

Occupational health practices among dental care professionals before and during the COVID-19 pandemic

Sean Banaee^{a,*}, Denise M. Claiborne^b and Muge Akpınar-Elci^a

^a*School of Community and Environmental Health, Old Dominion University, Norfolk, VA, USA*

^b*Gene W. Hirschfeld School of Dental Hygiene, Old Dominion University, Norfolk, VA, USA*

Received 15 December 2020

Accepted 26 January 2021

Abstract.

BACKGROUND: The COVID-19 pandemic has posed a substantial burden on dental care professionals. While dentistry is known as one of the most exposed and high-risk professions, dental care professionals are indeed at even greater risk.

OBJECTIVE: The aim of this study was to assess knowledge, attitudes, occupational health practices, personal protective equipment usage, and mental stressors during COVID-19 pandemic among dental care professionals.

METHODS: A cross-sectional study was conducted among dental care professionals who were subscribers to a dental hygiene journal using a self-administered online survey ($n = 1047$ respondents). Cross-tabulations were performed to determine differences in the responses to the statements related to different domains.

RESULTS: COVID-19 impacted the healthy work-life balance ($p < 0.001$) and caused sleeping difficulty among the respondents ($p < 0.001$). Moreover, a lower response on changing respirators and gloves for each patient compared with before viral pandemic was observed ($p < 0.01$).

CONCLUSIONS: Ongoing training on infection control, occupational health practices, and PPE usage can prevent the transmission of COVID-19 among dental care professionals and the public. Lack of adequate personal protective equipment (PPE) is a burden for applying occupational health practices in dental clinics and present a risk to the public. COVID-19 may contribute to developing psychological stress and disrupt healthy work-life balance among dental professionals.

Keywords: Personal protective equipment, dentistry, coronavirus

1. Introduction

Since the beginning of 2020, the world has been deeply affected by the severe acute respiratory syndrome coronavirus 2 (COVID-19) outbreak [1, 2]. This further escalated emergency procedures and

updated infection control protocols in most of the business sectors, public services, and the health system, including dental clinics.

In fact, due to the unique characteristics of dental clinics such as the dissemination of bio-aerosols during treatment procedures [3, 4] and high risk of cross-infection between dental hygienists and patients, dental care professionals such as dental hygienists are amongst the most vulnerable health-care providers with the greatest risk of exposure to COVID-19. According to the U.S. Bureau of Labor Statistics [5], there are 215,150 dental hygienists

*Address for correspondence: Sean Banaee, PhD, CIH, CSP, Assistant Professor and Program Director, School of Community and Environmental Health, 4608 Hampton Blvd Room 3120, Old Dominion University, Norfolk, VA 23529, USA. Tel.: +1 757 683 6010; E-mail: sbanaee@odu.edu; ORCID: <https://orcid.org/0000-0003-4119-5767>.

who provide essential preventive oral health services including oral health assessments, process and interpret dental x-rays, remove plaque and hard deposits, apply cavity-preventive agents, teach proper oral hygiene techniques, and counsel patients on individualized home oral hygiene plans [6].

Dental care professionals are predisposed to several occupational hazards and harmful agents [7] such as ionizing radiation [8, 9], noise and vibration [10], dental amalgams [11–14], ergonomical risk factors [15–17], and biological agents [18–20]. The biological agents include a wide range of microorganisms such as bacteria, virus, fungi, and protozoa living in patients' saliva, blood, contaminated instruments, and bio-aerosols in the environment [21]. The latter one is known as airborne transmission and consists of dissemination of airborne droplets or fine particulates containing infectious pathogens as *Mycobacterium tuberculosis*, Influenza A-B virus, MERS-CoV, Rubella virus, SARS-CoV and COVID-19 [22, 23].

Considering the massive generation of bio-aerosols [24] during dental procedures, utilizing generic standard protective measures during clinical care will not provide efficient protection against the spread of COVID-19. The prolonged disease's incubation period (5–16 days) and the recovery period make it cumbersome to detect any symptoms of COVID-19 infection and increases the risk of disease transmission during these lay periods [25]. Therefore, patients not experiencing symptoms and are unaware of their infection status can pose a threat to dental professionals. This suggests that dental settings should establish a robust occupational health plan for updating the awareness of the dental team to mitigate the impacts and protect their staff and the public from the disease [26].

