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Statement of Purpose

The Journal of Dental Hygiene is the refereed, scientific publication of the American Dental Hygienists' Association. The JDH promotes the publication of original research related to the profession, education, and practice of dental hygiene and supports the development and dissemination of a dental hygiene body of knowledge through scientific inquiry in basic, applied and clinical research.

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Continued Collaboration in a Global Pandemic

Ann Battrell, MSDH

This issue of the *Journal of Dental Hygiene* highlights another landmark moment of collaborative research between the American Dental Hygienists' Association (ADHA) and the American Dental Association (ADA) Health Policy Institute (HPI). One year ago, our organizations shared the results of two key research studies related to the COVID-19 pandemic; trends in dental hygiene employment and infection control practices among dental hygienists. Since that time, the ADHA and ADA HPI have continued to study both dental hygienists and dentists, gathering additional trend data as well as information about vaccination intention and hesitancy. Three papers summarizing the key data on infection prevention and control practices, dental hygiene employment patterns and vaccine intention and hesitancy of dental hygienists are published in this issue, highlighting what we have learned from over 7,000 of our dental hygiene colleagues.

Throughout this year-long study, we have been fortunate to learn many things. First, the journey of a pandemic has taught us that dental hygienists are both brave and resilient health care providers. Our colleagues have had to make a wide range of difficult decisions, none of which were taken lightly, and all of which have had a profound impact, both professionally and personally.

We have also witnessed changes to the dental hygiene workforce. Results from our research have shown that career trajectories, salaries, infection control protocols, and patient care procedures have been changing since the beginning of the pandemic. We would never have known this story without the thousands of participants who were willing to share their experiences every four to six weeks, for an entire year. We are grateful to every individual who chose to be part of this process. If you were involved in this study, you should be proud of your legacy and the body of knowledge that you helped to build!

Science can also be a teacher. The process of conducting research and discovering answers to the critical questions impacting the profession is an enlightening experience. We may think that we can anticipate a particular response in the scientific inquiry process, but the real learning comes from the results of the research. The results from these studies demonstrate positive changes over the past year, yet there is still more work to be accomplished. Workforce trends are improving as more dental hygienists return to clinical practice. However, infection control practices and procedures are decreasing in some areas, and vaccine hesitancy is apparent amongst some dental hygienists. We must ask ourselves what needs to be done to address these issues, and how can we work together to continue to support safe practices and growth for all dental hygienists?

Lastly, partnership is powerful. We have had the opportunity to work closely with a rich team of research experts at the ADA HPI. The collaborative spirit between our associations has been exceptional. We have shared ideas, resources, and countless hours working on a collective mission of understanding the impact of the pandemic on both dental hygiene and dentistry. This partnership has brought out the best in us—focus, respect, expertise, high level communication, and shared decision-making. We look forward to continuing this collaboration with our esteemed colleagues. This important partnership has enabled us to document the lived experiences of dental hygienists throughout this historic pandemic. By publishing the results of this research in the *JDH*, the historical record of these most challenging times of the COVID-19 pandemic will be preserved.

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Research

COVID-19 Vaccine Intention and Hesitancy of Dental Hygienists in the United States

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Abstract

Purpose: Vaccinations represent an important public health tool for mitigating dangerous diseases; nevertheless, there is concern and hesitancy regarding vaccinations including those for COVID-19. The purpose of this study was to determine the intentions and hesitancy among dental hygienists in the United States (US) toward COVID-19 vaccination.

Methods: Dental hygienists in the US were surveyed from 1/4/21 to 8/16/21 regarding their intentions to get vaccinated and whether they received a COVID-19 vaccine. The vaccination questions were part of an anonymous, ongoing longitudinal web-based survey of dental hygienists' employment and infection control trends. Willingness or actual COVID-19 vaccination versus vaccine hesitancy were analyzed by differences in demographic characteristics using multivariable logistic regression and X^2 and Fisher's exact tests.

Results: Full COVID-19 vaccination rates in US dental hygienists rose sharply from 2/5/21 to 3/5/21 (26.0% to 53.9%) and leveled off to 75.4% by 8/30/21. The highest rates of vaccine hesitancy were among dental hygienists aged 26-39 years and those who had contracted COVID-19 during the time of the survey. The lowest vaccination hesitancy rates were seen among Non-Hispanic Asians and individuals 65+. When controlling for age, race/ethnicity, and years practiced, dental hygienists who had contracted COVID-19 had higher odds of being vaccine hesitant (adjusted Odds Ratio (aOR): 1.847, 95% Confidence Interval (CI): 1.274, 2.678). Having contracted COVID-19 was also associated with respondents changing from being hesitant to be vaccinated to being willing to be vaccinated (aOR: 4.071, 95% CI: 1.652, 10.030).

Conclusion: Although vaccine acceptance is high among dental hygienists in the US, vaccine hesitancy remains an ongoing concern. Dental hygienists are key prevention specialists who should promote adherence to vaccination recommendations for the health of the public. Further education in virology, epidemiology, and vaccination education is recommended.

Key words: COVID-19, vaccine, vaccine hesitancy, vaccinations, dental hygienists, health promotion

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Introduction

From the beginning of the COVID-19 global pandemic, numerous lives and communities have been affected by this complex and serious disease. Worldwide, over 271 million people had been infected while more than 5.3 million died from this disease.[1] By December 2021, more than 50.1 million people had been infected in the United States (US) and 798,997 had died of COVID-19.[1] To address this health crisis, public health measures were instituted including social distancing, wearing face masks, hand washing, and avoidance of crowded indoor spaces. In November 2020, several pharmaceutical companies reported early results of large vaccine trials demonstrating efficacy for most participants.[2] Pharmaceutical companies began seeking federal and regulatory approvals, and by early December 2020 various state and national agencies were discussing vaccine acquisition, storage, and distribution.[2,3]

Vaccinations represent an important public health tool for mitigating dangerous diseases including polio, measles,

smallpox, influenza, and COVID-19. According to the World Health Organization (WHO), vaccines have prevented at least 10 million deaths between 2010-2015 worldwide and millions more have been protected from suffering and disability.[4] Nevertheless, skepticism and hesitancy surrounding vaccinations remains among populations around the world[5,6] and vaccine hesitancy is considered to be one of the top global health threats.[7] Vaccine hesitancy is the term used to describe individuals who display reluctance or refusal to receive vaccines despite the public health recommendations and the availability of vaccination services.[8,9] Hesitancy toward COVID-19 vaccination can be a significant barrier to the prevention efforts aimed at alleviating the devastating consequences of this pandemic.

The issue of vaccine hesitancy among the US public, both prior to and since the availability of COVID-19 vaccines, has been studied to better understand the factors influencing attitudes and behaviors. One longitudinal study conducted from March to August 2020, surveyed US residents from across the country (n=1,018) to determine the intention to receive the COVID-19 vaccine once available, along with general vaccination attitudes including intention to get a flu vaccine. Findings for all measures demonstrated a statistically significant decreasing trend in intention to receive a COVID-19 vaccine over the 6-month period of the study. This trend was identified as being driven by participants who identified their political party affiliation as Republican and who also tended to perceive the SARS-CoV-2 virus as less threatening. Influencing factors included exposure to media channels and social networks.[10] Another study related to the impact of COVID-19 and factors contributing to COVID-19 vaccine refusal was conducted among a cross section of individuals across the US to reflect national census data.[11] Results revealed that 68% (n=316) of respondents were supportive of being vaccinated when it became available, however concerns regarding the vaccine centered on possible side effects, efficacy, and length of testing.[11] It was concluded that messaging to the public should promote information regarding the safety of vaccines, transparency, and thoroughness of testing to improve vaccination rates.[11] Furthermore, it was recommended to emphasize the consequence of the pandemic on the overall health and well-being of the US population in vaccination messaging as well as ensuring that low-income populations have access to the COVID-19 vaccine.[11]

Another study of adults in the US (n=1,971) conducted in July of 2020, focused on the factors associated with the choices and willingness to accept a hypothetical COVID-19 vaccine.[12] Attributes included vaccine related attributes and political factors.[12] Results revealed that an increase in efficacy and duration were associated with a higher probability of choosing a vaccine as were endorsements from the US Centers for Disease Control and Prevention and the WHO as compared to other political endorsements.[12] Respondents who indicated Democrat political party were significantly more likely to report willingness to receive a COVID-19 vaccine than those who reported Republican political partisanship.[12] Older adults, Black individuals, women, and uninsured adults reported being less likely, on average, to receive a COVID-19 vaccine and it was recommended that public health authorities consider outreach strategies that address these specific factors.[12]

A similar national study of US adults was conducted in June 2020 to identify population subgroups with higher probabilities of vaccine hesitancy towards a potential COVID-19 vaccine.[13] Of these respondents, 22% (n=1,878) reported vaccine hesitancy, which was higher among females, African Americans, Hispanics, those who had children at home, rural dwellers, people in the northeastern US, and those identifying as Republicans.[13] It was concluded that evidence-based education and policy level interventions would be needed to promote COVID-19 immunization programs, and that willingness to be vaccinated might change once COVID-19 vaccines become available.[13]

Vaccine acceptance and hesitancy among health care workers is an important consideration to explore, as health care workers are exposed to a higher risk of infections.[14] In addition, health care providers are viewed as trusted individuals who are able to share evidence-based information regarding vaccines to their patients and the public.[15] Furthermore, as a means to ensure an adequate workforce to provide care for infected patients, health care workers were among the first group to receive the COVID-19 vaccine in early 2021. Assessing the attitudes of health care workers also helps address barriers to widespread vaccination acceptance.

Prior to the availability of a COVID-19 vaccine, health care workers across five hospital systems in New Mexico, Texas, Missouri, and Ohio were surveyed between October and November of 2020 to determine their willingness to receive a COVID-19 vaccine.[16] Only 36% (n=3,479) indicated willingness to take a COVID-19 vaccine as soon as it became available.[16] Most respondents were female, white, indicated that they were Democrat or Liberal, had no chronic medical conditions and were younger than 40 years of age.[16] Concerns included safety, adverse effects, effectiveness, rapidity of development/approval, and trust of government and regulatory authorities overseeing the vaccine development.[16] Females and Black health care workers had lower acceptance while those identifying as Democrat/Liberal indicated higher

vaccine acceptance.[16] Healthcare workers who had not taken care of COVID-19 patients had higher refusal rates.[16] Of those who were not planning to receive a COVID-19 vaccine, they also indicated that they would not recommend the vaccine to family and friends. Many respondents indicated trusting their own health care providers for recommending the COVID-19 vaccine. This finding could suggest an important role for key messaging through professional societies to increase vaccination acceptance and uptake among health care workers.[16]

Health care students represent another key population to consider regarding vaccinations. Vaccine hesitancy and acceptance among medical students at an allopathic medical school in southeast Michigan were assessed in an online survey during September 2020.[17] Findings revealed that 23% of the participants (n=167) were vaccine hesitant with concerns related to serious side effects, lack of trust from public health experts, politicization of the vaccine, transparency, and speed of vaccine development impacting safety. Based on the study results, it was recommended an educational curriculum be developed to enhance medical student knowledge about COVID-19 vaccine and to teach counseling skills so they can share vaccination experiences with patients and encourage vaccination.[17] In a companion study comparing COVID-19 vaccine acceptance and hesitancy among dental and medical students, results from the medical student study[17] were compared to dental students from Michigan, Florida and Utah who completed the same survey in December 2020.[18] Results revealed that 45% of the dental students (n=248) were hesitant to receive the COVID-19 vaccine[18] as compared to 23% of the medical students (n=167).[17] More dental students (11%) compared with medical students (3%) reported having contracted COVID-19 and were more likely to indicate that the only reason they will get the vaccine is if it is mandated.[18]

Oral health care providers, including dentists and dental hygienists, fall into the high-risk category for potential exposure to the SARS-CoV-2 virus. Dentists and in some states, dental hygienists, are now authorized to administer the COVID-19 vaccine to the public and patients. Oral health care providers can serve as advocates for the vaccine to their patients. However, before an oral health care provider is allowed and willing to perform duties as vaccinators, they should be knowledgeable about vaccines and agree to receive the COVID-19 vaccine themselves. Findings from the dental student vaccine acceptance and hesitancy study indicated that nearly half of the dental student participants do not meet these criteria and highlighted the need for additional curricular education designed to enhance knowledge about the COVID-19 vaccine and vaccine counseling skills.[18]

Outside of the US, in February 2021 a global study of vaccine hesitancy was conducted through the International Association of Dental Students.[19] Dental students from 22 countries (n= 6,639) completed the questionnaire.[19] Findings revealed that 22.5% of dental students were vaccine hesitant while 13.9% rejected COVID-19 vaccines.[19] Participants from lower income levels, females, and those infected and recovered from a COVID-19 infection, tended to be more vaccine hesitant or vaccine resistant.[19] They also indicated using media and social media as their primary source of vaccine-related information,[19] thus exposing them to misleading information. Insufficient knowledge about vaccines and their safety, and mistrust of governments and the pharmacological industry were identified as barriers for vaccination.[19] The authors indicated that urgent interventions by health organizations were needed to work proactively with media content creators to disseminate higher quality messaging as well as improved dental curricula related to infectious disease epidemiology education and vaccination trends.[19]

International studies have also been conducted among oral health care professionals. Vaccine hesitancy and adherence intentions among Italian dentists enrolled at the Board of Physicians and Dentists in Lombardy was surveyed in December 2020.[20] Of the participants (n=421), 10.9% had received a diagnosis of COVID-19, while 17.8% reported vaccine hesitancy or resistance.[20] Reasons cited included fear the vaccine was unsafe and fear of adverse events, concerns of pharmaceutical companies influence decisions on vaccination policies, previous diagnosis of COVID-19, and belief that the vaccine had suboptimal protective efficacy.[20] In another study conducted in Israel during December 2020, vaccination attitudes, including specific attitudes towards COVID-19 vaccines, were surveyed among dentists (n=67) and dental hygienists (n=73) as compared to the Israeli public (n=361).[21] In general, dental hygienists had more negative attitudes toward vaccines, demonstrated significant mistrust of vaccine benefits, more worries over unforeseen future effects, more negative attitudes toward the COVID-19 vaccines and showed significantly more concerns about commercial profiteering.[21] Compared to the general female Israeli adult population, dental hygienist respondents in this study appeared to have a higher anti-vaccination approach to the COVID-19 vaccine.[21]

Based on the results of these international studies, it can be concluded that the vaccination of health care workers, including oral health care providers, should remain a high priority due to heightened occupational risk levels[20] and that ongoing public health messaging, vaccination education programs and the promotion of trust by local health authorities may aid in decreasing vaccine hesitancy among

oral health care providers and the public.[21] Due to the limited scope of literature related to dental hygienists' attitudes regarding COVID-19 vaccination in the US, the purpose of this study was to determine the intentions and hesitancy among US dental hygienists toward COVID-19 vaccination.

Methods

Registered dental hygienists in the American Dental Hygienists' Association (ADHA) database (n=133,000) were invited to participate in a longitudinal anonymous web-based survey (Qualtrics; Provo, UT, USA) from 9/29/20 through 8/30/21. Eligibility criteria included being 18 years of age, licensed as a dental hygienist in the US, and employment as a clinical dental hygienist as of 3/1/20. Potential respondents signed an electronic informed consent before participating in the survey. The survey was sent monthly and remained open for 5-10 days for responses. The novel survey and research were approved by the ADA Institutional Review Board and preregistered at ClinicalTrials.gov (NCT04423770). Further details of the study population and questionnaires have been described previously.[22,23]

This study focused on survey questions related to COVID-19 vaccination. On 9/29/20 respondents were asked to rate the degree to which they were concerned about COVID-19 transmission to themselves or patients on a scale of 1-5, with 1 being very concerned and 5 being not concerned at all. Scores of 1-2 were categorized as very concerned, 3 as moderately concerned, and 4-5 as not concerned. Additional questions were added over the course of the longitudinal study, including on 1/4/21 inquiring whether respondents intended to be vaccinated for COVID-19, on 2/1/21 whether respondents had been vaccinated or planned to be vaccinated for COVID-19 and any barriers encountered to receiving a COVID-19 vaccination, and on 6/1/21 whether respondents felt safer having been vaccinated, or if unvaccinated, what information was needed in order to consider being vaccinated. Lastly, on 8/16/21 unvaccinated respondents were asked what they would do if a COVID-19 vaccination was mandated by their employers. Respondents were categorized as being willing to be vaccinated if they were either partially or fully vaccinated against COVID-19 or if they stated that they planned to be vaccinated; respondents were categorized as being hesitant if they stated they were not planning to be vaccinated. Not all questions were asked every month, and respondents were free to skip questions, or end the survey before completion. Respondents could skip months and re-join the survey at any point.

Content analysis was used to analyze write-in responses. Themes were identified inductively, with iterative coding of each response by two independent researchers. Disagreements were resolved via discussion. Descriptive statistics, Chi-square and Fisher Exact tests, and logistic regression modeling were conducted in SAS software, version 9.4 (SAS Institute Inc., Cary, NC, USA), with statistical significance set at 0.05. Purposeful model selection was used to build the multivariable regression model. Individual variables that were not statistically significant in single variable models and did not diminish the Akaike Information Criterion (AIC) value of the model, in comparison to other models, were not included in the final multivariable models. Multicollinearity was tested for, but none was found. There was no pattern in missing vaccination information (all regression p-values >0.05) indicating the data is missing at random. Under this assumption, available case analysis was used.

Results

Survey respondents were aged 18 to 77 years with a mean of 44.42 years (SD: 11.92). Most respondents were female (88.8%, n=6192), with 1.1% identifying as male (n=76), and 10.2% identifying as another gender or preferring not to say (n=708). Non-Hispanic Whites made up the majority (73.4%, n=5118), while 6.9% identified as Hispanic (n=483), 3.3% identified as Non-Hispanic Asian (n=231), 2.0% identified as Non-Hispanic Black (n=142) and 4.4% identified as another race or as preferred not to state (n=277). Every US state, as well as Washington, D.C., the Virgin Islands and Puerto Rico, was represented in the sample. Demographic characteristics of the sample are shown in Table I.

Rates of the fully vaccinated respondents increased sharply from 2/5/21 to 3/5/21 (26.0% to 53.9%), then leveled off in subsequent months and ended at 75.4% on 8/30/21 (Figure 1). Rates of the partially vaccinated stayed fairly level throughout the study, ending with 80.5% of the respondents having received at least one dose of a COVID-19 vaccine by 8/30/21. There were 4.7% of respondents who said they were planning on getting vaccinated but had not yet been vaccinated by the end of the survey.

The percentage of individuals who received at least one COVID-19 vaccine dose by 8/30/21 varied state by state (Figure 2). Of the respondents, the highest percentages of partially or fully vaccinated dental hygienists were found in Hawaii (100%, n=17), Alaska (92.3%, n=13) and Maryland (90.7%, n=75). The lowest percentages were identified in Kansas (60.0%, n=30), Alabama (60.0%, n=10) and New Mexico (68.9%, n=28).

COVID-19 vaccine hesitancy was found among approximately 14% (n=455) of respondents, and varied significantly

Table I. Characteristics associated with COVID-19 vaccination and intention as of 8/30/21 (n = 3,206)

Characteristic (n)	Fully vaccinated (%)	Partially vaccinated (%)	Planning to be vaccinated (%)	Unwilling to be vaccinated (%)	X^2 *p*-value
Age group					
18-25 (55)	67.27	3.64	9.09	20.00	
26-39 (914)	65.10	6.13	6.24	22.54	<.0001*
40-64 (2043)	80.62	4.26	4.06	11.06	
65+ (168)	89.29	2.98	2.38	5.36	
Gender					
Male (33)	81.82	0.00	15.15	3.03	
Female (3,158)	76.31	4.75	18.18	14.34	0.0175*
Other/undisclosed (11)	72.73	0.00	4.59	9.09	
Race/Ethnicity					
Non-Hispanic White (2,651)	76.73	4.41	4.60	14.26	
Non-Hispanic Black (66)	69.70	6.06	9.09	15.15	
Non-Hispanic Asian (106)	81.13	9.43	3.77	5.66	0.0422*
Hispanic (251)	74.90	4.38	5.98	14.74	
Other/Undisclosed (104)	74.04	4.81	3.85	17.31	
Health conditions					
Asthma (397)	77.83	4.79	3.02	14.36	0.3902
Chronic lung condition (26)	80.77	7.69	3.85	7.69	0.6132
Diabetes (87)	82.76	1.15	5.75	10.34	0.2631
Heart disease (126)	82.54	2.38	3.97	11.11	0.4396
Immunocompromised (174)	78.74	2.30	5.75	13.22	0.4076
Kidney disease (28)	85.71	0.00	10.71	3.57	0.1086
Liver disease (14)	100.00	0.00	0.00	0.00	0.4377
Obesity (446)	81.61	5.16	4.26	8.97	0.0041*
Rheumatoid (283)	78.45	3.18	4.95	13.43	0.6406
Smoking (64)	81.25	0.00	4.69	14.06	0.3271
Other (656)	80.03	2.59	5.34	12.04	0.0042*
No conditions (2,180)	75.32	4.91	4.86	14.91	0.2223

Continued on page 10

Table I. (continued)

Characteristic (n)	Fully vaccinated (%)	Partially vaccinated (%)	Planning to be vaccinated (%)	Unwilling to be vaccinated (%)	X^2 *p*-value
New COVID-19 infection during study period					
Yes (432)	57.64	6.25	10.19	25.93	<.0001*
No (2774)	79.31	4.43	3.89	12.36	
Was tested for COVID-19 during study period					
Yes (2400)	76.63	4.50	5.21	13.67	0.0727
No (806)	75.68	5.21	3.35	15.76	
Had contact with someone with COVID-19 during study period					
Yes (797)	73.15	4.77	5.14	16.94	0.0582
No (2,409)	77.46	4.65	4.61	13.28	
Socialized with groups of 10 or more during study period					
Yes (2,058)	78.67	2.09	3.45	15.79	<.0001*
No (1,148)	72.30	9.32	7.06	11.32	
Years practiced					
0-10 (917)	66.85	6.43	6.54	20.17	<.0001*
11-25 (1,171)	73.10	4.78	5.89	16.23	
25+ (1,115)	87.62	3.14	2.06	7.17	
Had anxiety during study period					
Yes (874)	78.83	4.92	4.92	11.33	0.0477*
No (2,304)	75.65	4.43	4.73	15.19	
Had depression during study period					
Yes (587)	81.09	3.92	5.11	9.88	0.0076*
No (2,589)	75.51	4.67	4.71	15.10	
Primary practice setting					
Academic (63)	88.89	6.35	4.76	0.00	0.0083*
Group (504)	73.41	6.75	3.97	15.87	
Other (61)	75.41	8.20	8.20	8.20	
Private (973)	76.88	3.80	4.21	15.11	
Public (118)	83.05	4.24	3.39	9.32	

*Significant *p*-value

Figure 1. Vaccination over time in US dental hygienists (n=3,249)

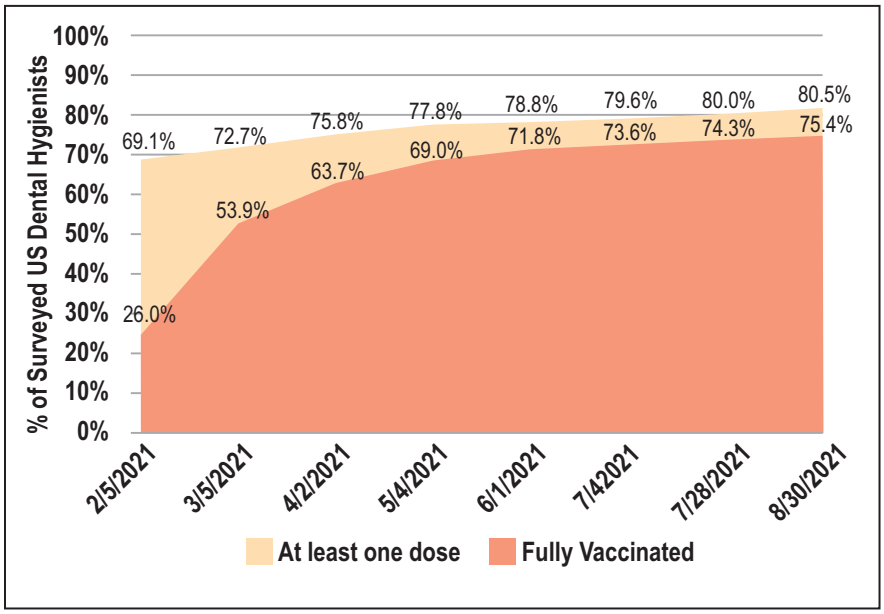
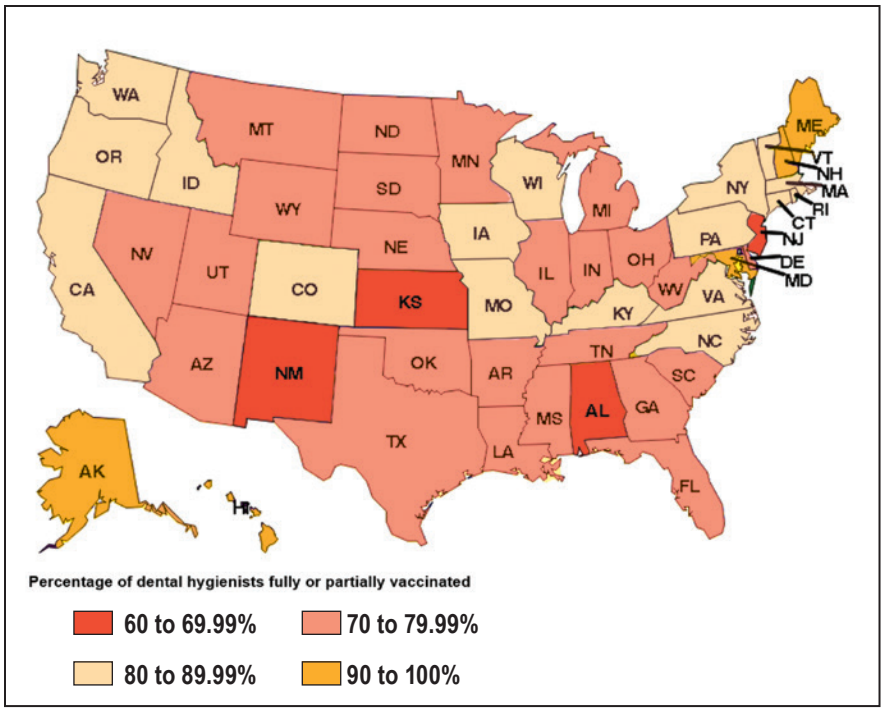


Figure 2. Proportion of dental hygienists who are partially or fully vaccinated, by state as of 8/30/21 (n=3,138)



based on age, gender, race/ethnicity, previous COVID-19 infections, history of socializing in groups of 10 or more during the pandemic, symptoms of anxiety or depression over the course of the survey, number of years of practice as a dental hygienist, and primary practice setting. There was no statistically significant relationship between pre-disposing medical conditions for more severe COVID-19 infections and hesitancy to be vaccinated (X^2 or Fisher *p*-values >0.05). The lowest rates of vaccine hesitancy were seen among Non-Hispanic Asians (5.7%, n=6), as well as among those 65+ (5.4%, n=9). The highest hesitancy rate was among those aged 26-39 years (22.5%, n=206) and individuals who had contracted COVID-19 (25.9%, n=112). Characteristics of the sample associated with COVID-19 vaccination and intention are shown in Table I.

Over the survey period of 9/28/20 to 10/8/20, respondents rated the degree to which they were concerned about COVID-19 transmission to themselves or patients. Both types of concerns were correlated to the participants who later chose to receive the COVID-19 vaccine. Those who indicated being significantly more concerned about COVID-19 transmission to themselves or patients were significantly less hesitant to get vaccinated (X^2 *p*-value for concern for self: <.0001, X^2 *p*-value for concern for patients: 0.001). Of the respondents who were highly concerned about transmission of a COVID-19 infection to themselves, 7.7% (n= 29) were vaccine hesitant, while 12.5% (n=32) of respondents who were moderately concerned and 19.4% (n=117) of those who were not very concerned about infection, indicated COVID-19 vaccine hesitancy. Of the respondents who were highly concerned about COVID-19 transmission to patients, 8.8% (n= 29) were hesitant to get vaccinated, while 13.9% (n= 39) respondents who were moderately concerned, and 17.6% (n= 110) of those who were not very concerned, indicated vaccine hesitancy.

To account for differences in age, race/ethnicity, or other characteristics, a multivariable logistic regression modeling on the final observation of each respondent was employed (Table II). Even controlling for all other factors, participants who had ever had a COVID-19 infection had statistically significant higher odds of being vaccine hesitant (aOR: 1.847, 95% CI:1.274, 2.678). Respondents who had socialized in groups of 10 or more between 1/4/21-8/16/21 also had statistically significant higher odds of being vaccine hesitant (aOR:1.550, 95% CI:1.151, 2.087). Respondents who displayed symptoms of anxiety or depression between

1/4/21 to 8/16/21, had statistically significant lower odds of being vaccine hesitant (aOR: 0.662, 95% CI: 0.456, 0.960).

Over the period of 2/1/21 to 2/6/21, respondents were asked whether they had encountered any barriers to being vaccinated; most respondents indicated no barriers (72.3% n= 829) while 27.7% (n= 317) experienced barriers. During the last month of the survey, 8/16/21 to 8/30/21, respondents who had been vaccinated were asked whether receiving the vaccine made them feel safer; 83.1% (n= 751) said yes and 8.3% (n= 75) said no, while 8.6% (n= 78) said they were unsure. Of the 75 who did not feel safer after the vaccination, 83.8% (n=61) were non-Hispanic white and 80.0% (n=60) were between 40-65 years old.

