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US dental health care workers' mental health during the COVID-19 pandemic

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ABSTRACT

Background. This study was designed to assess the prevalence of anxiety and depression symptoms and understand factors influencing mental health among dental health care workers (DHCWs) during the COVID-19 pandemic.

Methods. Beginning in June 2020, 8,902 DHCWs participated monthly in an anonymous longitudinal, web-based survey (response rate, 6.7%). The Patient Health Questionnaire-4 was used to estimate rates of anxiety and depression symptoms. Changes in mental health over time and differences by demographic and practice characteristics, COVID-19 community transmission level, and COVID-19 vaccination status were tested using χ^2 tests and multilevel multivariable logistic regression.

Results. Anxiety symptom rates peaked in November 2020 (28% of dental hygienists, 17% of dentists) and declined to 12% for both professions in May 2021. Depression symptom rates were highest in December 2020 (17% of dental hygienists, 10% of dentists) and declined to 8% in May 2021. Controlling for gender, age, race or ethnicity, and COVID-19 community transmission level, the authors found that dentists had significantly lower odds of anxiety symptoms (adjusted odds ratio [aOR], 0.82; 95% CI, 0.70 to 0.95) and depression symptoms (aOR, 0.79; 95% CI, 0.67 to 0.93) than dental hygienists. Compared with vaccinated respondents, those who were unvaccinated but planning on getting vaccinated had significantly higher rates of anxiety (aOR, 1.71; 95% CI, 1.20 to 2.44) and depression (aOR, 1.57; 95% CI, 1.07 to 2.29) symptoms.

Conclusions. DHCWs' mental health fluctuated during the pandemic. Anxiety and depression in DHCWs were associated with demographic and professional characteristics as well as perceived risk of COVID-19.

Practical Implications. Mental health support should be made available for DHCWs.

This clinical trial was registered at [ClinicalTrials.gov](https://clinicaltrials.gov). The registration numbers are NCT04423770 and NCT04542915.

Key Words. Mental health; COVID-19; health care worker; longitudinal study; COVID-19 vaccine; professional role.

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On March 11, 2020, the World Health Organization declared a pandemic of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the causative virus for COVID-19.¹ Health care delivery of all types was disrupted during this pandemic, and it was hypothesized that dental health care workers (DHCWs) were at particularly high risk of contracting COVID-19, because SARS-CoV-2 is transmitted primarily via close person-to-person airborne transmission. In addition to working directly with patients, DHCWs also are exposed to aerosolized oral fluids, including blood and saliva, which also can contain SARS-CoV-2.^{2,3} In response to this perceived risk, on March 16, 2020, the American Dental Association (ADA) and the American Dental Hygienists' Association recommended that US DHCWs should postpone elective dental procedures and focus on urgent and emergent oral health care.⁴ Shortly thereafter, a national poll of

dental practices found that 19% of private practices were closed to all patients and 76% were open only to emergency patients.⁵ Dental practices in the United States began reopening in May 2020. Thus, from June 2020 through June 2021, more than 90% of practices were back to providing elective care, and at least 33% were open at normal business levels.⁵

Concern and uncertainty during the COVID-19 pandemic have led to increased mental health concerns worldwide. In June 2020, it was reported that 25.5% of US adults experienced symptoms consistent with an anxiety disorder and 24.3% with a depressive disorder.⁶ These rates increased over time, with 41.5% of adults reporting symptoms of anxiety or depression in February 2021.⁷ Compared with the general public, health care workers may be at increased risk of COVID-19 exposure and may witness more instances of COVID-19 morbidity and mortality; previous research has reported heightened rates of mental health problems among health care workers during the COVID-19 pandemic.^{8,9} DHCWs work in close proximity with patients who cannot, by nature of the care provided, wear face coverings or other personal protective equipment (PPE). These work-related activities may present a heightened sense of exposure and infection risk. Furthermore, the uncertainty that DHCWs experienced during a period of rapidly changing practice situations with shifting infection prevention and control policies may have affected their mental health. At least 80% of dentists surveyed outside the United States felt anxious owing to concerns about COVID-19 infection, with additional concerns about their professional futures.^{10,11} Meanwhile, research including dentists in the United Kingdom (UK) found that 71% had anxiety-related symptoms and 60% had depression-related symptoms.¹² A multinational survey identified 49.1% of dental auxiliary staff members compared with 29.3% of dentists had symptoms of at least moderate anxiety.¹³ In Germany, 25.2% of dental nurses and 18.2% of dentists had symptoms of at least moderate anxiety, and 31.1% of dental nurses and 28.9% of dentists had symptoms of at least moderate depression.^{14,15}

Our investigation sought to describe levels of anxiety and depression symptoms among dentists and dental hygienists in the United States from June 2020 through June 2021. We did not locate existing literature on prevalence of anxiety and depression symptoms in US DHCWs before the pandemic, preventing the comparison of mental health before and during the pandemic. Of particular interest was determining whether mental health changed over the course of the pandemic, and if so, at which times. Furthermore, we tested the associations of demographic or professional characteristics, level of COVID-19 community transmission, and COVID-19 vaccination status with mental health.

