

Research

United States Dental Health Care Workers' Mental Health During the COVID-19 Pandemic

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Abstract

Purpose: The purpose of this study was to assess the prevalence of anxiety and depression symptoms and understand factors influencing mental health among dental health care workers (DHCWs) in the United States (US) during the COVID-19 pandemic.

Methods: Beginning in June 2020, dentists (DDS) and dental hygienists (DH) in the US were invited to participate monthly in an anonymous, longitudinal, web-based survey. The Patient Health Questionnaire-4 (PHQ-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: A total of 8,902 DHCWs (DH, DDS) participated in the survey for a response rate of 6.7%. Anxiety symptom rates peaked in November 2020 (28% DH; 17% DDS) and declined to 12% for both professions in May 2021. Depression symptoms were highest in December 2020 (17% DH; 10% DDS) and declined to 8% in May 2021. Controlling for gender, age, race, ethnicity and community COVID-19 transmission levels, DDS respondents had lower odds of anxiety symptoms (aOR 0.82; 95% CI 0.70 to 0.95) and depression symptoms (aOR 0.79; 95% CI 0.67 to 0.93) than DHs. Compared to vaccinated respondents, DHCWs who were unvaccinated but were planning on getting vaccinated had significantly higher rates of anxiety (aOR 1.71; 95% CI 1.20 to 2.44) and depression symptoms (aOR 1.57; CI 1.07 to 2.29).

Conclusions: The mental health status of DHCWs fluctuated during the COVID-19 pandemic. Anxiety and depression were associated with the demographic and professional characteristics of the DHCW as well as the perceived risk of COVID-19 infection. Mental health support should be made available for all DHCWs.

Keywords: mental health, COVID-19, health care worker, longitudinal study, COVID-19 vaccine, professional role

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Introduction

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 (ADHA) recommended that DHCWs in the United States (US) 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 US 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} Dental health care workers 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 US 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}

There is a gap in the existing literature on prevalence of anxiety and depression symptoms in DHCWs in the US prior to the COVID-19 pandemic, preventing the comparison of mental health status both before and during the pandemic. The purpose of this study was to assess the prevalence of anxiety and depression symptoms and understand factors influencing mental health among DHCWs in the US during the COVID-19 pandemic. Of particular interest was determining whether mental health changed over the course of the pandemic, and if so, at which times. Furthermore, this investigation also tested the associations of demographic or professional characteristics, level of COVID-19 community

transmission, and COVID-19 vaccination status with the mental health of DHCWs.

Methods

This clinical trial was registered at ClinicalTrials.gov; registration numbers NCT04423770 and NCT04542915. An anonymous web-based survey (Qualtrics XM Platform; Qualtrics, Provo, UT, USA) was administered monthly 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 US, 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-4¹⁸ (PHQ-4) 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, 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, the COVID-19 case rate per 100,000 people in each US state and territory was obtained 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 (≥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, therefore these categories were combined into a single category before defining a regression model. Furthermore, the rates of anxiety and depression symptoms in DHCWs who reported at least one dose of COVID-19 vaccine were contrasted with the rates in unvaccinated DHCWs. Vaccination status was added to the survey as of February 1, 2021, however it was modeled separately to avoid constricting the periods of the other regression models.

Statistical software (SAS, Version 9.4; SAS Institute, Cary, NC, USA) was used for the statistical analysis. Statistical significance was set at alpha of .05 and χ^2 tests were used to test associations between respondent characteristics and anxiety or depression symptoms. To achieve sufficient power to estimate the effect of time on mental health, consecutive months were grouped with similar rates of depression and anxiety symptoms, creating 4 periods of 3 months each. Multivariable multilevel logistic regression models were used 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, models were restricted to the ages (≥ 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. Multivariable regression models using purposeful model selection were used. 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, available case analysis was used.