During the period of 1/4/21 to 1/8/21, the survey respondents were asked if the vaccine became available to them if they intended to get vaccinated: 68.1% (n= 1,063) answered yes, 17.8% (n= 278) answered no, and 14.0% (n= 219) answered maybe. When the stated intentions were compared with the reported vaccine status in the final observation for each participant, 25 of the respondents had changed their intentions. One respondent went from wanting to get vaccinated to being hesitant, while the other 24 changed from being vaccine hesitant to either being vaccinated or to planning on being vaccinated (Table III). Participants who changed their minds about receiving the vaccine had higher odds of having had COVID-19 (aOR:4.071, 95% CI:1.652, 10.030). No clear causative patterns emerged in the participants who changed from being vaccine hesitant to getting vaccinated or becoming willing to get the vaccine. Data were available on each of these participants for 2 to 8 months of the survey, an average of 3.88 months from 2/1/21 to 8/30/21. One-third (33.3%, n=8) indicated changing their minds about being vaccinated after being infected with COVID-19. None of these participants responded to the item asked from 8/16/21 to 8/30/21 regarding employers mandating the vaccine, so it is unknown if the change of mind was because vaccination was required for employment.

The most common reason respondents gave from 5/24/21 to 6/21/21 for the type of information needed to consider getting a COVID-19 vaccine was that they needed to see longer term studies or more research conducted (41.6%, n=87). The next most common reasons included the desire to wait for the full Food and Drug Administration (FDA) approval (12.0%, n=25) or the belief that since they had already had a COVID-19 infection that they were already immune (10.0%, n=21). A minority (5.3%, n=11) gave reasons based on misinformation, such as that there was no COVID-19 pandemic or that COVID-19 vaccines were more lethal than a COVID-19 infection. Lastly, 7.7% (n=16) desired more information on what a COVID-19 vaccination could mean for future fertility, current pregnancy, or breast feeding.

Discussion

This study of vaccine status indicates that there was vaccine hesitancy among dental hygienists during the period of the survey. Approximately 14% (n=455) of the dental hygienists in the study were vaccine hesitant, less than that of previous studies of the public, medical and dental students, and international dental students,[13,18-20] and comparable to dentists. [20,21] However, in an international study of nurses' intent to receive the COVID-19 vaccine once available, vaccine hesitancy was shown to be 37% of the participants (n=1,205); a level considered to be suboptimal to achieve herd immunity.[24] Results from the current study indicate a high percentage of dental hygienists in the US are vaccinated, indicating a recognition of the high occupational risk related to clinical practice and the importance of disease prevention.

The highest rate of vaccine hesitancy was among younger individuals, those aged between 26-39 years. It may be that some of these individuals desired more information regarding the pandemic itself, vaccines in general, or issues related to pregnancy and breastfeeding. Seeking trusted and credible resources is an important consideration when gathering information about vaccines. Previous research has indicated that this age group tends to rely on social media for information, which may not provide evidence-based, current information[19] The Centers for Disease Control and Prevention (CDC) has a variety of educational materials available for the public and health professionals related to COVID-19 and vaccines.[25] More specifically, the CDC has a document that addresses COVID-19 vaccines during pregnancy, fertility problems and breastfeeding.[25] Furthermore, many respondents may have felt more research needed to be conducted or they were waiting for full FDA approval before deciding upon vaccination. These concerns were expressed during the data collection in the spring 2021 and may have been better addressed as additional information about vaccines became available. It should be noted that the FDA approved COVID-19 vaccines during the latter part of August 2021,[26] near the conclusion of this study.

It is of interest to note that there were respondents who expressed concern regarding the transmission of COVID-19 infections to patients yet were also hesitant to get vaccinated. In addition, those who indicated having had COVID-19, had contact with someone with the disease, or socialized in groups of 10 or more during the study period, had higher odds of being

vaccine hesitant. These findings indicate a lack of understanding of virology, disease transmission, epidemiology, and the general benefits of vaccinations. Further education is needed to help dental hygienists appreciate these concepts to enable informed decision-making regarding immunization.

It is also of relevance that twenty states have authorized dental hygienists to administer COVID-19 vaccines.[27] As vaccine administrators, dental hygienists must be cognizant of their responsibility to be knowledgeable regarding the disease and the vaccine. They should be capable of communicating with the public and their patients regarding the COVID-19 vaccine. The ADHA Code of Ethics supports efforts to promote public health and safety and create a work environment that minimizes health and safety risks.[28] The CDC has provided resources for how to talk to patients about the COVID-19 vaccine focusing on embracing an attitude of empathy and collaboration, asking permission to discuss

Table II. Odds of not planning to be vaccinated by characteristic (n= 1,371)

Characteristic	OR (95% CI)	*p*-value	AOR (95% CI)	*p*-value
Age group		<.0001*		0.2959
18-25 years	2.010 (1.023, 3.948)	0.0584	1.267 (0.464, 3.461)	0.7778
26-39 years	2.339 (1.900, 2.880)	<.0001*	1.474 (0.988, 2.200)	0.2390
40-64 years	ref*	—	ref	—
65+	0.456 (0.230, 0.904)	0.0003*	0.877 (0.257, 2.989)	0.6050
Race/Ethnicity		0.1494		0.2217
Non-Hispanic White	ref	—	ref	—
Non-Hispanic Black	1.074 (0.543, 2.123)	0.4818	0.907 (0.307, 2.680)	0.6518
Non-Hispanic Asian	0.361 (0.157, 0.829)	0.0114*	0.244 (0.075, 0.802)	0.0283*
Hispanic	1.040 (0.721, 1.498)	0.3497	1.091 (0.671, 1.774)	0.1339
Other	1.259 (0.749, 2.116)	0.1228	0.891 (0.363, 2.190)	0.6307
Health conditions		0.0078*		0.0129*
No health conditions	ref	—	ref	—
One or more health conditions	0.661 (0.488, 0.897)	—	0.667 (0.485, 0.918)	—
Infected with COVID-19 during study period		<.0001*		0.0012*
No	ref	—	ref	—
Yes	2.481 (1.945, 3.163)	—	1.847 (1.274, 2.678)	—
Was tested for COVID-19 during study period		0.1415		
No	ref	—	—	—
Yes	0.846 (0.678, 1.057)	—	—	—
Contact with someone with COVID-19 during study period		0.0105*		
No	ref	—	—	—
Yes	1.331 (1.069, 1.658)	—	—	—

Table Continued on page 14

Table II. (continued)

Characteristic	OR (95% CI)	*p*-value	AOR (95% CI)	*p*-value
Spent time in a group of 10 or more during study period		0.0005*		0.0039*
No	ref	—	ref	—
Yes	1.468 (1.181, 1.825)	—	1.550 (1.151 2.087)	—
Years practiced		<.0001*		0.0187*
0-10 years	ref	—	ref	—
11-25 years	0.766 (0.613, 0.959)	0.0022*	1.097 (0.734, 1.641)	0.0249*
25+ years	0.306 (0.231, 0.404)	<.0001*	0.583 (0.334, 1.016)	0.0123*
Had anxiety during study period		0.0054*		0.0296*
No	ref	—	ref	—
Yes	0.713 (0.562, 0.905)	—	0.662 (0.456, 0.960)	—
Had depression during study period		0.0011*		
No	ref	—	—	—
Yes	0.616 (0.460, 0.825)	—	—	—
Primary practice setting		0.2566		
Academic/university/college	<0.001 (<0.001, >999.999)	0.9555	—	—
Group practice	1.060 (0.788, 1.426)	0.9494	—	—
Other	0.502 (0.198, 1.273)	0.9622	—	—
Private solo dental practice	ref	—	—	—
Public health clinic/agency	0.578 (0.303, 1.101)	0.9598	—	—

*Significant *p*-value; ref = reference category

vaccination, using motivational interviewing, and responding to questions.[29] Additional training may be essential for individuals who are vaccine hesitant, to help them achieve vaccine administrator status.

There were limitations to this study. All the results are based on self-report and are therefore subject to recall bias. Due to the potentially contentious or sensitive nature of COVID-19 vaccination status in the US, responses regarding vaccination rates may have been subject to social desirability bias. The overall survey had a response rate of 5.2% (n=6,976) indicating that the findings may be subject to response bias. However, it is not known how many of the 133,000 email addresses contacted were eligible, web-based surveys have lower response rates than other methods, and there were no incentives associated with this study; all of which may ameliorate the extent of this bias. Strengths of these findings include the wide representativeness of the sample, and the longitudinal nature of this research enables the explication of temporal relationships and thereby causality. Further study could explore dental hygienists' attitudes towards vaccination given the new variants of COVID-19 infections, FDA approval of vaccines and boosters, and vaccination mandates.

Conclusion

Results from this longitudinal study of dental hygienists in the US indicate the percentage of COVID-19 vaccination is high amongst these oral health care professionals, demonstrating recognition of the importance of vaccinations

for the prevention and lowering risk of COVID-19 infection and disease severity. However, vaccine hesitancy remains an important consideration which must be addressed as dental hygienists are key prevention specialists who should promote adherence to vaccination programs for the health of the public. Further implementation of virology, epidemiology, and vaccination education is recommended.

Table III. Rates of transition from vaccination intention to vaccination (n=492)

Intention as of 1/4/2021	Vaccination Status as of 8/30/2021		
	Vaccinated	Plan to	Will not get vaccine
	n (%)	n (%)	n (%)
Will get vaccine (n=326)	312 (95.71)	13 (3.99)	1 (0.31)
Unsure (n=81)	45 (55.56)	18 (22.22)	18 (22.22)
Will not get vaccine (n=85)	14 (16.48)	10 (11.76)	61 (71.76)

Disclosures

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Research

Infection Prevention and Control Practices of Dental Hygienists in the United States During the COVID-19 Pandemic: A longitudinal study

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Abstract

Purpose: The SARS-CoV-2 virus continues to mutate, and the COVID-19 pandemic remains a global health crisis. The purpose of this longitudinal study was to continue to analyze the use of infection prevention and control practices (IPC) and personal protective equipment (PPE) by dental hygienists in the United States (US) during the COVID-19 pandemic.

Methods: Web-based surveys on COVID-19 related health, IPC, and PPE were administered monthly to a panel of US licensed dental hygienists (n=6,976) from September 2020 to August 2021. Trends over time and predictors of IPC and PPE use were estimated using Stata 17.0 xt commands and multilevel multivariable logistic regression. Linear regression modeling for trends in time and tests for changes in trends were conducted (Joinpoint Regression Program, Version 4.9.0.0).

Results: Almost all practicing dental hygienists (99.9%, 14,926 observations) reported COVID-19 specific IPC in place at their primary dental practice. Consistently >96% of dental hygienists reported operatory disinfection and staff masking over the study period. Patient face masking and physical protections such as barriers or air filtration increased in use over time, then declined in spring 2021. Screening or interviewing patients before appointments, checking patient temperatures before treatment, checking staff temperatures at shift start, disinfecting frequently touched surfaces, and encouraging distance between patients were reported by >85% of respondents until March 2021, at which point significant decreases were observed. Wearing a mask or respirator and eye protection during patient care consistently rose over time from September 2020 (77.1%) to August 2021 (81.4%). Always wearing a N95 or equivalently protective respirators during aerosol generating procedures peaked in 2/2021 and declined thereafter. Dental practice setting, supply of respirators, COVID-19 vaccination, and COVID-19 community transmission level were significantly associated with IPC and PPE use.

Conclusion: Most US dental hygienists reported always wearing masks and eye protection during patient care and a variety of IPC types have been instituted to reduce the risk of COVID-19 transmission in dental practice settings. However, the use of N95 or equivalent respirators and some additional IPC methods declined during 2021.

Key words: COVID-19, dental hygienists, personal protective equipment, infection control

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Introduction

On March 11, 2020, the World Health Organization (WHO) declared a global pandemic of COVID-19, an infection caused by a novel beta coronavirus, SARS-CoV-2.[1] The virus is primarily transmitted by inhalation or mucus membrane contact with infected respiratory droplets or aerosol particles.[2] Gravity causes larger respiratory droplets to fall out of the air over time and distance, while smaller droplets and aerosol particles dilute in the surrounding air. General principles adopted in the United States (US) to prevent a COVID-19 infection include distancing from other individuals (operationalized as 6 feet), wearing masks or other barrier face coverings, and avoiding enclosed shared spaces

where exhaled respiratory droplets and aerosol particles can accumulate.[2] However, in order to provide oral care, dental hygienists must work in close proximity to patients who are unmasked, creating the potential for higher SARS-CoV-2 transmission risk to dental hygienists. This risk may be increased by various dental procedures that generate droplets and aerosols (AGP),[3] or reduced via the use of personal protective equipment (PPE) and infection prevention and control (IPC) practices within the dental practice setting.

During the period of this study (September 2020 through August 2021), the Centers for Disease Control and Prevention (CDC) interim guidance for dental settings included face masks or coverings for everyone in a dental practice setting.[4] Dental healthcare workers were advised to continue to adhere to standard precautions, and in the case of an infectious disease diagnosis, transmission-based precautions. During procedures likely to generate splashing or spattering of blood or other body fluids, or AGPs, the CDC recommended dental health care workers wear a surgical mask, eye protection, a gown or protective clothing, and gloves. In areas with moderate community transmission (defined as ≥10 new COVID-19 cases per 100,000 people in the past 7 days),[5] the CDC recommended dental health care workers wear eye protection in addition to their surgical mask during all patient care encounters. During AGPs, or when providing oral care to a patient with suspected or confirmed COVID-19, the CDC recommended dental health care workers also wear an N95 respirator or a respirator that offers an equivalent or higher level of protection.[4]

During AGPs, the CDC also recommended that dental healthcare workers use four-handed dentistry, high evacuation suction, and dental dams to minimize droplet splatter and aerosols.[4] In terms of the practice environment, the CDC recommended dental practices use teledentistry instead of in-office care when appropriate, limit non-patient visitors, schedule appointments to minimize the number of people waiting or being treated simultaneously, limit clinical care to one patient at a time when possible, and set up operatories so only the supplies and instruments needed for the dental procedure are readily accessible. Ideally, oral care should be provided in individual patient rooms or operatories. If this is not possible, the patient chairs should be at least 6 feet apart or have physical barriers between them, and where possible, patients' heads should be oriented away from others and toward air vents or rear walls. In reception areas, the CDC recommended practices included posting visual alerts and supplies to encourage hand, respiratory, and cough hygiene, installing physical barriers, regularly cleaning and disinfecting frequently touched surfaces, and removing objects that cannot be regularly cleaned. If possible, patients should be screened for COVID-19 symptoms via telephone or teledentistry before their appointment, and everyone entering the practice setting should also be screened for symptoms. The CDC additionally recommended higher ventilation and air cleaning rates and efficiency and the use of upper-room ultraviolet germicidal irradiation. On a global level, the WHO interim guidance largely coincides with the CDC guidance, although WHO also recommended pre-procedural rinsing with 1% hydrogen peroxide or 0.2% povidone iodine.[6]

Research on dental hygienists' PPE and IPC is limited and largely conducted outside of the US. A web-based survey was administered to Italian dental hygienists in May 2020 (n=2,798), and found that in regards to ICP procedures: 64.6% triaged patients via telephone, 58.8% delayed appointments to reduce the number of patients waiting together, 65.9% verified patients' health status before treatment, 66.9% disinfected frequently touched surfaces, 77.4% frequently ventilated the waiting rooms, and 74.1% removed or disinfected all devices.[7] Compared to Italian dentists (n= 3,599),[8] a higher proportion of dental hygienists wore surgical masks (82.8%), but a lower proportion wore FFP2/FFP3 respirators (29.8%). An international survey of dental hygienists also conducted in May 2020 found that 69% of the respondents indicated wearing surgical masks to treat patients, 46% wore N95 respirators, and 76% also used face shields.[9] Regarding ICP practices, 71% screened patients for symptoms by telephone, 81% screened patients for symptoms before treatment, 68% limited patient contact within waiting rooms, 10% used negative air pressure air filtration, and 85% cleaned or disinfected all surfaces in the operatory between treatments.[9] Pre-procedural rinses were required of patients in practices of 57% of the surveyed dental hygienists; the most common rinse was hydrogen peroxide, used by 73% of the respondents.[9]

The infection prevention and control practices of dental hygienists in the US during the COVID-19 pandemic have been reported previously.[10] As the SARS-CoV-2 virus continues to mutate and the COVID-19 pandemic remains a global health crisis, it is important to continue to monitor the IPC and PPE practices of dental hygienists as front-line, essential oral health care providers. The purpose of this longitudinal study was to continue to explore the IPC and PPE trends and predictive factors of dental hygienists in the US.

Methods

A web-based survey designed by the American Dental Hygienists' Association (ADHA) and the American Dental Association (ADA) was administered via Qualtrics Core XM (Qualtrics, Provo, UT, USA) from September 2020

through August 2021. Email invitations to participate in the anonymous survey were sent to all licensed dental hygienists in the US and its territories from the ADHA database (n=133,000). Dental hygienists were eligible to participate if they were at least 18 years old, licensed to practice in the US or in one of its territories, and had been employed as a dental hygienist as of March 1, 2020. Membership in the ADHA was not required for participation. Respondents gave informed consent prior to starting the survey; there were no participation incentives.

Following recommendations by Riley et al.,[11] the sample size required for predictive multivariable logistic regression analysis in order to fulfill the study's primary aim of estimating COVID-19 risk was calculated to be n=2,059, based on assumptions that: prevalence of COVID-19 = 1.5%,[9] R^2 = 0.05, covariates=8, shrinkage=0.9, and that 68% of first wave survey respondents would continue to answer surveys over time.[12]

Surveys were emailed between 4-6 weeks apart. Participants could leave or join the study at any time and could skip any question. The surveys and study protocols were approved by the ADA Institutional Review Board and registered at ClinicalTrials.gov (NCT04423770).

Survey Instrument

Each participant received a baseline survey that collected demographics including age, gender, race/ethnicity, zip code, medical history and comorbidities related to COVID-19, and dental practice characteristics. Details of the baseline survey have been described in previous publications.[10, 13] In the survey administered in September 2020, respondents were asked to select all the types of PPE worn when treating patients. In subsequent surveys this question was divided into two separate items; one for dental procedures that do not generate aerosols, and another for procedures likely to generate aerosols. Each survey included items on the supply of PPE, frequency of reuse of masks or respirators, and IPCs. IPCs were based on the CDC and ADA and ADHA interim guidance for dental practice settings and included a list of 11 categories;[4, 14] respondents were asked to select which if any were in place in their primary dental practice. Additional items relating to COVID-19 vaccination and testing were added to the survey in January 2021; quantity of AGPs and the use of a fit-tested N95 or equivalent respirator during AGPs was added in May 2021; infection control procedures relevant to the Occupational Safety and Health Administration (OSHA) Emergency Temporary Standard (ETS) that was issued June 2021[15] were added in July and August of 2021.

Data Analysis

Community level of transmission of COVID-19 was defined by the COVID-19 case rate per 100,000 people in each US state and territory for the 7 days before each survey. It was categorized according to the CDC's criteria as low if <10 new cases per 100,000 and moderate or higher if ≥10 new cases per 100,000.[5] Respondents in areas with low community transmission were considered to have been wearing PPE according to CDC recommendations if they reported always wearing a surgical mask, eye protection, a gown or protective clothing, and gloves when treating patients. Respondents in areas with moderate or higher levels of community transmission were considered to have been wearing PPE according to CDC recommendations if they reported always wearing a surgical mask, eye protection, a gown or protective clothing, and gloves when treating patients during non-AGPs, and if during AGPs they always wore an N95 respirator or respirator offering an equivalent of higher level of protection. Since it was not possible to know which PPE respondents used during AGPs compared to non-AGPs in the September 2020 survey, PPE use during AGP for that survey was reported but not statistically compared to subsequent months. The use of PPE during patient care and the implementation of IPCs in the dental practice setting over the past month were calculated for respondents who had practiced during that month.

Statistical significance was set at 0.05. To adjust for multiple responses over time from the same individuals, descriptive statistics were conducted in Stata 17.0 (Stata Corp., College Station, TX, USA) using xt commands; multilevel multivariable logistic regression was used. Linear regression modeling for trends in time and tests for changes in trends were conducted in Joinpoint Regression Program, Version 4.9.0.0 (Statistical Methodology and Applications Branch, Surveillance Research Program, National Cancer Institute; Bethesda, MD, USA). Write-in responses were qualitatively analyzed using content analysis in Qualtrics independently by two researchers.

Results

Personal and professional characteristics

At the conclusion of the study period in August 2021, a total of 7,004 dental hygienists had responded to the survey and most provided informed consent to participate (99.6%, n=6,976). The first survey (September 2020) had the largest sample size (n=4,776), and 42.3% of those respondents (n=1,828) continued to respond to further surveys. Nearly half of the sample (47.3%, n= 3,299) responded to two or more surveys. Only a small number responded to all twelve surveys

(1.3%, n=92). Respondents were most commonly non-Hispanic White (73.4%, n=5,118), female (88.8%, n=6,192), and ranged in age from 18 to 77 years (mean: 44.4 years, SD: 11.9). Respondents' demographics are described elsewhere in more detail.[16]

In each of the months surveyed, between 3.8% to 7.9% of the respondents were not currently employed as a dental hygienist.[16] On average, over three fourths of the respondents (78.5%) had provided dental care during the previous month, ranging from a low of 70.3% in September 2020 to a high of 83.2% in December 2020. Aerosol-generating procedures were common throughout the survey period. Most of the respondents had performed or were in the room during AGPs during the previous month at the time of the September 2020 survey (90.7% (n=3,037); a proportion that steadily rose to 97.1% (n=941) at the time of the last survey in August 2021.

Participants were asked in the May 2021 survey how the current level of AGPs that they had performed in the past month compared to before the COVID-19 pandemic. One third reported performing fewer AGPs (34.2%, n=351), however a small number (7.7%, n=79) reported performing more AGPs than before the pandemic. About half (58.1%, n=596) performed the same number of AGPs as previously. Another noteworthy finding was that over the course of the survey, 0.9% of the respondents (n=62) reported the primary reason they voluntarily stopped working as a dental hygienist was due to concerns regarding safety standards in their place of employment.

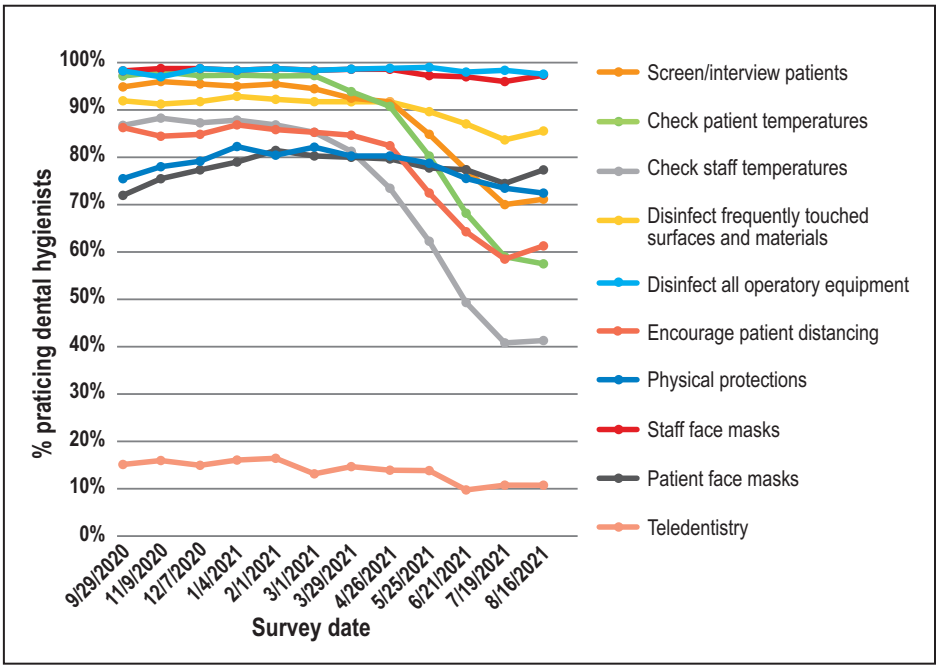
Infection prevention and control practices

Almost all practicing dental hygienists (99.9%, 14,926 observations) reported there were COVID-19 specific infection prevention control practices in place at their primary dental practice. On average, they selected a total of 8 (SD: 1.78) of the 11 different categories of IPC. Most common categories included disinfecting equipment in the operatory between patients (99.4%), staff masking (99.1%), screening patients for COVID-19 symptoms and exposure (97.4%) and disinfecting frequently touched surfaces (94.2%). Only 0.4% of the respondents indicated that there were no IPC protocols in their primary dental practice in response to COVID-19.

Each month, >96% of respondents reported disinfecting all operatory equipment between patients (linear regression slope for time trend: -0.0001, *p*-value: 0.7) and used face masks for all staff (linear regression slope: -0.001, *p*-value: 0.07) (Figure 1). The use of teledentistry decreased significantly over time (linear regression slope: -0.005, slope *p*-value: 0.0004) from the highest rate reported in February 2021 (15.8%) to the lowest rate in August 2021 (10.0%). Five different IPC practices (screening or interviewing patients before appointments, checking patient temperatures before treatment, checking staff temperatures at shift start, disinfecting frequently touched surfaces, and encouraging distancing between patients) were in place in most practice settings (85%) until March 2021, at which point significant decreases were reported (linear regression slopes: -0.051814, -0.084345, -0.084339, -0.016331, -0.057588 respectively, all slope *p*-values <0.005). Interestingly, providing patients with masks in the practice setting increased from September 2020 (72.2%) to February 2021 (81.7%), then declined to 77.3% by August 2021 (Joinpoint regression model *p*-value: 0.0007). Similarly, physical changes to the dental practice to reduce COVID-19 spread increased from 75.5% in September 2020 to a high of 82.3% in March 2021, then declined to 72.9% by August 2021 (Joinpoint regression model *p*-value: 0.02).

Expanded questions regarding specific IPC procedures were added to the August 2021 survey. Most reported using pre-procedural mouth rinses (63.7%, n=615), high evacuation suction (84.4%, n=814), four-handed dentistry (57.5%, n=555), and limited

Figure 1. Infection prevention and control practices (IPC) in the dental practice (n=5,521)



clinical care to one patient at a time per operatory (78.3%, n=756). About one quarter used dental dams (26.2%, n=253) and limited the number of dental health care professionals present in the operatory during procedures (23.5%, n=227).

Over the entire period of the study, nearly all (97.8%, n=5,431) of the respondents reported that their dental practices screened non-employees for COVID-19 symptoms and possible exposures and did not allow entry any individual with suspected or confirmed COVID-19 infection, making them exempt from the OSHA Healthcare ETS.[15] The OSHA Healthcare ETS requires non-exempt workplaces to have a COVID-19 plan.[15] A minority of the respondents (1.1%, n=59) reported that their dental practice allowed people with suspected or confirmed COVID-19 to enter the setting and so they were not exempt from the OHSHA requirement. Of the non-exempt practices, 45.5% (n=10) of the participants had a COVID plan while 18.2% (n=4) did not, and 36.7% (n=8) were unsure. Overall, nearly half (47.1%, n=397) of the respondents reported their dental practice had a COVID-19 plan, while 21.6% (n=182) did not, and 31.3% (n=264) were unsure.

After adjusting for other dental practice-related characteristics, years of experience and COVID-19 vaccination, were not significantly associated with the odds of practicing dental hygiene with eight or more types of IPC (Table I). Practice setting was a significant factor for the number of IPC measures. When compared to dental hygienists in private solo practices, dental hygienists in public health (adjusted Odds Ratio (aOR): 1.96, 95% Confidence Interval (CI): 1.01, 3.80) or academic settings (aOR: 6.41, 95% CI: 1.96, 20.93) had higher odds of practicing dental hygiene with more types of IPC. Higher respirator, but not mask, supply was also associated with significantly higher odds of more types of IPC (aOR: 2.50, 95% CI: 1.80, 3.47). Those who always wore CDC-recommended PPE had significantly higher odds of also practicing with more types of IPC (aOR: 3.32, 95% CI: 2.56, 4.29). Finally, increasing levels of COVID-19 infections in the community were associated with increasing odds of using more IPC (Table I).

