

Critical Issues Facing the Dental Hygiene Profession

COVID-19 Prevalence and Related Practices among Dental Hygienists in the United States

Cameron G. Estrich, MPH, PhD; JoAnn R. Gurenlian, RDH, MS, PhD, AFAAOM;
Ann Battrell, MSDH; Sue K. Bessner; Ann Lynch; Matthew Mikkelsen, MA; Rachel Morrissey, MA;
Marcelo W. B. Araujo, DDS, MS, PhD; Marko Vujcic, PhD

Abstract

Purpose: Throughout the COVID-19 pandemic, health care professionals have been challenged to provide appropriate preventive and therapeutic measures while using precautions to minimize disease transmission. The purpose of this study was to estimate the prevalence of COVID-19 among United States (US) dental hygienists, describe infection prevention and control procedures and any associated trends in mental health.

Methods: Registered dental hygienists (RDHs) licensed in the US were invited to participate in a 30-question web-based survey. COVID-19 infection items included probable and confirmed results, COVID-19 related symptoms experienced in the last month, and level of concern about COVID-19 transmission to patients and themselves. The validated Patient Health Questionnaire 4 screened respondents for depression or anxiety. Personal protective equipment (PPE) use when treating patients was assessed. The research protocol and survey were approved by the American Dental Association IRB and registered at clinicaltrials.gov (NCT04542915). Kruskal-Wallis and X^2 tests were used to test for associations between PPE use, PPE supply, mental health symptoms, and concern about COVID-19 transmission.

Results: As of October 8, 2020, a total of 4,776 dental hygienists from all 50 states and Puerto Rico participated in the study. Respondents reported elevated symptoms of anxiety and depression. Of the respondents, 3.1% ($n=149$) had ever tested positive or been diagnosed with COVID-19. The majority of respondents (99.1%; $n=3,328$) who practiced dental hygiene reported their primary dental practice had enhanced infection prevention or control efforts in response to the pandemic. PPE use was significantly associated with years of experience as a dental hygienist, level of concern about COVID-19, and level of PPE supplies available (p -values <0.01), but not type of dental practice (p -value 0.1).

Conclusion: As of October 2020, the estimated prevalence rate of dental hygienists in the US having had COVID-19 was low. There is a need for further support for dental hygienists' use of PPE and mental health.

Keywords: SARS-CoV-2, COVID-19, occupational health, infection control, personal protective equipment, dental hygienists

This manuscript supports the NDHRA priority area **Professional development: Occupational health** (Determination and assessment of risks).

Submitted for publication: 12/17/20; accepted 1/8/21.

Introduction

On February 11, 2020, the *Coronaviridae* Study Group of the International Committee on Taxonomy of Viruses named the novel beta coronavirus as SARS-CoV-2.¹ This etiologic agent, or COVID-19 disease, has reached nearly every country worldwide in less than six months, resulting in significant morbidity and mortality. As of this article's publication date, there are over 63 million cases of COVID-19 globally, with over 1.4 million deaths, and over 17 million

cases of COVID-19 in the United States (US) resulting in nearly 308,000 deaths.²

Infection and viral dissemination of SARS-CoV-2 occurs through respiratory droplets from infected individuals while sneezing, coughing or talking without covering the mouth and nose.³ The droplets may linger in the air and infect individuals who come into contact with them in an enclosed space.^{4,5} Transmission is also possible through direct bodily contact with infected persons or contacting contaminated surfaces.⁶

Currently, there are limited therapeutic options for management of COVID-19. Supplemental oxygen and mechanical ventilation or extracorporeal membrane oxygenation for patients with refractory hypoxemia are used. Other therapies include convalescent plasma and immunoglobulin G, cortisone, and antiviral agents with limited success.^{3,7} The development of several vaccines show promising results and are in active deployment. This accelerated development process for vaccines to prevent COVID-19 will necessitate further investigations concerning length of immunity, need for boosters, effects on high-risk populations, and equitable access.⁸

Throughout the pandemic essential workers have been challenged to provide appropriate preventive and treatment measures while using precautions to minimize disease transmission and risk. Due to close contact with patients, health care workers may be at increased risk of COVID-19 infection.⁹ This risk may be heightened among oral health care workers, who may also be exposed to aerosolized infectious particles through aerosol-generating dental procedures such as scaling or polishing teeth with sonic or ultrasonic devices.¹⁰ Alternately, dental professionals' customary use of personal protective equipment (PPE) and routine dental procedures, such as water irrigation and high-volume evacuation, may reduce infection risk.¹¹

Dental professionals have been diagnosed with COVID-19,¹² but since community transmission is possible, and a retrospective study found no instances of dental-practice transmission of COVID-19 to staff or patients,¹³ the level of occupational risk remains unresolved. A vital component of correctly balancing people's needs for oral health care, along with the occupational risk in providing such care, is an accurate assessment of the risk of COVID-19 transmission in dental practices. Unfortunately, data on COVID-19 among dental professionals in the US is limited. Most (84%) records available to the Centers of Disease Control and Prevention (CDC) are missing data on healthcare professions.¹⁴

