

Cover Story

COVID-2019 among dentists in the United States

A 6-month longitudinal report of accumulative prevalence and incidence

Marcelo W.B. Araujo, DDS, MS, PhD; Cameron G. Estrich, MPH, PhD; Matthew Mikkelsen, MA; Rachel Morrissey, MPA; Brittany Harrison, MA; Maria L. Geisinger, DDS, MS; Effie Ioannidou, DDS, MDS; Marko Vujcic, PhD

ABSTRACT

Background. In 2020, the Centers for Disease Control and Prevention and the American Dental Association released COVID-19 infection control interim guidance for US dentists, advising the use of optimal personal protection equipment during aerosol-generating procedures. The aim of this longitudinal study was to determine the cumulative prevalence and incidence rates of COVID-19 among dentists and to assess their level of engagement in specific infection control practices.

Methods. US dentists were invited to participate in a monthly web-based survey from June through November 2020. Approximately one-third of initial respondents (n = 785) participated in all 6 surveys, and they were asked about COVID-19 testing received, symptoms experienced, and infection prevention procedures followed in their primary practice.

Results. Over a 6-month period, the cumulative COVID-19 infection prevalence rate was 2.6%, representing 57 dentists who ever received a diagnosis of COVID-19. The incidence rates ranged from 0.2% through 1.1% each month. The proportion of dentists tested for COVID-19 increased over time, as did the rate of dentists performing aerosol-generating procedures. Enhanced infection prevention and control strategies in the dental practice were reported by nearly every participant monthly, and rates of personal protection equipment optimization, such as changing masks after each patient, dropped over time.

Conclusions. US dentists continue to show a high level of adherence to enhanced infection control procedures in response to the ongoing pandemic, resulting in low rates of cumulative prevalence of COVID-19. Dentists are showing adherence to a strict protocol for enhanced infection control, which should help protect their patients, their dental team members, and themselves.

Practical Implications. COVID-19 infections among practicing dentists will likely remain low if dentists continue to adhere to guidance.

Key Words. Severe acute respiratory syndrome; dentistry; infection control; aerosols; dental care. JADA 2021;152(6):425-433

<https://doi.org/10.1016/j.adaj.2021.03.021>

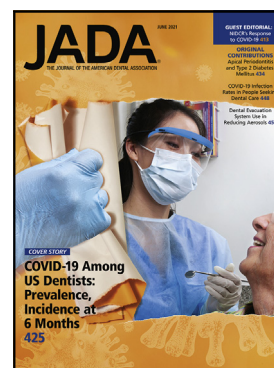
As of February 2021, severe acute respiratory syndrome coronavirus 2 (SARs-CoV-2) has infected tens of millions worldwide with severe cases resulting in hospitalization and death. SARS-CoV-2, the virus that causes COVID-19, is transmitted primarily through person-to-person contact, as well as via virus-containing droplets (5-12 μm) and aerosols ($\leq 5 \mu\text{m}$). Susceptible people may become infected if virus-containing respiratory droplets or aerosols settle on their mucosa or are inhaled.¹ The scientific community has established that transmission of COVID-19 is linked to aerosol-generating procedures (AGPs) and that the total viral load to which the health care providers (HCPs) are exposed is the main risk factor for infection.² Therefore, both the Centers for Disease Control and Prevention (CDC) and World Health Organization have issued statements specific to AGPs and the need for the use of enhanced personal protective



ADA American Dental Association



Supplemental material is available online.



This article has an accompanying online continuing education activity available at: <http://jada.ada.org/ce/home>.