METHODS

An anonymous web-based survey was administered monthly using Qualtrics XM Platform (Qualtrics) to a cohort of dentists beginning June 8, 2020, and a cohort of dental hygienists beginning September 29, 2020. Dentists were eligible to participate if they held a license to practice dentistry in the United States, were at least 18 years old, were in private practice or public health, and indicated a willingness to participate in the previous ADA-generated survey⁵ related to COVID-19. Dental hygienists were eligible to participate if they were licensed as a dental hygienist in the United States, were at least 18 years old, and were employed as a dental hygienist as of March 1, 2020. The research protocols and surveys were approved by the ADA Institutional Review Board. Potential respondents read and signed an electronic informed consent before responding to the survey. Further details of the study population and questionnaires are described in previous articles.^{16,17}

The survey included questions about respondents' gender, race or ethnicity, age, geographic location, dental practice type, dental practice setting, infection prevention and control practices while practicing dentistry, COVID-19 vaccination statuses, and COVID-19 tests or diagnoses. Dental hygienists were not surveyed about the specifics of the dental specialty in which they were employed, so comparisons were limited to general dentistry compared with those working in any dental specialty practice. The survey included the validated Patient Health Questionnaire-4 (PHQ-4)¹⁸ to screen respondents for symptoms of depression (using Patient Health Questionnaire-2¹⁹) or anxiety symptoms (using Generalized Anxiety Disorder-2¹⁹). Scores of 3 or greater on the Patient Health Questionnaire-2 indicate depressive disorder symptoms and have 83% sensitivity and 92% specificity for major depression.²⁰ Scores of 3 or greater on Generalized Anxiety Disorder-2 indicate anxiety disorder symptoms, with 86% sensitivity and 83% specificity for generalized anxiety disorder and greater than 50% sensitivity and specificity for panic disorder, social anxiety disorder,

ABBREVIATION KEY

ADA:	American Dental Association.
CDC:	Centers for Disease Control and Prevention.
DHCW:	Dental health care worker.
NA:	Not available.
NR:	Not recorded.
PHQ-4:	Patient Health Questionnaire-4.
PPE:	Personal protective equipment.
SARS-CoV-2:	Severe acute respiratory syndrome coronavirus 2.
UK:	United Kingdom.

posttraumatic stress disorder, or any anxiety disorder.²¹ In both cases, higher scores are indications for further mental health evaluation rather than a definitive diagnosis.¹⁹ To test whether COVID-19 risk was positively correlated with mental health concerns, we obtained the COVID-19 case rate per 100,000 people in each US state and territory from the Centers for Disease Control and Prevention (CDC) for the 7 days before each survey and categorized the level of community transmission using the CDC's criteria: low to moderate (< 50 cases per 100,000), substantial (50-99.99 cases per 100,000), and high (\geq 100 cases per 100,000) levels of community transmission.²² Initial analysis indicated no statistically significant difference in rates of anxiety or depression symptoms between low to moderate or substantial levels of community transmission, so we combined these categories into a single category before defining a regression model. Furthermore, we contrasted the rates of anxiety and depression symptoms in DHCWs who reported at least 1 dose of COVID-19 vaccine with the rates in unvaccinated DHCWs. Vaccination status was added to the survey as of February 1, 2021, so we modeled it separately to avoid constricting the periods of the other regression models.

We conducted statistical analysis using statistical software (SAS, Version 9.4; SAS Institute). We set statistical significance at alpha of .05. We used χ^2 tests to test associations between respondent characteristics and anxiety or depression symptoms. To achieve sufficient power to estimate the effect of time on mental health, we grouped consecutive months with similar rates of depression and anxiety symptoms, creating 4 periods of 3 months each. We used multivariable multilevel logistic regression models to estimate odds of mental health symptoms, with survey results nested within each respondent to account for the same respondents answering surveys over time. To evaluate whether mental health significantly differed by dental profession type, we restricted models to the ages (\geq 26 years) and months (September 2020-May 2021) for which data were available from both dentists and dental hygienists. No interaction term between independent variables was significant in regression models. We built multivariable regression models using purposeful model selection. Respondents were allowed to skip questions; over the year of this study, 4.4% ($n = 1,465$) of the observations lacked data on the PHQ-4. There was no pattern in missing PHQ-4 data (all regression models, $P > .05$), indicating the data were missing at random. Under that assumption, we used available case analysis.

RESULTS

The survey response rate was 6.7%. Survey respondents' mean (standard deviation) age was 47.2 (12.8) years. Dental hygienists' ages ranged from 18 through 77 years, and those of surveyed dentists ranged from 26 through 84 years. The cohort was 15.6% ($n = 1,386$) male and 76.2% ($n = 6,781$) female (Table 1). By profession, 59.9% ($n = 1,316$) of the dentists were men and 38.9% ($n = 854$) were women, and 1.0% ($n = 70$) of the hygienists were men and 88.4% ($n = 5,927$) were women. Most of the sample was non-Hispanic White (70.2%, $n = 6,249$), with 4.1% ($n = 366$) describing themselves as non-Hispanic Asian, 4.8% ($n = 428$) as Hispanic, 1.7% ($n = 147$) as non-Hispanic Black, and 4.8% ($n = 427$) as another race or ethnicity. Most respondents worked in general dentistry (57.2%, $n = 5,095$), although all dental specialties were represented. Most respondents worked in a private practice dental setting (71.0%, $n = 6,318$), and the remainder worked in a public health dental setting. The 8,902 respondents could be surveyed up to 12 times, for a total of 33,197 observations.