A review of the literature related to COVID-19 infection control practices among dental professionals is limited, given the time frame of the initiation of this virus. Many of the studies have occurred in practice settings outside of the US. For example, one study examined the signs and symptoms, protective measures, awareness and perceptions levels of COVID-19 among dentists in Lombardy, Italy, during April 2020. A total of 9,247 survey invitations were emailed and 3,599 were completed for a response rate of 39.4%. Of the participants, almost 15% experienced one or more symptoms associated with COVID-19, most notably fever and fatigue. Thirty-one dentists tested positive for the virus and 16

individuals developed COVID-19 disease. Precautionary measures used most frequently included delaying patient appointments, so the waiting room was not crowded, increased ventilation of the waiting room, and operator handwashing before and after each procedure. Only two percent of participants were confident that they could avoid the infection.¹⁵

A report on a cross-sectional study of the knowledge and practice of dentists in Lebanon was conducted in April 2020. Using a sample size calculator, a sample size of 357 participants was sought among a total population of 5000 dentists; and 358 dentists completed the survey. Findings revealed the majority had good knowledge about COVID-19; however, deficits were noted related to coronavirus incubation periods, disease transmission, actions in dealing with positive cases, and precautionary measures. More than half of the respondents (60%) reported good practice while the remainder noted poor practices related to COVID-19. Over 80% of the respondents reported they were afraid to treat a patient suspected or confirmed as infected with COVID-19 and had concerns about becoming infected from a colleague. Nearly all respondents (96%) were afraid of the impact of this disease on their livelihood. The authors noted that these findings have implications for the development of strategies for improving practice and enhancing prevention programs.¹⁶

Dentists in Saudi Arabia were surveyed in May 2020 concerning questions about COVID-19, management in dental clinics, preventive measures in the reception area, and knowledge, practice and attitudes toward the pandemic. Of the 1,000 surveys sent, 287 responses were received for a response rate of 28.7%. Findings revealed good adherence to screening patients and adoption of preventive measures in the reception area. There was less agreement (46%) related to use of an isolation room for suspected COVID-19 patients. Similarly, most respondents reported that an airborne infection isolation room and extra-oral suction system did not exist in the dental clinic where they worked, and half reported their dental clinic did not offer proper management training sessions for their staff. Overall knowledge and attitude percentages were high. The authors noted that until a vaccine is developed, adhering to developed guidelines to prevent the transmission of the COVID-19 infection is imperative; yet one-third of the respondents had no work plan or were unaware of a work plan for patient screening and dental management in their practice setting. It was recommended dental clinics utilize additional educational sessions for their dentists and staff on the latest COVID-19 recommendations and closely monitor practitioners and staff to ensure adherence to guidelines.¹⁷

To date, only one national study of US dentists has been published. A web-based survey was conducted in June 2020 among dentists designed to determine the prevalence of COVID-19 and infection control practices of dentists in private practice or public health. Survey questions pertained to COVID-19 symptoms, SARS-CoV-2 infection, mental well-being, and infection control procedures used in practice. Most respondents (82.2%) had no COVID-19 related symptoms within the past month of survey administration; the most common symptom reported was headache. One-third experienced mild psychological distress. Prevalence and positive testing rates were low among the respondents with 16.6% being tested and 0.9% reporting confirmed or probable COVID-19 cases. Enhanced infection control practices were implemented among nearly all respondents (99.7%) and the majority of practices (72.8%) used PPE according to CDC interim guidance. The authors concluded that the use of the CDC interim guidance in dental practice settings will contribute to reduced risk of developing infection and noted that surveillance of US dentists will remain ongoing.¹⁸

While organizations have continued to issue training, guidelines, and toolkits related to practicing oral health care during the COVID-19 pandemic,^{19,20} the actual infection prevention and control practices of dental hygienists have not been reported on since May 2020.^{21,22} One international study involved the impact of the pandemic on the dental hygiene profession from a global perspective. This study evaluated dental hygienists from 30 countries belonging to International Federation of Dental Hygienists and included 9,866 respondents (response rate not provided). Respondents indicated that guidance and PPE measures were being employed. Protective measures included screening patients for symptoms upon arrival (81%) and by phone when scheduling appointments (71%) and disinfecting all operatory surfaces after treatment (85%). Gloves, faces shields and surgical masks were being used by the majority of respondents. Nearly half reported wearing an N95 respirator, goggles, full gown and/or hair covering. However, concerns were expressed about PPE shortages (83%) and regarding patients delaying dental care (74%). Less than 2% had been diagnosed with COVID-19 and of those, fewer than 1% had symptoms.²¹

A cross-sectional survey of dental hygienists in Italy was performed during May 2020. This study used the same questionnaire that had been sent to dentists in Lombardy, Italy. Of 6,974 surveys sent, 2798 were entirely or partially completed, for a response rate of 40.12%. Findings revealed participants experienced symptoms of fatigue, headache and sore throat. Only 0.25% reported a positive diagnosis of COVID-19. Most frequent precautionary measures included

telephone triage, spacing appointments, frequent ventilation and disinfection of the waiting room, and handwashing before and after procedures performed. Protective glasses or visor, disposable gloves and surgical mask were the PPE most frequently used. The authors concluded that respondents appeared to be prepared to manage the COVID-19 infection in the dental practice environment and seemed confident being able to avoid the infection while performing work-related activities.²²

Presently, no studies have reported specifically regarding dental hygienists' COVID-19 practice experiences in the US. Therefore, a longitudinal survey was constructed to estimate the burden of COVID-19 among dental hygienists in the US, evaluate trends in mental health and professional practices, and identify COVID-19 risk factors for dental hygienists. The results from the first month's survey are reported here to describe COVID-19 prevalence, health, and COVID-19 related behaviors and practices among dental hygienists in the US.