Personal protective equipment

Nearly all (89.7%, 13,395 observations) participants reported their PPE use. In areas with little to no community transmission of COVID-19, the CDC recommended

Table I. Characteristics associated with higher number of infection prevention and control practices (IPC) (n=5,521)

Characteristic	n (%)	Unadjusted Odds Ratio (95% CI)	Adjusted* Odds Ratio (95% CI)
Years' experience			
0-10	1484 (77.0)	ref**	ref
11-20	1188 (80.1)	1.08 (0.86, 1.35)	1.02 (0.65, 1.62)
21 or more	1696 (84.0)	1.39 (1.14, 1.71)	1.31 (0.87, 1.97)
Practice setting			
Private solo practice	1907 (81.1)	ref	ref
Group practice	1074 (82.9)	1.08 (0.87, 1.34)	1.12 (0.78, 1.62)
Public health	185 (89.4)	1.44 (0.93, 2.25)	1.96 (1.01, 3.80)
Academic	91 (94.8)	4.46 (2.18, 9.12)	6.41 (1.96, 20.93)
Other	94 (74.6)	0.63 (0.35, 1.15)	0.44 (0.17, 1.16)
Mask supply			
≤7 days	248 (67.8)	ref	ref
>7 days	3895 (80.6)	1.69 (1.32, 2.16)	1.11 (0.68, 1.80)
N95 or equivalent respirator supply			
≤7 days	914 (65.0)	ref	ref
>7 days	3410 (83.0)	3.35 (2.83, 3.97)	2.50 (1.80, 3.47)
COVID-19 vaccination			
Unvaccinated	353 (71.3)	ref	ref
Fully or partially vaccinated	1795 (77.1)	1.24 (0.91, 1.69)	0.75 (0.48, 1.16)
COVID-19 community transmission level			
Low	110 (65.9)	ref	ref
Moderate	1078 (66.7)	1.27 (0.78, 2.07)	1.31 (0.62, 2.80)
Substantial	1781 (75.1)	2.23 (1.37, 3.62)	2.33 (1.10, 4.97)
High	2971 (78.9)	3.11 (1.93, 5.01)	3.62 (1.72, 7.62)
PPE			
Did not always wear CDC-recommended PPE	2527 (73.4)	ref	ref
Always wore CDC-recommended PPE	2807 (83.2)	2.60 (2.29, 2.95)	3.32 (2.56, 4.29)

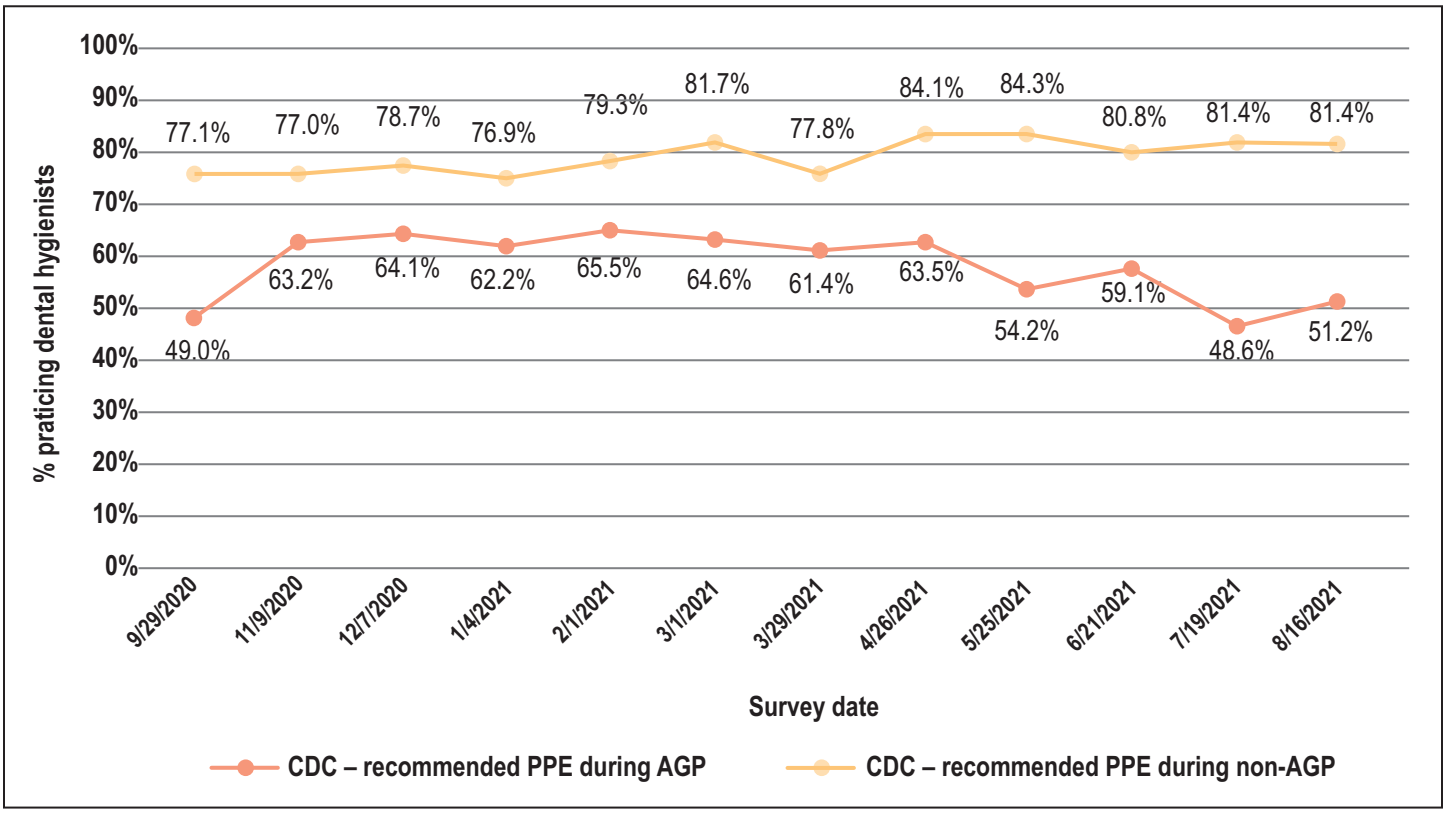
*Adjusted for all variables in the table. **ref = reference category

dental healthcare workers continue to adhere to standard precautions, whereas more protective PPE was recommended in areas with moderate or greater community transmission.[4] Over the period of study (September 2020 through August 2021), most US jurisdictions experienced at least moderate levels of community transmission of COVID-19.[5] Only 3.2% (n=167) of respondents reported practicing dental hygiene during a period of minimal community transmission in their state or territory. Most respondents reported always wearing a surgical mask or respirator, eye protection, gloves, and gown during non-AGPs, and this rose slightly over time (linear regression slope: 0.005, slope *p*-value: 0.004) from 77.1% (n=2,587) in September 2020 to >80% at all surveyed times after March 2021 (Figure 2).

There were more changes over time in the use of PPE during AGPs. In the first month of the survey (September 2020) nearly half of the respondents (49.0%, n=1,644) always wore CDC-recommended PPE, however this is likely underestimated as the survey item did not differentiate between PPE used in AGPs versus non-AGPs. In subsequent months, separate items addressed PPE used during AGPs and non-AGPs. From November 2020 through April 2021, more than 61% of the respondents reported always wearing CDC-recommended PPE during AGPs. However, beginning in May 2021 there was a significant decrease over time (linear regression slope: -0.012667, slope *p*-value: 0.005) in the proportion of respondents who always wore CDC-recommended PPE during AGPs and by the end of the study period (August 2021) only half (51.2%, n=496) followed CDC-recommended PPE guidelines. In the May 2021 survey, participants were asked how frequently they used a fit tested N95 or equivalent respirator during AGPs. Nearly half (45.6%, n=390) said they wore it all the time, 5.7% (n=49) most of the time, 7.5% (n=64) some of the time, and 41.2% (n=353) never wore a fit tested respirator during AGPs.

Most respondents (91%) reported that their primary dental practice had >7 days' supply of surgical masks each month of the survey; this response did not vary significantly over time (linear regression slope *p*-value: 0.3). More variations were seen in the proportion of dental practices with >7 days' supply of N95 or equivalent respirators, first increasing significantly from a low of 77.9% (n=2,619) in September 2020 to a high of 83.1% in March 2021 (n=964) (linear regression slope: 0.07046, slope *p*-value: 0.002), then decreasing significantly until the study ended in August 2021 to 76.7% (n=742) (linear regression slope: -0.016124, slope *p*-value: 0.013). Respirator supply levels were associated with always wearing CDC-recommended PPE. When compared to participants

Figure 2. Consistent use of personal protective equipment by survey month (n=5,521)



working in dental practices with ≤7 days' supply of N95 or equivalent respirators, significantly more participants working in dental practices with >7 days' worth of N95 or equivalent respirators reported wearing PPE according to the CDC guidelines (Table II). However, a dental practice days' worth supply of surgical masks was not associated with always wearing PPE according to CDC guidelines (Table II).

Table II. Characteristics associated with always wearing CDC recommended PPE (n=5,521)

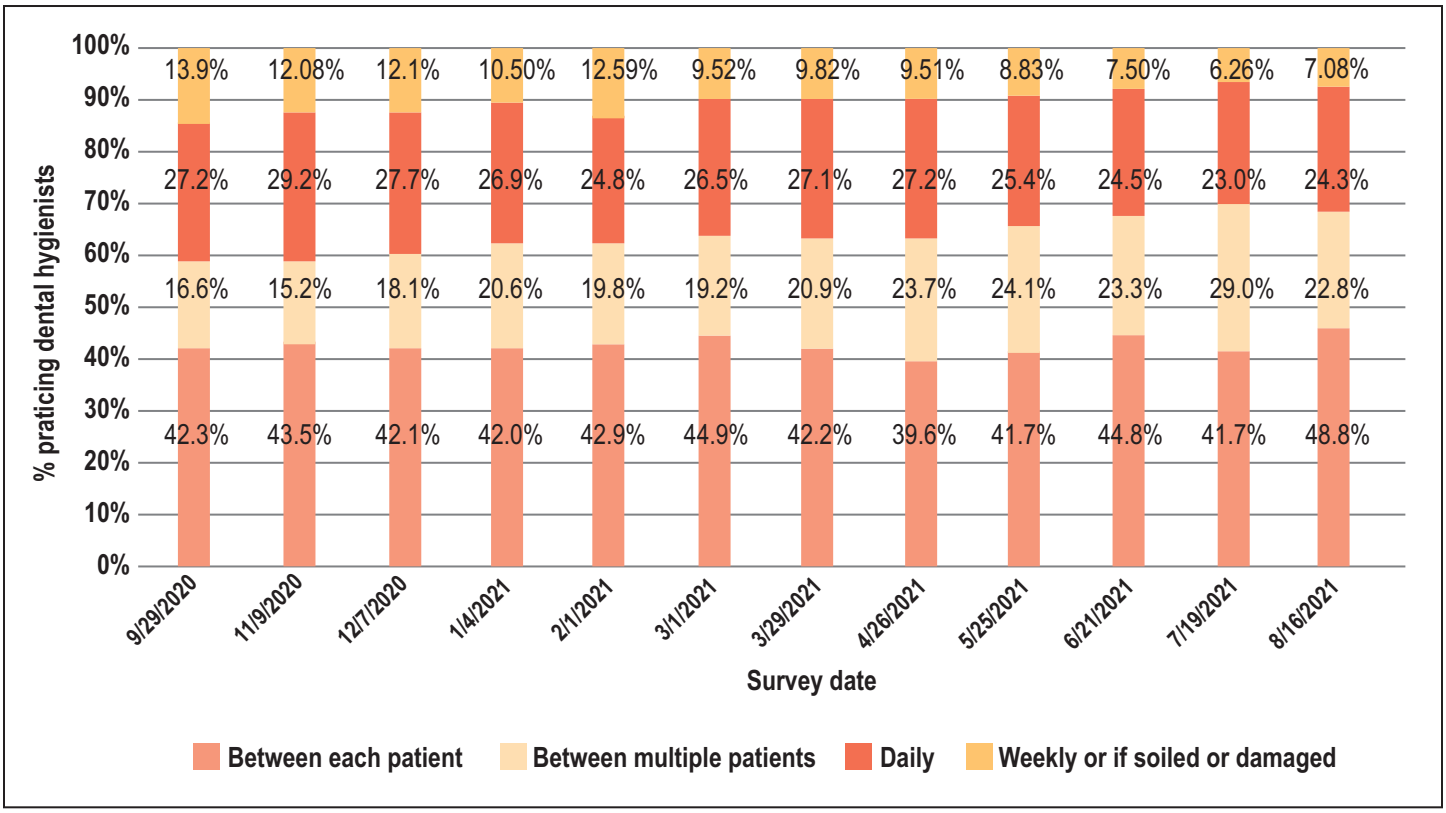
Characteristic	n (%)	Unadjusted Odds Ratio (95% CI)	Adjusted* Odds Ratio (95% CI)
Years' experience			
0-10	1126 (58.4)	ref**	ref
11-20	900 (60.7)	1.03 (0.83, 1.28)	0.94 (0.58, 1.54)
21 or more	1338 (66.2)	1.34 (1.10, 1.63)	1.52 (0.98, 2.35)
Practice setting			
Private solo practice	1404 (59.7)	ref	ref
Group practice	780 (60.2)	0.91 (0.76, 1.08)	0.65 (0.44, 0.97)
Public health	147 (71.0)	1.18 (0.84, 1.66)	2.00 (1.01, 3.99)
Academic	72 (75.0)	0.73 (0.53, 1.28)	2.80 (0.98, 8.05)
Other	81 (65.3)	0.82 (0.54, 0.66)	2.23 (0.77, 6.46)
Mask supply			
≤7 days	315 (51.0)	ref	ref
>7 days	2941 (60.9)	1.31 (1.04, 1.67)	0.70 (0.42, 1.17)
N95 or equivalent respirator supply			
≤7 days	550 (39.1)	ref	ref
>7 days	2742 (66.8)	4.18 (3.54, 4.93)	4.38 (3.06, 6.28)
COVID-19 vaccination			
Unvaccinated	242 (48.9)	ref	ref
Fully or partially vaccinated	1558 (66.9)	2.53 (1.82, 3.52)	3.53 (2.21, 5.64)
COVID-19 community transmission level			
Low	137 (82.0)	ref	ref
Moderate	842 (52.1)	0.10 (0.05, 0.17)	0.05 (0.02, 0.12)
Substantial	1323 (55.8)	0.13 (0.08, 0.23)	0.09 (0.03, 0.21)
High	2338 (62.1)	0.17 (0.10, 0.29)	0.10 (0.04, 0.24)
Infection prevention and control (IPC)			
Fewer than 8 IPC measures in practice	1056 (48.1)	ref	ref
8 or more IPC measures in practice	2807 (63.6)	2.63 (2.31, 3.00)	3.47 (2.65, 4.54)

***Adjusted for all variables in table. **ref = reference category**

Participants reported how frequently they changed masks or respirators. Each month between 39.6 to 45.8% of the respondents changed masks/respirators between each patient, 15.2 to 29.0% between multiple patients, and 24.8 to 29.2% daily (Figure 3). The proportion who changed their masks/respirators only weekly or if soiled or damaged significantly decreased over time from 13.9% (n=117) in September 2020 to 7.08% (n=73) in August 2021 (linear regression slope: -0.006324, slope p-value: 0.000001). Frequency of mask or respirator changing seemed associated with PPE supply levels. Most participants reporting changing their mask/respirator between every patient had >7 days' supply in their dental practice (94.9%, n=1,527), compared to 89.3% (n=324) of those who changed their mask only weekly, when soiled, or when damaged. Similarly, most respondents (83.7%, n=1,277) who changed their mask/respirator in between every patient had >7 days' supply in their dental practice, compared to 76.6% (n=279) of those who changed their mask/respirator weekly, when soiled, or when damaged.

A greater than 7 day supply of respirators was associated with higher odds of always wearing CDC-recommended PPE (aOR: 4.38, 95% CI: 3.06, 6.28). Controlling for years of experience, practice setting, mask and respirator supplies, level of community transmission of COVID-19, and IPC, dental hygienists with at least one dose of COVID-19 vaccine had 3.53 higher odds (95% CI: 2.21, 5.64) of always wearing PPE according to CDC guidelines as compared to unvaccinated respondents (Table II). Respondents practicing in dental settings with at least the mean number of IPC measures in place had higher odds (aOR: 3.47, 95% CI: 2.65, 4.54) of always wearing PPE according to CDC guidelines as compared with those who had implemented fewer IPC measures. Respondents were most likely to wear CDC-recommended PPE during periods of low COVID-19 community transmission (when N95 or

Figure 3. Frequency of changing masks/respirators by survey month (n=4,833)



equivalent respirators were not required during AGPs) and high COVID-19 community transmission (Table II).

COVID-19 testing

By the end of the study period (August 2021), half of the participants (50.7%, n=3,533) had been tested for COVID-19 at least once, and 8.8% (n=614) had ever had COVID-19. By August 2021, 6.8% (n=475) of the respondents reported ever meeting a dental patient in person who had a suspected or confirmed case of COVID-19. A slightly larger proportion (10.0%, n= 700) reported ever meeting someone they worked with in person who had a suspected or confirmed COVID-19. In January 2021 more participants rated the importance of rapid COVID-19 testing at their dental practice as extremely or very important for the dental team (60.1%, n=894), than for patients (52.3%, n=785), or themselves (59.6%, n=889).

Open-ended comments

Participants were given the opportunity to provide open-ended comments in the last survey (August 2021). Three main themes relating to PPE and IPC emerged. Respondents were concerned to see a decrease in precautions such as PPE, patient screening, and waiting room disinfection over time, particularly considering increasing SARS-CoV-2 variants and COVID-19 cases. These comments align with the observed declining trends in overall use of PPE and IPC measures and were also consistent with respondents' descriptions of declining supplies of N95 or equivalent respirators in dental practices. Finally, participants expressed frustration over a perceived lack of consistency in guidance and enforcement of safety standards.

Discussion

Throughout the study period, nearly all respondents reported COVID-19 specific IPC in place at their primary practice setting (>99% each month). The majority of practicing dental hygienists also reported always wearing a mask or respirator and eye protection during patient care (>76% each month). However, since the beginning of 2021, significant declines in use of N95 or equivalent respirators during AGPs as well as in some of the IPC methods were reported. Dental practice setting, respirator supplies, COVID-19 vaccinations, and COVID-19 community transmission levels were significantly associated with IPC and PPE use.

The continued use of AGPs, and in some cases increased use, when national guidance advised avoiding these procedures is concerning, particularly in light of the newer SARS-CoV-2 variants. Utilizing ultrasonic instrumentation when hand instruments are readily available may be associated with the misperception that ultrasonic instruments are superior to hand

instruments for treating periodontally-involved conditions. A recent meta-analysis comparing hand and sonic/ultrasonic instruments for periodontal treatment demonstrated no significant differences between the two instrumentation modalities in terms of clinical attachment level and probing pocket depth at 3 and 6 month time frames.[17] In another systematic review and meta-analysis ultrasonic and manual scaling was compared at different probing pocket depths along with clinical attachment loss reduction during periodontal treatment.[18] Results from this analysis revealed that manual subgingival scaling was superior when initial probing depths were 4-6 mm, manual scaling was superior in terms of periodontal pocket depth reduction.[18] Further findings indicated that when initial probing depths were ≥6 mm, the periodontal probing depth and clinical attachment reductions suggested that manual subgingival scaling produced superior results.[18] Clinicians should be able to provide effective patient care without increasing (or generating) aerosols in the operatory environment.

Academic and public health settings had higher rates of PPE usage and IPC measures than private practice settings. Combined with the close association between supply of N95 or equivalent respirators and consistent respirator use, these findings indicate that practice-level policies and resources influence the adherence to CDC guidance or OSHA regulations. Consistent with research in dental practices outside the US,[7, 8] high community transmission levels of COVID-19 were associated with more types of IPC measures and use of the CDC-recommended PPE. Content analysis of write-in responses showed that most dental hygienists would welcome more guidance and enforcement of the COVID-19 mitigation methods recommended by public health agencies such as the CDC and regulatory bodies such as OSHA.

There are limitations to this study. All the data is based on self-report, which is subject to recall and social desirability bias. There were missing data for 10.3% of the PPE questions, so there may be non-response bias. However, confidence in these findings can be strengthened by the size of the sample population (n=6,976) and representative demographics that included territories, and all states and districts of the US. Further, the study's prospective data collection allowed for a unique evaluation of trends in PPE use and IPC measures over the course of the pandemic in the US. Useful future research could include an evaluation of best practices in maintaining and encouraging COVID-19 risk mitigation procedures in dental settings.

Conclusion

Most dental hygienists indicated always wearing masks and eye protection during patient care. Dental practices have instituted a variety of IPC measures to reduce the risk of COVID-19 transmission. Nevertheless, the use of N95 or equivalent respirators and some IPC methods declined during 2021. Given the ongoing COVID-19 pandemic and the emergence of new variants, there is a need for increased education and policies to support continued use of PPE and IPC as recommended by the CDC and required by government regulatory agencies.

Disclosures

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Research

Employment Patterns of Dental Hygienists in the United States During the COVID-19 Pandemic: An update

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Abstract

Purpose: Despite recovery in dental practices' patient volume, dentists in the United States (US) continue to report difficulties in hiring dental hygienists due to the COVID-19 pandemic. This study updates previous data on US dental hygienists' employment patterns and attitudes concerning returning to work.

Methods: Licensed dental hygienists were invited to participate in monthly web-based surveys between September 2020 and August 2021. Employment questions included current and pre-pandemic work status as well as reasons for not currently working as a clinical dental hygienist. Descriptive statistics were used to describe dental hygienists' employment status and reasons for not currently working. Cross tabulation analysis included employment status and reasons for not working by age group.

Results: As of August 2021, 4.9% (n=59) of the participants reported that they were not currently employed as a dental hygienist. Most reported that the reason for non-employment as a dental hygienist was voluntary (74.1%; n=43). Safety concerns for self and others were the primary reasons for not returning to work; participants also indicated retirement or that they no longer wished to practice due to the pandemic. However, the percentage of respondents citing insufficient childcare, wanting the COVID-19 vaccine but not obtaining it, and having an underlying health condition, decreased between the beginning and the conclusion of the study.

Conclusion: A measurable degree of hesitancy among US dental hygienists to return to work has persisted over a year and a half into the pandemic and may continue despite some improvements in workplace safety and vaccine uptake. Future research should examine workforce levels after the pandemic resolves.

Keywords: COVID-19, employment patterns, dental hygienists, pandemic, dental hygiene workforce

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Introduction

More than a year and a half into the pandemic, COVID-19 continues to fill hospital beds and disrupt the United States (US) health care system. As of late October 2021, there have been more than 45 million reported cases in the US and more than 740,000 deaths.[1] Only 63.2% of the U.S. population is fully vaccinated,[1] and COVID-19 variants prevents the "return to normal" and poses risks to all sectors of the population, including children.[2] Despite these setbacks, the US dental care system has shown positive signs of recovery. As of the week of October 11, 2021, nearly all dental practices are open and average patient volume has been reported to be 90% of pre-COVID levels.[3] Supplies of personal protective equipment (PPE) are no longer as big of an obstacle for employers as they were in early 2020 and fewer dentists reported the need to take additional measures such as borrowing money from a bank to maintain financial stability.[3] However, a recurring issue reported by dentists is the inability to hire dental practice staff, particularly dental hygienists. Nearly one-third (31.7%) of surveyed dentists are actively recruiting dental hygienists, and 90% of those

dentists said recruiting dental hygienists is extremely or very challenging compared to before the pandemic.[3]

In a previous study of employment patterns of dental hygienists during the pandemic, it was noted that the majority of surveyed dental hygienists who were unemployed in October 2020 left the workforce voluntarily, primarily due to concerns about workplace safety as well as the ability to find childcare.[4] A study of dental hygiene employment conducted prior to the COVID-19 pandemic in 2019 found that 43% of dental hygienists indicated the primary reasons for seeking a new job in the coming year included not feeling valued or respected and finding their current compensation unacceptable.[5] The effects of COVID-19 compounded these sentiments in that employees were unhappy about being required to use paid vacation time and sick time to cover the office shutdowns; and once they returned to work, they faced longer hours, more rigorous safety protocols, and more hand scaling in order to reduce aerosols.[5] Studies continue to indicate that the pandemic has had a more significant economic impact on women.[6,7] Female-dominated professions, including dental hygiene, are bound to see setbacks in employment recovery.

Since September 2020, the American Dental Hygienists' Association (ADHA) and the American Dental Association's Health Policy Institute (HPI) have tracked employment pattern data among dental hygienists.[4,8] Continued research is needed to identify ways to support dental hygienists who may be reluctant to rejoin the workforce and for dentists and policymakers to better understand the challenges that remain in hiring of dental practice personnel. The purpose of this study was to update previous research on dental hygienists' employment patterns and reasons for exiting the workforce during the pandemic.

Methods

A total of twelve anonymous, web-based surveys (Qualtrics; Provo, UT, USA) were administered between September 2020 and August 2021, with gaps ranging from four to six weeks between waves of data collection. Licensed dental hygienists in the American Dental Hygienists' Association (ADHA) database (n=133,000) were invited to participate in the study if they were at least 18 years old and had been employed as a dental hygienist as of March 1, 2020, prior to the closure of dental practices in the US due to the COVID-19 pandemic. Participants gave written informed consent before the survey, and there was no incentive given to respondents for participating. The survey was sent monthly and remained open for 5-10 days for responses. Further details of the study population and questionnaires are described in previous publications.[4,9]

Statistical analysis was conducted in Qualtrics Core XM and SAS 9.4 (SAS Institute Inc., Cary, NC, USA). Descriptive statistics were used to track respondent employment status and reasons for not currently working. Cross tabulation analysis included employment status and reasons for not working by age group. Due to the complex survey question skip patterns and because respondents were able to skip any non-screening question or stop answering the survey at any time, not all respondents answered all questions.

Results

Of the respondents who opened the first survey in September 2020 (n=4,804) approximately 4,300 dental hygienists representing all 50 states, Washington D.C., Puerto Rico, and the Virgin Islands volunteered to join the panel and receive monthly surveys. In subsequent waves, new participants were recruited to increase the number of respondents and to replace those that dropped out. A total of 19,065 responses were received over the course of the study. Including those who joined the panel after the first wave of the survey, a total of 6,976 eligible dental hygienists agreed to the consent form and participated in at least one wave of the survey. The number of responses received following the baseline survey ranged from 960 to 1,629 per wave. Respondents were primarily female (88.8%, n=6,192), ranged in age from 18 to 77 years of age (mean: 44.4, SD:11.9), and predominantly non-Hispanic white (73.4%, n=5,118). Sample demographic information is highlighted in Table I.

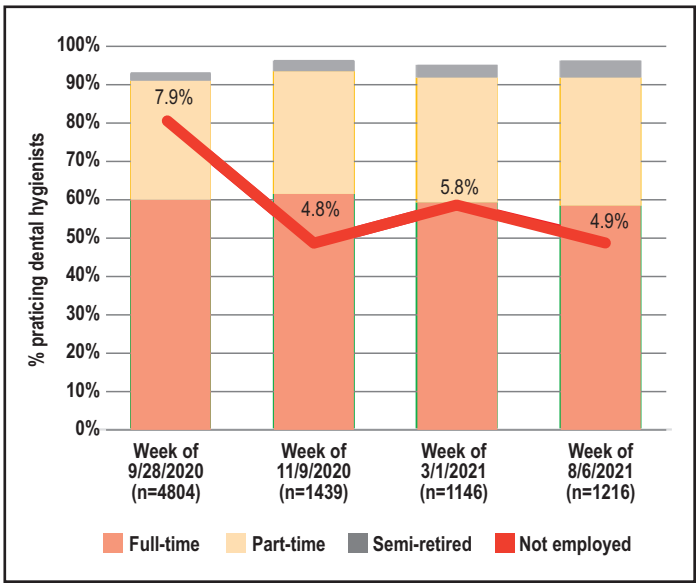
Six months into the pandemic and during the initial wave of the survey, about 8% of the respondents (n=360) who had been employed as of March 1, 2020, indicated that they had left their jobs. In subsequent months of the study, the percentage of respondents who were not employed as dental hygienists dropped to 3.8% (April 2021) and never rose above 5.8%. When the study concluded in August 2021, 4.9% (n=59) of participants were still not employed as dental hygienists (Figure 1).

All age groups experienced shifts in employment status compared to pre-pandemic work, and there was a decline in the percentage working full-time. In March 2020, 68.2% (n=4,600) of the participants were employed in full-time positions. As of August 2021, the number of participants employed full-time fell to 57.6% (n=701), whereas those working part-time (33.1%, n=403) or who were semi-retired (4.4%, n=53) increased compared to pre-COVID-19 levels. Respondents in older age groups were more likely to be working less or not at all in August 2021 compared to March 2020. One in seven dental hygienists over the age of 65 were not employed (14.5%, n=12) and one in four were semi-retired (24.1%, n=20), compared to

Table I. Sample demographics (n=6,976)

Characteristic	n (%)
18-29	722 (10.4)
30-39	1708 (24.5)
40-49	1533 (22.0)
50-64	1985 (28.5)
65-77	260 (3.7)
Did not indicate	768 (11.0)
Non-Hispanic White	5118 (73.4)
Hispanic/Latino	483 (6.9)
Non-Hispanic Asian	231 (3.3)
Non-Hispanic Black	142 (2.0)
Other or missing	1002 (14.4)
Male	76 (1.1)
Female	6192 (88.8)
Other or prefer not to say	708 (10.1)
Private solo practice	2717 (38.9)
Group dental practice	1490 (21.4)
Public health	263 (3.8)
Academic/university/college	129 (1.8)
Military	19 (0.3)
Other or failed to indicate	2213 (31.7)
0-10 years	2230 (32.0)
11-20 years	1693 (24.3)
21 or more years	2398 (34.4)
Did not indicate	655 (9.4)
New England (CT, ME, MA, NH, RI, VT)	535 (7.7)
Middle Atlantic (NJ, NY, PA)	700 (10.0)
East North Central (IN, IL, MI, OH, WI)	955 (13.7)
West North Central (IA, KS, MN, MO, NE, ND, SD)	433 (6.2)
South Atlantic (DE, DC, FL, GA, MD, NC, SC, VA, WV)	1013 (14.5)
East South Central (AL, KY, MS, TN)	273 (3.9)
West South Central (AR, LA, OK, TX)	467 (6.7)
Mountain (AZ, CO, ID, NM, MT, UT, NV, WY)	615 (8.8)
Pacific (AK, CA, HI, OR, WA)	988 (14.2)
Territories (PR, VI)	4 (0.1)
Did not indicate	993 (14.2)

Figure 1. Employment status of dental hygienists over time



2.8% (n=5) not employed and 0% semi-retired, among those under 35 years of age (Table II).

