral health condition in participants with COVID-19 infection, with a prevalence of 41.0%, followed by oral lesions (38.8%), orofacial pain (18.3%), and periodontal symptoms (11.7%).<sup>[33]</sup> In our survey, among all the oral manifestations dry mouth shows the highest percentage (46.6%). Xerostomia reported in Covid-19 patients may be triggered by stress, as dry mouth is usually found in psychiatric patients. It is commonly correlated with nutritional deficiencies, anxiety, tension, and distress, which are often observed in the case of Covid-19 patients, who are stressed because of their fear of the disease, in addition to the stressful conditions of isolation.<sup>[34]</sup>

Oral cavity is at potentially high susceptibility to Covid-19 infection because of the existence of ACE2 receptor and TMPRSS2 in the epithelial cells of the oral mucosa,<sup>[35]</sup> and the salivary glands.<sup>[36]</sup> Oral symptoms such as dry mouth,<sup>[30,36]</sup> oral ulcers,<sup>[30]</sup> halitosis,<sup>[37]</sup> white tongue coating,<sup>[38]</sup> burning mouth,<sup>[39]</sup> gum

bleeding,<sup>[40]</sup> swelling of gums have been reported by several studies. In our survey, oral symptoms such as dry mouth (46.6%), soar gums (8.1%), oral ulcers (11%), halitosis (22.3%), tongue coating (20.3%), burning mouth (10.8%), swelling gums (5.6%) and gum bleeding (5.3%) were reported.

Also in one survey, 23% of Covid-19 patients experienced oral or dental pain. This pain could be referred from muscles, as it was reported that 76.4% of Covid-19 patients experienced myalgia.<sup>[30]</sup> It has been reported that orofacial or dental pain sensation can be enhanced by psychological distress or emotional disturbances, which is the case in nearly all Covid-19 patients.<sup>[34]</sup> This is in accordance with several cases, in which blisters and oral ulcers occurred during Covid-19 infection.<sup>[41]</sup>

In our study oral ulcers are reported to be about 11%. It has been demonstrated in literature that psychological upsets, such as anxiety and stress, contribute to the development and progression of oral lesions like recurrent aphthous ulcers, and this applies to Covid-19 patients.<sup>[42]</sup>

Joint pain in Covid-19 patients is most probably caused by emotional distress rather than mechanical and occlusal aspects. Stressed people usually grind and clench their teeth. They eventually suffer from muscle fatigue and spasm. Patients experiencing joint pain usually complain of psychological symptoms, such as irritation, fear, worry, uneasiness, tension, malnutrition, and insomnia, which are the symptoms commonly experienced by Covid-19 patients.<sup>[41,42]</sup>



In contrast, a significant association was found between periodontal symptoms and Covid-19 severity, which has been linked to immune dysregulation, potentially leading to a cytokine storm found to cause thrombosis and multi-organ failure involving the brain, heart, and kidneys.<sup>[43]</sup> Note that periodontal symptoms can increase the levels of interleukin-6 (IL-6), interleukin-8 (IL-8), and tumor necrosis factors (TNF), which have been implicated as major interferons leading to a cytokine storm.<sup>[44]</sup> As for the rate of the oral hygiene measures taken by the patients while being infected with Covid-19, it was reported that in the patients with decreased oral hygiene measures, ulcerations and dental/oral pain were significantly increased. This can be attributed to plaque and calculus accumulation around the teeth in case of poor oral hygiene, which will subsequently lead to the inflammation and ulceration of the gingiva, and eventually cause periodontitis, orofacial pain and tooth loss. This finding is confirmed by a study which investigated the complications of Covid-19 in patients with poor oral health.<sup>[45]</sup> In our survey it was demonstrated that people infected with Covid-19, neglected their oral hygiene with 11.5% participants didn't brush during the

infection and from the people who brushed, more than half only brushed once a day. Proper oral hygiene is partially dependent on the mental health status of the patient. It has been reported that psychological disturbances can lead patients to neglect oral hygiene and that the resultant accumulation of plaque is detrimental to the periodontal tissue.<sup>[46]</sup> In a previous study painful gums, bleeding gums and loose teeth were reported in 2.7%, 11.2% and 3.3% of participants with Covid-19 infection, respectively.<sup>[47]</sup> However in our survey it was reported to be 8.1%, 5.3% and 3.3% respectively. Also stress is a risk factor for periodontitis.<sup>[48]</sup> Also psychological stressors may modulate the immune response to bacteria, and thus be expected to influence the progression and course of gingivitis and periodontitis.<sup>[49]</sup>