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 dentist respondent ages ranged from 26 through 84 years. The sample 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 dental 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

Table 1. Sample demographics (n= 8,902)

Characteristic	Dentists* n(%)	Dental hygienists** n(%)
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 data	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 data	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 data	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 data	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 data	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 data	635 (28.9)	3,828 (57.1)

* n = 2,196; 24.7% of total responses

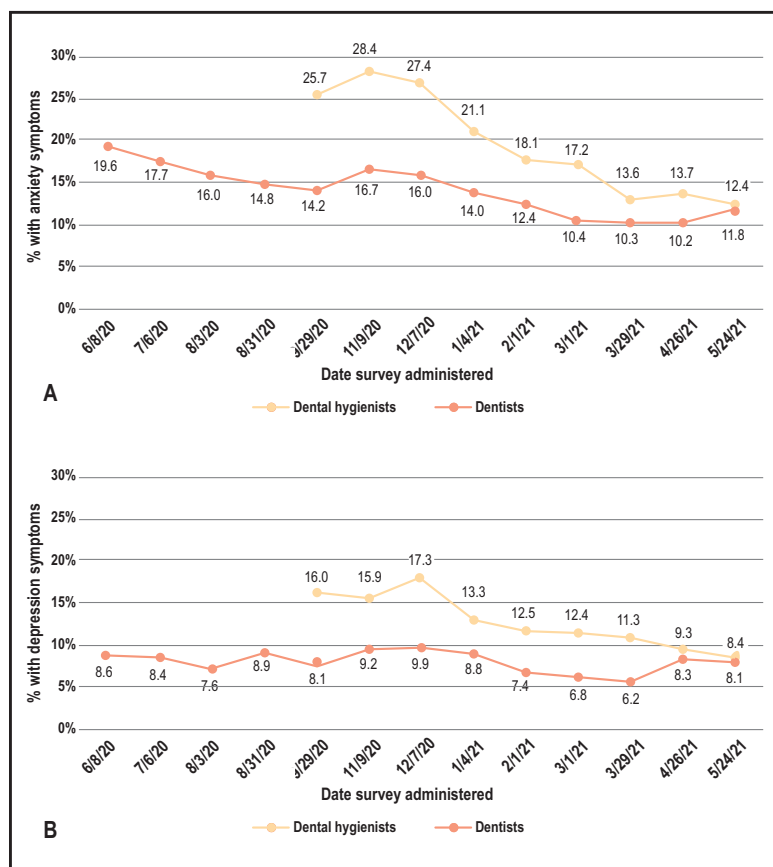
** n = 6,706; 75.3% of total responses

*** Percentages do not add up to 100 due to rounding

in general dentistry (57.2%, n=5,095), however all dental specialties were represented in the sample. Most respondents worked in a private practice dental setting (71.0%, n=6,318), while 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 1). 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 1). As with anxiety symptoms, dental hygienists had higher rates of depression symptoms than dentists at each surveyed time point (Figure 1). 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 1). 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.

Figure 1. 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).



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 II). Most demographic and professional groups experienced heightened rates of anxiety symptoms from September through December 2020 (Table II). The highest rates of anxiety and depression symptoms in non-Hispanic Black DHCWs occurred from March through May 2021 (Table II). 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 II). There were also significant differences in depression symptom rates by gender, age group, and professional role (Table II).

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 III and IV). There was evidence of multicollinearity between COVID-19 community transmission level and period (condition index of 21.1, much larger than the eigenvalue of 0.01), and were modeled separately (Tables III and IV). In multivariable models, dental practice type and practice setting were not associated statistically significantly with anxiety or depression symptoms and were excluded them from the final models (Tables III and IV). Compared with August through December 2020, DHCWs had significantly lower odds of anxiety and depression symptoms in all subsequent months (Tables III and IV). 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 < .05). Controlling for gender, age group, primary practice type, primary practice setting, professional role, and either period or COVID-19 community transmission level, DHCWs who were planning to be vaccinated but were not

Table II. Proportion of sample with anxiety and depression symptoms (n=8,902)

Characteristic	Anxiety symptoms per survey period (%)				χ^2 p-value for anxiety symptoms	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	< .0001	6.9	7.5	6.3	6.8	< .0001
Female	23.8	25.7	18.2	13.5		10.9	15.4	12.1	9.5	
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	< .0001	NA	25.7	13.3	23.5	< .0001
26-39	24.6	28.5	21.8	15.6		11.7	17.7	14.9	10.8	
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	< .0001	8.3	13.2	9.9	8.7	< .0001
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		5.4	15.0	13.0	7.1	
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	< .0001	NR	NR	9.2	10.1	.047
1 dose	NR	NR	14.9	16.8		NR	NR	9.2	9.1	
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	

*NA: not applicable **NR: not recorded

Table III. Odds of anxiety symptoms in dental health care workers, September 28, 2020 - June 2, 2021 (n= 7,534)*