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equipment (PPE).^{3,4} In 2020, a cross-sectional study published by our group reported that the prevalence of COVID-19 among US dentists was low, with a weighted estimated rate of 0.9% (95% CI, 0.5% to 1.5%).⁵ The study's results showed that dentists following interim safety guidance were well prepared to resume their practice.⁵

In addition to our study,⁵ there have been limited reports on rates of COVID-19 among dentists. One report evaluated safety practices in 3 specialty dental clinics in the New York, New York, area and observed 0 cases of COVID-19 among 2,810 patients, 2 dentists, and 3 registered dental hygienists during a 6-month period. The practices indicated enhanced use of PPE, increased measures to screen and protect patients seeking care, and assessment of infection risk factors.⁶ Considering the infection rate in New York, New York, at the time, the authors concluded that oral health care can be safely provided as long as appropriate safety measures are followed.⁶ Another report surveyed 454 members of the American Academy of Endodontics, finding a high rate of adherence to enhanced infection control measures, including the use of N95 respirator (also called an "N95 mask") by 83.1% of the participants.⁷

In the time after our initial study was deployed, the interim guidance for dental professionals from the American Dental Association (ADA) and CDC were revised on the basis of emerging scientific data. Most revisions addressed types of PPE for various procedure types, management of aerosols in the operatory area, and quarantine periods for dental HCPs exposed to COVID-19.^{3,8} As of December 2020, the revised CDC interim recommendations mandated that dental HCPs wear N95 masks or those that offer an equivalent or higher level of protection, gowns or protective clothing, and gloves and eye protection (goggles or full face shields) during AGPs and in areas with moderate to substantial community transmission of COVID-19 during AGPs.⁹

Although cross-sectional studies offer a snapshot of infection rates in a given population, there is a paucity of widespread longitudinal evidence of the safety levels and rates of infection among dentists and other HCP. Our 6-month longitudinal study aimed to

- determine the cumulative prevalence rate of COVID-19 among dentists;
- calculate the monthly incidence rate for the same population over the course of the study;
- assess the level of engagement in specific infection control practices among dentists over a 6-month period.

METHODS

We administered a novel web-based cross-sectional survey using Qualtrics from June 8 through November 13, 2020. Dentists were eligible to participate if they held a license to practice dentistry in the United States, were in private practice or public health, and indicated a willingness to participate in the previous ADA-generated survey related to COVID-19. The protocol and survey were approved by the ADA Institutional Review Board and registered at [ClinicalTrials.gov](https://clinicaltrials.gov) (NCT04423770). Details of the study population and questionnaire are described in our previous publication.⁵ We made several changes to the questionnaire after the first survey on June 8, 2020, which are detailed in the [Supplemental File](#). All participants signed an electronic informed consent before starting the survey.

We ascertained COVID-19 infection via self-reported date, type, and result of COVID-19 test (confirmed case) or, if not tested, the date an HCP told the respondent he or she had a probable COVID-19 infection (probable case). Each month, we considered those who reported a COVID-19 positive test or diagnosis who had not previously received a diagnosis of COVID-19 as newly infected. We calculated monthly incidence as the number of new confirmed or probable cases that month divided by the total number of dentists responding to the survey that month. The date a respondent was tested or received a diagnosis was missing for 22.0% of cases, so we used self-reported dates only to verify in which month a case should be counted. In no instance did the reported date not match the month in which it was counted. We also calculated the positivity rate as the number of confirmed cases over the total number of those tested that month. Respondents reported which PPE they used and how often when treating patients in the prior month as never, sometimes, or always. We used the CDC interim guidance document to categorize PPE use.³

We conducted all statistical analysis in Stata Version 13.0 (StataCorp). For COVID-19 testing results, we performed statistical weighting using linearization variance estimation so that the sample appropriately represented licensed US dentists in private practice or public health by age group and US Census Bureau division. We used single and multivariable multilevel regression models (logistic for binary outcomes, ordered logistic for ordinal outcomes), with survey results nested within each

ABBREVIATION KEY

ADA:	American Dental Association.
AGP:	Aerosol-generating procedure.
CDC:	Centers for Disease Control and Prevention.
HCP:	Health care provider.
PPE:	Personal protective equipment.
SARS-CoV-2:	Severe acute respiratory syndrome coronavirus 2.