## CONCLUSIONS

Though stress is being demonstrated in Covid-19 patients and an alteration of diet, oral habits, behavior, change in oral and periodontal conditions has been reported but a direct link between them cannot be established through the study. Further research is needed to prove the link.

## REFERENCES

1. Lai CC, Shih TP, Ko WC, Tang HJ, Hsueh PR. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges. *Int J Antimicrob Agents.* 2020;55(3):105924. doi: 10.1016/j.ijantimicag.2020.105924.
2. Chan JF, Yuan S, Kok KH, To KK, Chu H, Yang J, et al. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. *Lancet.* 2020;395(10223):514-523. doi: 10.1016/S0140-6736(20)30154-9.
3. Wilder-Smith A, Freedman DO. Isolation, quarantine, social distancing and community containment: pivotal role for old-style public health measures in the novel coronavirus (2019-nCoV) outbreak. *J Travel Med.* 2020;27(2):taaa020. doi: 10.1093/jtm/taaa020.
4. Selye H. The evolution of the stress concept. *Am Sci.* 1973;61(6):692-9.
5. Bindushree AR, Ranganth V, Nichani AS. Periodontal disease and stress: a review. *Int J Dent Health Sci.* 2014;1:575-88.





6. Khan AA, Lodhi FS, Rabbani U, Ahmed Z, Abrar S, Arshad S, Irum S, Khan MI. Impact of Coronavirus Disease (COVID-19) Pandemic on Psychological Well-Being of the Pakistani General Population. *Front Psychiatry*. 2021;11:564364. doi: 10.3389/fpsy.2020.564364.
7. Dhama K, Khan S, Tiwari R, Sircar S, Bhat S, Malik YS, et al. Coronavirus Disease 2019-COVID-19. *Clin Microbiol Rev*. 2020;33(4):e00028-20. doi: 10.1128/CMR.00028-20.
8. Cohen S, Williamson GM. Stress and infectious disease in humans. *Psychol Bull*. 1991;109(1):5-24. doi: 10.1037/0033-2909.109.1.5.
9. Gade S, Chari S, Gupta M. Perceived stress among medical students: to identify its sources and coping strategies. *Arch Med Health Sci*. 2014;2(1):80.
10. Kendzerska T, Zhu DT, Gershon AS, et al. The effects of the health system response to the COVID-19 pandemic on chronic disease management: a narrative review. *Risk Manag Healthc Policy*. 2021;14:575.
11. Fiorillo A, Gorwood P. The consequences of the COVID-19 pandemic on mental health and implications for clinical practice. *Eur Psychiatry*. 2020;63(1):1-2.
12. Hilbert JB, Hugo FN, Bandeira DR, Bozzetti MC. Stress, cortisol and periodontitis in a population aged 50 years and over. *J Dent Res*. 2006;85:324-28.
13. Rai B, Kaur J, Anand SC, Jacobs R. Salivary stress markers, stress, and periodontitis: a pilot study. *J Periodontol*. 2011;82:287-92.