Although applying engineering and administrative controls such as designing negative pressure rooms, isolation, time, and distance is always beneficial and recommended, the extreme contagious nature of COVID-19 virus requires strict application of personal protective equipment (PPE) during high-risk dental procedures which generates bio-aerosols in the environment. To address this, the American Dental Association (ADA), American Dental Hygienists' Association (ADHA), Center for Disease Prevention and Control (CDC), and National Institute for Occupational Safety and Health (NIOSH) developed occupational health and safety procedures and guidelines for patient care in the dental clinics. The aims of this study were to assess the occupational health

working practices, knowledge and behaviors, practice on PPE usage, infectious control measures, and mental stressors among dental hygienists during the COVID-19 pandemic.

2. Methods

2.1. Study design and recruitment

A cross-sectional survey research design was conducted among dental hygienists. The study included a total of 1,074 participants from 48 states who had been actively practicing as a registered dental hygienist at least in the last 6 months (97.6%) of completing the survey. The anonymous survey link was disseminated to the subscribers of a dental hygiene journal using Qualtrics® software weekly for four weeks. The institution's Human Subjects Committee deemed the study as exempt and informed consent was implied through the submission of the survey.

2.2. Assessment tool and method of administration

The questionnaire was comprised of 56 questions in 4 domains: the first regarded demographics (e.g. gender, age, race), the second work history (e.g. job tenure, state of practice, business firm), the third the workplace, training, and protective equipment (e.g. occupational health awareness, COVID-19 stress, instruments use, respirator use), and the fourth was based on a 5-point Likert Scale (from Strongly Agree = 5 to Strongly Disagree = 1) that included behaviors and PPE adopted before and during COVID-19 pandemic. Part of the survey on work history and PPE was adapted from King et al. study on dental hygienists' infection control attitudes and practices [27]. Other questions were designed to gather information on work practice modifications due to COVID-19 pandemic in accordance to the NIOSH standard job stress questionnaire [28], Centers for Disease Control and Prevention [29], and other national and international guidelines [30, 31]. The survey was reviewed for content and face validity by the researchers and modifications were made as necessary.

2.3. Statistical analysis

Descriptive statistics such as counts, frequencies, means, and standard deviation were used to describe the sample characteristics and responses to state-

ments on the survey. A Cronbach Alpha test was performed to examine the internal consistency of the Likert Scale items for domain five. The test revealed an internal consistency of 0.70 for those items.

To assess the difference in behaviors toward PPE scores among the participants before and during COVID-19 pandemic, Wilcoxon Signed Rank tests were conducted. Lastly, binary variables were created for education (\leq A.S. degree, \geq B.S. degree), years of experience (< 15 years, > 15 years), and membership in the American Dental Hygienists' Association (yes, no) to examine differences between groups on agreement statements related to behaviors and PPE during the COVID-19 pandemic. The Likert-scale agreement statements were categorized as disagree, indifferent, agree to create 2 x 3 contingency tables to examine differences between the groups. STATA 16.00 special edition (College Station, TX: Stata Corp LLC) and IBM SPSS V. 26 were used for all statistical analysis. Statistical significance for all analysis was determined at $p < 0.05$.

3. Results

3.1. Characteristics of the participants

The first domain reflects the demographic and occupational history of study participants as shown in Table 1. Most of the participants were female ($n = 1063$, 98.9%) with a mean age of 51 (SD \pm 11.36) years (range 26–79 years). A majority of the respondents declared their ethnicity as White ($n = 927$, 86.3%). A total of 274 (25.5%) participants were a member of ADHA and most of them received an associate degree or certificate ($n = 637$, 59.2%). The survey response on work tenure indicates 69.4% have been practicing for more than 15 years.

3.2. Knowledge, attitudes, and practices on occupational health

As shown in Table 2, respondents reported different ventilation and air conditioning systems within the dental offices. This includes central Heating, Ventilation, and Air Conditioning (HVAC) system (69.7%), HVAC system with negative pressure (1.8%), and portable air purifier units (37.9%). The majority of the participants (88%) reported some training on occupational health and safety since last year. The survey indicates that 96.6% of participants

Table 1
Demographic characteristics and occupational history of study participants ($n = 1074$)

	N (%)
Gender	
Female	1063 (98.9)
Ethnicity	
White, not of Hispanic origin	927 (86.3)
Hispanic or Latino	63 (5.9)
Asian or other Pacific Islander	40 (3.7)
Black, not of Hispanic origin	12 (1.1)
American Indian	
Education	
General	869 (80.8)
Pediatric	29 (2.7)
Periodontics	38 (3.5)
Education	35 (3.3)
Public health	46 (4.3)
Other*	58 (5.4)
Work experience	
1–15 years	329 (30.6)
16+ years	745 (69.4)
Weekly working hours (Before SARS-CoV-2)	
Under 10	81 (7.5)
10–20	169 (15.7)
21–30	318 (29.6)
31–40	467 (43.5)
41+	40 (3.7)
Membership in National Associations	
Yes	274 (25.5)