respondent to account for the same respondents answering surveys over time. We weighted COVID-19 incidence and used linearization variance so that the estimated incidence more accurately represented licensed US dentists in private practice or public health by age group and US Census Bureau division. We determined the weights on the basis of the ADA master file of all US dentists, as previously described.⁵

RESULTS

A total of 2,196 US dentists participated in our 6-month longitudinal study from June 8 through November 13, 2020. The initial response rate was 40.1% in the first month. A decreasing number of the initial respondents continued to participate in the survey, such that 1,291 (58.8% of those who participated in the first month) participated in the final month, and a total of 785 (35.7% of initial respondents) participated in all 6 surveys. One participant who completed the initial survey 3 days after the study period ended had been excluded from the previously reported cross-sectional results⁵ but was included in this analysis.

The median age of responding dentists was 52.6 years, and most (1,300 [59.2%]) were male (Table). Overall, most respondents were non-Hispanic White (1,673 [76.1%]), in private practice (2,081 [94.8%]), and general dentists (1,802 [82.1%]). Participants with missing demographic and practice information in the first survey were asked again the following month, allowing for lower proportions of missing data in this study than our initial report.⁵ When exploring factors potentially related to participation rates, we observed that age, sex, race and ethnicity, region, and dental practice type were not associated with continued participation ($P > .3$). Among the respondents, 536 (an estimated 24.4%) had at least 1 medical condition associated with higher risk of developing severe illness from COVID-19, most commonly asthma (160 [7.3%]) and obesity (166 [7.6%]).

To identify potential sources of infection, we asked dentists about their activities outside of their clinical practices. In the first month, 103 (4.7%) dentists reported no in-person contact (that is, interaction) with anyone outside their household in the month before answering the survey. This rate was significantly lower ($P < .01$) in all subsequent months (Figure 1). In-person contact in health care practice or social setting outside the household in the prior month were not significantly associated with participant age group or sex ($P > .6$) but was significantly associated with location. Specifically, over the course of the study, dentists in the Pacific region and Puerto Rico had the lowest overall rates of in-person contact ($P < .01$) compared with other regions of the nation. Rates of in-person contact with people outside of the household in the prior month did not significantly change in most regions over time ($P > .05$) but increased significantly over the study period in the Middle Atlantic region and Puerto Rico ($P < .05$).

Throughout the study period, a minority of participants reported contact with someone with a suspected or confirmed COVID-19 infection in the past month. The percentage reporting contact with someone with COVID-19 significantly increased over time, from 4.6% ($n = 100$) in the first survey to 16.1% ($n = 208$) in the final survey ($P < .01$). In total, contact with someone with a suspected or confirmed COVID-19 infection was reported 875 times among the 2,196 participants over the course of 6 months; 430 (49.1%) of those reports were because of contact with dental patients. Another 310 (35.4%) stated that within the past month a coworker had COVID-19. In the study period, the likely source of COVID-19 was identified via contact tracing by a health agency or clinic in only 23 cases among dentists; in 2 instances, the dental practice was identified as the likely infection source.

Each month, most participants indicated that they provided oral health care in the prior month, increasing significantly over time from 2,043 (93.0%) in the first survey to 1,266 (98.1%) in the sixth ($P < .01$). The rate of dentists performing AGPs increased from 92.8% ($n = 1,893$) in the first survey to 97.3% ($n = 1,502$) in the second survey and continued to rise over time to 98.4% ($n = 1,246$) by the end of the study period ($P < .01$). Over the period of our longitudinal study, the use of at least a surgical mask and eye protection while performing non-AGPs remained statistically stable, and similar results were observed for always wearing a N95 mask or equivalent and eye protection in the same month they performed AGPs ($P > .5$). We saw a statistically significant decline in dentists reporting sometimes or always wearing N95 or equivalent masks and eye protection during AGPs over time from 92.4% in the first survey to 88.0% in the final survey ($P < .01$) (Figure 2).