In the baseline survey, most participants (59.1%, n=205) who were currently not working were doing so voluntarily. Over the course of the study, voluntary departures were predominant and increased proportionately over time. As of August 2021, just under three-quarters (74.1%, n=43) of respondents not employed as dental hygienists left their positions voluntarily. The proportion of participants laid off or furloughed by their employers fell from 24.1% (n=84) in September 2020 to 6.9% (n=4) in August 2021, while those permanently let go increased slightly between those same time periods, rising from 16.7% (n=58) to 19.0% (n=11) (Figure 2).

Each month, respondents who were no longer employed in a position as a clinical dental hygienist reported the reasons they had left the workforce. Safety concerns for self and others were the primary reasons for electing not to work. Throughout the course of the study, "I do not want to work as a dental hygienist until after the COVID-19 pandemic is under control" was the response given by at least 30% of respondents; this response peaked during the December 2020 wave of data collection (71.4%, n=25). "I have concerns about my employer's adherence to workplace/safety standards" was reported by 20% to 60% of respondents in each round of the survey. Workplace safety remained the second most important concern reported by participants throughout the study.

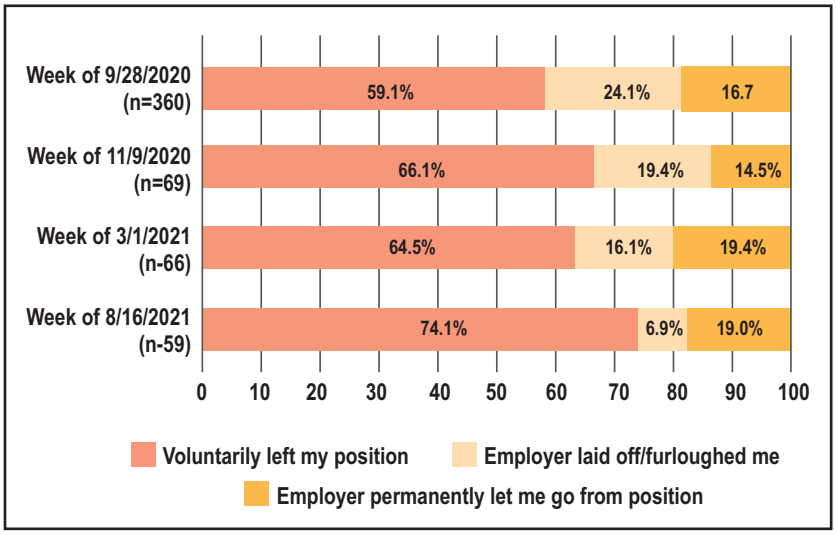
In early March 2021, nearly one-third (32.5%, n=13) of the participants choosing not to practice reported that they were waiting to receive the COVID-19 vaccine. By August 2021, 80.5% of the study participants were partially or fully

Table II. Employment status among respondents pre-COVID-19 (n=6,749) and as of August 2021 (n=1,216)

Status on March 1, 2020				Status as of August 16, 2021			
Years of Age	Employed Full-Time	Employed Part-Time	Semi-Retired	Employed Full-Time	Employed Part-Time	Semi-Retired	Not Employed
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
18-34	1175 (76.1)	368 (23.8)	2 (0.1)	128 (71.9)	45 (25.3)	0 (0.0)	5 (2.8)
35-44	1220 (71.4)	486 (28.5)	2 (0.1)	156 (60.7)	88 (34.2)	2 (0.8)	11 (4.3)
45-54	966 (66.9)	474 (32.8)	5 (0.3)	207 (64.7)	100 (31.3)	3 (0.9)	10 (3.1)
55-64	765 (61.2)	455 (36.4)	29 (2.3)	186 (50.5)	136 (37.0)	26 (7.1)	20 (5.4)
Over 65	104 (40.0)	138 (53.1)	18 (6.9)	19 (22.9)	32 (38.6)	20 (24.1)	12 (14.5)
All Ages*	4600 (68.2)	2081 (30.8)	68 (1.0)	701 (57.6)	403 (33.1)	53 (4.2)	59 (4.9)

*Includes respondents whose age was not reported.

Figure 2. Primary reason not working as a dental hygienist over time



vaccinated.[10] Waiting for the vaccine was no longer a significant factor for those voluntarily not employed as dental hygienists, as only 2.3% (n=1) cited this as a reason for not returning to clinical practice (Table III).

During the first several months of data collection, "I have insufficient childcare while working" was reported by about one-quarter of the voluntarily unemployed participants. However, beginning in April 2021, this reason began to decrease in prevalence and was reported to be 11.6% (n=5) at the conclusion of the study.

Early in this research, approximately one in ten participants reported voluntarily not returning to work in the dental practice because they had retired from the profession. Midway through the study in March 2021, one-fourth of the respondents (n=10) cited retirement as the reason for electing not to work in clinical practice. In the final wave of the study (August 2021), 37.2% (n=16) of respondents who were voluntarily no longer employed, indicated that they had retired. More than 80% of the participants who had voluntarily left dental hygiene practice due to retirement were over the age of 55.

Discussion

Study results indicate that the pandemic has resulted in a voluntary contraction of the US dental hygiene workforce by about 3.75%, or approximately 7,500 dental hygienists of the total dental hygiene workforce. In the final wave of the study, 1.6% of the participants indicated that they had either retired or no longer wanted to work clinically as a dental hygienist, which could represent a permanent reduction in the workforce of close to 3,300 dental hygienists.

The American Dental Association's Health Policy Institute (HPI) economic impact of COVID-19 dentist poll has periodically tracked the recruitment of dental hygienists throughout the pandemic.[3] In August 2021, 90% of dentists who were actively hiring dental hygienists considered recruitment "extremely" or "very" challenging compared to before the COVID-19 pandemic.[3] Recommendations for recruiting and retaining dental hygienists from the Academy of General Dentistry and others have included addressing reasons for dissatisfaction including workplace safety and compensation. Additional suggestions for recruitment and retention have included increasing communication and intentionally creating a culture that helps team members feel valued and appreciated such as reviewing compensation and offering retention bonuses, providing transparency, increasing benefits, reviewing dental hygiene production and hiring a dental hygiene assistant.[6,11] Effective interviewing, investing in the team, providing the opportunity

Table III. Reasons for not working as a dental hygienist at three points in time

Voluntary reasons for not working:	Week of November 9, 2020 (n=41)	Week of March 1, 2021 (n=40)	Week of August 16, 2021 (n=43)
	n (%)	n (%)	n (%)
I do not want to work as a dental hygienist until after the COVID-19 pandemic is under control	25 (61.0)	19 (47.5)	13 (30.2)
I have concerns about my employer's adherence to workplace/safety standards	13 (31.7)	11 (27.5)	9 (20.9)
I have insufficient childcare available while working	10 (24.4)	10 (25.0)	5 (11.6)
I have an underlying health condition	10 (24.4)	5 (12.5)	6 (14.0)
Someone in my household has an underlying health condition	7 (17.1)	8 (20.0)	7 (16.3)
I do not want to work as a dental hygienist any longer	4 (9.8)	5 (12.5)	6 (14.0)
I have retired from practicing dental hygiene	4 (9.8)	10 (25.0)	16 (37.2)
I am unable to tolerate wearing a mask or other PPE	4 (9.8)	2 (5.0)	6 (14.0)
I have accepted a non-dental hygienist position	3 (7.3)	5 (12.5)	6 (14.0)
My employer reduced my salary too much	3 (7.3)	1 (2.5)	0 (0.0)
I have moved to another state and am not licensed as a dental hygienist yet	1 (2.4)	0 (0.0)	3 (7.0)
I do not want to work as a dental hygienist until I receive the COVID-19 vaccine	n/a	13 (32.5)	1 (2.3)
Other reason	1 (2.4)	3 (7.5)	(3) 7.0
I prefer not to say	1 (2.4)	0 (0.0)	1 (2.3)

to take on new responsibilities and create innovation, and adherence to safety protocols following national guidance for a safe operatory were also recommended. [5,11]

Results of this study suggest that the COVID-19 pandemic has led to a reduction in the dental hygiene workforce, and based on recruitment challenges reported by dental practices, a labor shortage in the short-term. However, a small portion of the participants in this study indicated that they no longer want to be employed as a dental hygienist, even after the COVID-19 pandemic is under control. Findings from this study suggest that non-adherence to CDC infection control guidance and COVID-19 protocols in the workplace is of concern to dental hygienists and contributes to the decision whether to continue to be employed as a dental hygienist. It remains to be seen whether the supply of future dental hygienists will be sufficient in the long-term to replace those who are not returning to the workforce. The number of dental hygienists graduating from accredited dental hygiene programs in the United States from 2013 to 2019, hovered at around 7,300 annually, a number slightly below the estimated labor contraction caused by the pandemic.[12] Additionally, first-year enrollment in dental hygiene programs fell by about 7% for the 2020-21 academic year (the first cohort to enroll after the start of the pandemic), which may have a compounding impact on the outlook for the dental hygienist workforce. It is unknown whether this decline in enrollment was due to students selecting other fields of study or whether students were delaying the start of college for a year. Dental hygiene programs may also have reduced their enrollment numbers because of COVID-19 protocols for instruction.

This study is not without limitations. The research is based on self-reported data, which may be influenced by recall or social desirability bias. In addition, the small number of voluntarily unemployed respondents in each survey wave limits the generalizability of the results related to that subgroup. However, confidence in these findings can be strengthened by the large number of study respondents overall (n=6,976) and their representativeness of US dental hygienists. Future research should examine whether the supply of new dental hygiene graduates will be sufficient to maintain workforce levels after the COVID-19 pandemic

resolves. Studies should also address whether the recommended efforts to recruit and retain dental hygienists are effective. Examining the employment perspectives of dental hygienists from a qualitative perspective may yield greater understanding of the influencing factors that impact decisions to return to or engage in employment in clinical practice settings.

Conclusion

Results from this study provide the first empirical insight into the impact of COVID-19 on dental hygiene employment in the US. The impact of COVID-19 has led to a reduction in the dental hygiene workforce that is likely to persist at least until the pandemic passes. The labor market for dental hygienists has tightened, with significant recruitment challenges being reported by dentists looking to hire dental hygienists. Results also indicate there will likely to be a much smaller, but longer lasting impact, as some dental hygienists choose to permanently leave the workforce.

Disclosures

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Research

Compassion Satisfaction, Compassion Fatigue, and Burnout among Dental Hygienists in the United States

Amanda Knutt, RDH, CST, MSDH; Linda D. Boyd, RDH, RD, EdD; Jaymi-Lyn Adams, RDH, MS; Jared Vineyard, PhD

Abstract

Purpose: Compassion satisfaction allows for dental hygienists (DH) to grow professionally, but compassion fatigue can lead to burnout. The purpose of this study was to examine the relationship between compassion satisfaction (CS), compassion fatigue (CF), burnout (BO), to demographics and work characteristics, including thoughts of leaving the profession, among clinical DHs in the United States.

Methods: A cross-sectional survey research design was used with a non-probability sampling of clinical DHs (n=553) recruited via social media. Data collection consisted of demographics, work characteristics and the Professional Quality of Life Scale (ProQoL) (version 5). Descriptive, correlation, and logistic regression analyses were used to assess the relationships among variables. Thematic analysis was conducted for the open-ended question.

Results: The survey completion rate was 99% (n=527). The mean number of hours worked and number of days per week was 30.6 and 3.8 respectively and, on average, participants had worked 19.3 years in clinical practice. Approximately 70% of respondents indicated thinking about leaving the profession in the next five years. Participants with thoughts about leaving the field had a lower CS score ($p<0.001$), higher BO score ($p<0.001$), and higher CF ($p<0.001$) compared to those who had not thought about leaving the field. Age and years of experience positively correlated to CS and day per week worked negatively correlated to CF ($p<0.05$).

Conclusion: Compassion satisfaction appears to impact burnout and thoughts of leaving the dental hygiene profession. Findings suggest the need for further research to identify ways to prevent burnout and improve retention in the profession.

Keywords: Compassion satisfaction, compassion fatigue, burnout, dental hygienists, career satisfaction

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Introduction

Compassion is central to patient care and is considered to be an essential component of the role of a healthcare professional.[1] Compassion requires the provider to be intentional about getting to know a patient and their needs in order to take action to minimize pain and discomfort.[2] Compassion satisfaction (CS) is defined as pleasure derived from being able to do one's job well. Doing one's job well can contribute to a healthcare professionals' positive feelings towards one's job allowing for compassion competence.[1] Compassion competence is the ability to understand, identify, and limit patients' difficulties that can also contribute to the emotions of a health care professional.[3,4]

Studies have shown that over time compassion can diminish, allowing for an increase in compassion fatigue and burnout in health care professionals, including physicians, nurses, and midwives, just to name a few.[5–7] Negative emotions like cumulative work-related stress, depression, anxiety, and anger can play a critical role in compassion competence and can greatly affect the healthcare provider, leading to compassion fatigue.[5,6] This type of fatigue occurs in healthcare providers when they are no longer able to feel empathy and meet the emotional burden or needs of their patients.[2,8] Compassion fatigue has been referred to as the 'cost of caring' and occurs when the provider is not able to

adequately engage in self-care to refresh or refuel.[9] The risk factors for compassion fatigue include anxiety, excessive empathy, fewer years of experience, less education, and job-related factors.[5,10]

When compassion fatigue is not resolved, it can progress to burnout and impact the ability of the healthcare professional to provide compassionate care to patients.[4,8] Compassion fatigue may lead to healthcare professionals leaving their careers early, ahead of retirement, due to burnout.[11] To diminish clinical burnout, it is important to understand the factors leading to compassion fatigue and implement prevention and management strategies such as mindfulness.[11,12]

Most of the research related to the concept of compassion and compassion fatigue is in nursing with very little literature in the dental profession.[1,2,5,8,11,13,14] However, one study related to South Korean dental hygienists was conducted using the Professional Quality of Life (ProQoL) instrument. Results from the Han and Kim study showed compassion fatigue had a positive correlation with burnout whereas compassion satisfaction and social support was negatively correlated with burnout.[15] The stressors identified by Han and Kim were caused not only by the workplace itself, but also due to the interpersonal relationships in the workplace.[15] This included pressure, conflict, and competition between colleagues which lead to conflicts with patients.[15] While there could have been misinterpretation of the results due to the translation of the original study, the findings were consistent with the nursing literature. [5,8,11,13,14] Bercasio et al. used the Maslach Burnout Inventory to explore burnout in California DHs and found about a third of participants had high levels of emotional exhaustion which is a component of compassion fatigue in the ProQOL framework.[5,16,17] Patel et al. used the Oldenburg Burnout Inventory and also found emotional exhaustion was associated with burnout among clinical DHs.[18] In addition, Malcolm et al. found emotional demands was a predictor of burnout in clinical DHs.[19]

Given the centrality of compassion to dental hygiene care and paucity of research to explore compassion satisfaction, compassion fatigue, and burnout in clinical dental hygienists within the United States (US), more research is needed. The purpose of this study was to examine the relationship between compassion satisfaction (CS), compassion fatigue (CF), burnout (BO), demographics and work characteristics, such as thoughts of leaving the dental profession among clinical DHs in the US.

Methods

This study was granted exempt status by the MCPHS University Institutional Review Board (IRB) within accordance of revised Common Rule at 45 CFR 46.104 d (2)(ii) and was assigned protocol number IRB041120B. A cross-sectional survey research design was used with a non-probability sample of DHs. Participants were recruited from dental hygiene social media groups. Dental hygienists providing patient care in the US with a minimum of one year of clinical experience were eligible to participate. Respondents were excluded if they did not hold an active dental hygiene license, were not providing clinical patient care, had less than one year of clinical experience, and/or did not reside in the US.

A power analysis was conducted using G*Power for the most conservative prepared statistical test (one-way ANOVA, two-tailed, four groups) with a medium effect size (f=0.25), α=.05, and 80% power, recommended a minimum sample size of n=180. After adjusting for an expected attrition of 30%, the final recommended sample size was n=257.

Instruments

The survey consisted of two sections: demographics and work characteristics (17 items) and the ProQoL[20] (version 5; 30 items) for a total of 47 items. The demographic questions addressed age, gender, ethnicity, education, and geographic location. The work characteristic questions included: type of practice, days/hours worked per week, years of practice, average appointment times, possibility of leaving the field, and one open-ended question about reasons for wanting to leave the profession.

Professional Quality of Life Scale

The ProQoL[20] (version 5) is a validated survey used to evaluate professionals in a variety of fields defined as 'helper' professions about their levels of compassion satisfaction, compassion fatigue, and burnout. The instrument construct validity has been established in over 200 studies.[20,21] The ProQol consists of a series of 30 questions with sub-scales that include: compassion satisfaction (α=0.88), compassion fatigue (α=0.81), and burnout (α=0.75).[20,21] Convergent and discriminant validity have also been assessed and interscale correlations are small (2 to 5%) suggesting the sub-scales measure different constructs.[20] Test-retest reliability was good with small standard error.[20]

Each sub-scale contained 10 items scored on a five-point Likert-type scale (1=never, 2=rarely, 3-sometimes, 4=often, and 5=very often) and each sub-scale had a possible 50 points. The compassion satisfaction sub-scale scores were categorized as follows: high >42, moderate 33-41, and low <33 with an average of 37.[20] Burnout sub-scale scores were categorized as: high >27, moderate 18-26, and low <18 with an average of 22.[20] Compassion fatigue was categorized as: high >17, moderate 8-17, and low <8 with an average score of 13.[20]

Procedures

The survey was web-based and disseminated through social media groups. The social media group administrators were contacted for permission to post the survey invitation. Seven Facebook groups provided approval to post the survey invitation. Once permission was obtained, the invitation to participate was displayed on social media with the link to the electronic survey (Qualtrics; Provo, UT, USA). The survey link took the participant to the consent to participate page. If individuals did not meet study criteria and did not agree to participate, they were taken to the end of the survey. There were no incentives provided for participation. A reminder to complete the survey was posted weekly on the social media group sites. Once an adequate number of responses was obtained, the survey was closed. The survey was active for three weeks.

Analysis

The data was evaluated to identify any survey with less than 80% complete responses which were then excluded from parts or the entire analysis. Each variable was reviewed for change to report issues of non-normal distributions. Pearson's correlation coefficients were calculated to assess the relationship between continuous demographic variables and each ProQol subscale (compassion satisfaction, burnout, and compassion fatigue). Student's t-tests were calculated to determine if there was a difference in mean ProQol scores between dental hygiene degree type (associate or bachelor's), highest degree outside of dental hygiene (associate or bachelor's) and if a respondent had thought about leaving the field. For participants who had thought about leaving the field, a logistic regression was calculated with each subscale score to predict if the participant had thought about leaving (yes=1, no=0). The alpha level was set at .05 for hypothesis testing and all measures of effect size (i.e. 95% Confidence Interval, Phi Coefficient, R2, Cohen's d) were established and reported.

For the data from the open-ended question, responses were analyzed using a thematic approach to identify the most common words, phrases, or ideas from the data. While analyzing the responses, the data was continuously coded and organized categorically while being repeatedly reviewed. Codes were assigned to themes. Additionally, codes were cross checked by a second investigator to ensure trustworthiness and triangulate data to create a coherent justification for themes. In addition, respondent's words were used to illustrate the dimensions of the themes.

Results

A total of 553 individuals accessed the survey link. Twenty-six participants completed less than 80% of the survey, resulting in a completion rate of 99% (n=527). A national sample of DHs participated with an even distribution across the US with the exception of a smaller sample from the South. Most participants identified as White (88%, n=424), female (98.9%), had a mean age 44.6 (SD=11.8) of and worked clinically in private practice (89.7%). Approximately 73% (n=347) had an entry-level associate dental hygiene degree. The mean number of hours worked per week was 30.6 (SD=8.4) and the mean days worked per week was 3.8 (SD=1.0). The mean number of years providing clinical patient care was 19.3 (SD=12.8). More than two-thirds of the participants (68.2%, n=324) reported having thought about leaving the dental profession. However, less than one-third (28.8%, n=137) reported it was extremely or very likely they would leave dental hygiene practice within the next five years. Demographic and work characteristics are shown in Table I.

Professional Quality of Life

Nearly half of the participants (42.7%) indicated often or very often for the statement "I feel worn out because of my work as a helper" which is related to burnout, although a majority of participants (91.7%) responded often and very often to the statement "I get satisfaction from being able to help people" (Table II). Other findings noted with the ProQol was that participants stated, "I am happy (75.2%)," "My work makes me feel satisfied (55.7%)," and "I am happy that I chose to do this work (62.9%)", which are all related to compassion satisfaction. Other participants stated that "I feel 'bogged down' by the system (29%)," "I feel overwhelmed because my case workload seems endless (28.2%)," and "I feel trapped by my job as a worker (11.8%)." The mean levels of compassion satisfaction versus burnout and compassion fatigue were slightly different. The mean compassion satisfaction subscale scores were 39.0 (SD=6.2), while burnout was 22.73 (SD=5.6), and compassion fatigue was 20.68 (SD=5.2). Compassion satisfaction and burnout mean subscales scores were in the moderate range, while compassion fatigue mean scores was in the high range.

Pearson's correlation coefficients were calculated to assess the relationship between continuous demographic variables and each ProQol subscale (compassion satisfaction, burnout, and compassion fatigue). The correlation matrix for each comparison is shown in Table III. Increases in age (r=0.13) and years of experience (0.10) were positively correlated with compassion satisfaction (p<0.05). The number of days worked per week was negatively correlated with compassion fatigue

Table I. Demographics and work characteristics (n=527)

		Mean	SD
Age		44.6	11.8
		n	**%**
Gender	Male	3	0.6
	Female	469	98.9
	Not Listed	1	0.2
	Prefer Not to Answer	1	0.2
Ethnicity/Race	White	424	88
	Black or African American	6	1.2
	Native American or American Indian	4	0.8
	Hispanic or Latino	27	5.6
	Asian or Pacific Islander	15	3.1
	Other	6	1.2
Entry level dental hygiene degree	Certificate	10	2.1
	Associate Degree	347	73.2
	Bachelor's degree	117	24.7
Highest level of education	Associate Degree	241	50.8
	Bachelor's Degree	195	41.1
	Master's Degree	30	6.3
	Professional Degree	0	0.0
	Doctorate Degree	0	0.0
	Other	8	1.7

		n	%
Current Work Setting	Private Practice	426	89.7
	Public Health/FQHC	20	4.2
	Hospital Setting	3	0.6
	University Dental Clinic	7	1.5
	Nursing Homes	1	0.2
	Schools	6	1.3
	Prison Setting	3	0.6
	Dental Service Organizations (DSO)	14	2.9
	Mobile	1	0.2
	Other	20	4.2
US Region of Practice	West	134	28.2
	South	87	18.3
	Midwest	130	27.4
	Northeast	122	25.7
Thought of leaving the dental field	No	151	31.8
	Yes	324	68.2
Leave the dental hygiene field in the next 5 years	Extremely Unlikely	97	20.4
	Very Unlikely	125	26.3
	Somewhat Likely	116	24.4
	Very Likely	60	12.6
	Extremely Likely	77	16.2
Average hours worked per week			30.6 hrs
Average days worked per week			3.8 days
Average years providing clinical dental hygiene care			19.3 years

*Percentage may not total 100% due to missing responses

(r=-0.11) (p<0.05), although these relationships are considered small by conventional analysis.[22] All other correlations were non-significant (p>0.05).

Student's t-tests were calculated to determine if there was a difference in mean ProQol scores between dental hygiene degree type (associate or bachelor's), highest degree outside of dental hygiene (associate or bachelor's) and whether a DH had thought about leaving the field. Dental hygienists who have thought about leaving the field (n=324) had a lower compassion satisfaction score (M=37.6, SD=6.1, t=7.8, p<0.001), higher burnout score (M=24.3, SD=5.3, t=-9.9, p<0.001), and higher compassion fatigue (M=21.4, SD=5.2, t=-4.8, p<0.001) as compared to participants (n=151) who had not thought about leaving (M=42.1, SD=5.3; M=19.3, SD=4.6; M=19.0, SD=4.8). All significant p-values remained below 0.001 after assessing the assumption of equal variance using Levene's Test (p>0.05). Analysis showed no difference in mean subscale scores between an entry level associate degree versus a bachelor's degree in dental hygiene or for participants whose highest degree was an associate versus a bachelor's degree (p>0.05).

To determine the influence of each subscale score on leaving the dental hygiene profession, a logistic regression was calculated with each subscale score to predict if a respondent had thought about leaving (yes=1, no=0). The model predicted whether a respondent had thought about leaving the field (χ2(3)=97.2, p<0.001, Nagelkerk R=0.26). After controlling for the influence of burnout and compassion fatigue, compassion satisfaction was a significant predictor of thinking about leaving the profession (W=4.2, p=0.04). The model predicted for each unit increase in the compassion satisfaction score, an individual is 5% (Exp(β)=0.95) less

Table II. Responses to ProQoL items (n=527)

Pro QOL Sub-Scale		Never		Rarely		Sometimes		Often		Very Often	
		n	%	n	%	n	%	n	%	n	%
*BO	I am happy.	2	0.4	14	3	101	21	230	49	126	27
*CF	I am preoccupied with more than one person I help.	15	3	98	21	224	48	107	23	28	6
*CS	I get satisfaction from being able to help people.	0	0.0	2	0.4	37	8	168	36	266	56
BO	I feel connected to others.	0	0	11	2	95	20	209	44	156	33
CF	I jump or am startled by unexpected sounds.	34	7	168	35	159	34	73	15	41	9
CS	I feel invigorated after working with those I help.	2	0.4	32	7	149	31	191	40	100	21
CF	I find it difficult to separate my personal life from my life as a helper.	57	12	208	44	150	32	47	10	12	3
BO	I am not as productive at work because I am losing sleep over traumatic experiences of a person I help.	240	51	198	42	29	6	6	1	1	0.2
CF	I think that I might have been affected by the traumatic stress of those I help.	200	42	173	37	84	18	13	3	2	0.4
BO	I feel trapped by my job as a helper.	165	35	133	28	121	26	31	7	25	5
CF	Because of my helping, I have felt “on edge” about various things.	118	25	165	35	142	30	39	8	10	2
CS	I like my work as a helper.	3	0.6	16	3	98	21	234	49	124	26
CF	I feel depressed because of the traumatic experiences of the people I help.	184	39	197	42	81	17	9	2	3	0.6
CF	I feel as though I am experiencing the trauma of someone I have helped.	227	48	171	36	66	14	8	2	2	0.4
BO	I have beliefs that sustain me.	11	2	21	4	91	19	184	39	168	35
CS	I am pleased with how I am able to keep up with helping techniques and protocols.	1	0.2	14	3	99	21	252	53	108	23
BO	I am the person I always wanted to be.	2	0.4	39	8	157	33	208	44	68	14
CS	My work makes me feel satisfied.	8	2	36	8	166	35	173	37	91	19
BO	I feel worn out because of my work as a helper.	22	5	62	13	189	40	134	28	67	14
CS	I have happy thoughts and feelings about those I help and how I could help them.	1	0.2	7	2	134	28	232	49	101	21
BO	I feel overwhelmed because my case workload seems endless.	50	11	108	23	183	39	88	19	46	10
CS	I believe I can make a difference through my work.	3	0.6	30	6	158	33	168	35	116	24
CF	I avoid certain activities or situations because they remind me of frightening experiences of the people I help.	288	60.8	145	31	34	7	5	1	2	0.4
CS	I am proud of what I can do to help.	1	0.2	7	2	79	17	223	47	165	35
CF	As a result of my helping, I have intrusive, frightening thoughts.	304	64	135	29	31	7	4	1	0	0
BO	I feel “bogged down” by the system.	71	15	94	20	172	36	96	20	42	9
CS	I have thoughts that I am a “success” as a helper.	4	1	35	7	176	37	184	39	74	16
CF	I can’t recall important parts of my work with trauma victims.	208	44	178	38	62	13	14	3.0	7	2
BO	I am a very caring person.	1	0.2	3	0.6	27	6	181	38	263	55
CS	I am happy that I chose to do this work.	5	1	28	6	143	30	153	32	146	31

* BO-Burnout, CS-Compassion Satisfaction, CF-Compassion Fatigue

Table III. Demographic and ProQoL subcale correlations

	Compassion Satisfaction	Burnout	Compassion Fatigue
Age	.134*	-.074	-.028
Hours per week	.012	.013	-.058
Days per week	.021	-.026	-.111*
Years of experience	.099*	-.073	-.028

*Statistically significant correlation (p<0.05.)

likely to say they have thought about leaving the field. After controlling for compassion satisfaction and compassion fatigue, burnout predicted thinking about leaving the field (W=24.8, p<0.001). A one-unit increase in burnout predicted a 1.2 times increase in the likelihood a respondent had thought about leaving the field. After controlling for compassion satisfaction and burnout, compassion fatigue was not a significant predictor of thinking about leaving the dental hygiene profession (W=0.01, p=0.6).