Overall, rates of anxiety and depression symptoms varied over time and were higher for anxiety than depression (Figure). Rates of anxiety symptoms were highest in November and December 2020. Rates declined over the study period for both professional types, with a rebound increase in anxiety symptom rates observed for dentists in May 2021. At the end of the reporting period, rates were similar for dentists (11.8%) and dental hygienists (12.4%) (Figure). As with anxiety symptoms, dental hygienists had higher rates of depression symptoms than dentists at each surveyed time point (Figure). Depression symptom rates were highest in December 2020. Dental hygienists' depression rates declined thereafter, whereas the rates for dentists remained relatively steady, resulting in relatively similar rates for both groups at the end of the study period (Figure). Over the course of the entire survey, 17.7% of DHCWs reported anxiety symptoms, 10.7% reported depression symptoms, and 8.3% reported symptoms of both.

Table 1. Dental health care worker survey sample characteristics.

CHARACTERISTIC	DENTISTS,* NO. (%)	DENTAL HYGIENISTS,† NO. (%)
Gender		
Male	1,316 (59.9)	70 (1.0)
Female	854 (38.9)	5,927 (88.4)
Other	14 (0.6)	47 (0.7)
Missing	12 (0.6)	662 (9.9)
Age Group, Y		
18-25	0 (0.0)	194 (2.9)
26-39	305 (13.9)	2,138 (31.9)
40-65	1,454 (66.2)	3,421 (51.0)
≥ 66	272 (12.4)	186 (2.8)
Missing	165 (7.5)	767 (11.4)
Race or Ethnicity		
Non-Hispanic White	1,752 (79.7)	4,497 (67.1)
Non-Hispanic Asian	163 (7.4)	203 (3.0)
Hispanic	105 (4.8)	323 (4.8)
Non-Hispanic Black	24 (1.1)	123 (1.8)
Other	126 (5.7)	301 (4.5)
Missing	26 (1.3)	1,259 (18.8)
Primary Practice Type		
General dentistry‡	1,819 (82.8)	3,276 (48.9)
Specialty	351 (16.0)	943 (14.1)
Missing	26 (1.3)	2,487 (37.1)
Primary Practice Setting		
Private‡	2,099 (95.5)	4,219 (62.9)
Public	80 (3.6)	213 (3.2)
Missing	17 (0.8)	2,274 (33.9)
COVID-19 Vaccination Status		
Fully vaccinated‡	1,402 (63.8)	2,015 (30.1)
1 vaccine dose	56 (2.6)	199 (3.0)
Not vaccinated	103 (4.7)	664 (9.9)
Missing	635 (28.9)	3,828 (57.1)

* N = 2,196; 24.7% of total responses. † N = 6,706; 75.3% of total responses. ‡ Percentages do not add up to 100 owing to rounding.

Rates of anxiety symptoms differed significantly by gender, age group, race or ethnicity, primary practice type, and DHCW professional role (χ^2 P s < .05) (Table 2). Most demographic and professional groups experienced heightened rates of anxiety symptoms from September through December 2020 (Table 2). The highest rates of anxiety and depression symptoms in non-Hispanic Black DHCWs occurred from March through May 2021 (Table 2). Similarly, although all other age groups experienced the highest rates of depression symptoms from September through December 2020, DHCWs aged 18 through 25 years also reported a high rate of depression symptoms from March through May 2021 (Table 2). There were also significant differences in depression symptom rates by gender, age group, and professional role (Table 2).

Even when controlling for gender, age group, race or ethnicity, period, and COVID-19 community transmission level, dentists had statistically significantly lower odds of anxiety and depression symptoms than dental hygienists (Tables 3 and 4). There was evidence of multicollinearity between COVID-19 community transmission level and period (condition index of 21.1,