14. Goyal S, Jajoo S, Nagappa G, Rao G. Estimation of relationship between psychological stress and periodontal status using serum cortisol level: a clinico-biochemical study. *Indian J Dent Res*. 2011;22:6-9.
15. Warren KR, Postolache TT, Groer ME, Pinjari O, Kelly DL, Reynolds MA. Role of chronic stress and depression in periodontal diseases. *Periodontol*. 2014;64:127-38.
16. De Marco T. Periodontal emotional stress syndrome. *J Periodontol*. 1976;47:67-68.
17. Ekwebelem OC, Ofielu ES, Nnorom-Dike OV, Iweha C, Ekwebelem NC, Obi BC, et al. Threats of COVID-19 to Achieving United Nations Sustainable Development Goals in Africa. *Am J Trop Med Hyg*. 2020;104(2):457-460. doi: 10.4269/ajtmh.20-1489.
18. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA*. 2020;323:1061-9.
19. Wang C, Pan R, Wan X, Tan Y, Xu L, Ho CS, et al. Immediate psychological responses and associated factors during the initial stage of the 2019 Coronavirus disease (COVID-19) epidemic among the general population in China. *Int J Environ Res Public Health*. 2020;17:1729.
20. Moayed MS, Vahedian-Azimi A, Mirmomeni G, Rahimi-Bashar F, Goharimoghadam K, Pourhoseingholi MA, et al. Depression, Anxiety, and Stress Among Patients with COVID-19: A Cross-Sectional Study. *Adv Exp Med Biol*. 2021;1321:229-36.
21. Lee AM, Wong J. G. W. S., Mcalonan GM, Cheung V, Cheung C, et al. Stress and psychological distress among SARS survivors 1 year after the outbreak. *Can J Psychiatry*. 2007;52:233-40.
22. Park H, Lee N, Lee JH, Lee D, Kim KA, Kim H-S, et al. Stress Experience of COVID-19 Patients as Reported by Psychological Supporters in South Korea: A Qualitative Study. *Front Psychiatry*. 2022; 13:834965.
23. Salari N, Khazaie H, Hosseini-Far A, Khaledi-Paveh B, Kazeminia M, Mohammadi M, et al. The prevalence of stress, anxiety and depression within front-line healthcare workers caring for COVID-19 patients: a systematic review and meta-regression. *Hum Resour Health*. 2020;18(1):100. doi: 10.1186/s12960-020-00544-1.
24. Susan J. Torres, Caryl A. Nowson, Relationship between stress, eating behavior, and obesity. *Nutrition*. 2007;23:887-94.
25. Almogbel E, Aladhadh AM, Almotyri BH, Alhumaid AF, Rasheed N. Stress Associated Alterations in Dietary Behaviours of Undergraduate Students of Qassim University, Saudi Arabia. *Open Access Maced J Med Sci*. 2019;7:2182-88.
26. Sachan A, Chaturvedi T P. Onychophagia (Nail biting), anxiety, and malocclusion. *Indian J Dent Res*. 2012;23:680-2.
27. Chemelo VDS, Né YGS, Frazão DR, de Souza-Rodrigues RD, Fagundes NCF, Magno MB, et al. Is There Association Between Stress and Bruxism? A Systematic Review and Meta-Analysis. *Front Neurol*. 2020;11:590779.