To assess whether ProQol subscale scores were related to responses to the item regarding the likelihood of leaving the field in the next five years, response options were first recoded from extremely unlikely=1, unlikely=2, somewhat likely=3, likely=4, and extremely likely=5, into a new variable with two categories (1-2=unlikely [n=222]; 3-5=likely [n=253]). Three t-tests were calculated with the groups as dependent variables and each ProQol subscale score as a dependent variable. There was a difference in mean compassion satisfaction scores (t(473)=3.1, p=0.002), burnout (t(473)=-3.5, p<0.001), and compassion fatigue (t(473)=-2.1, p=0.04). The unlikely to leave category had a higher mean compassion satisfaction score (M=39.9, SD=6.0, p=0.002) than the likely to leave (M=38.2, SD=6.2) group. Those in the unlikely group had a lower mean burnout score (M=21.8, SD=5.3, p<0.001) than the likely (M=23.6, SD=5.7) group, and a lower mean compassion fatigue score (M=20.2, SD=5.4, p=0.04) compared to the likely (M=21.3, SD=5.0) group.

A Cohen's d was calculated for each t-test to determine the magnitude of effect. For compassion satisfaction (d=0.3) and burnout (d=0.3) Cohen's d indicated a medium effect size. The difference between likely and unlikely groups resulted in a small effect size (d=0.2).

Themes

A thematic analysis was conducted for responses to the open-ended question "What is your reason for wanting to leave the dental hygiene profession?" Four themes arose from the responses including: 1) stress, 2) physical demands, 3) negative work environment, and 4) production over patient care. Two-thirds (66%, n=349) of the participants responded to the open-ended question.

Theme 1: Stress

A common theme reported by participants related to signs of occupational stress. One participant illustrated their experience stating: "There is a lot of pressure to complete a lot of tasks with each patient along with caring confidently for the patient and doing home care and getting a room turned around between patients. There is [sic] honestly just too many tasks getting piled up into that one hour and sometimes it feels my license could be at risk because it is hard to meet all of the tasks. My level of stress is super high because I am trying to squeeze every second out of every hour, every day while I'm at work trying to make sure my patients get quality care.". "#1 COVID-19, #2 job stress/ body stress, and #3 possible retirement before I am ready due to COVID."

Theme 2: Physical Demands

Another theme that emerged as a reason for wanting to leave the field was related to physical demands of dental hygiene practice. Examples of quotes illustrating this theme included "Physical demands on my body. Back pain, hand/ finger pain, arthritis, etc." as well as "hand, shoulder, neck, and back pain."

Theme 3: Negative Work Environment

A negative work environment was also a theme from the respondents. Dental hygienists reported lack of respect by office staff or dentists: Sample quotes for this theme included "…profession not respected by dentist as a collaborating oral health care professional" and "Dentist unappreciative. No respect." A toxic environment was also described by respondents such as "Offices keeping toxic employees who create an environment that it's not easy to change any policy or procedure without major blowback."

Theme 4: Production over Patient Care

The final theme that emerged from open-ended comments was related to production being considered more important than patient care. Examples of this theme included "Push for production over patients' actual needs" and "Change from patient-centered to production centered."

Discussion

The purpose of this study was to examine compassion satisfaction, compassion fatigue, and burnout among clinical DHs and their relationship to demographics and work characteristics. Levels of compassion satisfaction, compassion fatigue, and burnout in DHs and selected

demographic and work characteristic variables were shown to be statically significant. In addition, when comparing the ProQoL general quartile cut-points to this study's findings, study participants had a compassion satisfaction (CS) and burnout (BO) score near the 75th percentile range (CS 42 [ProQoL] vs. 44 [study sample] and BO (27 [ProQoL] vs. 26 [study sample]).[16] However, participants in this study had a higher 75th quartile for compassion fatigue score at 24 vs. the ProQoL cut-off which was 17.[16] This comparison suggests a higher level of compassion fatigue in DHs when compared to other helper professions. This is an unexpected finding and needs further investigation because despite the study sample compassion fatigue score being above the 75th quartile, the standard deviation was less than one SD at 0.43. In addition to further research, the finding regarding compassion satisfaction suggests the importance of self-care to prevent and manage compassion fatigue. Employers could support clinical DHs by offering employee wellness programs.[5] In addition, integrating self-care strategies into the entry-level education programs could also serve to support DH students in developing habits that would serve them well once they begin clinical practice.[5,23]

In the 2016 study by Wu et al., oncology nurses had the following mean ProQoL scores of compassion satisfaction 42.37, compassion fatigue 22.65, and burnout 22.66,[14] which were similar to the mean scores of this study. The Han and Kim study found the mean burnout, compassion fatigue, and compassion satisfaction for a sample of Korean DHs trended higher than the values for this study's population.[15] These findings suggested the US sample had higher compassion satisfaction, lower compassion fatigue, and lower levels of burnout than the Korean sample of DHs.[15]

When exploring relationships between outcome variables (compassion satisfaction, compassion fatigue, and burnout) and demographic/work characteristics, the study findings showed greater age to result in higher compassion satisfaction and those working more days per week had lower compassion fatigue.[15] It is unknown why compassion fatigue would be lower when working more days per week. Potentially these individuals were more integrated into the office team with more effective teamwork for support, which might reduce stress. The findings related to age and compassion satisfaction in this study were slightly different than those of Han and Kim, who found a significant association between younger age and earlier in their career with burnout, but not compassion fatigue.[15] However, the Korean study found years of experience resulted in higher compassion satisfaction,[15] which is consistent with this study's findings. Other literature in nursing reported inconsistent findings regarding age and relationship to compassion satisfaction. In some studies, there was no relationship, while in others the findings show lower compassion satisfaction with increased age.[24,25] With age comes maturity, confidence, and resilience which may relate to compassion satisfaction. However, findings from this study may also result from those with higher compassion satisfaction self-selecting to remain in clinical practice whereas those with lower compassion satisfaction experienced burnout and have left clinical practice.

Despite the importance of compassion as it relates to dental hygiene care, there is little reported in the literature related to dental hygiene, with the majority of research related to nursing.[1,3–8,11,13,14] Patients have reported that they feel they receive the highest quality of care when their clinician shows compassion.[8] Although there is limited literature evaluating the three constructs of the ProQoL in dental professionals, studies have been reported in the literature using the Maslach Burnout Inventory and Oldenburg Burnout Inventory to assess burnout in dentists and dental hygienists.[16,18,26-28] Similar to the findings in this study, previous research with dentists and DHs suggests that increases in age result in decreases in burnout. [16,18,26-28] In addition, participants in this study reported higher levels of compassion fatigue (e.g. emotional exhaustion and high workload) which is consistent with other literature suggesting emotional exhaustion and emotional demands along with workload were predictors of burnout for both dentists and DHs.[16,18,19,26-28]

To expand on the ProQoL findings, participants in this study who had thought about leaving the field were given the opportunity to respond to the open-ended question "What is your reasoning for wanting to leave the dental hygiene profession?" The majority of participants stated that they are burned out or felt under appreciated by staff, management, and dentists. Some stated that they felt extreme pressure to complete multiple tasks while trying to provide the best patient care. These are consistent with the findings of Han and Kim who found DHs negative emotions regarding their workplace can greatly affect overall feelings about their job, thus impacting the quality of patient care.[15]

The value of using the ProQoL is that it allows for data sharing; raw data from this study will be added to the database from other professions. This not only allows for dental hygiene to be represented in the database, but also allows for the data to become part of the ProQoL general quartile cut points and means along with other health professions.

Further studies on compassion, compassion satisfaction, compassion fatigue, and burnout are needed to explore these concepts in more depth in the dental hygiene profession. In

addition, research is needed to identify effective strategies to minimize compassion fatigue to prevent burnout and retain qualified dental hygiene professionals. In addition, given the differences in findings for mean compassion satisfaction, compassion fatigue, and burnout in Korean DHs, further research is needed to explore differences in dental hygiene clinical practice and the issues facing DHs in other countries.

This study had limitations. A non-probability sample was used, limiting the generalizability of the findings. Although social media has advantages including access to a national sample, quick and cost-free delivery of the survey invitation to specific target groups, limitations include limiting access to members of the social media groups, creating selection bias, and the inability to calculate a response rate.[29] In addition, the survey research design has limitations related to possible self-report, self-selection, and recall bias. Although the ProQoL instrument has been used in a number of helping professions, it is unknown what compassion fatigue may look like in dental hygiene practice, since some of the secondary trauma items may not fit with the experiences of dental hygienists. Inconsistent word choice related to leaving the dental hygiene profession (e.g., leaving the field, leaving the dental field, leaving the dental hygiene field) may have resulted in misinterpretation of some questions. An inherent limitation of quantitative research is the inability to investigate other causes of compassion satisfaction, compassion fatigue, and burnout in-depth within dental hygiene. However, the open-ended question study allowed for some added depth. A unique situation for this study was also that at the time the survey was implemented, dental hygienists were just beginning to return to work after the initial closure of dental practices due to the coronavirus (COVID-19) pandemic which may have impacted their responses. The many unknowns of a COVID-19 infection, loss of family, friends, and possibly colleagues and patients along with continuing changes to infection control guidelines created additional anxiety.

Conclusion

Findings from this study suggest DHs have high levels of compassion fatigue as compared to nurses and other health professionals. In addition, a significant number of DHs have thought about leaving the profession and nearly one-third planned to leave the dental field within the next five years. Results from this study point to the urgency of identifying strategies to help clinical DHs manage compassion fatigue, including the promotion of supportive work environments with a common patient-centered philosophy, healthy interpersonal relationships with colleagues, and attention to self-care.

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Research

Disparities in Caregiver-Reported Dental Cavities and Toothaches Among Children in the Special Supplemental Nutrition for Women, Infants, and Children (WIC) Program

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Abstract

Purpose: Dental caries is prevalent among low-income and minority children despite oral health promotion programs. The purpose of this study was to examine disparities associated with caregiver-reported cavities and toothaches among children in the United States aged 2-4 years by their eligibility for and participation in the Special Supplemental Nutrition for Women, Infants, and Children (WIC) program.

Methods: A secondary data analysis was performed using the 2016 National Survey of Children's Health (NSCH) data on children aged 2-4 years (n=7,719) with complete WIC participation information. Three groups were formed based on WIC eligibility and participation status: WIC participants, income-eligible non-participants, and higher-income non-participants. Caregiver-reported cavities and toothaches were compared by WIC eligibility and participation using chi-square tests and multivariate logistic regression analysis.

Results: Among all children in the data set, 2,069 were WIC eligible, 49.8% of whom participated in WIC. Participants in WIC had higher reported cavities and toothaches (10.0% and 5.2%) than income-eligible, or higher-income non-WIC participating children (8.9% and 3.2%; 4.4% and 0.1%, respectively; $p < 0.001$). However, non-Hispanic, white WIC participants, had a higher proportion of reported cavities (14.0%) and toothaches (8.2%) than income-eligible non-participants (6.7% and 1.9%, respectively; $p < 0.05$). While non-Hispanic, black WIC participating children, had nearly 3.6 times more reported cavities than income-eligible nonparticipants (9.0% vs. 2.5%, $p < 0.05$).

Conclusion: Caregiver-reported cavities and toothaches varied by sociodemographic characteristics within WIC participation and eligibility groups. These findings suggest that more research is warranted to explore factors that are contributing to oral health disparities associated with WIC eligibility and participation.

Keywords: dental caries, tooth decay, toothache, pediatric oral health, socioeconomic factors, low-income, public health

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Introduction

While a number of pediatric oral health promotion programs have been implemented over the past fifty years in the United States (US), dental caries remain prevalent among low-income and minority children as compared to their counterparts.[1] In 2015, the highest prevalence of dental caries (56.3%) were among children from households with incomes below 100% of the Federal Poverty Level (FPL), compared with 51.8%, 42.2%, and 34.8% among children from household income groups of 100%-199%, 200%-300%, and over 300% of the FPL, respectively.[1] In 2007, 4.35 million US children were reported as having a toothache and dental caries within a 6-month period[2] and of the over 12 million children with untreated dental caries in 2011-2014, roughly 2 million were aged 0-5 years.[3] When left untreated, dental caries overtime can become symptomatic, resulting in dental pain and infection, which in turn can influence nutrition, growth, development, and overall quality of life.[4-5] While one of the major symptoms of untreated dental caries is a toothache, tooth eruption particularly in younger aged children, may also result in dental pain.[6] Therefore, it is important for parents and caregivers to receive ongoing oral health education from both dental and non-dental professionals concerning their

child's oral health, so they are aware of the various oral cavity changes at each age milestone.

Programs such as the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is one mechanism to promote oral health through collaboration with dental professionals such as dental hygienists, or by training WIC staff members on basic oral health as it relates to nutritional health.[6-7] The WIC program is one of the largest federally funded public health programs providing nutritious foods, nutritional education, and referrals to health care services[8] including dental care[7] to low-income pregnant, breastfeeding, and non-breast-feeding postpartum women, infants,[8] and children under age 5. In 2018, there were roughly 7 million participants monthly;[9] more than half of the infants in the US participate in the program.[7] Access to nutritious foods and nutritional education are necessary elements in promoting good oral health-related behaviors, which results in decreased dental caries risk. In some states, WIC programs address oral health through promoting a dental visit for the child by age one, ensuring families have a dental home, and discussing nutritional topics related to oral health if desired by the caregiver.[10] Only a few studies have specifically examined oral health outcomes or the use of dental services in a WIC population.[11-13] Among these cohort studies, findings have revealed that the prevalence of dental caries among child WIC participants increases with age[13] and that WIC participants are more likely to receive preventive dental services compared to non-participants.[11-12]

Since many children under age 5 participate in WIC, it is important to understand the oral health status of these participants compared to non-participants. The purpose of this study was to use a nationally representative dataset to examine disparities associated with caregiver-reported cavities and toothaches among children aged 2-4 years across three categories of WIC eligibility and participation.

Methods

To address the study aim, data was obtained from the 2016 National Survey of Children's Health (NSCH),[14] a nationally representative cross-sectional survey that includes key information related to the health and well-being of children and their families.[15] The NSCH has been used in previous studies to examine oral health outcomes and dental service use among children.[2, 16-17] The NSCH data collection process consists of an address-sampling frame to identify households across the 50 states and District of Columbia. The inclusion criteria required participants to have a valid residential address and a completed screening survey for one child in the household. Among 138,009 households who completed the screening surveys, 67,047 households were eligible to complete the NSCH survey. The final NSCH 2016 dataset included a total of 50,212 non-institutionalized children aged 0-17 years and had an overall weighted response rate of 40.7%.[15]

The analytic sample for this study included children aged 2-4 years with complete information about the household's WIC participation (n=7,719). Since the survey asked parents/caregivers to report on children's conditions and status in the previous 12 months, children under the age of 2 years were not included in this analysis. It is rare for children under 12 months of age to experience a dental cavity because the first primary tooth does not erupt until around age 6 months. Similarly, with toothaches, the report of this problem would most likely be related to pain associated with tooth eruption (teething) instead of untreated dental cavities. More technical details about the survey can be found in the 2016 NSCH methodology report.[15] Old Dominion University's Human Subjects Committee approved this study as exempt.

Independent Variables

The primary independent variables were the indicators of WIC eligibility and participation status. For the NSCH 2016 dataset, federal poverty level defined as total family income and family poverty threshold ranging from 50-400>FPL.[15] Income eligibility for WIC, which is a household income ≤ 185% of the FPL was used for this study. Participation in WIC was defined as a family member in the household receiving WIC benefits during the past 12 months. Based on income eligibility and participation status, three groups were created: WIC participants, income-eligible non-participants, and higher-income non-participants. Child-level socio-demographics included age (2-4 years), sex (male or female), race and ethnicity (Hispanic, non-Hispanic white [NHW], non-Hispanic black [NHB]. Non-Hispanic other/multi-racial [NHO] was defined as children who reported as one race category of American Indian or Alaska Native, Native Hawaiian, or Pacific Islander and some other race. Multi-racial included non-Hispanic children who were reported as having more than one race); and type of health insurance was defined as public only, private only, other (private and public or unspecified), or uninsured.[14] Caregiver-level socio-demographic variables were the highest educational attainment in the household (≤ high school/GED, some college/technical school, and college degree or higher), mother's age at the time the child was born was grouped by the researchers (18-25 years, 26-30 years, 31-35 years, and ≥ 36 years), and caregiver-reported condition of the child's teeth (excellent/very good, good, fair/poor).[15]

Dependent Variables

The dependent variable was defined by the caregiver's report of dental cavities and toothaches of the child. Both outcome measures were defined as binary indicators, i.e., yes or no, based on the following questions from the NSCH: "During the past 12 months, has [this child] had frequent or chronic difficulty with any of the following: decayed teeth or cavities, or toothaches."[18]

Statistical Analysis

The data were analyzed with Stata Statistical Software: Release 15 (StataCorp.; College Station, TX). All analyses were weighted to account for the complex survey design. Missing data were removed from the analysis. Weighted proportion and chi-square tests were estimated for all sociodemographic variables among WIC participants, income-eligible non-participants, and higher-income non-participants. Similarly, chi-square tests were performed to evaluate differences in caregiver-reported dental cavities and toothaches among the three groups. Multivariate logistic regressions were used to examine the disparities in caregiver-reported oral health status (dental cavities and toothaches) among the three groups. All models were stratified by child and caregiver-level sociodemographic characteristics while controlling for covariates and WIC participants were the reference group for each model. Statistical significance for all analysis was reported at $p < 0.05$.

Results

Demographics

The analytical sample included children aged 2-4 years (n=7,719), over half were NHW (54.4%) and most were reported as having private insurance. Among all children, there were WIC participants (n=1,032), income-eligible non-participants (n=1,037), and higher-income non-participants (n=5,650). Roughly one-third of the WIC participants were NHW (33.0%) and 74.4% were insured through public insurance. Over 40% of caregivers who were WIC participants attained less than a high school diploma, or high school/GED and 37.7% were age 18-25 years. Income-eligible non-participating children had a higher proportion of no-insurance (10.3%) than WIC participating children (6.6%) and higher-income non-participating children (2.4%) ($p<0.001$).

Higher-income non-participating children had statistically different demographics from WIC participating children. For example, there was a higher proportion of higher-income non-participating children who were NHW, privately insured, and had a caregiver(s) with a higher educational attainment and were older in age. In terms of the caregivers' report of their child's teeth condition, WIC participants were more likely to report their child's teeth as fair/poor (6.0%) than income-eligible non-participants (4.4%) and higher-income non-participants (1.5%) ($p<0.001$) (Table I).

Caregiver-Reported Dental Cavities

Overall, the prevalence of caregiver-reported dental cavities differed among WIC participants and non-participants. The proportion of caregiver-reported dental cavities was greater among WIC participants (10.0%) than income-eligible non-participants (8.9%) and higher-income non-participants (4.4%) ($p<0.001$). The proportion of caregiver-reported dental cavities increased with age for WIC participants with children aged 4 years having the highest reported cavities (18.6%) compared with income-eligible non-participants (10.4%) and higher-income non-participants (7.4%) ($p<0.001$). When stratified by race and ethnicity, NHW WIC participants had higher caregiver-reported dental cavities (14.0%) than income-eligible non-participants (6.7%) ($p=0.03$). This racial disparity was consistent among all WIC participating children. Hispanic WIC participants had the lowest caregiver-reported (5.9%) dental cavities than income-eligible participants (13.4%), but the disparity was not statistically significant ($p=0.08$). However, NHB WIC participants had nearly 3.6 times (9.0%) more caregiver-reported dental caries than NHB income-eligible non-participants (2.5%) ($p=0.03$). Children participating in WIC whose mothers were aged >36 years had a higher proportion of reported dental cavities (17.2%) than non-WIC participating children (income-eligible non-participants - 8.6% and Higher-income non-participants – 4.0% ($p=<0.001$) (Table II).

Caregiver-Reported Toothaches

In terms of toothaches, WIC participants (5.2%) had higher caregiver-reported toothaches than income-eligible non-participants (3.2%), and higher-income non-participants (0.1%) ($p<0.001$). Similar to caregiver-reported dental cavities, WIC participants who were aged 4 years also had higher caregiver reported toothaches (6.6%) than income-eligible non-participants (1.9%) ($p=0.03$). Among race and ethnic groups, NHW WIC participants (8.2%), had higher caregiver-reported toothaches than NHW income-eligible nonparticipants (1.9%) ($p=<0.01$). However, among Hispanic WIC participants there was a lower caregiver report of toothaches (0.5%) than Hispanic income-eligible non-participants (2.8%) ($p=0.03$). Also similar to dental cavities, WIC-participating children whose mothers aged >36 years, reported more toothaches (5.9%) than non-WIC participating children (income-eligible non-participants-2.9% and higher-income non-participants (0.7%) ($p=<0.01$) (Table III).

Table I. Weighted characteristics and condition of the child's teeth for WIC Participants and Non-participants (NP)

Characteristics	All sample (n=7,719)	WIC Participants (n=1,032)	Income-eligible NP (n=1,037)	*p* value [c]	Higher-income NP (n=5,650)	*p* value[d]
		(≤ 185% FPL)[f]	(≤ 185% FPL)		(>185% FPL)	
	%[a] (SE)[b]	%[a] (SE) [b]	%[a] (SE) [b]		%[a] (SE) [b]	
Age				0.36		0.58
2 years	32.5 (0.01)	33.7 (0.03)	28.7 (0.03)		33.4 (0.01)	
3 years	33.2 (0.01)	33.7 (0.03)	33.6 (0.03)		33.0 (0.01)	
4 years	34.2 (0.01)	32.6 (0.03)	37.7 (0.03)		33.7 (0.01)	
Sex of Child				0.20		0.31
Male	50.8 (0.01)	49.4 (0.03)	55.0 (0.03)		50.0 (0.01)	
Female	49.2 (0.01)	50.6 (0.03)	45.0 (0.03)		50.0 (0.01)	
Race and Ethnicity of Child				0.02		< 0.001
Hispanic	21.7 (0.01)	33.3 (0.03)	27.7 (0.03)		15.0 (0.01)	
Non-Hispanic White	54.4 (0.01)	33.0 (0.02)	44.0 (0.03)		67.0 (0.01)	
Non-Hispanic Black	11.6 (0.01)	23.0 (0.02)	15.1 (0.02)		5.8 (0.01)	
Non-Hispanic Other/Multi-racial[e]	12.2 (0.01)	11.0 (0.01)	13.1 (0.02)		12.4 (0.01)	
Child, Health Insurance Type				< 0.001		< 0.001
Public only	31.0 (0.01)	74.4 (0.03)	47.8 (0.03)		7.4 (0.01)	
Private only	59.0 (0.01)	8.8 (0.01)	35.9 (0.03)		87.3 (0.01)	
Other	5.2 (0.01)	10.1 (0.01)	5.8 (0.02)		2.9 (0.00)	
Uninsured	4.9 (0.01)	6.6 (0.02)	10.3 (0.02)		2.4 (0.00)	
Education, Caregiver				0.08		< 0.001
≤HS/GED	22.2 (0.01)	44.2 (0.03)	42.3 (0.03)		7.0% (0.01)	
Some college/technical school	22.0 (0.01)	34.4 (0.03)	28.4 (0.02)		14.7% (0.01)	
College degree or higher	55.9 (0.01)	21.3 (0.02)	29.2 (0.03)		78.3% (0.01)	
Age of Mother				0.32		< 0.001
18-25	21.5 (0.01)	37.7 (0.02)	32.8 (0.03)		11.1 (0.01)	
26-30	29.2 (0.01)	24.0 (0.03)	30.5 (0.03)		31.0 (0.01)	
31-35	28.5 (0.01)	20.5 (0.02)	17.7 (0.02)		35.4 (0.01)	
> 36	21.0 (0.01)	17.9 (0.02)	19.0 (0.02)		22.6 (0.01)	
Caregiver-reported condition of the child's teeth[g]				0.25		<0.001
Excellent/very good	87.1 (0.01)	78.1 (0.03)	84.0 (0.02)		91.8 (0.01)	
Good	9.8 (0.01)	15.8 (0.02)	11.7 (0.02)		6.7 (0.01)	
Fair/poor	3.1 (0.01)	6.0 (0.02)	4.4 (0.01)		1.5 (0.00)	

[a] % represents weighted percentage, and [b] SE represents weighted standard error. [c] WIC participants vs. Income-eligible NP. [d] WIC participants vs. Income-eligible NP vs. Higher-income NP. [e] Non-Hispanic, other/multi-racial include one category of American Indian or Alaska Native, Native Hawaiian, or Pacific Islander, and some other race. Multi-racial includes non-Hispanic children who were reported as having more than one race. [f] FPL= federal poverty level is defined as total family income and family poverty threshold. ≤ 185% FPL is the threshold used for determining WIC eligibility. [g] Caregivers' report of the child's teeth condition. *p* values are from χ^2 test.

Table II. Caregiver-reported cavities by WIC eligibility and participation: Child and caregiver characteristics

	WIC Participants (n=1,011)		Income eligible non-participants (n=1,026)		*p* value[c]	Higher-income non-participants (n=5,577)		*p* value[d]
	% [a]	SE[b]	%[a]	SE[b]		% [a]	SE[b]	
All	10.0	0.01	8.9	0.01	0.63	4.4	0.00	< 0.001
Child-level Age								
2	3.4*	0.01	2.2*	0.01	0.45	0.8	0.00	0.01
3	8.3*	0.02	13.0*	0.04	0.25	4.9	0.01	0.02
4	18.6*	0.03	10.4*	0.02	0.06	7.4	0.01	<0.001
Sex								
Boy	8.9	0.02	5.3	0.01	0.12	4.3	0.01	0.02
Girl	11.0*	0.11	13.3*	0.03	0.54	4.5	0.01	<0.001
Race								
Hispanic	5.9	0.02	13.4	0.05	0.08	5.3*	0.02	0.07
Non-Hispanic, white	14.0*	0.03	6.7*	0.02	0.03	4.1	0.01	<0.001
Non-Hispanic, black	9.0*	0.03	2.5*	0.01	0.03	8.2*	0.02	0.13
Non-Hispanic, Other, Multi-racial	12.2*	0.03	13.7*	0.06	0.83	3.1	0.01	0.01
Health insurance type								
Public only	11.4	0.02	13.6*	0.03	0.54	10.2	0.03	0.67
Private only	2.0*	0.01	2.9*	0.01	0.51	3.9	0.01	0.34
Other	11.0*	0.03	4.8**	0.01	0.11	4.4*	0.03	0.11
Uninsured	2.4**	0.01	9.8**	0.02	0.09	4.5*	0.03	0.21
Caregiver-level education								
≤HS/GED	12.2*	0.03	11.4*	0.03	0.86	6.0	0.02	0.31
Some college/technical school	8.3*	0.02	10.9*	0.04	0.51	8.4	0.02	0.74
College degree or higher	5.6*	0.02	3.8*	0.01	0.33	3.5	0.00	0.27
Age of mother								
18-25	10.9*	0.02	11.9*	0.04	0.81	8.3	0.02	0.62
26-30	6.7*	0.02	3.7*	0.01	0.23	4.0	0.01	0.37
31-35	5.6*	0.02	12.1*	0.05	0.13	3.7	0.01	0.01
> 36	17.2*	0.04	8.6*	0.03	0.11	4.0	0.01	<0.001
Caregiver-reported condition of the child's teeth								
Excellent/very good	2.2	0.01	3.2	0.01	0.46	2.1	0.00	0.50
Good	30.0*	0.06	23.3	0.06	0.48	24.0	0.04	0.65
Fair/poor[e]	57.4	0.03	83.2	0.05	0.06	57.5	0.14	0.36

[a] % represents weighted percentage, and [b]SE represents weighted standard error. [c] WIC participants vs. Income-eligible NP. [d] WIC participants vs. Income-eligible NP vs. Higher-income NP. [e] Fair/poor observations were <50 for all three groups.
Note: some sample sizes for categories are smaller than the total sample n for each WIC eligibility and participation group.
*<500 observations; **<100 observations. p values are from χ^2 test.