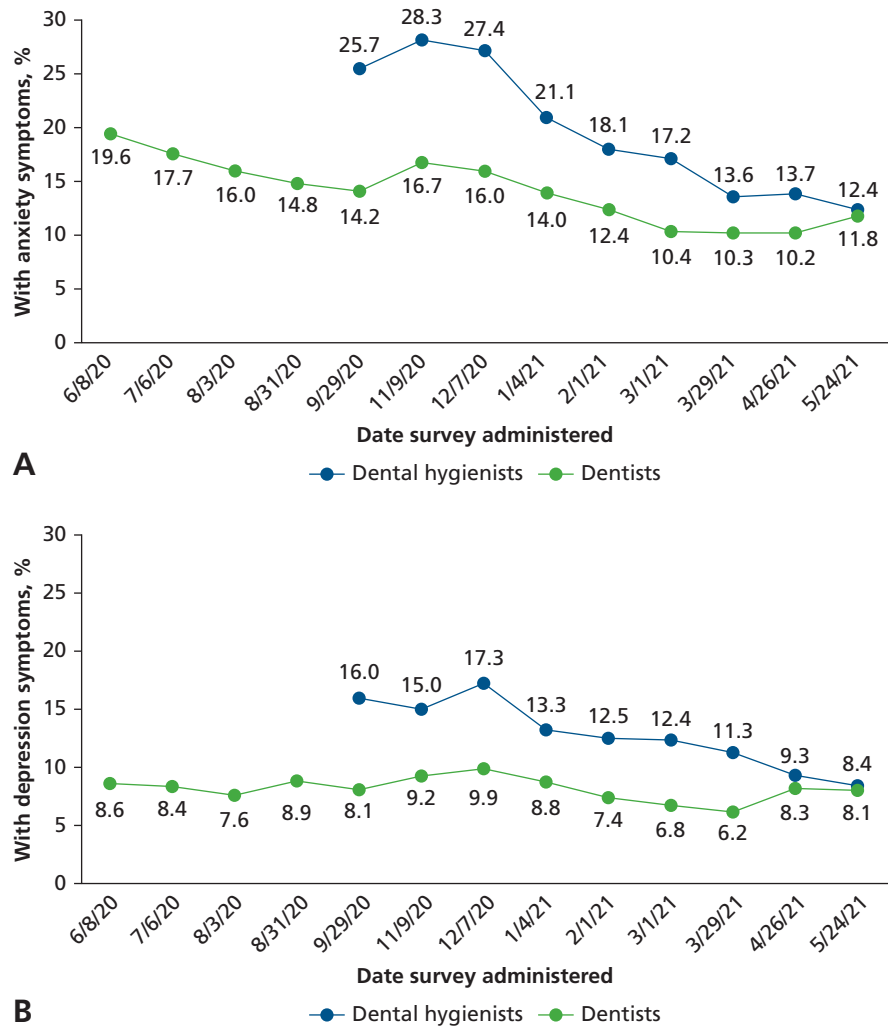


Figure. Anxiety (A) and depression (B) symptoms by dental profession from June 8, 2020, through May 24, 2021 (N = 8,902; dentists = 2,196; dental hygienists = 6,706).

much larger than the eigenvalue of 0.01), so we modeled them separately (Tables 3 and 4). In multivariable models, dental practice type and practice setting were not associated statistically significantly with anxiety or depression symptoms, and so we excluded them from the final models (Tables 3 and 4). Compared with August through December 2020, DHCWs had significantly lower odds of anxiety and depression symptoms in all subsequent months (Tables 3 and 4). DHCWs living in states and during periods with high levels of COVID-19 community transmission had significantly higher odds of anxiety (adjusted odds ratio [aOR], 1.37; 95% CI, 1.21 to 1.55) and depression (aOR, 1.25; 95% CI, 1.09 to 1.44) symptoms than those living with lower transmission.

From January through March 2021, DHCWs who were unvaccinated but intended to be vaccinated experienced significantly higher rates of anxiety (20.6%) and depression (14.0%) symptoms than DHCWs who were partially vaccinated (14.9% anxiety, 9.2% depression) or fully vaccinated (14.1% anxiety, 9.2% depression) or those who did not intend to be vaccinated (12.6% anxiety, 11.3% depression) (P s < .05). Controlling for gender, age group, primary practice type, primary practice setting, professional role, and either period or COVID-19 community transmission level, we found that those who were planning to be vaccinated but were not yet vaccinated had significantly increased odds of anxiety symptoms (aOR including period, 1.73 [95% CI, 1.22 to 2.46]; aOR including COVID-19 transmission level, 1.71 [95% CI, 1.20 to 2.44]) than DHCWs who had received at least 1 dose of COVID-19 vaccine. Similarly, controlling for gender, age group, primary practice type, primary practice setting, professional role, and either period or COVID-19 community transmission level, those who were planning to be vaccinated but were not yet vaccinated had significantly increased odds of depression symptoms (aOR including period, 1.57

Table 2. Proportion of US dental health care workers with anxiety and depression symptoms.*

CHARACTERISTIC	WITH ANXIETY SYMPTOMS PER SURVEY PERIOD, %				χ^2 P VALUE FOR ANXIETY SYMPTOMS	WITH DEPRESSION SYMPTOMS PER SURVEY PERIOD, %				χ^2 P VALUE FOR DEPRESSION SYMPTOMS
	6/8/20-8/31/20	9/29/20-12/7/20	1/4/21-3/1/21	3/28/21-5/24/21		6/8/20-8/31/20	9/29/20-12/7/20	1/4/21-3/1/21	3/28/21-5/24/21	
Gender										
Male	13.4	12.4	10.6	8.8		6.9	7.5	6.3	6.8	
Female	23.8	25.7	18.2	13.5	< .0001	10.9	15.4	12.1	9.5	< .0001
Other	7.1	17.7	12.5	20.0		0.0	15.9	9.4	4.0	
Age Group, Y										
18-25	NA [†]	30.9	20.0	17.7		NA	25.7	13.3	23.5	
26-39	24.6	28.5	21.8	15.6	< .0001	11.7	17.7	14.9	10.8	< .0001
40-65	17.3	21.1	15.0	11.8		8.5	12.3	9.5	8.5	
≥ 66	10.3	11.5	9.7	7.4		5.3	6.6	6.5	6.0	
Race and Ethnicity										
Non-Hispanic White	17.1	22.3	15.4	12.3		8.3	13.2	9.9	8.7	
Non-Hispanic Asian	14.0	18.6	10.9	8.5		7.3	11.8	8.0	6.4	
Hispanic	19.3	23.2	15.8	8.6	< .0001	5.4	15.0	13.0	7.1	< .0001
Non-Hispanic Black	13.6	13.9	11.5	15.1		9.1	8.9	4.4	11.4	
Other	25.3	30.9	25.4	16.4		14.7	21.0	16.4	12.8	
Primary Practice Type										
General dentistry	17.2	21.2	15.2	11.3	< .0001	8.4	13.0	10.1	8.1	.27
Specialty	18.2	23.6	13.3	10.9		8.6	13.7	7.5	8.3	
Primary Practice Setting										
Private	17.0	21.7	15.0	11.3	.99	8.3	13.1	9.8	8.2	.62
Public	27.0	23.2	15.1	13.1		12.2	13.2	8.8	7.5	
Professional Role										
Dental hygienist	NA	26.5	19.0	13.2	< .0001	NA	16.1	12.8	9.8	< .0001
Dentist	17.4	15.7	12.4	10.8		8.5	9.1	7.7	7.5	
COVID-19 Vaccination Status										
Fully vaccinated	NR [‡]	NR	14.1	14.2		NR	NR	9.2	10.1	
1 dose	NR	NR	14.9	16.8	< .0001	NR	NR	9.2	9.1	.047
Planning to be vaccinated	NR	NR	20.6	14.0		NR	NR	14.0	8.9	
Unvaccinated	NR	NR	12.6	9.9		NR	NR	11.3	6.5	