Methods

A web-based survey was administered using Qualtrics (Qualtrics, Provo, UT) from September 29-October 8, 2020. All 133,000 registered dental hygienists who were in the American Dental Hygienists' Association's (ADHA) database received an invitation to participate on September 29, 2020; and a reminder invitation was emailed October 6, 2020. Individuals were eligible to participate in the survey if they were licensed as a dental hygienist in the US, were at least 18 years old, and were employed as a dental hygienist on March 1, 2020.

Potential participants read and signed an electronic informed consent before responding to the survey. The 30-question survey was constructed for this research and similar to the survey of US dentists.¹⁸ Based on the first two months of identical questions among a panel of dentists, test-retest reliability was on average 85.4%. Demographic survey questions included birth year, race, ethnicity, gender, primary practice location, and years of experience as a dental hygienist. COVID-19 infection was ascertained by self-reported date, type, and positive result of a COVID-19 test (confirmed case) or, if not tested, the date a healthcare provider told the respondent they had COVID-19 (probable case). COVID-19 prevalence was estimated based on this information. Consistent with CDC surveillance, the positive test rate was defined by the numbers of confirmed cases over the total number of tested cases.²³ Respondents were also asked to identify symptoms experienced in the last month (defined as since August 29, 2020), health conditions associated with COVID-19 severity,²⁴ and dental and non-dental activities in the last month.

Since stressful events such as a pandemic may affect mental well-being, respondents were asked their level of concern about COVID-19 transmission to patients and to themselves on a 5 point scale (1 meaning “very concerned” and 5 meaning “not concerned at all), and the validated Patient Health Questionnaire 4 (PHQ-4) screened respondents for depression (using the PHQ-2 scale) or anxiety (using GAD-2).^{25,26} Respondents who reported providing dental care in the last month were asked about infection prevention or control procedures in their primary dental practice. Respondents indicated which PPE they used when treating patients in the past month, and whether they used it sometimes, or always. The CDC interim guidance document was used to categorize PPE use,¹⁹ such that respondents were categorized as following PPE guidance for aerosol-generating procedures, if in addition to basic clinical PPE of gloves and protective clothing, they wore an N95 or similarly protective respirator (also called N95 mask) with eye protection. Dental hygienists who performed no aerosol-generating procedures in the past month were categorized as following PPE guidance if they wore gloves, protective clothing, a surgical mask (or a mask or respirator that offers an even higher level of protection) and eye protection. Finally, respondents who reported wearing respirators or masks were asked how often they were changed. The research protocol and survey were approved by the American Dental Association Institutional Review Board and registered at clinicaltrials.gov (NCT04542915).

Proportions, frequencies, and means were calculated in Stata 13.0 (StataCorp LP, Texas). For categorical variables, differences were tested using χ^2 tests, and with Kruskal-Wallis tests for non-normal continuous variables, with statistical significance set at 0.05. Due to complex survey design skip patterns, and because respondents were able to skip any question or stop answering the survey at any time, not all respondents answered all questions; the percent missing ranged from <1 to 9% per question. Since respondents’ behaviors, health, and concern may be related to the level of COVID-19 risk in their area, the average incidence rate of COVID-19 in their state or territory, for the days included in the survey (August 29-October 8, 2020), was calculated using data made publicly available by Johns Hopkins University.²⁷

Results

Of the dental hygienists identified in the ADHA database, 4,804 volunteered to participate in this research study. Of these individuals, a total of 4,776 dental hygienists originating from all 50 states and Puerto Rico participated in the web-based survey from September 29-October 8, 2020 for a completion rate of 99.4%. Respondents were aged 18 to 77

years (mean: 44.1, standard deviation: 12.0). The majority were non-Hispanic White (72.5%, n=4,066), female (98.1%, n=4,034), and primarily worked in a private solo dental practice (52.5%, n=2,161). Of the total sample, 31.9% (n=1,523) had at least one medical condition associated with a higher risk of developing severe illness from SARS-CoV-2.²⁴ Respondents had varying levels of experience, but the majority (64.4%, n=2,655) had been a practicing, licensed dental hygienist for 11 years or more. Demographic information is summarized in Table I. Dental hygienists were asked regarding their experiences of symptoms associated with COVID-19, even if they thought the symptoms were not due to COVID-19. Respondents could report multiple symptoms. The most common physical symptoms experienced in the past month were headaches (32.2%, n=1,547), congestion (24.8%, n=1,189), or fatigue (17.3%, n=829) (Table II). Respondents also answered the Patient Health Questionnaire-4, which evaluates symptoms of anxiety and depression. In the two weeks before taking the survey, 25.7% (n=1,077) of the respondents experienced elevated symptoms of anxiety (GAD-2 mean:1.73, standard deviation: 1.84) and 16.05% (n=673) experienced elevated symptoms of depression (PHQ-2 mean:1.21, standard deviation:1.59). Symptoms of anxiety and depression were significantly associated with age, with the highest levels of symptoms among those aged 18-29 years and the lowest levels among those aged 64 years or older (Kruskal-Wallis *p*-values <0.01).