Table III. Caregiver-reported toothaches by WIC eligibility and participation: Child and caregiver-level characteristics

	WIC Participants (n=1,023)		Income eligible non-participants (n=1,030)		*p* value[c]	Higher-income non-participants (n=5,608)		*p* value[d]
	%[a]	SE[b]	%[a]	SE[b]		%[a]	SE[b]	
All	5.2	0.01	3.2	0.01	0.30	0.1	0.00	<0.001
Child-level age								
2	2.1*	0.01	0.5*	0.01	0.01	0.8	0.00	0.01
3	6.9*	0.05	7.0*	0.03	0.99	0.5	0.00	0.01
4	6.6*	0.03	1.9*	0.02	0.03	1.0	0.01	<0.01
Sex								
Boy	4.7	0.03	2.4	0.01	0.38	0.7	0.00	0.02
Girl	5.7*	0.02	4.2	0.02	0.59	0.9	0.00	<0.01
Race								
Hispanic	0.5*	0.00	2.8*	0.01	0.03	1.5	0.01	0.25
Non-Hispanic, white	8.2	0.03	1.9	0.01	<0.01	0.7	0.01	<0.001
Non-Hispanic, black	8.0*	0.07	2.7**	0.01	0.25	0.5	0.00	0.06
Non-Hispanic, Other, Multi-racial	4.5*	0.02	9.4*	0.06	0.34	0.6	0.00	<0.01
Health insurance type								
Public only	6.6	0.03	4.5*	0.02	0.49	3.0*	0.01	0.40
Private only	0.9*	0.01	1.4*	0.01	0.62	0.6	0.00	0.23
Other	1.7*	0.01	3.5**	0.01	0.32	0.1*	0.00	0.04
Uninsured	1.2**	0.01	2.8**	0.02	0.44	1.1*	0.00	0.40
Caregiver-level education								
≤HS/GED	5.1*	0.02	4.5*	0.02	0.85	1.4*	0.01	0.39
Some college/technical school	7.1*	0.05	3.9*	0.02	0.44	1.2	0.00	0.09
College degree or higher	3.2*	0.01	0.9*	0.00	0.04	0.6	0.00	<0.01
Age of mother								
18-25	5.8*	0.04	6.4*	0.03	0.91	1.0	0.01	0.25
26-30	2.5*	0.02	0.7*	0.01	0.28	1.2	0.01	0.48
31-35	6.7*	0.04	1.7*	0.01	0.05	0.4	0.00	<0.001
> 36	5.9*	0.03	2.9*	0.02	0.32	0.7	0.00	<0.01
Caregiver-reported condition of the child's teeth								
Excellent/very good	2.0	0.01	0.5	0.00	0.03	0.4	0.00	<0.01
Good	10.3	0.04	9.0	0.04	0.81	1.9	0.01	0.04
Fair/poor[e]	33.5	0.03	37.1	0.05	0.91	18.4	0.11	0.67

[a] % represents weighted percentage, and [b]SE represents weighted standard error. [c] WIC participants vs. Income-eligible NP.
[d] WIC participants vs. Income-eligible NP vs. Higher-income NP. [e] Fair/poor observations were <50 for all three groups.
Note- some sample sizes for categories are smaller than the total sample n for each WIC eligibility and participation group.
*<500 observations; **<100 observations. *p* values are from χ^2 test.

In general, there was a higher portion of caregiver-reported fair/poor teeth conditions associated with dental cavities, or toothaches for all three WIC eligibility and participation groups. When stratified by eligibility and participations groups there were differences but without statistical significance (Tables II and III).

Adjusted odds for caregiver-reported dental cavities and toothaches

The adjusted logistic regression results after controlling the confounders with WIC participants as the reference group for all models are shown in Table IV. In general, higher-income non-participants had higher odds (OR: 1.93; 95% CI: 1.05-3.52; p <0.05) of caregiver-reported dental cavities than WIC participants. This association holds in certain socio-demographic subgroups as well. For example, higher-income non-participants who were girls (OR: 3.17; 95% CI: 1.31-7.64; p<0.05), NHB (OR: 20.58; 95% CI: 2.82-150.48; p<0.05) or insured through public insurance (OR: 3.03; 95% CI: 1.19-7.74; p<0.05) had higher odds of caregiver-reported dental cavities than WIC participants. When examining dental cavities, higher-income non-participant children whose caregivers were aged 18-25 years, had higher odds of reported dental cavities (OR: 3.17; 95%CI: 1.06-9.49; p<0.05) than WIC participants. Caregivers of higher-income non-participating children who reported their child's teeth condition as excellent or very good had higher odds of dental cavities (OR: 4.04; 95%CI: 1.18-13.85) than WIC participants. In terms of toothaches, caregivers of income-eligible non-participating children who reported their child's teeth condition as fair/poor had higher odds of toothaches (OR: 7.90; 95% CI 1.71-36.57) than WIC participants (Table V).

Discussion

While some studies have examined the oral health outcomes and dental service use of WIC children at the local or state-levels;[11-13] to the best of the authors' knowledge, this is the first study to use a nationally representative dataset to examine caregiver-reported dental cavities and toothaches by WIC eligibility and participation. When comparing all three WIC eligibility and participation groups, caregiver-reported dental cavities were higher than toothaches. However, the adjusted odds ratio revealed an opposite finding when all socio-demographic characteristics were controlled in the logistic regression model for dental cavities.

Higher-income non-participants had higher odds of caregiver-reported dental cavities than WIC participants. This observed pattern varied when stratified by sociodemographic characteristics. Specifically, higher-income non-participants, insured through public insurance, had higher caregiver-reported odds of dental cavities than WIC participants. It should be noted that in the current study the federal poverty level used to determine WIC eligibility was ≤185%. Some families whose household income is >185% FPL may be eligible for other federal and state-level benefits such as Medicaid or the Children's Health Insurance Program (CHIP) within their respective state.[19-20] Medicaid provides the Early and Periodic Screening, Diagnostic, and Treatment (EPSDT) for children under 21 years and offers children services such as periodic screenings for hearing, vision, and dental health.[19] The CHIP program provides coverage for children under 19 years and whose family income does not meet the Medicaid eligibility limit and also includes dental benefits for children.[20] One of the benefits of WIC, aside from nutritional education and services, are referrals to the welfare, health care system and dental services.[10] Early recognition and diagnosis of dental cavities leads to better health and oral outcomes for the child.

Overall findings of this study suggest that dental cavities in some WIC eligibility and participant groups may be addressed prior to becoming symptomatic. Among WIC participating children, when the caregiver-reported conditions of teeth were examined independently among all three WIC eligibility and participation groups, WIC participants had a higher report of fair/poor teeth conditions than non-WIC participants, which is reflective of the caregivers' report of dental cavities. In general, there was a higher caregiver-report of fair/poor conditions associated with dental cavities and toothaches among all WIC eligibility and participation groups.

These findings potentially highlight the caregivers' awareness of the child's dental needs, which may lead to timely treatment. Talekar et al. found that parents of pre-school aged children identified their child's oral health as poor if they perceived the need for dental treatment or preventive dental care.[21] Similarly, Sohn et al. also found parents' perception of their child's oral health to be related with the clinical observations of dental caries.[22] Divaris et al. also reported similar findings.[23] However, their results also highlighted the overestimation of the child's oral health status but an underestimation of dental treatment needs particularly, among very young children (aged <2 years).[23] These observed differences must be considered when measuring caregiver-reported outcomes for the child.

Caregiver-reported dental cavities and toothaches

When examining only WIC participating children, caregiver-report of dental cavities increased with age; with children aged 4 years having this highest reported among all three age groups and nearly doubled when compared to nonparticipants. This finding is consistent with Gold et al.

Table IV. Adjusted odds ratio for caregiver-reported cavities and toothaches by WIC eligibility and participation: Child characteristics

	Cavities (n=7,513)		Toothaches (n=7,559)	
	OR	95% CI	OR	95% CI
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	1.05	0.58-1.91	0.82	0.35-1.94
Higher-income nonparticipants (> 185% FPL)	1.93*	1.05-3.52	0.46	0.14-1.53
Child-Level Characteristics				
Age 2				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	0.69	0.18-2.65	0.26*	0.08-0.92
Higher-income nonparticipants (> 185% FPL)	0.71	0.08-6.34	0.11*	0.02-0.57
Age 3				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	2.32	0.97-5.52	1.24	0.32-4.78
Higher-income nonparticipants (> 185% FPL)	2.58	0.92-7.24	0.26	0.03-2.39
Age 4				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	0.56	0.26-1.21	0.45	0.13-1.53
Higher-income nonparticipants (> 185% FPL)	1.81	0.80-4.11	1.42	0.29-6.95
Boys				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	0.55	0.26-1.20	0.76	0.20-2.86
Higher-income nonparticipants (> 185% FPL)	1.19	0.53-2.69	0.19*	0.04-0.81
Girls				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	1.87	0.84-4.14	1.05	0.41-2.70
Higher-income nonparticipants (> 185% FPL)	3.17*	1.31-7.64	1.54	0.48-4.92
Non-Hispanic, White				
WIC participant (Ref)	–	–	–	–
Income-eligible non-participants (≤ 185% FPL)	0.53	0.25-1.11	0.41	0.13-1.29
Higher-income nonparticipants (> 185% FPL)	0.89	0.44-1.79	0.82	0.31-2.21
Non-Hispanic, Black[b]				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	0.18	0.03-1.11	0.18	0.02-1.49
Higher-income nonparticipants (> 185% FPL)	20.58*	2.82-150.48	0.01	0.00-2.32
Hispanic[a]				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	4.12*	1.24-13.64	9.29	0.88-98.47
Higher-income nonparticipants (> 185% FPL)	3.94	0.91-17.13	1.54	0.17-13.93
Non-Hispanic, Other, Multi-racial				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	1.40	0.46-4.21	4.07*	1.07-15.48
Higher-income nonparticipants (> 185% FPL)	1.25	0.34-4.68	1.28	0.09-19.05
Public only				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	1.17	0.56-2.43	0.62	0.20-1.89
Higher-income nonparticipants (> 185% FPL)	3.03*	1.19-7.74	0.57	0.09-3.66
Private only				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	1.45	0.43-4.85	4.92	0.56-43.55
Higher-income nonparticipants (> 185% FPL)	2.03	0.54-7.60	0.14*	0.03-0.75
Other[b]				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	0.25	0.05-1.32	3.48	0.43-28.22
Higher-income nonparticipants (> 185% FPL)	0.33	0.08-1.32	0.02*	0.00-0.44
Uninsured[b]				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	1.36	0.25-7.54	5.07	0.46-56.03
Higher-income nonparticipants (> 185% FPL)	0.89	0.03-51.88	1.48	0.00-265.30

Model controls for child's age, race, sex, insurance type, household income (FPL); caregivers' age and education, where appropriate. Note- sample sizes may vary by the regression model.
a < 1000 observations; b <500 observations. * Significant at ($p < 0.05$).

Table V. Adjusted odds ratio for caregiver-reported cavities and toothaches across WIC eligibility and participation: Caregiver characteristics

Caregiver-Level Characteristics	Cavities		Toothaches	
	OR	95% CI	OR	95% CI
≤HS/GED[a]				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	0.91	0.39-2.14	0.86	0.27-2.75
Higher-income nonparticipants (> 185% FPL)	1.99	0.68-5.80	5.05	0.47-54.46
Some college/technical school				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	1.55	0.56-4.29	0.60	0.13-2.85
Higher-income nonparticipants (> 185% FPL)	1.08	0.39-2.98	0.19*	0.04-1.04
College degree or higher				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	0.58	0.21-1.60	0.74	0.15-3.60
Higher-income nonparticipants (> 185% FPL)	1.94	0.65-5.82	0.17*	0.41-0.68
18-25 years old				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	0.97	0.36-2.60	1.21	0.31-4.81
Higher-income nonparticipants (> 185% FPL)	3.17*	1.06-9.49	0.40	0.03-4.83
26-30 years old				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	0.69	0.18-2.64	0.16	0.10-2.57
Higher-income nonparticipants (> 185% FPL)	0.67	0.21-2.09	0.46	0.31-6.65
31-35 years old				
WIC participant (Ref)	–	–		–
Income-eligible nonparticipants (≤ 185% FPL)	2.00	0.54-7.50	0.17	0.24-1.24
Higher-income nonparticipants (> 185% FPL)	3.50	0.73-16.70	0.08*	0.01-1.00
>36 years old				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	0.59	0.21-1.70	0.59	0.93-3.74
Higher-income nonparticipants (> 185% FPL)	0.67	0.20-2.26	0.34	0.80-1.46
Caregiver-reported condition of the child's teeth				
Excellent/very good				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	1.61	0.53-4.94	0.31	0.08-1.16
Higher-income nonparticipants (> 185% FPL)	4.04*	1.18-13.85	0.73	0.16-3.41
Good[b]				
WIC participant (Ref)	–	–	-–	–
Income-eligible nonparticipants (≤ 185% FPL)	0.85	0.30-3.38	1.05	0.27-4.02
Higher-income nonparticipants (> 185% FPL)	1.90	0.54-6.68	0.70	0.05-9.51
Poor[b]				
WIC participant (Ref)	–	–	–	–
Income-eligible nonparticipants (≤ 185% FPL)	3.26	0.61-17.42	7.90*	1.71-36.57
Higher-income nonparticipants (> 185% FPL)	0.09	0.00-3.11	0.07	0.01-0.91

Model controls for child's age, race, sex, insurance type, household income (FPL); caregivers' age and education, where appropriate. Note- sample sizes may vary by the regression model.
a< 1000 observations; b<500 observations. *Significant at ($p < 0.05$)

who also examined dental caries prevalence among children in a community-based WIC oral health program in Florida.[13] Their findings revealed that among children aged ≤1-5 years, dental caries increased with age and the highest prevalence were among children aged 4 and 5 years (43.5% and 81.1%, respectively). The current study also found a consistent pattern with caregiver-reported toothaches among WIC participating children. While the proportion of caregiver-reported toothaches decreased for all WIC participating age groups, caregivers of children aged 4 years, reported nearly two-times more incidence of toothaches than higher-income non-participants. Lewis et al. used the 2007 NSCH dataset and found that children from low-income families (<100% FPL and 101%-200% FPL) and Medicaid insured, (14.7%) had a higher prevalence of toothaches compared to those who were privately insured (8.6%).[2]

Among race and ethnicity groups, WIC participating children who were Hispanic, had higher caregiver-reported dental cavities but lower reported toothaches. However, among WIC participating children who were NHB, caregivers reported dental cavities nearly 3.6 times more than income-eligible nonparticipating children. In general, NHB and Hispanic children tended to have a higher prevalence of dental caries.[1] One study found that African American children were more likely to have never had a dental visit, or had longer intervals between dental visits than White children.[24] A national study found that children WIC participants who were NHB had a poorer diet and nutrient intake to include more added sugars and sodium than NHW children.[25] The time between dental visits paired with dietary habits may explain the dental cavities prevalence observed among NHB children.

In addition to timely routine dental care and diet, WIC participation rates across race/ethnicity may help explain the oral health disparities among Hispanic and NHB children. For example, in 2015 Hispanic infants and children had the highest rate of participation out of those were eligible (62.7%, n=5,190,958) compared to NHW (42.2%, n=5,854,332) and NHB (57%, n=2,721,555) children.[26] Similar to the current study findings, there was a higher proportion of NHW children who were income-eligible but non-WIC participants than Hispanic, NHB, NHO children. Participation in the WIC program may offer Hispanic families the resources and support needed to navigate the health care system while providing continuous nutritional education in the first years of life. The literature suggests that Hispanic mothers and their social networks who perceive preventive dental care as important are more likely to obtain dental care at an early age and continue dental care.[27]

In general, it has been shown that WIC participating children are more likely to receive preventive and restorative dental services than nonparticipating children.[11] These factors may help to explain the positive impact of WIC observed among some participants in the current study. However, more culturally sensitive studies may be needed to design effective programs to reduce the racial/ethnic disparities identified in WIC programs. It was also shown that caregivers who were older or had attained less than a college degree, reported more dental cavities and toothaches with varying degrees among the three WIC participation and eligibility groups. These socio-demographic characteristics provide further support that caregivers' level of educational attainment may be related to greater awareness of their child's dental needs; however, accessing dental services in a timely manner may also be a barrier.

Limitations

This study had limitation. Due to the cross-sectional design of the 2016 NSCH data collection, causal inferences could not be determined. Most of the demographic variables included in the analysis were non-modifiable factors. Subjectivity and recall bias must also be considered for caregivers' report of dental cavities and toothaches. Additionally, due to the self-administered format of the survey, other biases, such as social desirability and interpretation of questions, must be taken into consideration. Particularly, the question concerning dental cavities used in the survey. In the asymptomatic stages of dental cavities, caregivers may underestimate the appearance dental caries[28] as well as treatment needs.[23] This may explain differences observed among WIC eligibility and participation groups by sociodemographic characteristics. Self-selection bias into the WIC program may also explain differences associated with a higher caregiver-report of dental cavities and toothaches among WIC participants compared to income-eligible non-participants. Children who participate in the WIC program may be more likely to access dental services through referrals that the WIC program provide and therefore, are advised about dental problems earlier than non-participants.

Given these limitations, the use of caregiver-reported information has been used when clinical data is not available.[2,16-17] Future research may include comparing clinical findings of dental caries to those that are caregiver- reported from a representative sample that include various racial and ethnic groups by WIC eligibility and participation.

Implications for dental hygienists

While not required of WIC programs, in some states, WIC clinics have dental partnerships, to assist in the promotion of oral health and offer preventive services such as education,

screenings, and fluoride treatments.[7] Further, WIC programs that have partnered with dental and medical professionals, safety net, and health clinics have been able to provide education, preventive dental services and referrals as needed for children.[29] In addition, with increasing direct access[20] and innovative workforce models such as the dental therapist,[31] dental hygienists can provide patient care in diverse settings such as WIC, to narrow the oral health disparity gap. Increasing collaborative partnerships and direct access to dental hygiene care within WIC programs is one strategy to address the dental caries burden among children.

Conclusions

Using a nationally representative data, this study provided insight on the oral health outcomes of WIC participants compared to non-participants. When stratified by child and caregiver-level characteristics there were oral health disparities across WIC eligibility and participation. However, in some cases, WIC participation revealed a lower caregiver-report of dental cavities and toothaches compared to non-participating groups Examining the oral health promotion and education practices within WIC programs for caregivers is warranted to identify factors contributing to the disparities in reporting cavities and toothaches. Partnerships between dental hygienists, dentists, WIC programs, and health clinics can promote early prevention and detection of dental cavities, which will narrow the oral health disparity gap among children.

Disclosure.

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Research

Attitudes of Virginia Dental Hygienists Toward Dental Therapists

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Abstract

Purpose: The state of Virginia faces a reported dental health professional shortage affecting approximately half of its residents. The purpose of this study was to assess the opinions and attitudes of dental hygienists in Virginia toward a mid-level dental provider model, dental therapists (DTs), and to determine whether current education level and years of practice affected opinions regarding the education requirements for DTs.

Methods: A 22-item questionnaire was distributed online to a convenience sample of Virginia dental hygienists (n=910). Items assessed attitudes of participants toward the DT using a seven-point Likert-type scale ranging from 1 (strongly disagree) to 7 (strongly agree). Participants were asked to provide demographic information and to respond to open-ended questions regarding potential advantages and/or disadvantages to DTs. Independent samples *t*-tests and chi-square analyses were used to analyze the data.

Results: A response rate of 22% was obtained (n=200). Most respondents agreed a DT was needed in Virginia (M=5.78, $p<0.001$) and supported the concept that dental therapy could be a solution to the problem of access to care issues in Virginia (M=5.97, $p<0.001$). While most respondents agreed it was important for Virginia to adopt legislation for a dental therapy model (M=5.89, $p<0.001$), most disagreed that DTs' practice should be restricted to acknowledged underserved areas in the state (M=3.19, $p<0.001$). No significant association was found between years of practice and opinions toward education requirements for DTs; however, a significant association was found between current education level and opinions toward education requirements for DTs (Fisher's Exact Test=34.17, df=9, $p=.000$, Cramer's V=.28).

Conclusion: Results revealed Virginia dental hygienists had overwhelmingly positive attitudes toward DTs. Research with a larger sample could provide more insight into opinions of the Virginia dental hygienist population regarding this mid-level oral health care provider.

Keywords: dental therapy, dental therapist, mid-level provider, dental hygienist, access to care, underserved populations

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Introduction

The oral health objectives of Healthy People 2030 include increasing access to preventive and restorative dental care for all ages, reducing the number of persons unable to obtain timely dental care, and reducing the number of persons with untreated tooth decay and periodontal disease.[1] The United States (US) Department of Health and Human Services reports that the state of Virginia faces a dental health professional shortage affecting 55.61% of its residents, over 1.3 million individuals.[2] The most underserved populations include children, the economically disadvantaged, and individuals living in or near rural areas.[3,4] In alignment with these population groups, Virginians most frequently report cost, location, and difficulty in finding a dentist as barriers to oral health care access.[2] Approximately 3.2 million Virginians lack any type of dental insurance,[5] and neither Medicare nor Medicaid cover routine dental care for most individuals.[6,7] For low-income or uninsured patients, Virginia has implemented safety net programs; however, 67 state localities still have no dental safety net provider, and communities with providers are only able to receive services on a part-time basis.[5,8] The state has also implemented free and charitable oral health care clinics, but these facilities rely on services donated by volunteers, limiting availability.[8] The Virginia Department of Health also reports difficulty recruiting oral health care

professionals in and around rural communities, with only 7% of Virginia dentists working in rural areas.[3,9] Furthering the shortage, the National Center for Health Workforce Analysis projects an 8% decline of the national dentist workforce by 2025, with a 4% decline in Virginia.[3]

New workforce models have been proposed to address access to care shortages. One such model is the mid-level oral health practitioner as defined by the American Dental Hygienists' Association (ADHA).[10] In this model, the mid-level provider would be "a licensed dental hygienist who has graduated from an accredited dental hygiene program and who provides primary oral health care directly to patients to promote and restore oral health through assessment, diagnosis, treatment, evaluation, and referral services. The Mid-level Oral Health Practitioner has met the educational requirements to provide services within an expanded scope of care, and practices under regulations set forth by the appropriate licensing agency."[10]

There are multiple models of mid-level dental providers (MLDPs).[11] While all models fill roles to bridge the gap between preventive and restorative care, each has unique characteristics. Dental hygiene-based MLDPs are dental hygienists with abilities to perform certain restorative treatments, whereas non-hygiene-based MLDPs perform certain restorative treatments without previous dental hygiene education and licensure.[11] Other oral health care providers that can also help address the access to care shortage include community dental health coordinators, who offer oral health education to underserved communities and help link residents to dentists, as well as dental hygienists with additional expanded functions to perform dental hygienist duties under direct access provisions.[11]

One emerging model of a MLDP is the dental therapist (DT). Currently, 13 states have adopted dental therapy legislation, though not all have actively-practicing DTs.[12] In Minnesota, DTs practicing under indirect supervision and advanced dental therapists (ADTs) practicing under general supervision each hold master's degrees; however, ADTs are required to complete 2000 clinical practice hours and pass an additional exam.[11-16] In Alaska, certificate-holding dental health aide therapists (DHATs) can work under general supervision in tribal communities.[11] Research suggests positive outcomes in areas where dental therapy has been implemented.[15-25] The Minnesota Department of Health reports greater access to care for underserved communities, decreased patient wait and travel times, and increased dental team productivity.[15] In interviews with 16 health providers and 125 community members exposed to DHATs in Alaska, Chi et al. found improved access to care for patients with previously limited or irregular access.[17] In addition, Chi et al. also noted that providers observed reduced disease prevalence and severity, and dentists identified more availability to provide major dental services to patients.[17]

Though a relatively new field, dental therapy has educational program accreditation standards set by the Commission on Dental Accreditation (CODA).[18] A minimum of three years of dental therapy education at the post-secondary college level are required for CODA accreditation, with competencies that include simple extractions of erupted primary teeth, emergency palliative treatment of dental pain, preparation and placement of direct restorations in primary and permanent teeth, and prescriptive authority including administering analgesics, anti-inflammatory agents, and antibiotics.[19] The Commission recognizes DTs as members of the oral healthcare team, noting graduates must be competent in communicating and collaborating with other healthcare team members.[19] In 2020, Alaska became the first state to have a CODA-accredited dental therapy program.[20]

The field of dental therapy continues to grow, and this career path may be of interest to current practicing dental hygienists, particularly since the ADHA model defines the DT as a dental hygienist.[10] Accordingly, it is important to determine the opinions and attitudes of dental hygienists toward DTs, and previous studies began this exploration. In a survey of Oregon dental hygienists (n=440), Coplen et al. found 59% of those surveyed supported the need for DTs.[21] In another survey of dental hygienists in the Pacific Northwest (n=187), Ly et al. found 65% of the respondents supported an existing need for DTs.[26] Studies of dental hygienist perspectives in Maine, Colorado, Kentucky, and North Carolina have also demonstrated support for the DT.[27-29] Regarding potential interest in actually pursuing dental therapy education and licensure, Coplen et al. found 43% of the respondents in Oregon were interested in becoming a DT.[21] Comparatively, in a survey of Maine dental hygienists (n=268), Smallidge et al. found 65% of the participants expressed interest in enrolling in a dental therapy program.[27]

While previous research has provided valuable insight, there is a gap in the literature regarding dental hygienists licensed in the state of Virginia. The National Center for Health Workforce Analysis projects a 13% increase in dental hygienists in Virginia by 2025.[3] Given dental health professional shortages, barriers to oral health care access, and potential career enhancement, key policymakers are exploring opportunities for dental therapy legislation in Virginia; however the attitudes and support for DTs among dental hygienists in the state are unknown. The purpose of this study was to assess the opinions and attitudes of Virginia dental hygienists towards dental therapists (DTs) and to determine

whether current education level and years of practice affected opinions regarding the education requirements for DTs.

Methods

A cross-sectional survey design was used to assess attitudes of a convenience sample of Virginia dental hygienists toward DTs. Following Institutional Review Board (IRB) approval, the investigator-designed questionnaire was sent via email to 1,015 Virginia dental hygienists from a purchased online email database (E-Database Marketing). The instrument was adopted, with permission, from a previously validated survey by Self et al. [30] and included additional researcher-developed questions. Eleven items assessed attitudes of participants toward DTs with responses using a seven-point Likert-type scale ranging from 1 (strongly disagree) to 7 (strongly agree). Participants were asked to respond to six demographic questions (age, gender, years of practice, predominant work setting, professional membership, and current level of education), appropriate levels of supervision and education for DTs, and two open-ended questions regarding potential advantages and/or disadvantages of DTs. A final open-ended question allowed participants the opportunity to provide additional comments. A panel of five dental hygiene faculty members reviewed the researcher-developed questions for content validity and clarity; adjustments were made based on their review.

The survey was initially distributed in March 2020; however, due to a low response rate likely related to the COVID-19 pandemic, a reminder survey was not sent until six weeks later. Three follow-up emails were sent to non-respondents over the next six weeks at one- and two-week intervals. Of 1,015 emails initially sent, 105 returned as undelivered, for a total of 910 survey invitations. The anonymous responses and data were collected by an electronic survey program (Qualtrics; Provo, UT, USA). Cronbach's alpha reliability coefficient among Likert-type scales revealed a value of .91, indicating high internal consistency.

Descriptive statistics such as means, standard deviation, and frequencies were used to describe attitudes and perceptions. Additionally, an independent samples *t*-test was used to compare mean values in Likert-type questions to a neutral rating of 4.0 with significance set at .05. Open-ended questions were transcribed and qualitatively analyzed by coding responses according to distinct ideas. All coding was reviewed by a colleague prior to frequency analysis to establish content validity and reliability. Chi-square analysis was used to analyze results related to education level, years of practice, and opinions toward education requirements for DTs. The Fisher's Exact Test was used when cells with expected frequencies were less than 5 and the Bonferroni adjusted criterion for statistical significance was established as p=.0125.

Results

Of 910 emailed surveys, 200 were returned, resulting in a response rate of 22%. The majority of participants were female (94.5%, n=189), age 40 or above (63%, n=126), and held a bachelor's degree or higher (85%, n=170). The highest numbers of participants had been practicing for less than ten years (36%, n=72) and worked predominantly in group practices (35%, n=70). Among participants who selected "other" for predominant work setting, written comments included retired, military/federal settings, and full-time temporary hygienists. Approximately half of the respondents were ADHA members (53%, n=106). Participant demographics are shown in Table I.

Results from descriptive statistics for Likert-type

Table I. Sample demographics (n=200)

	n	%
Gender		
Female	189	94.5
Male	3	1.5
Do not wish to disclose	8	4
Age (Years)		
Under 29	29	14.5
29-39	45	22.5
40-49	55	27.5
50 and over	71	35.5
Highest education level		
Associate degree	30	15
Bachelor's degree	118	59
Master's degree	44	22
Doctorate	8	4
Years practicing dental hygiene		
Less than 10	72	36
10-19	48	24
20-29	41	20.5
30 or more	39	19.5
Predominant work setting		
Community/Public Health	20	10
Education	31	15.5
Free/Safety Net Clinic	5	2.5
Group Practice	70	35
Solo Practice	62	31
Other	12	6
American Dental Hygienists' Association membership		
Yes	106	53
No	94	47

questions assessing attitudes and perceptions of participants toward DTs are shown in Table II. A one-sample *t*-test was used to determine statistically significant differences in Likert-type questions compared to a neutral rating of 4.0. Results revealed significantly more hygienists agreed than disagreed that a DT was needed in Virginia (M=5.78, SD=1.90) (d=1.78, 95% CI [1.51 to 2.04], t(199)=13.25, $p<0.001$) and supported the concept that dental therapy could be a solution to the problem of access to care issues in Virginia (M=5.97, SD=1.80) (d=1.97, 95% CI [1.72 to 2.22], t(199)=15.47, $p<0.001$). Similarly, significantly more respondents agreed than disagreed they had an understanding of the services performed by DTs (M=5.90, SD=1.42) (d=1.90, 95% CI [1.70 to 2.09], t(199)=18.84, $p<0.001$) and agreed there was evidence DTs could perform high-quality work (M=5.75, SD=1.75) (d=1.75, 95% CI [1.51 to 1.99], t(199)=14.17, $p<0.001$). Further, significantly more respondents were interested than uninterested in becoming a DT if it was recognized in Virginia (M=4.96, SD=2.28) (d=.96, 95% CI [.64 to 1.27], t(199)=5.92, $p<0.001$). However, while significantly more hygienists agreed than disagreed it was important for Virginia to adopt legislation for a dental therapy model (M=5.89, SD=1.87) (d=1.89, 95% CI [1.72 to 2.15],

Table II. Perceptions of dental therapists (n=200)

	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
A mid-level dental provider is needed in Virginia.	15 (7.5)	7(3.5)	6 (3.0)	13 (6.5)	16 (8.0)	24(12.0)	119 (59.5)
A mid-level dental provider, such as a dental therapist, could be part of the solution to the problem of access to care in Virginia.	13 (6.5)	5 (2.5)	7 (3.5)	8 (4.0)	15 (7.5)	21 (10.5)	131 (65.5)
It is important for Virginia to adopt legislation for a dental therapist model.	15 (7.5)	6 (3.0)	6 (3.0)	9 (4.5)	13 (6.5)	25 (12.5)	126 (63.0)
I have an understanding of the services dental therapists may perform.	5 (2.5)	2 (1.0)	9 (4.5)	12 (6.0)	28 (14.0)	53 (26.5)	91 (45.5
There is evidence dental therapists can perform high-quality work.	12 (6.0)	4 (2.0)	5 (2.5)	22 (11.0)	19 (9.5)	34 (17.0)	104 (52.0)
Dental therapists' practice should be restricted to acknowledged underserved areas in Virginia.	58 (29.0)	34 (17.0)	26 (13.0)	30 (15.0)	17 (8.5)	15 (7.5)	20 (10.0)
I would be interested in becoming a dental therapist if it was recognized in Virginia.	33 (16.5)	12 (6.0)	6 (3.0)	19 (9.5)	24 (12.0)	22 (11.0)	84 (42.0)
A dental therapist should be able to perform simple extractions of primary teeth.	13 (6.5)	6 (3.0)	3 (1.5)	8 (4.0)	14 (7.0)	31 (15.5)	125 (62.5)
A dental therapist should be able to perform simple restorations (Class I occlusal or Class V buccal/lingual).	14 (7.0)	4 (2.0)	4 (2.0)	7 (3.5)	20 (10.0)	23 (11.5)	128 (64.0)
A dental therapist should be able to provide emergency palliative care; for example, pulpal capping.	13 (6.5)	5 (2.5)	10 (5.0)	18 (9.0)	15 (7.5)	34 (17.0)	105 (52.5)
A dental therapist should be able to prescribe non-narcotic analgesics, anti-inflammatory, and antibiotic medications.	13 (6.5)	3 (1.5)	6 (3.0)	7(3.5)	12 (6.0)	34 (17.0)	125 (62.5)

t(199)=14.28, p<0.001), significantly more disagreed than agreed that DTs' practice should be restricted to acknowledged underserved areas in the state (M=3.19, SD=2.02) (d=-.81, 95% CI [-1.09 to -.52], t(199)=-5.64, p<0.001).