*Other: Working at multiple settings, Prosthodontics, University, not working due to the pandemic etc.

use different models of respirators, with N95 masks (56.2%) as the most common, followed by surgical masks (38.2%) and half-face masks (2.2%). In terms of respirator replacement, only 14% reported on changing the respirator for each patient. Moreover, 20% of the respondents did not use a respirator, as it was not provided by the workplace. When asked about the respirator required while examining positive COVID-19 patients, 59% believed that N95 is the best fit rather than surgical masks (16.2%).

Table 3 shows the statements on occupational health behaviors and practices, which focus on PPE usage before and during the COVID-19 pandemic. There was a statistically significant increase on eight of the responses related to the statements during the COVID-19 pandemic compared to before the pandemic ($p < 0.05$). For example, the statement, "I always wear a disposal gown or lab coat" agreement increased ($p < 0.001$) when referenced during the pandemic. A similar pattern was observed for the statement, "I take contaminated work clothing home" ($p < 0.001$).

Table 2
Knowledge, attitude, and practices on occupational health of study participants (n = 1074)

Variable	N (%)
Ventilation and air conditioning systems**	
HVAC system, central	749 (69.7)
HVAC system, negative pressure	19 (1.8)
Natural ventilation (windows/doors)	153 (14.2)
Portable air purifier units	408 (37.9)
No ventilation	94 (8.7)
Received occupational health training	
Yes	942 (87.7)
Training topics received**	
General occupational health	700 (65.2)
Bloodborne pathogens	717 (66.8)
Airborne pathogens	481 (44.8)
Chemical exposure	376 (35)
Ergonomics or proper work posture	287 (26.7)
PPE usage	522 (48.6)
Use of PPE during daily practice**	
Disposable gown	478 (44.5)
Lab coat	602 (56.1)
Face mask	819 (76.3)
Face mask with shield	375 (34.9)
Visor face shield	496 (46.2)
Safety glasses	511 (47.6)
Prescription glasses	401 (37.3)
Side shields for prescription glasses	182 (16.9)
Gloves	967 (90)
The time PPE is not being used**	
Always use	763 (71.2)
When not available	96 (8.9)
Interferes with working skills	55 (5.1)
Too hot	81 (7.5)
Bothers the patient	5 (0.4)
Forgot	33 (3.1)
Gloves used for handling/cleaning contaminated instruments*	
Utility gloves	322 (32.2)
Disposable exam gloves	673 (67.4)
Bare hands	4 (0.4)
Type of the respirator being used*	
N95 respirator	557 (56.2)
Surgical mask	379 (38.2)
Half-face mask	22 (2.2)
Dust mask	10 (1)
No mask	20 (2)
Respirator being used while examining positive COVID-19 clients**	
N95 respirator	673 (59)
Surgical mask	185 (16.2)
All above	176 (15.4)
I am not sure	108 (9.4)
If using respirator, measures to replace the mask or filters*	
When they are visibly dirty	227 (22.6)
By a predetermined schedule	288 (28.7)
Change for each patient	141 (14.1)
Change daily	240 (23.9)
Change weekly	89 (8.8)
Won't ever replace them	17 (1.7)
When start using respiratory protection*	
Before & during COVID-19 pandemic	205 (22.5)
Only during COVID-19 outbreak	519 (56.9)
I don't use respirator	188 (20.6)

Table 2
(Continued)

Variable	N (%)
If not using respirator, because of*	
Not provided by employer	128 (11.9)
It's provided, but not replaced when contaminated	46 (4.3)
Not accessible at the time I need it	40 (3.7)
Don't think it's necessary	23 (2.2)
I don't know how to use it	8 (0.7)
COVID-19 transmission routes**	
Aerosol	842 (78.4)
Splash/splatter	764 (71.1)
Blood/saliva	573 (54.7)
Dermal contact	351 (32.7)
Touching dry surfaces	347 (32.3)
Touching clothing	305 (24.7)
Needle stick or injury with a dental instrument	292 (24.7)
Responsible person for infection control supervision at clinic*	
Dentist	428 (39.9)
Dental hygienist	173 (16.1)
Dental assistant	188 (17.5)
Office manager	112 (10.4)
Other	155 (14.4)
Aerosol and water removal tools**	
Standard HVE	480 (44.7)
Saliva ejector	952 (88.6)
HVE suction mirror	101 (9.4)
Existing stress-related symptoms during COVID-19	
Yes	758 (70.6)
No	316 (29.4)
Experience any work-related mental or physical health problems	
No	585 (54.5)
Yes	270 (25.1)
Not sure	219 (20.4)

*Not all participants responded. **Multiple responses.