Dental hygienists were surveyed regarding activities outside of their home in the past month (Table II). Of those responding, 18.8% (n=896) reported no contact with those outside of their household. Less than a third (32.4%; n=1,548) reported interacting with a group of ten or more people, while 12.8% (n=610) had attended a large public event in the past month. Only 9.1% (n=436) of dental hygienists reported they had in-person contact with someone with suspected or confirmed COVID-19 in the past month.

In the month preceding the survey, 70.3% (n=3,357) responding dental hygienists had provided dental care to patients as summarized in Table III. For the majority of respondents (90.7%; n=3,037), this care included dental procedures likely to generate aerosols. Among those who practiced dentistry that month, 99.1% (n=3,328) reported at least one enhanced infection prevention or control effort in their primary dental practice. The most common methods were disinfection between patients (97.9%, n=3,287), staff masking (97.8%, n=3,284), and screening patients prior to dental treatment (96.7%, n=3,247) (Table III). Most respondents (96.8%, n=3,249) reported that their primary

Table I. Sample demographics (n=4776)

Characteristic	%	n
Age group (years)		
18-29	12.5	500
30-39	28.2	1133
40-49	23.9	961
50-64	31.2	1254
65-77	4.2	169
Race/ethnicity		
Non-Hispanic White	72.5	4066
Hispanic/Latino	5.9	331
Non-Hispanic Asian	2.8	154
Non-Hispanic Black	1.8	100
American Indian/Alaska Native	0.6	34
Native Hawaiian/Pacific Islander	0.2	9
Other	16.3	916
Gender		
Male	1.0	42
Female	98.1	4034
Other or prefer not to say	1.0	40
Dental practice type		
Private solo practice	52.5	2161
Other dental practice	38.4	1581
Public health clinic/Community health center/Federally Qualified Health Center/Tribal health center	4.5	185
Academic/university/college	2.8	115
School-based setting	1.0	40
Military	0.5	19
Other	0.3	14

Characteristic	%	n
Experience as a dental hygienist (years)		
0-10	35.6	1468
11-20	27.6	1136
21 or more	36.8	1519
US Census Bureau division		
New England	9.0	341
Middle Atlantic	11.5	439
East North Central	16.2	616
West North Central	7.3	276
South Atlantic	17.2	654
East South Central	5.0	190
West South Central	7.2	274
Mountain	10.4	397
Pacific	16.3	621
Territories	0.03	1
Conditions (multiple conditions per person allowed)		
Asthma	9.5	455
Chronic lung disease	0.5	23
Diabetes	2.2	106
Heart condition	3.0	96
Immunocompromised	2.9	140
Kidney disease	0.4	17
Liver disease	0.3	12
Obesity	8.4	402
Rheumatologic or autoimmune condition	5.3	255
Smoking	1.8	85
Other	9.0	432

dental practice had at least five different infection control practices in place. A minority of respondents also reported their primary dental practice asked staff (2.3%, n=78), patients (28.8%, n=968), or both (12.0%, n=401) to sign a waiver related to COVID-19 (Table III).

At the time of the survey, CDC interim guidelines for PPE included wearing eye protection in addition to a mask during all patient care encounters, and using an N95 respirator or equivalent during dental procedures likely to generate aerosols.¹⁹ Among the respondents who provided oral health care that month, 28.2% (n=945) reported not following the CDC interim guidelines for PPE for patient care (Table III). Dental practice type was not statistically significantly associated with whether hygienists used PPE according to CDC guidelines (X^2 p -value=0.1) (Table IV).

However, years of experience as a dental hygienist was significantly associated with always following CDC PPE guidelines. Over half, (54.6%, n=659) of those with 10 or less years of experience always used PPE according to guidelines, compared with 55.4% (n=511) of those with 11-20 years, and 60.7% (n=692) of those with 21 or more years of experience (X^2 p -value<0.01) (Table IV). Respondents expressing the highest levels of concern regarding COVID-19 transmission to themselves or patients were more likely to always use PPE according to CDC guidelines (Kruskal-Wallis tests p -values <0.01). The incidence of COVID-19 in their state during the study period was not statistically significantly associated with whether dental hygienists always wore PPE according to CDC guidelines (Kruskal-Wallis test p -value=0.4).