During the course of our study, the CDC encouraged PPE optimization strategies in instances of limited PPE supplies.³ In the first month, only 355 (17.6%) dentists reported changing their masks

Table. Characteristics of the survey sample and comparison with all private practice or public health dentists licensed in United States.

CHARACTERISTIC	PROPORTION OF SAMPLE,* NO. (%)
Age Group[†], y	
27-39	344 (15.7)
40-49	509 (23.2)
50-59	589 (26.8)
60-69	601 (27.4)
70-84	105 (4.8)
Missing	48 (2.2)
Race and Ethnicity	
Non-Hispanic White	1,673 (76.1)
Non-Hispanic Asian	168 (7.7)
Hispanic or Latino	186 (8.5)
Non-Hispanic Black	26 (1.2)
American Indian or Alaska Native	5 (0.2)
Native Hawaiian or Pacific Islander	4 (0.2)
Other or missing	134 (6.1)
Sex	
Male	1,300 (59.2)
Female	845 (38.5)
Prefer not to say or missing	51 (2.3)
Dental Practice Type[†]	
Private practice	2,081 (94.8)
Federally qualified health center	56 (2.6)
Nonfederally qualified health center	8 (0.4)
City or county health department	10 (0.5)
Missing	41 (1.9)
Practice Type[†]	
General dentist	1,802 (82.1)
Dental anesthesiology	2 (0.1)
Endodontics	34 (1.6)
Oral and maxillofacial pathology	1 (0.05)
Oral and maxillofacial surgery	58 (2.6)
Oral medicine	2 (0.1)
Orofacial pain	2 (0.1)
Orthodontics and dentofacial orthopedics	44 (2.0)
Pediatric dentistry	147 (6.7)
Periodontics	50 (2.3)
Prosthodontics	14 (0.6)
Missing	40 (1.8)
Census Bureau Division[†]	
New England	143 (6.5)
Middle Atlantic	269 (12.3)
East North Central	426 (19.4)

* N = 2,196. † Percentages may not total 100 due to rounding.

Table. Continued

CHARACTERISTIC	PROPORTION OF SAMPLE,* NO. (%)
West North Central	226 (10.3)
South Atlantic	339 (15.4)
East South Central	98 (4.5)
West South Central	178 (8.1)
Mountain	149 (6.8)
Pacific	344 (15.7)
Territories	24 (1.1)

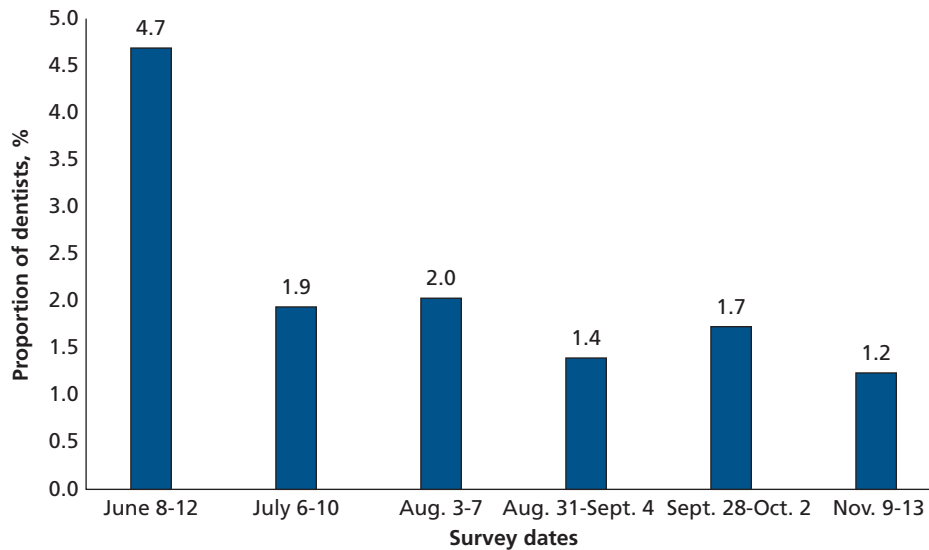


Figure 1. Dentists reporting any in-person contact outside the home, by month and US Census Bureau division (9,320 observations).