3.3. Differences in agreement by education, years of experience, and ADHA membership

Cross-tabulations were performed to determine differences in the responses to the statements related to occupational health behaviors and practices and PPE usage during the COVID-19 pandemic based on educational attainment (\leq Associate's degree, \geq Bachelor's degree), work experience (< 15 years, > 15 years), and membership in ADHA (yes or no). In terms of education, 61.7% of respondents with and \leq A.S. degree agreed with the statement, "I always change soiled and contaminated clothing between patients" compared to 70.4% of respondents with a B.S. degree or higher ($\chi^2 = 6.85, p = 0.03$).

Respondents practicing < 15 years (33.7%) disagreed with the statement related to taking

contaminated clothes home while 66.3% of respondents practicing >15 years disagreed ($\chi^2=7.26$, $p=0.03$). In addition, 29.8% of respondents practicing <15 years agreed that they had good infection control training compared to 70.2% of those practicing >15 years ($\chi^2=6.44$, $p=0.04$). While 30.5% of respondents practicing <15 years agreed that it was important to minimize splatter created from air/water syringe, ultrasonic scalers, and air polishers compared to 69.5% of those practicing >15 years ($\chi^2=5.96$, $p=0.05$). Roughly, 30% of dental care professionals who were members of the ADHA disagreed with taking contaminated clothes home while 69.1% of non-members disagreed with the statement ($\chi^2=6.64$, $p=0.04$).

3.4. Mental health

Although the respondents reported different work-related mental or physical health problems, 70.6% experienced stress-related symptoms at clinics during COVID-19 pandemic. The symptoms include flushing face (32.5%), dry mouth (31.2%), sweaty hands (24.8%), and heart palpitation (14.9%). Moreover, respondents reported their healthy work-life balance was impacted by COVID-19 pandemic ($p<0.001$) and experienced sleeping difficulty ($p<0.001$) due to the same reason.

4. Discussion

To the best of our knowledge, this is the first study of occupational and mental health stressors, work behaviors and practices, and PPE usage among dental hygienists during the COVID-19 pandemic in the U.S. When it comes to accessing proper PPE, especially respirators, the availability and replacement of the contaminated respirators seems to be a major concern as indicated by 20% of respondents and reflected in other studies [32–34]. This concern was potentially due to the shortage in the supply of respirators and other PPE since the COVID-19 pandemic [35]. The decrease in responses on changing face masks and gloves for each patient compared to before the viral pandemic emphasizes this shortage. Moreover, responses on office PPE usage policy indicates a higher dissatisfaction during COVID-19 compared to before the pandemic. The aforementioned shortcomings may put dental care professionals and patients at risk of contamination [36–40]. Adopting a strict PPE policy at dental clinics along with providing

adequate respirators will mitigate the risk among the employees and the public.

The respondents' knowledge and self-perceived risk of infection indicates that although most of them are aware of the COVID-19 routes of transmission, some employees do not believe that COVID-19 is airborne and cannot cause infection through air. Similarly, many respondents reported blood/saliva and dermal contact are not counted as COVID-19 transmission routes. While most of the participants received at least one training topic on occupational hazards, the responses indicate a significant drop in infection control training during COVID-19. The knowledge gap on occupational health preventive measures among dental staff has also been reported as a major concern in other studies [41–44].

As the dental clinics returned to providing routine or non-urgent dental care, implementing the updated protocols, modifying buildings and spaces, providing required PPE, and conducting efficient occupational health training was not feasible for many clinics. The findings of this study are confirming all of these challenges. Responses on taking contaminated clothes home indicates a higher level of awareness and safety behaviors among ADHA members compared with non-members. ADHA has been leading the integration of dental hygiene professionals [45, 46] and providing support and recommendations for minimizing risk to the public and dental care professionals during the current viral outbreak [47].

Reports on infectious disease episodes such as SARS, H1N1 pandemic [48], and the COVID-19 pandemic [49–51] indicate a high prevalence of stress and psychological trauma among dental care professionals, which are all in-line with the findings of the current study. Moreover, the dental care profession, by nature, is known as the job with intensive psychological and mental risk factors such as stress, tension, depression, and emotional exhaustion [52]. Lack of adequate personal protective equipment may also contribute to mental disorders among dental care professionals as it has been cited in similar studies on other healthcare professions [53].