28. Mottaghi A, Razavi SM, Pozveh EZ, Jahangirmoghaddam M. Assessment of the relationship between stress and temporomandibular joint disorder in female students before university entrance exam (Konkour exam). *Dent Res J (Isfahan)*. 2011;8:S76-9.
29. E.F. Gherlone, E. Polizzi, G. Tetè, R. De Lorenzo, C. Magnaghi, P. Rovere Querini, et al. Frequent and persistent salivary gland ectasia and oral disease after COVID-19. *J Dent Res*. 2021; 100(5):464-471
30. N. AbuBakr, Z. Salem, A. Kamel Oral manifestations in mild-to-moderate cases of COVID-19 viral infection in the adult population. *Dent Med Probl*. 2021;58(1):7-15
31. Biadsee A, Biadsee A, Kassem F, Dagan O, Masarwa S, Ormianer Z. Olfactory and Oral Manifestations of COVID-19: Sex-Related Symptoms-A Potential Pathway to Early Diagnosis. *Otolaryngol Head Neck Surg*. 2020;163(4):722-728. doi: 10.1177/0194599820934380.
32. Fantozzi PJ, Pampena E, Di Vanna D, Pellegrino E, Corbi D, Mammucari S, et al. Xerostomia, gustatory and olfactory dysfunctions in patients with COVID-19. *Am J Otolaryngol*. 2020;41(6):102721. doi: 10.1016/j.amjoto.2020.102721.
33. Qi X, Northridge ME, Hu M, Wu B. Oral health conditions and COVID-19: A systematic review and meta-analysis of the current evidence. *Aging Health Res*. 2022;2(1):100064. doi: 10.1016/j.ahr.2022.100064.
34. Mehrotra V, Garg K, Raju MS, Sharma P, Singh R, Chauhan SK. Stress: As etiological agent for oral lesions - a research study. *Rama Univ J Dent Sci*. 2015;2(3):3-11.
35. Xu H, Zhong L, Deng J, Peng J, Dan H, Zeng X, et al. High expression of ACE2 receptor of 2019-nCoV on the epithelial cells of oral mucosa. *Int J Oral Sci*. 2020;12:8.
36. L. Pascolo, L. Zupin, M. Melato, P.M. Tricarico, S. Crovella TMPRSS2 and ACE2 Coexpression in SARS-CoV-2 Salivary Glands Infection. *J Dent Res*. 2020;99:1120-21.
37. Riad A, Kassem I, Hockova B, Badrah M, Klugar M. Halitosis in COVID-19 patients. *Spec Care Dentist*. 2021;41(2):282-85.
38. Pang W, Zhang D, Zhang J, Li N, Zheng W, Wang H, Liu C, Yang F, Pang B. Tongue features of patients with coronavirus disease 2019: a retrospective cross-sectional study. *Integr Med Res*. 2020;9(3):100493.
39. Katz J, Sacks I. Glossodynia, burning mouth syndrome, and COVID-19. *Am J Dent*. 2022;35(1):9-11.
40. Manzalawi R, Alhmamey K, Abdelrasoul M. Gingival bleeding associated with COVID-19 infection. *Clin Case Rep*. 2020;9(1):294-97.
41. dos Santos JA, Costa Normando AG, Carvalho da Silva RL, et al. Oral mucosal lesions in a COVID-19 patient: New signs or secondary manifestations? *Int J Infect Dis*. 2020;97:326-28.
42. Kaur D, Behl AB, Isher PPS. Oral manifestations of stress-related disorders in the general population of Ludhiana. *J Indian Acad Oral Med Radiol*. 2016;28(3):262-69.
43. Jose RJ, Manuel A. COVID-19 cytokine storm: the interplay between inflammation and coagulation. *Lancet Respir Med*. 2020;8(6):e46-e47. doi: 10.1016/S2213-2600(20)30216-2.
44. Tanaka T, Narazaki M, Kishimoto T. Immunotherapeutic implications of IL-6 blockade for cytokine storm. *Immunotherapy*. 2016;8(8):959-70. doi: 10.2217/imt-2016-0020.
45. Meister TL, Brüggemann Y, Todt D, Conzelmann C, Müller JA, Groß R, et al. Virucidal Efficacy of Different Oral Rinses Against Severe Acute Respiratory Syndrome Coronavirus 2. *J Infect Dis*. 2020;222(8):1289-1292. doi: 10.1093/infdis/jiaa471.
46. Bhagat M, Tapashetti R, Fatima G. Effects of stress over periodontium. *Gal Int J Health Sci Res*. 2020;5(1):46-57.
47. Larvin H, Wilmott S, Wu J and Kang J. The Impact of Periodontal Disease on Hospital Admission and Mortality During COVID-19 Pandemic. *Front. Med (Lausanne)*. 2020;7:604980.
48. Goyal S, Gupta G, Thomas B, Bhat KM, Bhat GS. Stress and periodontal disease: The link and logic!! *Ind Psychiatry J*. 2013;22(1):4-11. doi: 10.4103/0972-6748.123585.
49. Breivik, T., Thrane, P.S., Murison, R. and Gjermo, P. Emotional stress effects on immunity, gingivitis and periodontitis. *Eur J Oral Sci*. 1996;104:327-34.

Source of Support: Nil, Conflict of Interest: None declared