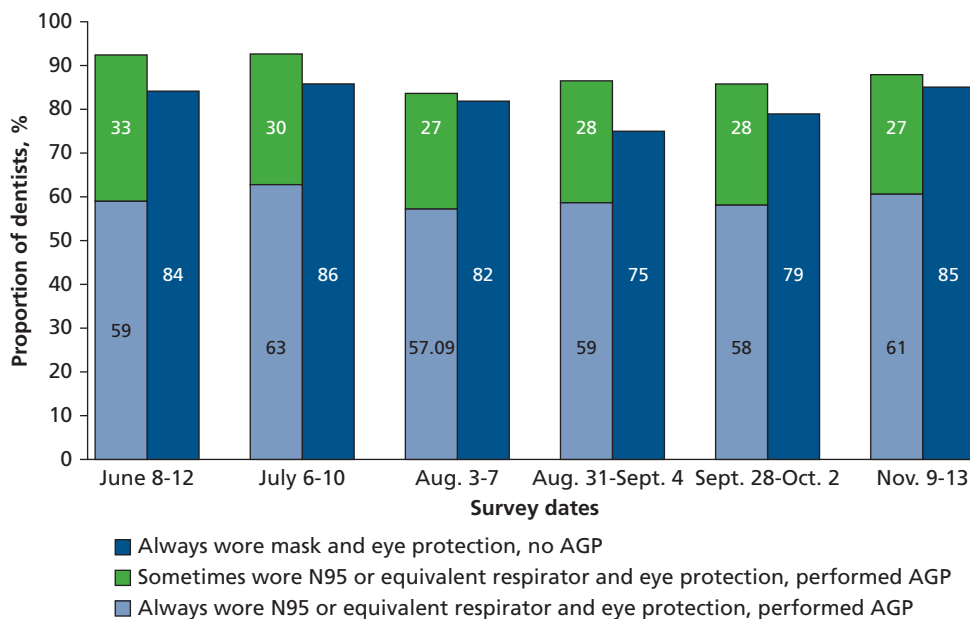


Figure 2. Personal protective equipment use according to Centers for Disease Control and Prevention interim guidelines for dental settings by month (8,966 observations, restricted to those practicing dentistry each month). AGP: Aerosol-generating procedure.