Table II. Recently reported symptoms and activities (n=4776)

	%	n
Physical symptoms in the last month		
Chills	3.1	147
Congestion or runny nose	24.8	1189
Diarrhea	11.2	536
Dry cough	8.9	427
Fever	1.8	84
Headache	32.2	1547
Muscle pain or body aches	16.7	800
Nausea or vomiting	5.1	244
New loss of taste or smell	1.6	79
Repeated shaking with chills	0.5	25
Sore throat	13.5	647
Shortness of breath or difficulty breathing	5.1	245
Fatigue/malaise	17.3	829
Other	2.9	141
Mental health in last two weeks		
Likely anxiety (GAD-2 ≥3)	25.7	1077
Likely depression (PHQ-2 ≥3)	16.0	673
Activities in the past month		
Provided emergency dental care	11.8	564
Provided elective dental care	69.8	3334
Attended a health care visit for myself or a companion	47.3	2259
Met in person with anyone outside your household	76.4	3650
Met with a group of 10 or more people in a social setting	32.4	1548
Attended any public event with 50 or more people	12.8	610
Traveled by taxi, ride share, or public transportation	8.1	388
Met in-person with anyone with suspected or confirmed COVID-19:	9.1	436
Member of household	1.3	63
Coworker	3.5	168
Dental patient	2.8	135
Someone else	2.9	139

Dental hygienist use of N95 respirators was statistically significantly associated with the number of days' supply of N95 respirators, or their equivalent, in their primary place of employment. Only 1.3% of respondents always used N95s during patient care if their practice had 0 days' supply. However, this percentage increased with increasing supply, such that 14.2% always used N95s if they had 8-14 days' supply, and 61.9%

always used N95s if their practice had more than 14 days' supply (X^2 p -value<0.01). Since CDC interim guidance includes the use of a N95, or equivalents, during aerosol-generating dental procedures, it naturally followed that practice level of supplies of N95 or equivalent respirators was also significantly associated with respondent's use of PPE according to CDC guidelines (Table IV). Respondents most commonly reported changing their mask or respirator between each patient (42.3%, n =1157); the remainder changed it less often. Respondents who had more than 14 days of surgical masks or N95 or equivalent respirators were most likely to change their mask or respirator between every patient (X^2 p -values <0.01).

Dental hygienists were asked if they had ever been tested or diagnosed with COVID-19. Approximately one-third (35.4%, n =1,691) had been tested for SARS-CoV-2 at least once. The most common testing method utilized nasal or throat swabs (33.1%, n =1,583), with a 7.8% positive test rate (n =123). Only 5.4% (n =260) were tested using blood samples, with an 8.5% positive test rate (n =22). The least common testing method used were saliva samples, reported by 1.4% of respondents (n =65), with a 4.6% (n =3) positive test rate. Twenty-three (0.5%) dental hygienists surveyed were not able to be tested but were diagnosed with COVID-19 by a physician. In total, 3.1% (n =149) of the respondents had ever had COVID-19 by October 8th, 2020 (Table V). About one third of the dental hygienists with COVID-19 (37.8%, n =55) reported that contact tracing for the likely source of their COVID-19 infection was performed. For 25.5% (n =14) of those traced, contact tracing identified the respondent's primary place of work as the likely source of transmission.

Not all respondents remembered the date for which they sought testing or medical care for COVID-19, however, 10.3% (n =492) reported being tested or diagnosed since September 1, 2020. In total, 0.8% (n =39) of the respondents were diagnosed with COVID-19 or tested positive between September 1, 2020 and October 8, 2020, while 9.5% (n =453) tested negative for COVID-19. Among those tested or diagnosed in the past month, a significantly higher proportion of those

Table III. Reported infection prevention and control efforts in dental practices (n=3357)*

	Reporting (%)	n
Infection prevention and control efforts in the past month		
Screen or interview patients for known or suspected COVID-19 infection before dental appointment or treatment	94.0	3157
Check patient temperatures with a thermometer before dental treatment	96.7	3247
Check dental hygienist's temperature with a thermometer at the beginning of their shift	86.5	2904
Disinfect frequently touched surfaces and materials such as pens or light switches	91.4	3069
Disinfect all equipment in the operatory between patients	97.9	3287
Encourage distance between patients, such as scheduling appointments farther apart, asking patients to wait elsewhere, or asking patients not to bring companions	85.7	2876
Physical protection in the practice, such as erecting barriers, opening windows, or using air filters or scrubbers	75.0	2516
Provide face masks or coverings to staff	97.8	3284
Provide face masks or coverings to patients	71.6	2404
Teledentistry	14.8	497
Other	7.5	250
COVID-19 related waiver		
Dental practice asks staff or patients to sign a waiver	43.1	1447
No waiver	55.3	1857
Unknown	1.6	53
Personal Protective Equipment while treating patients in the past month		
Did not report using PPE according to current CDC interim guidelines	28.2	945
Sometimes used PPE according to current CDC interim guidelines	16.1	541
Always used PPE according to current CDC interim guidelines	55.7	1871

* Limited to respondents who performed dental procedures in the past month

with symptoms (11.6%, n=36) had COVID-19 than without (1.7%, n=3) (p -value<0.01). There was no statistical difference in COVID-19 positive tests in the past month among those who practiced (1.9%, n=48) or did not practice dental hygiene (1.1%, n=14) in the past month (X^2 p -value= 0.09). There was also no statistical difference in COVID-19 incidence rate in their

state or territory between those who tested positive or negative since September 1, 2020 (Kruskal-Wallis p -value = 0.9).