* N = 8,902. † NA: Not applicable. ‡ NR: Not recorded.

[95% CI, 1.08 to 2.30]; aOR including COVID-19 transmission level, 1.57 [95% CI, 1.07 to 2.29]) than fully or partially vaccinated DHCWs.

DISCUSSION

Despite expectations that DHCWs would experience heightened mental health problems owing to COVID-19 occupational infection concerns, in our investigation, at every time point their rates of anxiety and depression symptoms were lower than in the reported rates in the overall US adult population.^{7,23,24} As in the general population of US adults, rates of mental health concerns increased in fall and early winter 2020⁷ and then improved in spring 2021.²⁴

Similar to previous reports both before and during the COVID-19 pandemic,^{7,23} rates of anxiety and depression symptoms were lowest in the oldest age groups. As has also been commonly found,^{7,23,25} women reported higher rates of anxiety and depression than men. Unlike a survey of mental health in UK dentists,¹² we identified no differences in rates of anxiety or depression symptoms among US DHCWs by practice setting (that is, private practice versus public health).

Table 3. Odds of anxiety symptoms in dental health care workers, September 28, 2020, through June 2, 2021.*

CHARACTERISTIC	OR [†] (95% CI)	P VALUE	OR (95% CI), ADJUSTING FOR DEMOGRAPHICS, PROFESSIONAL ROLE, AND PERIOD	P VALUE	OR (95% CI), ADJUSTING FOR DEMOGRAPHICS, PROFESSIONAL ROLE, AND COVID-19 TRANSMISSION LEVEL	P VALUE
Gender	— [‡]	—	—	—	—	—
Male	[Reference]	< .0001	[Reference]	< .0001	[Reference]	< .0001
Female	2.32 (2.06 to 2.60)		1.75 (1.48 to 2.06)		1.74 (1.48 to 2.05)	
Age Group, Y	—	< .0001	—	< .0001	—	< .0001
26-39	1.92 (1.65 to 2.23)	< .0001	1.33 (1.14 to 1.55)	< .0001	1.36 (1.17 to 1.58)	< .0001
40-65	[Reference]	< .0001	[Reference]	< .0001	[Reference]	< .0001
≥ 66	0.48 (0.35 to 0.66)	< .0001	0.73 (0.58 to 0.94)	.01	0.74 (0.58 to 0.94)	.01
Race and Ethnicity	—	—	—	—	—	—
Non-Hispanic White	[Reference]	.0001	[Reference]	< .0001	[Reference]	< .0001
Non-Hispanic Asian	0.65 (0.46 to 0.92)	.02	0.76 (0.57 to 1.01)	.06	0.79 (0.60 to 1.05)	.11
Hispanic	1.10 (0.80 to 1.52)	.58	1.03 (0.77 to 1.37)	.85	1.04 (0.78 to 1.37)	.84
Non-Hispanic Black	0.65 (0.34 to 1.27)	.21	0.29 (0.14 to 0.62)	< .0001	0.29 (0.14 to 0.62)	< .0001
Other	1.79 (1.32 to 2.42)	< .0001	1.94 (1.50 to 2.51)	< .0001	1.95 (1.51 to 2.52)	< .0001
Primary Practice Type	—	—	—	—	—	—
General dentistry	[Reference]	< .0001	[Reference]	NA [§]	[Reference]	NA
Specialty	1.37 (1.17 to 1.60)		—		—	
Primary Practice Setting	—	—	—	—	—	—
Private	[Reference]	.45	—	NA	—	NA
Public	0.79 (0.42 to 1.47)		—		—	
Professional Role	—	—	—	—	—	—
Dental hygienist	[Reference]	< .0001	[Reference]	< .0001	[Reference]	< .0001
Dentist	0.51 (0.46 to 0.56)		0.80 (0.68 to 0.93)		0.82 (0.70 to 0.95)	
Period	—	—	—	—	—	—
8/28/20-12/7/20	[Reference]	< .0001	[Reference]	< .0001	—	
1/4/21-3/1/21	0.56 (0.50 to 0.62)	< .0001	0.65 (0.57 to 0.71)	< .0001	—	NA
3/28/21-5/24/21	0.37 (0.32 to 0.42)	< .0001	0.49 (0.42 to 0.57)	< .0001	—	
COVID-19 Transmission Level	—	—	—	—	—	—
Low to substantial	[Reference]	< .0001	—	NA	[Reference]	< .0001
High	1.44 (1.27 to 1.63)		—		1.37 (1.21 to 1.55)	

* N = 7,534 (dentists = 1,824; dental hygienists = 5,710). † OR: Odds ratio. ‡ —: No OR for this model in this category. § NA: Not applicable.