Characteristic	OR† (95% CI)	p-value	OR (95% CI) Adjusting for demographics, professional role, and survey 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)	< .0001	1.75 (1.48 to 2.06)	< .0001	1.74 (1.48 to 2.05)	< .0001
Age Group, Y						
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)	< .0001	**		-	
Primary Practice Setting						
Private	[Reference]	.45	-	NA	-	NA
Public	0.79 (0.42 to 1.47)	.45	-		-	
Professional Role						
Dental hygienist	[Reference]	< .0001	[Reference]	< .0001	[Reference]	< .0001
Dentist	0.51 (0.46 to 0.56)	< .0001	0.80 (0.68 to 0.93)	< .0001	0.82 (0.70 to 0.95)	< .0001
Period						
8/28/20-12/7/20	[Reference]	< .0001	[Reference]	< .0001	-	NA
1/4/21-3/1/21	0.56 (0.50 to 0.62)	< .0001	0.65 (0.57 to 0.71)	< .0001	-	
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)	< .0001	-		1.37 (1.21 to 1.55)	< .0001

* Dentists = 1,824; Dental hygienists = 5,710 ** No OR for this model in this category *** NA: not applicable

yet vaccinated had significantly increased odds of anxiety symptoms (aOR including period, 1.73 [95% CI, 1.22 to 2.46]; a OR 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 [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 this investigation, at every

Table IV. Odds of depression symptoms in dental health care workers, September 28, 2020 - June 2, 2021 (n= 7,534)*

Characteristic	OR (95% CI)	p-value	OR (95% CI) Adjusting for demographics, professional role, and survey 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	2.67 (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						
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]	< .0001	[Reference]	< .0001	[Reference]	< .0001
≥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)	.051	—		—	
Primary Practice Setting						
Private	[Reference]	.47	—	NA	—	NA
Public	0.77 (0.37 to 1.57)	.47	—		—	
Professional Role						
Dental hygienist	[Reference]	< .0001	[Reference]	< .0001	[Reference]	< .0001
Dentist	0.52 (0.46 to 0.59)	< .0001	0.77 (0.66 to 0.90)	< .0001	0.79 (0.67 to 0.93)	< .0001
Period						
8/28/20-12/7/20	[Reference]	< .0001	[Reference]	< .0001	—	NA
1/4/21-3/1/21	0.63 (0.55 to 0.72)	< .0001	0.79 (0.68 to 0.91)	< .0001	—	
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)	< .0001	—		1.25 (1.09 to 1.44)	< .0001

* Dentists = 1,824; Dental hygienists = 5,710 ** No OR for this model in this category *** NA: not applicable

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 in other studies,^{7,23,25} women reported higher rates of anxiety and depression than men. Unlike a survey of mental health among dentists in the United Kingdom (UK),¹² no differences in rates of anxiety or depression symptoms among US DHCWs were identified by practice setting (that is, private practice versus public health). This discrepancy may be due to differences in dental health care delivery systems and payers between the UK and the US or may be a reflection on the different times of data collection. In results consistent with another report,²⁵ no significant differences in mental health concerns were identified between DHCWs in general dentistry and those practicing specialties.

In Germany, differences in mental health by professional type were seen during the pandemic, with dental nurses exhibiting more anxiety and depression symptoms than dentists.^{14,15} Similarly, in the current 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 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 this 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 that DHCWs have the necessary resources to safely practice dentistry, including PPE, vaccination, and adherence to CDC guidance, may reduce psychological distress. The ADA and the ADHA have expanded resources available to support dentists' and dental hygienists' mental and emotional health.^{29,30}

There are limitations to these 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 one professional group disproportionately to the other. 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 this study do not reflect prevalence of definitive mental health diagnoses.

Conversely, there are also strengths to this research. The sample of dentists was broadly similar to US dentists on all measured variables. How representative the sample of surveyed dental hygienists was of dental hygienists nationally is unknown, but those surveyed represented every level of experience, type of dental practice, measured demographic characteristic, and US state. To the best of the authors' knowledge, this is the first, and perhaps only, study evaluating mental health in a cohort of DHCWs over the course of the COVID-19 pandemic. Results from this study show 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. This

study was 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 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 including 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

This analysis assessed time trends and risk factors associated with anxiety and depression symptoms in DHCWs over the course of one year during the COVID-19 pandemic. Although rates for anxiety symptoms were higher than rates for depression symptoms and were also 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.

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