Significant differences were also found when evaluating participants' attitudes toward proposed scopes of practice. Significantly more respondents agreed than disagreed that DTs should be able to perform simple extractions of primary teeth (M=5.99, SD=1.76) (d=1.99, 95% CI [1.74 to 2.23], t(199)=15.92, p<0.001), perform simple restorations (M=5.98, SD=1.77) (d=1.98, 95% CI [1.73 to 2.23], t(199)=15.79, p<0.001), provide emergency palliative care (M=5.70, SD=1.83) (d=1.70, 95% CI [1.44 to 1.95], t(199)=13.08, p<0.001), and prescribe non-narcotic analgesics, anti-inflammatory, and antibiotic medications (M=6.02, SD=1.73) (d=2.02, 95% CI [1.78 to 2.26], t(199)=16.56, p<0.001).

Regarding proposed levels of supervision, nearly half of the respondents (45%, n=89) indicated general supervision would be most appropriate for DTs, with 31% (n=61) indicating no supervision was needed. Sixteen percent of respondents (n=32) selected indirect supervision, and 9% of respondents (n=18) believed direct supervision would be appropriate for DTs. For proposed levels of education, a majority (67%, n=133) felt a master's degree was most appropriate for DTs, while 26% (n=52) selected bachelor's degree. Seven percent (n=14) felt an associate degree was appropriate, and 0.5% (n=1) selected certificate.

Results for the chi-square test of association revealed a statistically significant difference in the frequency of responses based on a participant's education level and their opinion toward education requirements for DTs (Fisher's Exact Test=34.17, df=9, p=.000, Cramer's V=.28). Most participants (67%, n=133,), regardless of highest degree held, felt DTs should have master's degrees. However, roughly one-third of participants with associate degrees felt DTs should have associate degrees, compared to only 3% of all other degree holders (Table III). Results revealed no significant associations between frequency of responses based on years of practice as a dental hygienist and opinions toward education requirements for DTs (p>.0125). Regardless of years of practice, respondents selected master's degree for the appropriate education level for DTs (Table IV).

Table III. Opinions toward dental therapy education requirement by current education level (n=200)

Education Level	What level of education should be required for dental therapists?			
	Certificate n (%)	Associate n (%)	Bachelor's n (%)	Master's n (%)
Associate degree (n=30)	—	10 (33.3)	8 (26.7)	12 (40)
Bachelor's degree (n=118)	—	4 (3.4)	35 (29.7)	79 (66.9)
Master's degree (n=44)	1 (2.3)	—	7 (15.9)	36 (81.8)
Doctorate (n=8)	—	—	2 (25)	6 (75)
Total	1 (0.5)	14 (7)	52 (26)	133 (66.5)

Table IV. Opinions toward dental therapy education requirements by years of practice (n=200)

Years of Practice	What level of education should be required for dental therapists?			
	Certificate n (%)	Associate n (%)	Bachelor's n (%)	Master's n (%)
Less than 10 (n=72)	—	2 (2.8)	19 (26.4)	51 (70.8)
10-19 (n=48)	—	5 (10.4)	14 (29.2)	20 (60.4)
20-29 (n=41)	1 (2.4)	4 (9.8)	7 (17.1)	29 (70.7)
30 or More (n=39)	—	3 (7.7)	12 (30.8)	24 (61.5)
Total	1 (0.5)	14 (7)	52 (26)	133 (66.5)

For open-ended questions, 182 responses were provided for potential advantages, 106 for potential disadvantages, and 32 for additional comments. "Increased access to care" (56%, n=102) was the most frequent advantage cited by participants, followed by "autonomy/advancement of the dental hygiene profession" (13%, n=22). The most frequent response for potential disadvantages was "Lack of support from dentists" (27%, n=29), closely followed by "No disadvantages" (26%, n=27). Categorized themes for responses to potential advantages and disadvantages are found in Table V.

Discussion

Considering the shortage of oral healthcare providers affecting over 1.3 million residents in the state of Virginia, DTs could provide much-needed assistance to those experiencing access to care barriers.[2] In addition, Virginia may consider adopting dental therapy legislation in the future.[2] Assessing opinions of dental hygienists, the workforce expected to fill the role of the proposed DT, was essential[10] and the results from this study indicated overall positive attitudes of Virginia dental hygienists toward DTs.

Table V. Open-ended responses to Potential advantages and disadvantages of dental therapists

	n	%
Potential advantages (n=182)		
Increased access to care	102	56
Autonomy/advancement of dental hygiene profession	22	12.8
Provide support for dentist	18	10.5
Enhanced quality of care	16	9.3
More affordable care	12	6.6
Increase in revenue/production	6	3.5
No advantages	6	3.5
Potential disadvantages (n=106)		
Lack of support from dentists	29	27.4
Lower quality of care	19	17.9
Public confusion/acceptance	18	17
Cost/pay issues	16	15.1
Safety/liability concerns	14	13.2
More responsibility/stress for dental hygienists	12	11.3
No disadvantages	27	25.5

Findings suggested that Virginia dental hygienists were aware of a need for DTs and supported implementing this MLDP model to address access to care barriers in the state. Participants added additional comments reflecting on the need for DTs in Virginia. These findings were comparable to other studies exploring opinions of hygienists toward DTs, notably Coplen et al. and Ly et al., in which the majority of surveyed dental hygienists in Oregon and Idaho supported the need for DTs.[21,26] Given that both Oregon and Idaho have adopted dental therapy legislation, it is possible that policymakers in Virginia may consider dental therapy legislation, considering the support of dental hygienists within the state. However, findings from this study contrasted with those of Virginia dentists (n= 145) by Howell et al., in which most respondents strongly disagreed that DTs were needed in Virginia.[31] Other studies involving opinions of dentists toward DTs identified similar findings, such a To'olo et al. and Blue et al., in which most of the dentists surveyed did not support a need for DTs.[32,33]

Participants in this study acknowledged differing opinions between Virginia dentists and dental hygienists in open-ended comments; over one-fourth indicated "Lack of support from dentists" as the top potential disadvantage of this provider model. One reason for contrasting opinions could be the possibility of dental therapy leading dental hygienists away from the direct authority of dentists. Independently practicing DTs could also be perceived by dentists as competition for patients, thus impacting practice incomes. The second most-cited potential advantage to DTs was "Autonomy/advancement of dental hygiene profession" (13%), second only to "Increased access to care" (56%). Concerns amid the COVID-19 pandemic appeared to fuel Virginia dental hygienists' support for autonomy; additional comments included the following statements: "I really hope this paves the way for future dental hygienists to practice independently from dentists, especially with all the mistreatment from some dentists to many hygienists across the country. It's been very difficult to hear how hygienists are being treated during this pandemic" and "If there is anything we have learned from the current pandemic it is that we are bound by the whims of our dentist employers. So many dental hygienists are being forced to return to work while feeling unsafe. It is imperative that we continue to work towards autonomy for dental hygienists, which includes the mid-level provider."

Support for autonomy was also evidenced by most surveyed respondents believing general supervision was appropriate for DTs (45%), with nearly a third supporting no supervision (31%) at all. Additionally, all four Likert-type questions related to scope of practice were answered with the majority of respondents agreeing or strongly agreeing. These findings suggest Virginia hygienists supported the autonomy and advancement of the dental hygiene profession, to include a broader scope of practice. In contrast to dental hygienists, Howell et al. found 70% of Virginia dentists (n=145) believed direct supervision would be appropriate for DTs.[31] These findings were comparable to those of Ly et al. in the Pacific Northwest, in which nearly half of the dentists surveyed (48%, n=39) supported direct supervision for DTs, while most of the dental hygienists surveyed (57%, n=42) supported indirect or general supervision.[26] Dentists may have opposed less supervision for DTs given the potential financial implications of competition for patients with independently-practicing DTs.

Regarding education, most participants in this study chose the master's degree as the appropriate education level for DTs; it was the selected degree requirement regardless of the degree held by the respondent. Current dental therapy programs in Alaska and Minnesota, the two states in which dental therapy has been in practice the longest, have 2- to 4-year post-baccalaureate curriculums.[34] Respondents in this study may have been aware of the successes of dental therapy implementation in these states and acknowledged the need for higher education to practice safely as DTs. However, these findings were in contrast with other studies assessing dental hygienists' opinions of proposed dental therapy degree requirements. In the Ly et al. study of dental hygienists in the Pacific Northwest, only 24% of the respondents agreed a master's degree was necessary.[26] Coplen et al. found the highest number of dental hygienists surveyed in Oregon selected bachelor's degree (48%, n=205), while 39% (n=167) selected master's degree.[21] Interestingly, in this study, a significant association was found between education level and opinions toward dental therapy education requirements; respondents holding associate degrees were more likely to choose associate degree for the proposed education requirement. Dental hygienists in Virginia with higher levels of education may have placed more value on higher-level dental therapy education requirements. Also, respondents holding associate degrees might have felt apprehension toward completing the additional education required for a master's degree. If Virginia adopted dental therapy legislation with master's degree requirements, associate degree practitioners would be forced to spend more time and financial resources on their education to become a DT as compared to dental hygienists with bachelor's or master's degrees. Given the overwhelming support of the study respondents for the autonomy and advancement of the dental hygiene profession, associate degree holders may have felt a master's degree requirement would create a barrier to their own professional development.

When comparing years of practice and opinions regarding dental therapy education requirements, the researchers hypothesized dental hygienists with more years of experience would place more value on experience than formal education, choosing lower-level degree requirements for DTs. However, the findings did not support this. Results revealed participants chose master's degree as the appropriate dental therapy education requirement, regardless of the number of years of clinical practice. These findings suggest no significant relationship exists between years of practice and opinions toward dental therapy education requirements. More experienced dental hygienists may have had increased exposure and familiarity with nuances associated with restorative treatment, regardless of complexity, and subsequently understood the need for more formal education to become a DT.

Both dental hygienists and dentists in Virginia appeared to agree on the topic of education requirements for DTs. Howell et al. found most Virginia dentists (58%, n=84) believed master's degrees should be required for DTs.[31] The highest number of dentists (38%, n=28) in Virginia cited "lower quality of care" as the top potential disadvantage for DTs.[31] Findings from this study suggest dental hygienists acknowledged the importance of high-quality care based on their agreement with Virginia dentists regarding the required dental therapy education levels being set at the master's degree level. Most dental hygienists in this study (53%) agreed or strongly agreed that they would be interested in becoming a DT if this provider model were to be recognized in Virginia. Furthermore, two participants clarified that they would have been interested in becoming a DT if they were not in retirement. These were similar to other studies in which most surveyed hygienists expressed interest in becoming a DT.[21,27,29] Should Virginia policymakers decide to pursue dental therapy legislation, findings from this study demonstrate that dental hygienists in the state were most supportive of DTs.

Limitations

Several limitations may have influenced the results of this study. A convenience sample was used from a purchased online database and the survey was sent digitally via email. Not all email addresses for dental hygienists in Virginia were included in the data set; with a digitally administered survey, all participants needed internet access and valid email addresses. Future studies could explore methods of sending surveys to all licensed dental hygienists in the state for a more representative sample. Upon viewing the survey invitation, dental hygienists who supported dental therapy may have been more likely to respond, while others may have felt they did not understand the concept of DTs well enough to participate. Future studies could include a brief synopsis of dental therapy in the invitation letter with a short explanation of the importance of participation. Lastly, the COVID-19 pandemic came to a forefront when the survey questionnaire invitation was initially distributed, and Virginia closed dental offices for routine care in March 2020. This disruption may have contributed to the low initial response rate, with participants unable to check work emails. Future studies could repeat this survey once the COVID-19 pandemic has subsided. Many pandemic-related comments were negative, and a delay in repeating the survey could allow dental offices opportunities to refine safety policies and procedures, possibly changing negative outlooks of some dental hygienists.

Conclusion

Findings suggest Virginia dental hygienists were highly supportive of DTs in the state. Attitudes were overwhelmingly

positive, with most participants indicating interest in becoming a DT if it was recognized in Virginia. Most respondents supported a broader scope of practice for DTs and non-direct supervision. Most respondents, regardless of years of practice, supported a master's degree as the appropriate degree requirement for DTs. Data gathered from this study may provide policymakers with information for future initiatives regarding dental therapy legislation in Virginia. Findings underscore the need for more research with a larger sample, which could provide more insight into opinions of the dental hygienist population in Virginia.

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Research

Efficacy, Safety and Patient Preference of Knotted Floss Technique in Type II Gingival Embrasures

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Abstract

Purpose: The purpose of this crossover clinical trial was to compare the changes in scores of plaque biofilm accumulation, gingival inflammation, gingival bleeding and gingival trauma in patients who used conventional flossing (CFt), knotted floss (KFt) and an interdental brush (IBt) for 6-weeks each in Type II gingival embrasures.

Methods: Sixty healthy, tooth-brushing adults with at least one Type II gingival embrasure were randomly assigned to perform any of above interdental cleaning techniques in each phase of six weeks. Crossover to another technique was undertaken after washout of 2 weeks. Test-sites were scored at baseline, 3 and 6 weeks for Rustogi Modification of Navy Plaque Index (RMNPI), Modified Gingival Index (MGI), Modified Papillary Bleeding Index (MPBI), and Carter-Hanson scoring for gingival trauma. Acceptability of each technique was evaluated by subjects' responses to the post-trial questionnaire.

Results: Analysis of data showed a significant improvement in RMNPI, MGl and MPBI scores within all three groups over the time-period of 6-weeks from baseline. RMNPI and MGI scores were significantly more in the CFt group when compared to KFt and IBt and there was no difference in KFt and IBt. Additionally, no significant gingival trauma was recorded in any test group. Equal percentages of participants selected KFt or IBt for its ability to clean and preference to continue to use.

Conclusion: Use of a KFt and IBt are statistically similar in safety and efficacy for reducing plaque biofilm accumulation, gingival inflammation, and bleeding in Type II gingival embrasures, when either is used as an interdental cleaning aid in conjunction with regular tooth-brushing. KFt and IBt demonstrated better efficacy than CFt.

Keywords: interdental cleaning, dental floss, interdental brush, oral hygiene, gingival embrasures

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Introduction

The plaque biofilm that forms on all hard and soft oral tissues in the oral cavity is reported to be the primary etiological agent for periodontal diseases.[1-4] Procedures and devices have been designed for an efficacious plaque biofilm control, with the objective to mechanically disrupt its adherence to the tooth or gingival surface and/or to prevent its formation itself.[1,5] Oral health care professionals recommend a daily dental plaque biofilm control that may consist of mechanical and chemical procedures.[5-8] Substantial evidence shows that mechanical and/or chemical plaque biofilm control leads to reduction in prevalence and severity of gingival inflammation.[6-8] Even though the complementary use of chemotherapeutic agents has been used, clinical evidence demonstrates that oral mechanical hygiene is fundamental to prevent and control caries and periodontal disease.[9-11] More specifically tooth-brushing remains the primary method for controlling supra-gingival accumulations.[9,11] Although use of a toothbrush with dentifrice is an effective means for removing plaque biofilm on many tooth surfaces, it cannot completely clean the interdental surfaces when used exclusively.[12]

In populations that use tooth-brushing alone, the proximal surfaces of posterior teeth are the predominant sites of residual plaque biofilm. Gingivitis and periodontitis are more pronounced in interproximal areas than on oral or facial aspects in patients who are prone to periodontal disease.[9] Additionally, periodontal disease is recognized to progress faster interdentally.[13] Good interdental oral hygiene requires a device that can adequately reach the interproximal area.[14,15] Different types of products are designed to achieve this, such as

floss, woodsticks, rubber-tip simulators, interdental brushes and single-tufted brushes.[5,6,12,15,16] Interdental brushes are advised for patients with Type II interdental embrasures or embrasures that are having fifty percent of papillary fill, or rather half the embrasure space is open.[15-17] These are small, specially designed brushes with soft nylon filaments twisted into a fine stainless steel wire and mimicking a miniaturized bottle-brush.[5,6,15-17]

Dental flossing is useful in cleaning interproximal surfaces of teeth with few adverse consequences,[18] especially in type I interdental embrasures wherein the interdental space is filled with gingival papilla.[17,18] The improved interproximal gingival health when supplementing conventional tooth-brushing with flossing has been ascribed to the ability of the floss to have improved access to the interdental sulcular area. However, flossing may not effectively clean wide interdental spaces, root surfaces or concavities.[15,16] To make the dental floss effective in such conditions, Gomes et al,[19] have recently presented a modification to the flossing technique and called it the 'Knotted Floss Technique' (KFt). In their modification, a knot was tied in the floss at any distance in the middle third of the floss length enabling an increase in the effective width of the floss. This has enabled modified floss to be used in embrasures wider than those recommended for regular finger flossing. The modified floss was inserted past the interdental contact point by the regular finger flossing technique in the non-knotted area. The knotted area was engaged through the embrasure by a 'to and fro movement' against the interdental tooth surface.[19] It has been reported in a randomized-control-crossover study, that the KFt is as safe and as effective an oral hygiene method for reducing plaque biofilm, inflammation and bleeding when compared to conventional finger flossing (CFt) in type I gingival embrasures.[18] However, this clinical evaluation of the KFt was not carried out in type II gingival embrasures and was not compared with interdental brushing (IBt) in such embrasures.

To assess the efficacy of interdental cleaning methods, one has to consider two points of references. One being the theoretical efficacy of the method based upon the clinical evidence while the second being the practical efficacy, influenced by the acceptability of the method to clients and therefore their compliance.[20] The purpose of this study was to compare the changes in scores of plaque biofilm accumulation, gingival inflammation, gingival bleeding and gingival trauma in patients who all used CFt, KFt and IBt for 6-weeks each in Type II gingival embrasures. Patients' acceptability of the techniques was also evaluated.

Methods

Study Design

For this 22-week, triple phase, examiner blind, randomized crossover clinical trial, a sample size of sixty individuals who were eighteen years and above were selected from among the outpatients of the Department of Periodontology and Oral Implantology at the Uttaranchal Dental and Medical Research Institute. A pilot study involving a convenience sample of six participants was conducted to determine the sample size for the main study. The sample size was calculated with a power of 80% and a confidence level of 95%, as per the criteria of Chow et al.[21] The pilot study was used to verify that a 'washout' phase of 2-weeks in-between any two treatment phases was sufficiently long, to rule out any carryover effect of the previous treatment procedure into the phase of the next treatment. Data obtained from pilot study was also used to measure the intra- and inter-examiner reliability. The inclusion criteria that were employed for selection of participants is described in Figure 1. The criteria were designed such that a cohort was selected that were without any confounding factors for plaque biofilm accumulation and gingival inflammation. For example, habitual unilateral mastication usually leads to accumulation of plaque and calculus on the contralateral side.[24] The trial was conducted as per the guidelines in the Handbook for Good Clinical Practice.[25] The research protocol was approved by the Institutional Ethics Committee of Uttaranchal Dental and Medical Research Institute, Dehradun, certificate No IEC/PA- 001/2017 (April 20, 2017).

Figure 1. Participant Inclusion Criteria

- One type-II embrasure in the premolar-first molar area, [only one type-II embrasure was selected per participant][17]
- Full mouth Plaque Index[22] score ≥ 1.8
- Full mouth Gingival Index[23] ≥ 1.0 and <2.0,
- Good general health
- No missing teeth in the quadrant bearing the embrasure being tested, except for third molars
- No missing teeth in the quadrant opposite to the embrasure being tested, except for third molars
- No more than two teeth missing in each of the other two quadrants
- Available for a 22-week study period
- Willing to abide with the study criteria
- Minimum education of higher secondary school certification

Prior to their enrollment, each volunteer received written and verbal instructions on the three test techniques, namely CFt, KFt and IBt (Figure 2). Investigators AG and MS demonstrated to the volunteers all three techniques on models, for half-hour session, for three consecutive days. Each educational session consisted of not more than ten participants per investigator. On the fourth day, if AG and MS were both satisfied with the volunteer's proficiency in demonstrating each of the three interdental cleansing technique on models, an informed consent was taken and the volunteer was enrolled as a participant into the 22-week, three-phase crossover, single-(examiner) blind study protocol. If either of AG or MS were not satisfied with any volunteer's ability to perform the techniques as instructed, then that participant had to attend another educational session of half hour and was evaluated again on the subsequent day. Thereafter, if either of AG or MS was unsatisfied with the ability of the volunteer to perform any one of the three techniques of interdental cleansing, then he/she was not enrolled into the study protocol and no further educational sessions were conducted.

Figure 2. Participant instructions

1.	Brush the teeth twice a day using supplied toothbrush and dentifrice only.	
2.	Do not use any other oral hygiene aid except for the assigned interdental cleaning aid.	
3.	Use the assigned interdental cleansing aid once a day in the method demonstrated.	
	Conventional Floss Phase*	Wrap the floss around the middle or index fingers. Hold the floss taut and gently slide the floss between the teeth and move it along the margin, curved into a "C" shape. Movement of the floss should be 'up & down' and 'back & forth' (in a push-pull motion) three to five times between each tooth without using excessive pressure. Finally allow the floss out through the embrasure by releasing the floss from one finger.
	Knotted Floss Phase*	Wrap the floss around the middle or index fingers. Hold the floss taut and gently slide the floss between the teeth in the portion that does not contain the knot. Move it along the margin, curved into a "C" shape. Movement of the floss should be 'up & down' and 'back & forth' (in a push-pull motion) three to five times between each tooth without using excessive pressure, such that the knotted area passes across the interdental area from buccal to lingual or vice-versa. Finally allow the floss out through the embrasure by releasing the floss from one finger.
	Interdental Brushing Phase*	Gently insert the brush into the interdental area with an inclination akin to the angle of the interdental gums (gingiva), and perform to and fro buccal to lingual movements and a little apico-coronal movement such that the gingiva is not impinged, and finally removing the brush out buccally.
	Washout Phase	Perform normal oral hygiene practices of tooth-brushing with dentifrice. Refrain from using interdental cleansing aid or other plaque biofilm control aids.
4.	Write in the diary (provided in the sample kit) any interdental cleansing experience that you feel is significant, including missing an interdental cleansing activity, performing an extra oral hygiene procedure (like tooth picking), taking any medication or any gingival trauma, cut, etc.	
5.	Discuss queries regarding interdental cleansing only with the first and third investigator. Do not mention anything about your interdental cleansing experience to the other investigators or any other study participant.	
6.	Return all unused interdental cleansing aids provided in the sample kit to the first investigator at the end of each treatment phase.	

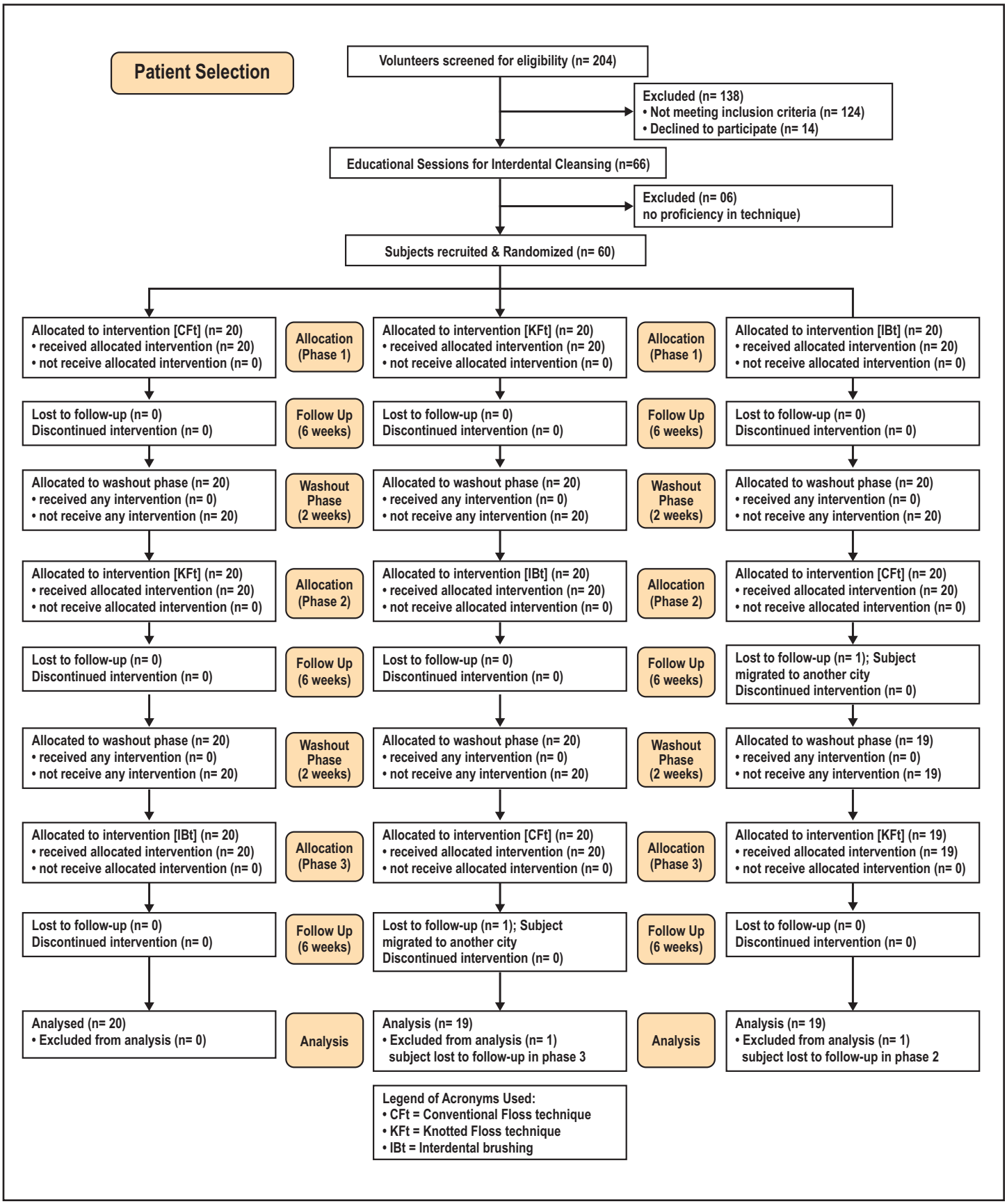
* Only the first investigator had knowledge of flossing technique assignments

Investigator AG randomly placed all participants into one of three groups by a draw of lots. Twenty lots were each inscribed as "CFt-KFt-IBt", "KFt-IBt-CFt" and "IBt-CFt-KFt". After a participant chose a lot, that lot was discarded from the bowl of lots thus ensuring a linear decrease in available lots with enrollment of each participant. Only AG was responsible for this allocation and coding of participants to respective treatment groups, the other three investigators were blinded to the assignments.

Each group participated in three treatment phases of 6-weeks each, with a 2-week washout phase in-between any two treatment phases. The "CFt-KFt-IBt" group performed CFt in first phase, followed by KFt and IBt in the second and third treatment phase respectively. The "KFt-IBt-CFt" group performed KFt, IBt and CFt in the first, second and third treatment phase respectively; while the "IBt-CFt-KFt" group performed IBt, CFt, KFt, in their first, second and third treatment phases respectively. The study design flow chart is shown in Figure 3.