Discussion

This study is one of the only descriptions of COVID-19 prevalence, infection control practices or PPE use among dental hygienists in the US during the COVID-19 pandemic. Dental hygienists' rates of enhanced infection control procedures in dental practices are similar to the rates reported by US dentists¹⁸ and higher than those found in international surveys of dental hygienists.^{21,22}

Similar to other surveys of dental hygienists practicing during the pandemic,^{21,22} not all dental hygienists participating in the present study reported wearing N95 or equivalent respirators. As was found in a study among Italian dental hygienists,²² years of experience, but not community level of COVID-19 infections, are associated with PPE use. As intuitively makes sense, in the current study, dental hygienists' use of N95 or equivalent respirators was associated with respirator availability at their workplace. Increasing dental practices' supplies of N95, or equivalent respirators, may enhance PPE use. Alternatively, if dental practices followed national guidance and avoided aerosol generating procedures whenever possible, the limited supply and use of N95 or equivalent respirators by dental professionals would not be as problematic.^{19,20}

The issue of national guidance to protect dental health care personnel and patients from infection is an important consideration. This study revealed that slightly more than half of the respondents (55.7%) always used PPE according to current CDC interim guidance. Consistent adherence to PPE guidance was highest among those who were most concerned about COVID-19, had more years of experience as a dental hygienist, or had higher supplies of N95 or their equivalent. A global study of dental hygienists indicated that almost half of respondents were wearing an N95 respirator, goggles, full gown and/or hair covering, but the majority (92%) indicated that they would have to wear more PPE in the future. They were also

Table IV. Factors associated with adherence to CDC Interim Guidelines for PPE (n=3357)*

Characteristic	Always used PPE according to CDC interim guidelines (%)	n	X ² p-value
Dental practice type			0.1
Private solo practice	54.5	952	
Other dental practice	56.2	731	
Public health clinic/Community health center/Federally Qualified Health Center/Tribal health center	62.0	85	
Academic/university/college	70.4	50	
School-based setting	50.0	9	
Military	53.9	7	
Other	55.6	5	
Experience as a dental hygienist (years)			<0.01
0-10	54.6	659	
11-20	55.4	511	
21 or more	60.7	692	
N95 or equivalent masks or respirators supply			<0.01
Not sure	52.5	253	
0 days	13.6	29	
1-7 days	46.4	185	
8-14 days	58.3	266	
More than 14 days	63.8	1112	

* Limited to respondents who had performed dental procedures in the past month

Table V. Probable and confirmed COVID-19 infection (n=4776)*

Tested for COVID-19	Tested (%)	n	Positive test (%)	n
Nasal or throat swab (tests for current SARS-CoV-2 virus)	33.1	1583	7.8	123
Blood sample (tests for past SARS-CoV-2)	5.4	260	8.5	22
Saliva sample (tests for current SARS-CoV-2 antigen)	1.4	65	4.6	3
Not tested, but diagnosed by healthcare provider	NA**	NA	0.5	23
Total ever tested positive or had positive diagnosis	3.1	149	NA	NA

*Multiple types of testing may have been performed

** not applicable

concerned (>80%) that there would not be an adequate supply of PPE to treat patients.²¹ A study of Italian dental hygienists revealed a higher level of adherence to national and international guidelines for use of PPE, but less so with other precautionary measures.²² Further study is needed to identify other factors that may be associated with strict adherence to guidelines including awareness of current guidelines, philosophy of dental practice, availability of other PPE, and financial issues.

The Joint American College of Academic International Medicine-World Academic Council of Emergency Medicine Working Group on COVID-19 caution that significant rates of anxiety, depression, and other mental health disorders among the general health population, as well as health care providers, are to be expected, including suicidal ideation and suicide. The proportion of dental hygienists experiencing anxiety in the present study (25.7%) is similar to anxiety levels found among the general US population (25.5%), during the COVID-19 pandemic; however respondents had lower levels of depression (16.0%) as compared to the general population (24.3%).²⁸ In comparison, dentists in the US reported lower rates of anxiety (14.8%) and depression (8.9%) than the dental hygienists;¹⁸ however, nurses in Michigan reported significantly higher rates of anxiety (54.95%) and depression (59.5%)²⁹ than either dentists or dental hygienists. A study of dentists and dental hygienists in Israel revealed a low rate of elevated psychological distress, found (11.5%) experiencing distress, most notably associated with those who had background illness, fear of contracting COVID-19 from a patient, and higher subjective overload.³⁰ These differences in mental health symptoms by profession may reflect longer periods of contact with potentially infectious patients, may be related to levels of perceived control in the workplace, age differences, or other

factors, and warrant further investigation. These findings underscore the importance of mental health resources needed to help individuals cope with the emotional stress of the pandemic.³¹

As of October 8, 2020, an estimated 3.1% of dental hygienists in the US have had COVID-19. In the general US population on the same date, an estimated 2.3% or 7.6 million people have had COVID19.² Both of these cumulative prevalence rates are lower than has been found in non-dental, health care workers in the US.³² The two international studies focusing on dental hygienists also reported prevalence rates of less than 2%.^{21,22} The low rate reported in the present study may reflect the safety measures taken by dental hygienists to protect their patients and dental team members.