This discrepancy may be due to differences in dental health care delivery systems and payers between the UK and United States or may be a reflection of different times of data collection. In results consistent with another report,²⁵ we found no significant differences in mental health concerns between DHCWs in general dentistry and those practicing specialties.

In German reports, differences in mental health by professional type have been seen during the pandemic, with dental nurses exhibiting more anxiety and depression symptoms than dentists.^{14,15} Similarly, in our study, even controlling for other factors related to mental health outcomes such as age and gender, dentists had significantly lower odds of anxiety or depression symptoms than dental hygienists. There are several potential underlying explanations for these differences. Dentists may have felt more in control of infection prevention and control procedures in their primary dental practice, which may have provided a protective buffer against anxiety or work-related stress. In addition, whereas dentists may own their practices, fewer dental hygienists operate independently; most work as employees. Thus, elevated rates of anxiety and depression symptoms among dental

Table 4. Odds of depression symptoms in dental health care workers, September 28, 2020, through June 2, 2021.*

CHARACTERISTIC	OR [†] (95% CI)	P VALUE	OR (95% CI), ADJUSTING FOR DEMOGRAPHICS, PROFESSIONAL ROLE, AND PERIOD	P VALUE	OR (95% CI), ADJUSTING FOR DEMOGRAPHICS, PROFESSIONAL ROLE, AND COVID-19 TRANSMISSION	P VALUE
Gender	— [‡]		—		—	
Male	[Reference]		[Reference]		[Reference]	
Female	2.67 (2.21 to 3.24)	< .0001	1.55 (1.30 to 1.84)	< .0001	1.56 (1.30 to 1.85)	< .0001
Age Group, Y	—	< .0001	—	< .0001	—	< .0001
26-39	1.92 (1.61 to 2.28)	< .0001	1.25 (1.07 to 1.47)	.01	1.27 (1.09 to 1.49)	< .0001
40-65	[Reference]		[Reference]		[Reference]	
≥ 66	0.53 (0.37 to 0.75)	< .0001	0.81 (0.62 to 1.04)	.10	0.81 (0.62 to 1.04)	.10
Race and Ethnicity	—		—		—	
Non-Hispanic White	[Reference]	.01	[Reference]	< .0001	[Reference]	< .0001
Non-Hispanic Asian	0.77 (0.53 to 1.14)	.19	0.81 (0.60 to 1.10)	.16	0.83 (0.61 to 1.12)	.21
Hispanic	1.22 (0.85 to 1.76)	.28	1.16 (0.87 to 1.55)	.33	1.16 (0.87 to 1.55)	.32
Non-Hispanic Black	0.71 (0.34 to 1.60)	.44	0.33 (0.14 to 0.77)	.01	0.33 (0.14 to 0.78)	.01
Other	1.68 (1.19 to 2.36)	< .0001	1.82 (1.40 to 2.37)	< .0001	1.83 (1.41 to 2.39)	< .0001
Primary Practice Type	—		—		—	
General dentistry	[Reference]	.051		NA [§]		NA
Specialty	1.2 (0.99 to 1.44)					
Primary Practice Setting	—		—		—	
Private	[Reference]	.47		NA		NA
Public	0.77 (0.37 to 1.57)					
Professional Role	—		—		—	
Dental hygienist	[Reference]	< .0001	[Reference]	< .0001	[Reference]	< .0001
Dentist	0.52 (0.46 to 0.59)		0.77 (0.66 to 0.90)		0.79 (0.67 to 0.93)	
Period	—		—		—	
8/28/20-12/7/20	[Reference]	< .0001	[Reference]	< .0001	—	
1/4/21-3/1/21	0.63 (0.55 to 0.72)	< .0001	0.79 (0.68 to 0.91)	< .0001	—	NA
3/28/21-5/24/21	0.50 (0.43 to 0.59)	< .0001	0.68 (0.57 to 0.79)	< .0001	—	
COVID-19 Transmission Level	—		—		—	
Low to substantial	[Reference]	< .0001	—	NA	[Reference]	< .0001
High	1.32 (1.15 to 1.51)		—		1.25 (1.09 to 1.44)	

* N = 7,534 (dentists = 1,824; dental hygienists = 5,710). † OR: Odds ratio. ‡ —: No OR for this model in this category. § NA: Not applicable.

hygienists could correlate with concerns of availability of PPE, being unemployed or furloughed,²⁶ managing childcare issues, bringing infection home to family members, and properly following national guidance without the control to dictate policies within their primary practice environment.²⁷ The narrowing of the gap in anxiety and depression rates between dentists and dental hygienists through May 2021 may indicate that as DHCWs continued to be provided information about national guidance, they were able to deliver care at volumes that approached prepandemic rates, and, as data about low COVID-19 infection rates among DHCWs were reported, their mental health may have been influenced positively. Strategies that enable dental hygienists to be informed, empowered, and included in decision-making processes in dental settings may reduce psychological distress and improve working conditions within the dental team.