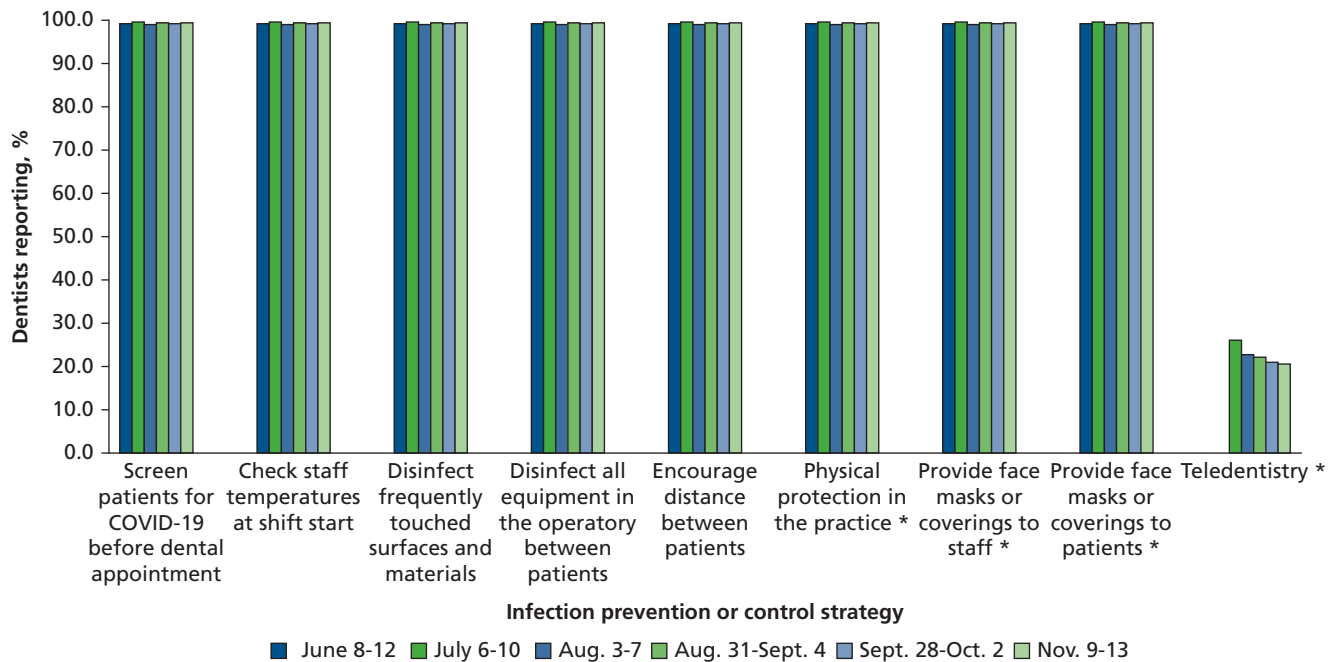


Figure 3. Infection prevention and control methods used in dental practices by month (8,966 observations, restricted to those practicing dentistry each month). * Significantly different over time, $P < .05$

or respirators between patients, and 407 (20.2%) changed them only if soiled or damaged. Over time, there was a decrease in PPE optimization, as significantly more dentists changed their masks with every patient ($P < .01$). Since June 2020, the rate never fell below 25.5%, and fewer dentists reported changing their masks only if soiled (by November, only 99 [8.2%] did so).

Enhanced infection prevention and control strategies in the dental practice were reported by at least 99.7% of all dentists each month (no significant change over time; $P = .2$). Throughout the study period, high and statistically unchanged numbers of dental practices reported screening patients and staff members for COVID-19, disinfecting between patients, and encouraging social distancing between patients ($P > .05$) (Figure 3). Although in the initial survey most dental practices already reported providing face masks to staff members and patients and had physical protections such as barriers, open windows, or air filters or scrubbers, an increasing proportion of practices instituted these strategies over time ($P < .01$). We added a question about teledentistry to the survey the second month, and the results showed that this was used at the highest rate in July (418 [26.1%]) and declined to 265 (20.5%) by November ($P < .01$).

The proportion of dentists who had been tested for COVID-19 increased over time, from 355 (16.6%) in the initial survey to 566 (43.9%) in the final survey. Testing for COVID-19 using saliva samples was relatively rare (47 [2.1%]) compared with testing with nasal or pharyngeal swabs (703 [32.0%]). A minority (317 [14.4%]) were tested for COVID-19 antibodies via blood samples. As of the first survey, 20 (0.9%) dentists reported having ever been told they had COVID-19 by a medical HCP. New cases identified in each subsequent month were tallied to calculate monthly incidence and cumulative prevalence rates (Figure 4). In total, our 6-month analysis showed a cumulative prevalence rate of 2.6%, representing 57 dentists ever with confirmed or probable COVID-19 infection. The weighted incidence rates varied month by month, ranging from 0.2% through 1.1% (Figure 4).

DISCUSSION

Owing to the aerosol-generating nature of many dental procedures, it was originally hypothesized that dentistry presented a high risk of transmitting SARS-CoV-2¹⁰; however, no confirmed cases of COVID-19 transmission related to patients' receiving oral health care have been reported to date. Furthermore, the results of our earlier cross-sectional study⁵ and the results of this study show that prevalence and incidence rates among dentists continue to be very low in comparison with the population as a whole and with other HCPs.