This study shows that COVID-19 pandemic added an extra burden on top of the routine job demands. The symptoms reported in this survey such as flushing face, dry mouth, and sweaty hands along with significant disruption of healthy work-life balance, sleeping quality, and stress load during COVID-19 are confirming the psychological toll on dental care professionals. The results are in line with the findings of other studies on work-related stressful situations

Table 3
Occupational health practices and behaviors about PPE usage and infection control before and during SARS-CoV-2 pandemic among dental care professionals

Practice and believes about PPE usage and infection control *	Before the pandemic		During the pandemic		z-value	p-value***
	Mean**	SD	Mean**	SD		
I always use a face mask	4.93	0.35	4.97	0.23	-2.23	0.030
I change my face mask after each patient	4.44	1.04	3.96	1.44	-9.06	<0.001
I always use gloves	4.98	0.17	4.97	0.27	-1.61	0.110
I change my gloves after each patient	4.99	0.12	4.96	0.32	-3.07	0.002
I always wash my hands prior to putting on gloves	4.57	0.79	4.80	0.57	-9.06	<0.001
I wash my hands after removing gloves	4.48	0.82	4.76	0.60	11.06	<0.001
I always wear a disposable gown or lab coat	3.88	1.44	4.55	1.06	12.95	<0.001
I take contaminated work clothing home	3.50	1.47	2.83	1.63	11.51	<0.001
I always change soiled, contaminated clothing between patients	3.26	1.40	3.79	1.36	11.46	<0.001
I always wear safety glasses or side shields for prescription glasses	4.36	1.13	4.66	0.82	-8.75	<0.001
My office has good infection control measures	4.22	0.95	4.18	1.10	-1.94	0.050
My office has a good policy for PPE usage	4.03	1.08	3.98	1.22	-1.30	0.190
I have good occupational safety and health training	4.18	1.02	4.23	1.02	-2.51	0.010
I have good infection control training	4.46	0.80	4.40	0.90	-2.65	0.008
Minimizing the spray/splatter created from using the air/water syringe, ultrasonic scaler, and air polisher is important	4.33	1.04	4.79	0.61	12.20	<0.001
I reschedule any patient who discloses they have had flu-like symptoms	4.14	1.22	4.79	0.60	14.36	<0.001

*Not all participants responded. **Mean values are based on a 5-point Likert Scale (from Strongly Agree = 5 to Strongly Disagree = 1).

***p-values are based on the Wilcoxon Signed Ranks Tests.

and well-being of healthcare workers [54–57]. Moreover, the exact behavior, extent of the contagiousness, transmission dynamics, and pathogenic toxicity factor of the virus are still not fully understood by scientists [58–60].

5. Limitations

This study is designed as a self-reporting survey and recall bias in terms of selective memory, attribution and exaggeration for responding to the questions are possible. Moreover, we could not attest to the number of e-mails that were invalid or if the survey reached all the journal subscribers. It should also be mentioned that as a cross-sectional study, the data was collected in a defined time slot and prompt impacts of this viral pandemic may have altered respondent's mindset at the time. However, it was one of few studies that sought to understand and describe occupational health practice and behaviors on PPE usage among dental care professionals during the existing pandemic. Dental care professionals are faced with several contributing risk factors such as safe distance and viability of the virus in the environment and surfaces which need further investigation accordingly [61].

6. Conclusion

These findings indicate the importance of ongoing training and webinars related to stress control measures, occupational health practices, and training programs on infection control to limit the spread and transmission of COVID-19 within the dental settings. The shortage in the supply of PPE, especially N95 respirators, is a burden for applying best occupational health practices in dental offices. Dental care professionals are looking for clear and universal guidance from the regulatory agencies to address the existing inconsistencies in infection control measures and PPE usage. COVID-19 pandemic added an extra psychological toll on top of the dental professional's routine job demands. The bottom line is to achieve a balance between the occupational health and well-being of dental providers yet maintaining paramount and safe dental care to the public.

Acknowledgments

This research was supported by the Johns Hopkins NIOSH Education and Research Center for Occupational Safety and Health pilot project grant.

Conflict of interest

None to report.