Perceptions of COVID-19 risk have shown an influence on anxiety and depression symptoms in other surveys of DHCWs.^{11,28} In our study, DHCWs experienced higher rates of anxiety and depression symptoms during high levels of community transmission of COVID-19, and those who wanted to be vaccinated but were not yet vaccinated reported higher levels of anxiety and

depression symptoms than those already vaccinated and those not intending to be vaccinated. These findings imply that external factors associated with perceived occupational risks have a significant impact on anxiety and depression symptom rates among DHCWs. Ensuring DHCWs have the resources necessary to safely practice dentistry, including PPE, vaccination, and adherence to CDC guidance, may reduce psychological distress. The ADA and American Dental Hygienists' Association have expanded resources available to support dentists' and dental hygienists' mental and emotional health.^{29,30}

There are limitations to our findings. There were high rates of missing data regarding dental hygienists' personal and professional characteristics, which may introduce nonresponse bias. The survey response rate of 6.7% also may indicate nonresponse bias. There may be survivorship bias in that adverse mental health decreases the likelihood of continued survey participation³¹ or social desirability bias against reporting mental health concerns that affects 1 professional group disproportionately. Unmeasured factors such as overall household income and expenses, financial difficulties, known stressors (for example, childcare or eldercare) during the pandemic, or level of patient contact also may influence mental health and account for the measured differences between dentists and dental hygienists. Furthermore, the PHQ-4 is meant for mental health screening, not diagnosis, and thus the results of our study do not reflect prevalence of definitive mental health diagnoses. Conversely, there are also strengths to this research. The sample of dentists is broadly similar to US dentists on all measured variables. How representative the surveyed dental hygienists are of dental hygienists nationally is unknown, but those surveyed do represent every level of experience, type of dental practice, measured demographic characteristic, and US state. To our knowledge, it is the first, and perhaps only, study evaluating mental health in a cohort of DHCWs over the course of the COVID-19 pandemic and shows distinct differences between dentists and dental hygienists that could be used to tailor communication strategies to each group as well as inform mental health screening and support. Our study is uniquely suited to identify points in time at which anxiety and depression particularly troubled DHCWs and align such increased rates of adverse mental health outcomes with local COVID-19 transmission rates. This is also the first study, to our knowledge, to evaluate the association between COVID-19 vaccination and US DHCW mental health and highlight the potential psychological impact of vaccination on the overall well-being of DHCWs. These findings highlight the importance of monitoring mental health in DHCWs and suggest areas for future research, such as investigating the incidence of trauma, self-harm, and related disorders or exploring why certain demographic or practice groups experienced high rates of anxiety and depression over time.

CONCLUSIONS

Our analysis assessed time trends and risk factors associated with anxiety and depression symptoms in DHCWs over the course of 1 year during the COVID-19 pandemic. Although rates for anxiety symptoms were higher than rates for depression symptoms and higher among dental hygienists than dentists, overall rates declined in both types of DHCWs by the end of the study. Those who were unvaccinated but planning to get vaccinated had significantly higher rates of anxiety and depression symptoms. Good mental health is essential. Resources and research should continue to focus on this important public health topic to ensure that DHCWs and other health care providers are able to perform at their best, ensuring the optimal quality of life and care for their patients. ■

SUPPLEMENTAL DATA

Supplemental data related to this article can be found at <https://doi.org/10.1016/j.adaj.2022.02.011>.