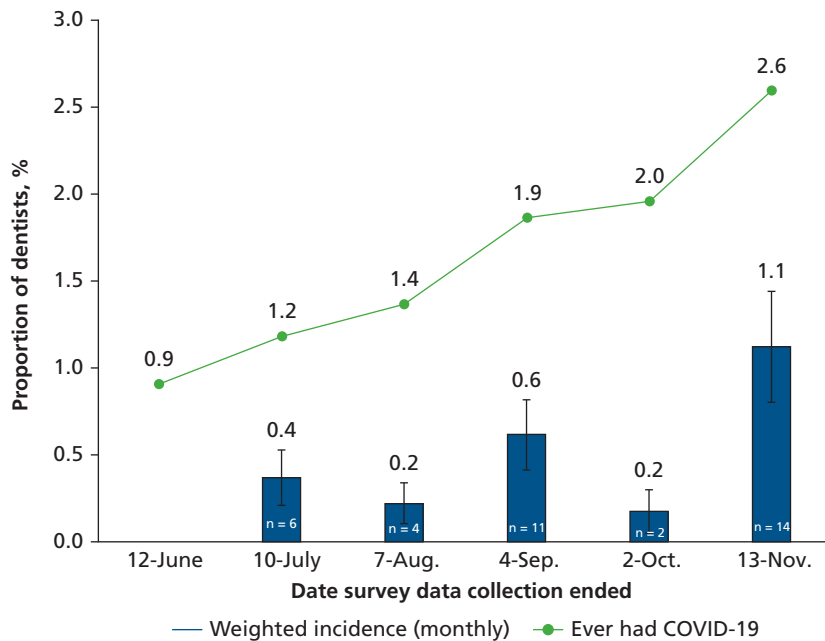


Figure 4. Monthly incidence and percentage ever had COVID-19 in survey of US dentists, June through November 2020 (n = 2,196).

At the conclusion of our study, robust data among front-line HCPs in the United States and the United Kingdom (2,035,395 HCPs) showed a higher rate of COVID-19 infection¹¹ compared with findings from our study. A prevalence of COVID-19 was found among 2,727 cases per 100,000 HCPs compared with 242 cases per 100,000 people in the general population. The high number of cases mostly were associated with direct contact with infected patients and lack of appropriate PPE, with the highest rates reported in large metropolitan areas such as New York, New York, and London, United Kingdom.¹¹ In addition, the same study showed that in the United States, 4.1% of medical HCPs were tested during the period of the study compared with 1.1% of the general population. In another report, results of a cross-sectional survey of front-line HCPs in the United States (n = 3,083) showed a reported prevalence rate of 29%,¹² which is much higher than the 2.6% rate among dentists reported in our study. In August 2020, 24% of employees of a large oncology hospital in New York, New York, were quarantined because of COVID-19.¹³ Another cross-sectional study examined levels of antibodies among HCPs and indicated that 265 of the 500 HCPs tested showed presence of SARS-CoV-2 antibodies, possibly resulting from a previous infection with the virus.¹⁴ Compared with these reports of nondental HCPs, our longitudinal data show lower rates for US dentists over the June through November 2020 time frame. Although the near universal adoption of enhanced PPE per the interim CDC guidance may have minimized the risk of getting an infection in the dental office, we also observed a higher rate of testing among dentists (up to 43.9%) than front-line HCPs. Despite this high testing rate, the cumulative prevalence among dentists in our survey was 2.6% by November 13, 2020.

Furthermore, dentists have shown continued low monthly incidence of disease despite several regional and national COVID-19 rate spikes during the study period. This may indicate that dentists are able to mitigate much of their own exposure in clinical environments through consistent use of enhanced PPE and interim guidance adherence. The results of our study show high rates of preappointment screening of patients and appropriate infection control measures throughout the study period.