References

- [1] Čosić K, Popović S, Šarlija M, et al. Impact of Human Disasters and COVID-19 Pandemic on Mental Health: Potential of Digital Psychiatry. *Psychiatr Danub*. 2020;32(1):25-31.
- [2] Yang Q, Huo J, Li J, Jiang Y. Research on the influence of the COVID-19 epidemic on work stress of returning workers in China: A study based on empirical analyses of industrial enterprises. *Work*. 2020;67(1):67-79.
- [3] Volgenant CMC, Persoon IF, Ruijter RAG, et al. Infection control in dental health care during and after the SARS-CoV-2 outbreak. *Oral Dis*. 2020;10.1111/odi.13408.
- [4] Prabhu N, Issrani R. Dilemma in the foreign lands during COVID-19: An outlook of expat health care professionals with a take on a social perspective. *Work*. 2020;67(4):779-82.
- [5] Bureau of Labor Statistics (BLS). Occupational Employment Statistics. 29-1292 Dental Hygienists. 2019. [updated 2019 June 6; cited 2020 Dec 5]. Available from: <https://www.bls.gov/oes/current/oes291292.htm#st>.
- [6] Crawford L, Gutierrez G, Harber P. Work environment and occupational health of dental hygienists: a qualitative assessment. *J Occup Environ Med*. 2005;47(6):623-32.
- [7] Moodley R, Van Wyk J. Multidisciplinary perspectives to prevent occupational health-related conditions among dental practitioners. *BDJ Open*. 2019;5:6. Published 2019 Apr. 11.
- [8] Lintag K, Bruhn AM, Tolle SL, et al. Radiation Safety Practices of Dental Hygienists in the United States. *J Dent Hyg*. 2019;93(4):14-23.
- [9] Shuhaiber S, Einarson A, Radde IC, et al. A prospective-controlled study of pregnant veterinary staff exposed to inhaled anesthetics and x-rays. *Int J Occup Med Environ Health*. 2002;15(4):363-73.
- [10] Burk A, Neitzel RL. An exploratory study of noise exposures in educational and private dental clinics. *J Occup Environ Hyg*. 2016;13(10):741-49.
- [11] Nagpal N, Bettiol SS, Isham A, et al. A Review of Mercury Exposure and Health of Dental Personnel. *Saf Health Work*. 2017;8(1):1-10.
- [12] Hilt B, Svendsen K, Syversen T, et al. Occurrence of cognitive symptoms in dental assistants with previous occupational exposure to metallic mercury. *Neurotoxicology*. 2009;30(6):1202-6.
- [13] Joshi A, Douglass CW, Kim HD, et al. The relationship between amalgam restorations and mercury levels in male dentists and non dental health professionals. *J Public Health Dent*. 2003;63(1):52-60.
- [14] Svendsen K, Syversen T, Melø I, et al. Historical exposure to mercury among Norwegian dental personnel. *Scand J Work Environ Health*. 2010;36(3):231-41.
- [15] Netanel S, Luria S, Langer D. Musculoskeletal disorders among dental hygienist and students of dental hygiene. *Int J Dent Hyg*. 2020;18(2):210-6.
- [16] Hayes MJ, Smith DR, Cockrell D. An international review of musculoskeletal disorders in the dental hygiene profession. *Int Dent J*. 2010;60(5):343-52.
- [17] Barry RM, Spolarich AE, Weber M, et al. Impact of Operator Positioning on Musculoskeletal Disorders and Work Habits Among Mississippi Dental Hygienists. *J Dent Hyg*. 2017;91(6):6-14.