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1. WHO Director-General's statement on IHR Emergency Committee on novel coronavirus (2019-nCoV). World Health Organization. March 11, 2020. Accessed July 15, 2020. <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19—11-march-2020>
2. Interim infection prevention and control guidance for dental settings during the COVID-19 response. Centers for Disease Control and Prevention. Updated February 2, 2022. Accessed June 29, 2020. <https://www.cdc.gov/coronavirus/2019-ncov/hcp/dental-settings.html>
3. To KK, Tsang OT, Yip CC, et al. Consistent detection of 2019 novel coronavirus in saliva. *Clin Infect Dis*. 2020;71(15):841-843.
4. Burger D. ADA recommending dentists postpone elective procedures. American Dental Association. *ADA News*. March 16, 2020. Accessed March 28, 2022. <https://www.ada.org/publications/ada-news/2020/march/ada-recommending-dentists-postpone-elective-procedures>
5. COVID-19 economic impact on dental practices. American Dental Association, Health Policy Institute. Accessed August 4, 2021. <https://www.ada.org/en/science-research/health-policy-institute/covid-19-dentists-economic-impact>
6. 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;69(32):1049-1057.
7. Vahratian A, Blumberg SJ, Terlizzi EP, Schiller JS. Symptoms of anxiety or depressive disorder and use of mental health care among adults during the COVID-19 pandemic: United States, August 2020-February 2021. *MMWR Morb Mortal Wkly Rep*. 2021;70(13):490-494.
8. Marvaldi M, Mallet J, Dubertret C, Moro MR, Guessoum SB. Anxiety, depression, trauma-related, and sleep disorders among healthcare workers during the COVID-19 pandemic: a systematic review and meta-analysis. *Neurosci Biobehav Rev*. 2021;126:252-264.
9. Firew T, Sano ED, Lee JW, et al. Protecting the front line: a cross-sectional survey analysis of the occupational factors contributing to healthcare workers' infection and psychological distress during the COVID-19 pandemic in the USA. *BMJ Open*. 2020;10(10):e042752. <https://doi.org/10.1136/bmjopen-2020-042752>
10. Consolo U, Bellini P, Bencivenni D, Iani C, Checchi V. Epidemiological aspects and psychological reactions to COVID-19 of dental practitioners in the northern Italy districts of Modena and Reggio Emilia. *Int J Environ Res Public Health*. 2020;17(10):3459.
11. Mahdee AF, Gul SS, Abdulkareem AA, Qasim SSB. Anxiety, practice modification, and economic impact among Iraqi dentists during the COVID-19 outbreak. *Front Med*. 2020;7:595028.
12. Ranka MS, Ranka SR. Survey of mental health of dentists in the COVID-19 pandemic in the UK. *J Int Soc Prev Community Dent*. 2021;11(1):104.
13. Al-Amad SH, Hussein A. Anxiety among dental professionals and its association with their dependency on social media for health information: insights from the COVID-19 pandemic. *BMC Psychol*. 2021;9(1):1-9.
14. Mekhemar M, Attia S, Dörfer C, Conrad J. Dental nurses' mental health in Germany: a nationwide survey during the COVID-19 pandemic. *Int J Environ Res Public Health*. 2021;18(15):8108.
15. Mekhemar M, Attia S, Dörfer C, Conrad J. The psychological impact of the COVID-19 pandemic on dentists in Germany. *J Clin Med*. 2021;10(5):1008.
16. Estrich CG, Mikkelsen M, Morrissey R, et al. Estimating COVID-19 prevalence and infection control practices among US dentists. *JADA*. 2020;151(11):815-824.
17. Estrich CG, Gurenlian JR, Battrell A, et al. COVID-19 prevalence and related practices among dental hygienists in the United States. *J Dent Hyg*. 2021;95(1):6-16.
18. Kroenke K, Spitzer RL, Williams JB, Lowe B. An ultra-brief screening scale for anxiety and depression: the PHQ-4. *Psychosomatics*. 2009;50(6):613-621.
19. Löwe B, Wahl I, Rose M, 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 Rep*. 2010;122(1-2):86-95.
20. Kroenke K, Spitzer RL, Williams JB. The Patient Health Questionnaire-2: validity of a two-item depression screener. *Med Care*. 2003;41(11):1284-1292.
21. Kroenke K, Spitzer RL, Williams JB, Monahan PO, Löwe B. Anxiety disorders in primary care: prevalence, impairment, comorbidity, and detection. *Ann Intern Med*. 2007;146(5):317-325.
22. COVID data tracker. Centers for Disease Control and Prevention. Accessed September 2, 2021. <https://covid.cdc.gov/covid-data-tracker/>
23. Czeisler MÉ, Wiley JF, Facer-Childs ER, et al. Mental health, substance use, and suicidal ideation during a prolonged COVID-19-related lockdown in a region with low SARS-CoV-2 prevalence. *J Psychiatr Res*. 2021;140:533-544.
24. Jia H, Guerin RJ, Barile JP, et al. National and state trends in anxiety and depression severity scores among adults during the COVID-19 pandemic: United States, 2020-2021. *MMWR Morb Mortal Wkly Rep*. 2021;70(40):1427-1432.
25. Salehiniya H, Abbaszadeh H. Prevalence of corona-associated anxiety and mental health disorder among dentists during the COVID-19 pandemic. *Neuro-psychopharmacol Rep*. 2021;41(2):223-229.
26. IFDH 2020 COVID survey. International Federation of Dental Hygienists. Accessed July 24, 2020. <http://www.ifdh.org/ifdh-2020-covid-survey.html>
27. Gurenlian JR, Morrissey R, Estrich CG, et al. Employment patterns of dental hygienists in the United States during the COVID-19 pandemic. *J Dent Hyg*. 2021;95(1):17-24.
28. Shacham M, Hamama-Raz Y, Kolerman R, Mijiritsky O, Ben-Ezra M, Mijiritsky E. 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;17(8):2900.
29. New program aims to support dentists' mental wellness. American Dental Association. March 29, 2021. Accessed August 6, 2021. <https://www.ada.org/en/publications/new-dentist-news/2021/march/new-program-aims-to-support-dentists-mental-wellness#:~:text=Action%3A%20Hope%20for%20the%20Day,his%20friends%20die%20by%20suicide>
30. COVID-19 resource center for dental hygienists. American Dental Hygienists' Association. Accessed September 24, 2021. <https://www.adha.org/covid19>
31. Czeisler M, Wiley J, Czeisler C, Rajaratnam S, Howard M. Uncovering survivorship bias in longitudinal mental health surveys during the COVID-19 pandemic. *Epidemiol Psychiatr Sci*. 2021;30:e35. <https://doi.org/10.1017/S204579602100038X>