The risk of getting SARS-CoV-2 infection decreases substantially with appropriate PPE use.¹⁵ An important distinction between dentists and other HCPs is that many medical procedures that do not involve intubation for anesthesia can be performed while a patient is wearing a mask. However, dental procedures universally require patients to be seen unmasked. This highlights the importance of continued use of enhanced PPE, in particular N95 masks, and the need for continued availability and prioritization of such protections for dental HCPs. We observed a minor shift in the

use of PPE during the 6-month period of our study, most likely owing to access to the equipment, clinical judgment, schedule planning, and other resources that dentists implemented since practice reopening. In mid-November 2020, 59.8% of dental practices in the United States reported having at least a 2-week supply of N95 or KN95 masks.¹⁶ Expanded use of N95 masks may be limited by supply shortages and the number of hours each HCP may be exposed to potentially infected patients.

To our knowledge, this is the first large-scale longitudinal report of incidence rates of COVID-19 among dentists in the United States. The results of our report may show a decreased response rate over time but still present a sample that is nationally representative of US dentists. Our surveys also used the strictest definitions for infection prevention and control. These findings are self-reported and, therefore, subject to recall and social desirability biases. Unfortunately, the survey was limited to dentists' PPE use and whether they performed AGPs that month and thus did not entirely match CDC interim guidelines for PPE use; it did not ask about dentists' PPE use during AGPs compared with non-AGPs. Conceivably, dentists could answer the survey as sometimes wearing the correct PPE during a month they performed AGPs and be in compliance with CDC recommendations. Furthermore, not all dentists were tested for COVID-19 during the study; asymptomatic cases for which dentists did not seek testing or care were likely missed. We also could not survey participants who were hospitalized or died during our survey time frame. These people would not have been captured in this study. However, data on hospitalizations and deaths from March through May 2020 by health care occupation indicate both dental professionals and physicians had hospitalization rates below some occupations not expected to have patient contact, such as administrators.¹⁷ Therefore, we expect our estimation of the monthly incidence and cumulative prevalence to be affected less by hospitalization or death than survey research in professions with higher rates of severe COVID-19 cases.

CONCLUSIONS

The level of adherence to enhanced infection control procedures in response to the COVID-19 pandemic continues to be high among US dentists. The low rates of cumulative prevalence (2.6%) and monthly incidence ranging from 0.2% through 1.1% reflect the high level of self-care among dentists. Oral health care is being delivered safely because dentists are showing adherence to a strict protocol for enhanced infection control, which should help protect their patients, their dental team members, and themselves. ■

SUPPLEMENTAL DATA

Supplemental data related to this article can be found at <https://doi.org/10.1016/j.adaj.2021.03.021>.

Dr. Araujo is the chief science officer, American Dental Association, and the chief executive officer, ADA Science and Research Institute, Chicago, IL. Address correspondence to Dr. Araujo, 211 E Chicago Ave, Chicago, IL 60611, e-mail araujom@ada.org.

Dr. Estrich is a health science research analyst, ADA Science and Research Institute, Chicago, IL.

Mr. Mikkelsen is the manager of education surveys, American Dental Association Health Policy Institute, Chicago, IL.

Ms. Morrissey is an education research analyst, American Dental Association Health Policy Institute, Chicago, IL.

Ms. Harrison is a coordinator for research and editing, American Dental Association Health Policy Institute, Chicago, IL.

Dr. Geisinger is a professor and the director, Advanced Education Program in Periodontology, University of Alabama at Birmingham, Birmingham, AL.

Dr. Ioannidou is a professor, Oral Health and Diagnostic Sciences, and the director, Dental Clinical Research Center, University of Connecticut Health Center, Farmington, CT.

Dr. Vujcic is the chief economist and vice president, American Dental Association Health Policy Institute, Chicago, IL.

Disclosures. The authors have no disclosures to report.

The authors thank all of the dentists who participated in this survey and shared their time and expertise and Kelly O'Brien for her advice and insights.

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