- [18] Chen C, Zhao B, Cui W, et al. The effectiveness of an air cleaner in controlling droplet/aerosol particle dispersion emitted from a patient's mouth in the indoor environment of dental clinics. *J R Soc Interface*. 2010;7(48):1105-18.
- [19] Li Y, Huang X, Yu IT, et al. Role of air distribution in SARS transmission during the largest nosocomial outbreak in Hong Kong. *Indoor Air*. 2005;15(2):83-95.
- [20] Samaranyake LP, Peiris M. Severe acute respiratory syndrome and dentistry: a retrospective view. *J Am Dent Assoc*. 2004;135(9):1292-302.
- [21] Laheij AM, Kistler JO, Belibasakis GN, et al. European Oral Microbiology Workshop (EOMW) 2011. Healthcare-associated viral and bacterial infections in dentistry. *J Oral Microbiol*. 2012;4.
- [22] Zemouri C, de Soet H, Crielaard W, et al. A scoping review on bio-aerosols in healthcare and the dental environment. *PLoS One*. 2017;12(5):e0178007.
- [23] Bizzoca ME, Campisi G, Muzio LL. Covid-19 Pandemic: What Changes for Dentists and Oral Medicine Experts? A Narrative Review and Novel Approaches to Infection Containment. *Int J Environ Res Public Health*. 2020;17(11):3793.
- [24] Meng L, Hua F, Bian Z. Coronavirus Disease 2019 (COVID-19): Emerging and Future Challenges for Dental and Oral Medicine. *J Dent Res*. 2020;99(5):481-7.
- [25] Lauer SA, Grantz KH, Bi Q, et al. The Incubation Period of Coronavirus Disease 2019 (COVID-19) From Publicly Reported Confirmed Cases: Estimation and Application. *Ann Intern Med*. 2020;172(9):577-82.
- [26] Khader Y, Al Nsour M, Al-Batayneh OB, et al. Dentists' Awareness, Perception, and Attitude Regarding COVID-19 and Infection Control: Cross-Sectional Study Among Jordanian Dentists. *JMIR Public Health Surveill*. 2020;6(2):e18798.
- [27] King TB, Muzzin KB. A national survey of dental hygienists' infection control attitudes and practices. *J Dent Hyg*. 2005;79(2):8.
- [28] National Institute for Occupational Safety and Health (NIOSH). Organization of Work: Measurement Tools for Research and Practice. NIOSH Generic Job Stress Questionnaire. 2017. [updated 2017 June 14; cited 2020 Dec 7]. Available from: <https://www.cdc.gov/niosh/topics/workorg/detail088.html>.
- [29] Centers for Disease Control and Prevention (CDC). Guidance for Dental Settings Interim Infection Prevention and Control Guidance for Dental Settings During the Coronavirus Disease 2019 (COVID-19) Pandemic. 2020. [updated 2020 Dec 4; cited 2020 Dec 8]. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/hcp/dental-settings.html>.
- [30] American Dental Hygienists Association (ADHA). Frequently Asked Questions Related to Return to Work. 2020. [updated 2020 June 4; cited 2020 Dec 8]. Available from: https://www.adha.org/resources-docs/ADHA_TaskForceReport_FAQ_4_30.pdf.
- [31] The International Federation of Dental Hygienists (IFDH). IFDH 2020 COVID Survey. 2020. [updated 2020 Aug 12; cited 2020 Dec 8]. Available from: <http://www.ifdh.org/ifdh-2020-covid-survey.html#links>.
- [32] Villani FA, Aiuto R, Paglia L, et al. COVID-19 and Dentistry: Prevention in Dental Practice, a Literature Review. *Int J Environ Res Public Health*. 2020;17(12):4609.