There are limitations to these findings. This study is based on self-reported data, which may be subject to recall or social desirability bias. COVID-19 testing is limited and is primarily available to those with symptoms or contact with someone who has already tested positive for COVID-19, so, as with surveillance in the general US population,²³ less severe, or asymptomatic cases of COVID-19, may be missed. Severe cases of COVID-19 resulting in hospitalization or death would also be underestimated by this study. There was insufficient statistical power to test for differences in recent COVID-19 infection by dental-practice-related factors, such as PPE use or infection control practices.

Future research, using data from this ongoing longitudinal study, may be able to evaluate these factors and will continue to examine prevalence of COVID-19 among dental hygienists in the US, risk factors for COVID-19, use of PPE in dental practice settings, employment factors, and mental health status. Further study is needed to identify other factors that may be associated with COVID-19 infection including awareness of, and strict adherence to guidance, philosophy of dental practice, availability of other PPE, and financial issues.

Conclusion

As of October 2020, the prevalence of ever having had COVID-19 was estimated to be 3.1% among dental hygienists in the US. Enhanced infection control efforts were reported in 99.1% of dental practices. Not all dental hygienists reported using PPE during dental procedures according to CDC interim guidelines; this finding may improve with increased access to PPE. Ongoing data collection among this sample, will enable estimation of the incidence rate of COVID-19 among US dental hygienists and identifying dental practice-related risk factors for SARS-CoV-2 infection.

Disclosure

The authors have no conflicts of interest to report.

Cameron G. Estrich, MPH, PhD is a Health Research Analyst, Evidence Synthesis and Translation Research, American Dental Association Science & Research Institute, LLC, Chicago, IL, USA.

JoAnn R. Gurenlian, RDH, MS, PhD, AFAAOM is a Professor and Graduate Program Director, Department of Dental Hygiene, Idaho State University, Pocatello, ID, USA.

Ann Battrell, MSDH, is the Chief Executive Officer, American Dental Hygienists' Association, Chicago, IL, USA.

Sue K. Bessner is the past Director of Professional Development, American Dental Hygienists' Association, Chicago, IL, USA.

Ann Lynch is the Director of Education and Advocacy, American Dental Hygienists' Association, Chicago, IL, USA.

Matthew Mikkelsen, MA is the Manager, Education Surveys, Health Policy Institute, American Dental Association, Chicago, IL, USA.

Rachel Morrissey, MA is a Research Analyst, Education, Health Policy Institute, American Dental Association, Chicago, IL, USA.

Marcelo W. B. Araujo, DDS, MS, PhD is the Chief Science Officer, American Dental Association, Science & Research Institute, Chicago, IL, USA.

Marko Vujcic, PhD is the Chief Economist and Vice President, Health Policy Institute, American Dental Association, Chicago, IL, USA.

Corresponding Author: Cameron G. Estrich, MPH, PhD; estrichc@ada.org

References

1. Gorbalenya AE, Krupovic M, Mushegian A, et al. The new scope of virus taxonomy: partitioning the virosphere into 15 hierarchical ranks. *Nat Microbiol.* 2020 May; 5(5):668-74.
2. John Hopkins University & Medicine. Coronavirus Resource Center. COVID-19 dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University [Internet]. Baltimore (MD): JHU. edu; 2020 [cited 2020 November 30]. Available from: <https://coronavirus.jhu.edu/map.html>
3. Macchi J, Herskovitz J, Senan AM, et al. The natural history, pathobiology, and clinical manifestations of