- [33] Boškoski I, Gallo C, Wallace MB, et al. COVID-19 pandemic and personal protective equipment shortage: protective efficacy comparing masks and scientific methods for respirator reuse. *Gastrointest Endosc.* 2020;92(3):519-23.
- [34] Kotfis K, Williams RS, Wilson JE, et al. COVID-19: ICU delirium management during SARS-CoV-2 pandemic. *Crit Care.* 2020;24(1):176.
- [35] Gomes BA, Queiroz FLC, Pereira PLO, et al. In-House Three-Dimensional Printing Workflow for Face Shield During COVID-19 Pandemic. *J Craniofac Surg.* 2020;31(6):e652-e653.
- [36] Yue L. Ventilation in the Dental Clinic: An Effective Measure to Control Droplets and Aerosols during the Coronavirus Pandemic and Beyond. *Chin J Dent Res.* 2020;23(2):105-7.
- [37] Kampf G, Todt D, Pfaender S, et al. Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *J Hosp Infect.* 2020;104(3):246-51.
- [38] Khurshid Z, Asiri FY, al Wadaani H. Human saliva: non-invasive fluid for detecting novel coronavirus (2019-nCoV). *Int J Environ Res Public Health.* 2020;17:E2225.
- [39] Peng X, Xu X, Li Y, Cheng L, et al. Transmission routes of 2019-nCoV and controls in dental practice. *Int J Oral Sci.* 2020;12(1):9.
- [40] Guo H, Zhou Y, Liu X, et al. The impact of the COVID-19 epidemic on the utilization of emergency dental services. *J Dent Sci.* 2020.
- [41] Campus G, Diaz-Betancourt M, Cagetti MG, et al. Study Protocol for an Online Questionnaire Survey on Symptoms/Signs, Protective Measures, Level of Awareness and Perception Regarding COVID-19 Outbreak among Dentists. A Global Survey. *Int J Environ Res Public Health.* 2020;17(15):E5598.
- [42] Bhagavathula AS, Aldhaleei WA, Rahmani J, et al. Knowledge and Perceptions of COVID-19 Among Health Care Workers: Cross-Sectional Study. *JMIR Public Health Surveill.* 2020;6(2):e19160.
- [43] Cagetti MG, Cairoli JL, Senna A, et al. COVID-19 Outbreak in North Italy: An Overview on Dentistry. A Questionnaire Survey. *Int J Environ Res Public Health.* 2020;17(11):3835.
- [44] Spagnuolo G, De Vito D, Rengo S, et al. COVID-19 Outbreak: An Overview on Dentistry. *Int J Environ Res Public Health.* 2020;17(6):2094.
- [45] Battrell A, Lynch A, Steinbach P, et al. Advancing education in dental hygiene. *J Evid Based Dent Pract.* 2014;14(Suppl):209-21.e1.
- [46] Battrell A, Lynch A, Steinbach P. The American Dental Hygienists' Association Leads the Profession into 21st Century Workforce Opportunities. *J Evid Based Dent Pract.* 2016;16(Suppl):4-10.
- [47] American Dental Hygienists' Association. ADHA Releases Interim Guidance on Returning to Work. 2020. [updated 2020 Aug 4; cited 2020 Dec 8]. Available from: <https://www.adha.org/adha-interim-guidance-on-returning-to-work>.
- [48] Ahmed MA, Jouhar R, Ahmed N, et al. Fear and Practice Modifications among Dentists to Combat Novel Coronavirus Disease (COVID-19) Outbreak. *Int J Environ Res Public Health.* 2020;17(8):2821.
- [49] Mijiritsky E, Hamama-Raz Y, Liu F, et al. Subjective Overload and Psychological Distress among Dentists during COVID-19. *Int J Environ Res Public Health.* 2020;17(14):E5074.
- [50] Tysiąc-Miśta M, Dziedzic A. The Attitudes and Professional Approaches of Dental Practitioners during the COVID-19 Outbreak in Poland: A Cross-Sectional Survey. *Int J Environ Res Public Health.* 2020;17(13):4703.
- [51] Ren Y, Feng C, Rasubala L, Malmstrom H, et al. Risk for dental healthcare professionals during the COVID-19 global pandemic: an evidence-based assessment. *J Dent.* 2020;101:103434.
- [52] Ayatollahi J, Ayatollahi F, Ardekani AM, et al. Occupational hazards to dental staff. *Dent Res J (Isfahan).* 2012;9(1):2-7.
- [53] Arnetz JE, Goetz CM, Sudan S, et al. Personal Protective Equipment and Mental Health Symptoms Among Nurses During the COVID-19 Pandemic. *J Occup Environ Med.* 2020;62(11):892-7.
- [54] Carmassi C, Gesi C, Simoncini M, et al. DSM-5 PTSD and posttraumatic stress spectrum in Italian emergency personnel: correlations with work and social adjustment. *Neuropsychiatr Dis Treat.* 2016;12:375-81.
- [55] Carmassi C, Gesi C, Corsi M, et al. Exploring PTSD in emergency operators of a major University Hospital in Italy: a preliminary report on the role of gender, age, and education. *Ann Gen Psychiatry.* 2018;17:17.
- [56] Kim, Young-Jae, and Kang, Seung-Woo. The Quality of Life, Psychological Health, and Occupational Calling of Korean Workers: Differences by the New Classes of Occupation Emerging Amid the COVID-19 Pandemic. *Int J Environ Res Public Health* 2020;17(16):5689.
- [57] Feiz Arefi M, Babaei-Pouya A, Poursadeqiyan M. The health effects of quarantine during the COVID-19 pandemic. *Work.* 2020;67(3):523-27.
- [58] Sheervalilou R, Shirvaliloo M, Dadashzadeh N, et al. COVID-19 under spotlight: A close look at the origin, transmission, diagnosis, and treatment of the 2019-nCoV disease. *J Cell Physiol.* 2020;235(12):8873-924.
- [59] Drechsler Y, Vasconcelos EJR, Griggs LM, et al. Host Gene Expression of Macrophages in Response to Feline Coronavirus Infection. *Cells.* 2020;9(6):1431.
- [60] Pascarella G, Strumia, Alessandro P, et al. "COVID19 Diagnosis and Management: A Comprehensive Review." *J Intern Med.* 2020;288(2):192-206.
- [61] Hamidi S, Sabouri S, Ewing R. Does Density Aggravate the COVID-19 Pandemic? *J Am Plann Assoc.* 2020;86(4): 495-509.