- SARS-CoV-2 infections. *J Neuroimmune Pharmacol.* 2020 Jul; 21:1-28.
4. Gandhi M, Yokoe DS, Havlir DV. Asymptomatic transmission, the Achilles' heel of current strategies to control COVID-19. *N Engl J Med.* 2020 May; 382(21):2158-60.
 5. Meselson M. Droplets and aerosols in the transmission of SARS-CoV-2. *N Engl J Med.* 2020 May; 382(21):2063.
 6. Li Q, Guan X, Wu P, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. *N Engl J Med.* 2020 Mar; 382:1199-1207.
 7. Guo Y-R, Cao Q-D, Hong Z-S, et al. The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak – an update on the status. *Mil Med Res.* 2020 Mar 13; 7(1):11.
 8. Jeyanathan M, Afkhami S, Smaill F, et al. Immunological considerations for COVID-19 vaccine strategies. *Nat Rev Immunol.* 2020 Oct; 20(10):615-32.
 9. Nguyen LH, Drew DA, Graham MS, et al. Risk of COVID-19 among front-line health-care workers and the general community: a prospective cohort study. *Lancet Public Health.* 2020 Sep;5(9):e475-e83.
 10. Ge Z-Y, Yang L-M, Xia J-J, et al. Possible aerosol transmission of COVID-19 and special precautions in dentistry. *J Zhejiang Univ Sci B.* 2020 May;21(5):361-8.
 11. Epstein JB, Chow K, Mathias R. Dental procedure aerosols and COVID-19. *Lancet Infect Dis.* 2020 Aug 10;S1473-3099
 12. Meng L, Hua F, Bian Z. Coronavirus disease 2019 (COVID-19): emerging and future challenges for dental and oral medicine. *J Dent Res.* 2020 May;99(5):481-7.
 13. Froum SH, Froum SJ. Incidence of COVID-19 virus transmission in three dental offices: a 6-Month retrospective study. *Int J Periodontics Restorative Dent.* 2020 Oct; 40(6):853-9.
 14. Burrer SL, de Perio MA, Hughes MM, et al. Characteristics of health care personnel with COVID-19 United States, February 12–April 9, 2020. *MMWR Morb Mortal Wkly Rep* 2020 Apr 17;69(15):477-81.
 15. 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 Jun; 17(11):3835.
 16. Nasser Z, Fares Y, Daoud R, et al. Assessment of knowledge and practice of dentists towards Coronavirus disease (COVID-19): a cross-sectional survey from Lebanon. *BMC Oral Health.* 2020 Oct; 20:281.
 17. Al-Khalifa KS, Al-Sheikh R, Al-Swuailem AS, et al. Pandemic preparedness of dentists against coronavirus disease: a Saudi Arabian experience. *Plos One.* 2020 Aug; 15(8): e0237630.
 18. Estrich CG, Mikkelsen M, Morrissey R, et al. Estimating COVID-19 prevalence and infection control practices among US dentists. *J Am Dent Assoc.* 2020 Nov; 151(11):815-24.
 19. CDC. Interim infection prevention and control guidance for dental settings during the COVID-19 response [Internet] Atlanta,(GA): U.S. Department of Health and Human Services; 2020 [modified 2020 Jun 29; cited 2020 Nov 30]. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/hcp/dental-settings.html>
 20. ADHA. ADHA COVID-19 center 2020 [Internet] Chicago (IL): American Dental Hygienists' Association; 2020 [modified 2020 Nov 23; cited 2020 Nov 30] Available from: <https://www.adha.org/covid19>
 21. IFDH. IFDH 2020 COVID survey [Internet] Rockville (MD): International Federation of Dental Hygienists; 2020 [modified Jul 24; cited 2020 Nov 30] Available from: <http://www.ifdh.org/ifdh-2020-covid-survey.html>
 22. Bontà G, Campus G, Cagetti MG. COVID-19 pandemic and dental hygienists in Italy: a questionnaire survey. *BMC Health Serv Res.* 2020 Oct 31;20(1):994.
 23. CDC. Coronavirus disease 2019 (COVID-19): cases, data, & surveillance: purpose and methods [Internet] Atlanta,(GA): U.S. Department of Health and Human Services; 2020 [modified 2020 Jul 5; cited 2020 Dec 1] Available from: <https://www.cdc.gov/coronavirus/2019-ncov/covid-data/covidview/purpose-methods.html>
 24. CDC. Coronavirus disease 2019 (COVID-19): who is at increased risk for severe illness? [Internet] Atlanta,(GA): U.S. Department of Health and Human Services; 2020 [modified Jun 25; cited 2020 Dec 1] Available from: <https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-at-higher-risk.html>
 25. Löwe B, Wahl I, Rose M, Spitzer C, et al. A 4-item measure of depression and anxiety: validation and standardization of the Patient Health Questionnaire-4 (PHQ-4) in the general population. *J Affect Disord.* 2010 Apr; 122(1-2):86-95.

26. Pfizer. Patient Health Questionnaire Screeners [Internet]. New York (NY): Pfizer Inc; 2020 [modified 2020 May 5; cited 2020 Dec 1] Available from: <https://www.phqscreener.com/select-screener>
27. Dong E, Du H, Gardner L. An interactive web-based dashboard to track COVID-19 in real time. *Lancet Infect Dis.* 2020 May 20;(5):533-4.
28. Czeisler MÉ, Lane RI, Petrosky E, et al. Mental health, substance use, and suicidal ideation during the COVID-19 pandemic—United States, June 24–30, 2020. *MMWR Morb Mortal Wkly Rep.* 2020 Aug; 69(32):1049-57.
29. 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 Nov; 62(11):892-7.
30. Shacham M, Hamama-Raz Y, Kolerman R, et al. COVID-19 factors and psychological factors associated with elevated psychological distress among dentists and dental hygienists in Israel. *Int J Environ Res Public Health.* 2020 Apr;17(8):2900.
31. Stawicki SP, Jeanmonod R, Miller AC, et al. The 2019-2020 novel coronavirus (severe acute respiratory syndrome coronavirus 2) pandemic: a joint American college of academic international medicine-world academic council of emergency medicine multidisciplinary COVID-19 working group consensus paper. *J Glob Infect Dis.* 2020 Apr-Jun; 12(2):47-93.
32. Kambhampati AK, O'Halloran Ac, Whitaker M, et al. COVID-19-associated hospitalizations among health care personnel--COVID-NET, 13 States, March 1-May 31, 2020. *MMWR Morb Mortal Wkly Rep.* 2020 Oct; 69(43):1576-83.