At the baseline appointment for each treatment phase, every participant was given their assigned interdental cleansing

Figure 3. Study design flow chart



products by AG. Participants assigned to conventional flossing received forty-six pieces of waxed floss (Reach; Johnson & Johnson, Mumbai, IND) 15 centimeters in length each piece, equally divided in two bags. Participants assigned to knotted flossing aid received the same except that every floss thread had a simple knot at around the middle of the strand. Each participant assigned to the interdental brush cleansing regimen received eight units of narrow size interdental brushes (Thermoseal; ICPA Health Products Ltd, East Mumbai, IND) instead of the pieces of floss. Participants were to use the respective interdental cleansing aids in the evening after dinner. Floss strands were to be discarded after a single session of use, while the interdental brush was reused for 6-7 sessions. Interdental brushes were to be rinsed in running water and placed in the interdental brush sleeve in an upright position. All participant received a sample of toothbrush (Oral B Allrounder Soft; Proctor and Gamble India Ltd.) and dentifrice (Colgate Strong Teeth; Colgate-Palmolive Ltd, Mumbai, IND) at the start of each treatment phase. Participants were instructed to brush their teeth twice a day in their customary manner and were cautioned not to use any other oral hygiene aid except for the assigned interdental cleaning device once a day. The first and second treatment phase were each followed by a 'washout period'. During the washout period the participants were instructed to perform normal oral hygiene practices of tooth-brushing with dentifrice and refrain from using any floss, interdental brush or any additional aid for plaque biofilm control.

Clinical Evaluations

Clinical evaluations of all participants were done at baseline, three-weeks and six-weeks of each treatment phase. Both adjacent teeth and gingiva at test sites were scored for the Rustogi Modification of Navy Plaque Index (RMNPI),[26] Lobene's Modified Gingival Index (MGI),[27] and Barnett's Modified Papillary Bleeding Index (MPBI).[28] The sequencing of examination was specifically chosen as plaque index, gingival index and bleeding index, to avoid the possibility that the plaque biofilm would be removed during the recording of the other two indices.[29,30] A disclosing agent (AlphaPlac; DPI Inc, Mumbai, IND) for plaque biofilm was applied gently using a cotton pledget to visually identify plaque biofilm. Gingival trauma (GT) was assessed by the method described by Carter-Hanson et al.,[29] as the presence or absence of signs of trauma in the marginal and papillary gingiva of adjacent teeth. The facial and lingual surfaces were examined visually for gingival lacerations. Presence of laceration, floss cut, or demarcation line/indentation at the site were scored as one, while a score of zero was recorded when there was absence of any signs of trauma. The score per participant was obtained by totaling all scores and dividing by number of sites examined.[18,29]

The indices were recorded by investigators AR and DP. To establish the intra- and inter-rater reliability, at least nine volunteers, selected at random from the out-patient clinic were examined at three weekly intervals throughout the study. Data recorded from the pilot study was also included for this purpose. Scores recorded from these volunteers and those of the pilot study were not included in the main study. The study schedule was distributed, so not more than six participants reported for examination on any given day of the week. AR and DP were blinded regarding the technique the participant was using.

Compliance

A compliance diary was also given to each participant at the baseline appointment of each treatment phase and was assessed at the end of each phase by AG and at end of all three treatment phases by AG & MS. The participants were instructed to record each interdental cleaning experience in this diary and any other event he/she felt was significant. A patient satisfaction questionnaire was answered by every participant at the end of the third and final treatment phase. Compliance or non-compliance by the participant was empirically established by calculating the amount of any unused portion of interdental cleaning product and by the entries in the diary. MS contacted the participants after completion of the study to verify any unusual entries in the compliance diary or to ascertain the reasons of excess unused floss returned to the department if any.

Data Analysis

Data was recorded by AR and DP into coded case sheets per participant, which was later decoded by AG. The data were entered into an Excel sheet (MS Office 2010) and then analyzed using SPSS® software version 17.0 (SPSS; Chicago, IL, USA). Gender wise distributions were compared and the mean age was calculated. Since the sequencing of the treatment during the three phases of a crossover study has the potential to affect the comparison of scores between test and comparator groups, a 3-factor analysis of variance (ANOVA) was conducted to examine the effects of sequence of treatment phase and the possibility of any 'carry-over' of the effects of first treatment phase into the second and third phase, despite the 2-week 'washout' phase in between. The scores recorded during use of the CFt from all three groups were tabulated together for respective index at different time-points and the means and standard deviation calculated. Similarly, the scores of KFt and IBt were tabulated and means calculated for the observed indices at different time-points.

The mean differences of scores at respective time intervals of each of the index scored were compared between the three interdental cleansing techniques by using the analysis of variance (ANOVA) and the paired sample test. Also, a statistical analysis by paired t-test was done of scores recorded between time-points of 3-weeks versus baseline, six-weeks versus baseline, 6-weeks versus 3-weeks of the respective index within the same treatment technique. This determined the improvement/worsening/no effect of respective scores of plaque biofilm, gingival inflammation, gingival bleeding, and gingival trauma over different time intervals while using the same interdental cleaning technique. All results were examined for statistical significance at p value ≤0.05. Participant responses to the end-study questionnaire were aggregated and analyzed on a percentage scale to compare preferences between each technique.

Results

An inter-examiner reproducibility for exact agreement with κ=0.77 ± 0.08 (SE) was observed for readings made between AR and DP, indicating an excellent level of agreement. An intra-examiner reproducibility for exact agreement with κ=0.83 ± 0.05 (SE) and 0.81 ± 0.08 (SE) for replicating the readings was recorded by AR and DP respectively, also indicating an excellent level of agreement.

Data gathered from two participants was not included because they did not complete the third treatment phase as they moved out of the country for employment. All clinical data was based on that recorded with the participants (n=58) who had completed all the treatment phases of study and no data has been included of the participants that withdrew from the study before completion. The age and gender distribution of the participants is shown in Table I.

Mean scores at baseline, 3-weeks and 6-weeks for RMNPI, MGI, MPBI and GT for the respective treatment groups and the differences when the scores were compared between a pair of groups are shown in Table II. Baseline scores for the first three indices were statistically similar. The mean RMNPI scores of KFt and IBt group were significantly lesser than the CFt scores at 3-weeks and 6-weeks. The mean MGI scores of KFt and IBt group were statistically lower than CFt scores at 6-weeks. The mean MPBI scores recorded at 6-weeks in the IBt group was statistically lower than the respective mean score in the CFt group. There was no statistically significant difference between the mean scores of KFt group and IBt at respective time-points of the study for any of the indices studied.

Within the same treatment group, the mean scores were compared to observe any improvement/worsening in scores (Table III). The mean scores of the CFt, KFt, and IBt group for the RMNPI, MGI, MPBI, were statistically lesser at 3-weeks when compared to baseline and statistically lesser at 6-weeks when compared to baseline. The scores of KFt and IBt group for all three above indices were statistically lesser at 6-weeks when compared to respective 3-weeks scores.

No incidence of gingival laceration or floss cut, was reported nor observed during the period of study, when using any of the three interdental cleaning aids.

Percentage of replies and preferences by the participants to the patient questionnaire are shown in Table IV. Only two of the participants that completed the study stated that the CFt was better than other two technique in its ability to clean and only one participant preferred to continue using the CFt as a future oral hygiene regimen. Of the remainder of the participants, they equally preferred between the KFt and IBt for its ability to clean the interdental embrasure and for willingness to continue using the technique for their oral hygiene regimen in future.

Discussion

In this three-phase crossover study, a 'washout' phase of 2-weeks in-between any two treatment phases was used to rule out any carryover effect of the previous treatment procedure into the phase of the next treatment. In previous

Table I. Sample Demographics (n=58)

	Phase 1			Phase 2			Phase 3			Total
	CFt	KFt	IBt	CFt	KFt	IBt	CFt	KFt	IBt	
Participants	20	19	19	19	20	19	19	19	20	n=58
Males	10	9	7	7	10	9	9	7	10	n=26(45%)
Females	10	10	12	12	10	10	10	12	10	n=32(55%)
Age range (years)	22 – 51			22 – 51			22 – 51			22 – 51
Mean age (years)	39.1 (± 9.6)			39.1 (± 9.6)			39.1 (± 9.6)			39.1 (± 9.6)

Table II. Comparison of mean scores between treatment groups at various time intervals. (n=58)

Index	Examination Period	CFt*	KFt*	IBt*	*p*-value** CFt-KFt	*p*- value CFt-IBt	*p*- value KFt-IBt
Plaque Index	Baseline mean (SD)*	2.67 (0.96)	2.70 (0.95)	2.63 (0.96)	0.990	0.990	0.960
	3-weeks mean (SD)	2.03 (0.62)	1.57 (0.68)	1.50 (0.57)	0.013	0.004	0.910
	6-weeks mean (SD)	1.93 (0.58)	1.23 (0.50)	1.07 (0.45)	0.001	0.001	0.426
Gingival Index	Baseline mean (SD)	2.52 (0.64)	2.55 (0.61)	2.60 (0.64)	0.977	0.864	0.949
	3-weeks mean (SD)	1.93 (0.54)	1.81 (0.38)	1.75 (0.43)	0.583	0.268	0.838
	6-weeks mean (SD)	1.85 (0.48)	1.37 (0.47)	1.28 (0.45)	0.001	0.001	0.769
Bleeding Index	Baseline mean (SD)	2.43 (0.82)	2.37 (0.72)	2.50 (0.63)	0.933	0.933	0.757
	3-weeks mean (SD)	1.83 (0.65)	1.73 (0.45)	1.90 (0.61)	0.779	0.895	0.502
	6-weeks mean (SD)	1.73 (0.58)	1.43 (0.50)	1.40 (0.49)	0.078	0.044	0.968
Gingival Trauma Index	Baseline mean (SD)	–	–	–	–	–	–
	3-weeks mean (SD)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	–	–	–
	6-weeks mean (SD)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	–	–	–

*CFt = Conventional flossing technique; **KFt = Knotted flossing technique; IBt = Interdental brushing; SD = Standard Deviation;
**level of significance p≤0.05

Table III. Mean differences of scores within each treatment groups at various time intervals (n=58)

Outcome Measure	Examination Time Interval	CFt*		KFt**		IBt*	
		Mean Diff.	*p*-value**	Mean Diff	*p*-value	Mean Diff.	*p*-value
Plaque Index	Baseline – 3weeks	0.63 (0.67)	<0.001	1.13 (0.68)	<0.001	1.14 (0.67)	<0.001
	3weeks – 6weeks	0.10 (0.31)	0.083	0.33 (0.48)	<0.001	0.43 (0.50)	<0.001
	Baseline – 6weeks	0.73 (0.74)	<0.001	1.47 (0.86)	<0.001	1.57 (0.94)	<0.001
Gingival Index	Baseline – 3weeks	0.58 (0.53)	<0.001	0.73 (0.68)	<0.001	0.85 (0.71)	<0.001
	3weeks – 6weeks	0.83 (0.23)	0.057	0.45 (0.49)	<0.001	0.47 (0.51)	<0.001
	Baseline – 6weeks	0.67 (0.55)	<0.001	1.18 (0.62)	<0.001	1.31 (0.74)	<0.001
Bleeding Index	Baseline – 3weeks	0.60 (0.68)	<0.001	0.63 (0.81)	<0.001	0.60 (0.77)	<0.001
	3weeks – 6weeks	0.10 (0.31)	0.083	0.04 (0.47)	<0.001	0.50 (0.63)	<0.001
	Baseline – 6weeks	0.70 (0.79)	<0.001	0.93 (0.83)	<0.001	1.10 (0.80)	<0.001

*CFt = Conventional flossing technique; KFt = Knotted flossing technique; IBt = Interdental brushing

**level of significance p≤0.05

Table IV. Patient satisfaction questionnaire (n=58)

Questions	CFt*	KFt*	IBt*
	n (%)	n (%)	n (%)
Ease of use	18 (31%)	16 (28%)	24 (41%)
Time taken – faster	20 (35%)	14 (24%)	24 (41%)
Pain, sensitivity etc.	8 (14%)	22 (38%)	28 (48%)
Ability to clean	4 (7%)	26 (45%)	28 (48%)
Continual use?	2 (3%)	30 (52%)	26 (45%)

*CFt = Conventional flossing technique; KFt = Knotted flossing technique; IBt = Interdental brushing

crossover studies, Carter-Hanson et al.,[29] used a 2-week washout period when comparing a floss holding device to conventional finger-flossing procedure, while Torkzaban et al.,[31] used a 7-day washout period when comparing a brushing and flossing sequence. In this study, the 2-week washout phase ensured parity in baseline clinical measurements prior to starting each treatment phase. Moreover, it was mandatory that the same inclusion and exclusion criteria applied to all volunteers at the start of each treatment phase.

Tooth brushing (up to twice daily) was shown to significantly improve gingival heath. However, it has been reported that brushing alone may remove less than 60% of overall plaque biofilm at each episode of self-cleaning.[32] In a systematic review, Worthington et al.,[11] has stated that home use of any one of interdental cleaning devices like dental floss, interdental brushes, tooth-cleaning sticks or oral irrigators, utilized in conjunction with toothbrushing is effective in reducing gingivitis, and even scores of plaque biofilm accumulation. In a recent, representative, cross-sectional study of adults in the United States aged >30years, it was discovered that self-care that included interdental cleaning was associated with less periodontal disease, decreased coronal and interproximal caries, and fewer missing teeth.[33] A higher frequency of interdental cleaning (4 to 7 times per week) was associated with significantly lesser interproximal periodontal disease as compared to lower-frequency use of interdental cleansing (1 to 3 times per week) and non-users.[33] However, investigators have reported a reluctance by the general public to routinely use interdental cleaning aids.[29,34] Hence, there is a need for an alternative product or procedure for interdental cleaning, which can increase acceptability and compliance amongst the intended user.[18,29] One such new procedure is the KFt.[19] Results from this study have revealed a similar ability of the KFt as compared to IBt with respect to decreasing scores of plaque biofilm accumulation and gingival inflammation in Type II interdental embrasures. Both techniques were superior to CFt at the same test-sites. Patient preference was high with the KFt and IBt and low with CFt. None of the three techniques tested resulted in any gingival trauma.

All participants performed regular toothbrushing with dentifrice for their daily oral hygiene, in addition to the assigned interdental cleaning technique. Hence, the changes in scores obtained with use of any of the interdental cleaning technique are not the result of the exclusive use of the interdental technique but when used in addition to toothbrushing. Use of interdental cleansing aids as an adjunct to toothbrushing has been recommended in multiple previous reports.[11,18,31,33]

There is only one other study in the literature that has evaluated the KFt. In that two-phase, single blinded, clinical trial, it was reported that KFt was a safe and effective interdental cleaning technique for reducing plaque biofilm accumulation, gingival inflammation, and bleeding.[18] The decreases in scores of plaque biofilm and gingival inflammation were similar to those when CFt was used, over a six-week test phase of each technique. Similarly, in 2011, Imai and Hatzimanolakis,[35] conducted an examiner blinded, randomized, 12-week, split-mouth clinical trial to compare the efficacy of IBt and CFt in the reduction of scores of gingival bleeding and plaque biofilm accumulation at Type I embrasure sites in 30 volunteers. They inserted a color-coded probe to determine the best-fitting interdental brush for these proximal sites. Though no statistical differences were reported between the IBt and CFt for plaque scores, use of the IBt demonstrated statistically significant reductions in bleeding. Both the above studies were specifically carried out in participants with type I interdental embrasures. Therefore, the participants had intact interdental papillae, which limited the participants' and examiner's visibility of the disclosed plaque biofilm on interproximal tooth and root surfaces.

The current study was undertaken in type II gingival embrasures where interdental brushes are usually recommended over dental floss as an interdental cleaning aid.[15,17] All the test techniques, namely CFt, KFt and IBt, demonstrated significant reductions in scores of plaque biofilm accumulation and gingivitis. However, KFt and IBt were each statistically better than CFt in demonstrating these benefits of reduction in gingival inflammation and plaque biofilm accumulation. Hence, a modification in the flossing technique can result in similar efficacy in reduction of scores of plaque biofilm accumulation and gingival inflammation as the IBt in type II embrasures.

Interdental brushes are known to be effective in removing plaque biofilm as far as 2–2.5 mm below the gingival margin.[12] The consensus statement from the European Federation of Periodontology 2015 workshop states that

"cleaning with interdental brushes is the most effective method for interproximal plaque biofilm removal, consistently associated with more plaque biofilm removal than flossing or woodsticks."[36] The adjunctive use of interdental brushes has been shown to achieve significant improvements in clinical parameters such as scores of plaque biofilm, gingival bleeding and sulcus probing depth, when compared to brushing alone.[11] In a review of interdental cleaning aids by Sälzer et al., the interdental brush was shown to more effectively demonstrate reductions in interdental plaque biofilm and bleeding, especially in participants with clinical attachment loss, and thus, open embrasure areas. [37]

The superiority of interdental brushes was thought to be due to higher efficacy of plaque biofilm removal and high patient acceptance, as well as ease of use.[35,36] In a randomized controlled clinical trial, Jackson et al.,[38] demonstrated that by interdental cleaning, especially with IBt, patients with chronic periodontitis were able to improve clinical periodontal outcomes and reduce the clinical signs of disease and inflammation over a 12-week period. Since their participants were recruited from a periodontal waiting list, they were likely to have open embrasures, meaning type II or III embrasures. A similar efficacy in reducing gingival outcomes was shown in the current study on type II embrasures. Because the bristles of an appropriately sized interdental brush are able to disrupt the interdental oral biofilm, especially in the concave tooth and root anatomy of premolars and molars, it has been argued that IBt can more effectively remove plaque biofilm from the invaginated axial cervical tooth surfaces as compared to CFt.[35] Gomes et al.,[19] theorized that the increased cross-sectional width of the floss at the knot area can also disrupt the plaque biofilm accumulation in similar anatomical areas. These findings were also demonstrated in this study as the KFt and IBt showed similar disruption of the interproximal oral biofilm which was sufficient to cause a shift in the equilibrium towards gingival health.

Participants' compliance with interproximal oral self-care is associated with their perceptions of ease of use and motivation. Lack of client compliance and/or the manual complexity of oral hygiene technique can be directly or indirectly responsible for lack of efficacy.[37] Imai and Hatzimanolakis, reported that an interdental brush, if properly chosen for its fit in the interdental embrasure, is easy to use, is well accepted by clients and may positively influence daily interproximal self-care compliance.[39] In the present study, nearly the same number of participants preferred the KFt and IBt for its cleaning ability of food impacted in the embrasure and would prefer to continue using either of these techniques in the future. When using IBt, it is necessary to choose the size of device according to the papillary fill. Choice of an oversized device can result in a risk of gingival trauma and papillary recession. Thus, it can be argued that a client who is adopting adjunctive use of IBt for self-care, will need to use a combination of different sized devices for different types of embrasures. Results from this study have shown that the KFt is as effective as IBt in type II embrasures. Findings from a previously published study have demonstrated the efficacy of KFt to be similar to CFt in type I embrasures.[18] Moreover, since the KFt entails only a small home-made modification in cheap and easily available dental floss, long-term use of the KFt is much less expensive than the use of IBt that has been used in previous studies.[13,35,38]

In a study on 26 dentate participants, Renton-Harper et al,[40] demonstrated that the use of an instructional video using a "watch-and-follow" program was beneficial in improving the efficacy of plaque biofilm removal with an electric toothbrush. They suggested the importance of such education techniques for improving results of other forms of mechanical tooth cleaning.[40] It is easier to motivate participants with a high level of education as compared to participants with low education and low literacy levels.[41] In the present study, the interventional techniques were demonstrated to the volunteers and only those who showed proficiency in the techniques were enrolled. They possessed a minimum education of higher secondary school certification and were able to satisfactorily understand oral hygiene education sessions. In a study by Segelnick, it was shown that after repeated, intensive one-on-one instructions, most participants demonstrated effective dental flossing technique.[42] This could be the reason that no participant in the present study reported any episode of gingival trauma. It is therefore recommended that like any inter-proximal oral hygiene technique, recommendations of the KFt should include a demonstration of the proper technique.

Limitations and Future Research

Age, sex, economic status, frequency of visits to the dentist, smoking, and alcohol consumption have been considered as potential confounding factors in any study of periodontitis, including gingivitis.[43,44] Though smokers were excluded from the cohort of this study, the selection criteria did not exclude volunteers based on any of other confounding factors. The choice of test area (upper or lower arches, left or right sides) did not affect the selection of participants nor criteria of being only left-handed (LH) or right-handed individuals (RH). All the participants in this study happened to be RH, which was observed when they completed their medical health histories and participated in the oral hygiene instruction sessions. Kadkhodazadeh et al., reported that LH individuals have lower plaque biofilm scores in the right quadrants and RH

individuals have lower plaque biofilm indices in the left quadrants. [45] Right handed individuals have been reported to have lower oral hygiene scores and a lower incidence of caries, possibly because of their better manual dexterity and brushing efficiency.[46] These confounding variables may not necessarily have affected results of this study, as these variables were common during all intervention phases of the crossover study.[18,29] However in a crossover study on flossing, Torkzaban et al., reported a significant influence of gender on scores of plaque biofilm and gingival bleeding.[31] Future studies will need a larger sample size such that all confounding variables of periodontal disease are identified during sampling, and include a variety of socioeconomic groups as well as groups with different kinds of eating habits.[43]

Participants who were enrolled into this study were given instructions in interdental cleaning techniques and were thus well-motivated in diligently performing the procedure as required. It is debatable whether the favorable results in the efficacy of the three test techniques were achieved by cognitive behavioral intervention, or by the Hawthorne effect.[5] This limitation may be diminished in a long-term study. Hujoel et al. advised against the extrapolation of results obtained from studies with professionally supervised flossing to typical floss users, since unsupervised self-flossers didn't show any significant reduction in incidence of interdental caries. [47] Since the participants were not directly supervised during the flossing procedure per se, it cannot be considered as supervised oral hygiene. Their compliance was ascertained not only by entries in their diary but also by the amount of interdental hygiene aids remaining in the supply kit at the end of the study. For ethical reasons, individuals with severe inflammatory gingival disease needing urgent professional care were excluded from the sample population. Since severely inflamed gingival tissues are more prone to injury, it is possible that such individuals would have had more cases of papillary gingival trauma while using interdental hygiene aids.

Ranganathan et al.[48] and Sedgwick[49] have recommended to look at the statistical and clinical significance independently. The statistical significance of the data was analyzed with a p-value of ≤0.05. The clinical significance reflects the extent of change, whether the change makes a real difference to an individual's life, how long the effects last, consumer acceptability, cost-effectiveness, and ease of implementation.[48,49] Even though the KFt conforms to the latter three factors, its efficacy (as well as that of other interdental cleaning aids) necessitates a regular use by a well-motivated patient to achieve a beneficial effect over a long-term period. Future research is needed to test the effects of interdental cleaning aids in areas of previously inflamed gingiva or periodontitis. A detailed periodontal charting along with staging and/or grading of the periodontal status of the participants is also recommended.

Conclusion

Results from this clinical trial demonstrated that KFt is a safe and effective inter-dental oral hygiene cleaning technique for reducing plaque biofilm accumulation, gingival inflammation and bleeding, as compared to IBt techniques in type II gingival embrasures, when used in conjunction with regular tooth-brushing over a 6-week period. Both the KFt and IBt have shown to be superior to CFt for interdental cleansing in type II embrasures. The KFt appears to be a viable alternative to IBt in assisting patients in establishing cost-effective interdental cleansing habits in type II gingival embrasures.

Disclosures

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Attitudes of Dental Hygiene and Nursing Students Following a Simulation Activity

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Abstract

Purpose: Interprofessional education (IPE) activities assist health care professionals outside of dentistry learn about the importance of oral care and its connection to overall health, while also encouraging the integration of dental hygienists into primary health care teams. The purpose of this study was to evaluate the effect of a simulation activity on dental hygiene and nursing students' attitudes about interprofessional collaboration (IPC).

Methods: Second-year dental hygiene (n=35) and nursing students (n=45) from a community college in the Midwestern United States were recruited to participate via e-mail. Participants completed an online module about oral care and ventilator-associated pneumonia followed by the Interprofessional Education Collaborative (IPEC) Competency Self-Assessment Survey version 3 prior to participating in an IPE simulation activity. The IPEC survey measures two domains: interprofessional interaction and interprofessional values. Following the simulation activity, participants completed the survey again. A Wilcoxon signed-rank test compared pre/post-survey responses.

Results: A total of 61 students completed the pre-IPE survey (73%; dental hygiene: n= 29, nursing: n=32); and a total of 38 students (47%) completed the post-IPE survey. Ten post-IPE surveys were excluded in the final analysis (dental hygiene: n=15, nursing: n=13). A significant difference was found between pre-IPE and post-IPE scores for the interprofessional interaction domain (p<.001). No difference was found for the interprofessional values domain (p<.18)

Conclusions: Participants had a high regard for IPC and their attitudes improved following the simulation activity. Open-ended responses indicated an increase in knowledge of the importance of IPC and a heightened awareness of professional roles and responsibilities. Interprofessional activities are needed across the health professions curricula to provide future collaboration and quality patient care.

Key Words: interprofessional education, interprofessional collaboration, professional attitudes, dental hygiene education, nursing education, health professions curricula, ventilator-associated pneumonia

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Introduction

The oral cavity is a recognized source of inflammation,[1,2] yet approximately 70% of medical school curricula only include five hours or less of oral health content and 10% do not have any education or training in oral health.[1] Until recently, few healthcare professions had defined oral health education training or required oral health competencies as part of their curricula. Interprofessional education (IPE) activities that include oral healthcare providers, have been shown to be a vital component for teaching effective and comprehensive patient care.[1] Such activities allow future health care providers from other disciplines to learn about the oral cavity and how oral health influences systemic health, as well as proper preventive care.

To meet the demands of an evolving and complex healthcare system and the cultural shift towards interprofessional collaboration (IPC) and partnerships, new models of IPE may increase the quality and cost-effectiveness of care. Interprofessional education is defined as when "students from two or more professions learn about, from and with each other to enable effective collaboration and improve health outcomes."[3] Health professions accreditation standards now require some form of IPE in most curricula. In dental hygiene

education there are two standards required for accreditation by the Commission on Dental Accreditation (CODA).[4] Standard 2-15 states, "Graduates must be competent in communicating and collaborating with other members of the health care team to support comprehensive patient care."[4] Standard 2-19 states, "Graduates must be competent in the application of the principles of ethical reasoning, ethical decision-making and professional responsibility as they pertain to the academic environment, research, patient care and practice management."[4] Thus, to create sustainable and longitudinal IPE activities, coordination across academic institutions, local health systems, and community partners is required for successful IPE learning activities.[5] In conjunction with core competencies, IPE activities help institutions move beyond profession-specific learning to interactive learning, where students from different professions learn from each other. This collaboration can lead to measurable, outcome driven universal objectives that are applicable to all health professions. From a dental perspective, IPE highlighting the importance of oral care can enlighten and empower other health care profession students to implement best practices, thereby improving confidence, collaboration, and patient outcomes.

As health care models highlight the importance of IPC and evidence continues to show a bidirectional relationship between oral health and systemic disease, there is an opportunity to incorporate oral health into IPE learning activities.[1] Oral health care providers and other health professionals should be taught to recognize the oral manifestations of systemic diseases and understand the implications of poor oral health on the overall well-being of a patient.[6] Because research suggests that dental hygiene[7] and nursing program directors[8] agree that IPE activities improve teamwork and patient care, health care professional programs and community partners should strive to implement successful IPE activities. However, common barriers to IPE activities include communication, schedule coordination, and curriculum overload. Accreditation standards have become more specific about what constitutes quality IPE and health care professional programs are working to overcome these barriers by exploring new learning activities including classroom or lab simulations.

Interdisciplinary teams are common to care for patients who suffered a stroke, with head and neck cancers, undergoing methamphetamine addiction treatment, and treating chronic conditions, such as hypertension, diabetes, and polypharmacy.[9] As such, interventions from a variety of health care providers can help prevent, manage, and treat medical conditions to reduce healthcare costs, increase patient satisfaction, and improve patient outcomes.[9] In general, IPE initiatives involve medical, nursing, pharmacy, respiratory, social work, and physical therapy students.[1] While research discussing IPE activities involving oral health providers is available, there is room for improvement on documentation of interprofessional experiences emphasizing the oral-systemic connection.[1,] The purpose of this study was to evaluate the effect of an IPE simulation activity on dental hygiene and nursing students' attitudes regarding IPC.

Methods

This study was granted approval from the Institutional Review Boards of Parkland College and A.T. Still University. A cross-sectional, pre/post-survey design was used.

A convenience sample of dental hygiene (n=35) and nursing students (n=45) from a Midwest community college were invited to participate via email. Potential participants had to be second-year students in the dental hygiene or nursing associate degree programs at the college. Participants were excluded from analyses if they did not complete all survey questions or if they did not complete the survey before (pre-IPE) and after (post-IPE) the simulation activity. Participation was completely voluntary and did not affect student grades. All participants completed an informed consent form before participation.

Simulation activity

The complications associated with meth mouth in overall health and role of oral health to reduce the risk of ventilated-associated pneumonia (VAP) following intubation were highlighted in a simulation activity for this study. The simulation IPE model was based on recommendations of the Interprofessional Education Collaborative (IPEC)[3] and included a framework based on the oral-systemic connection enabling students to learn the importance of oral care in overall health from each other. The simulation activity was a faculty-driven project designed to meet interprofessional accreditation standards. Prior to participating in the simulation activity, participants were asked to complete an online module that outlined the epidemiology of VAP, contributing factors, evidence-based practices to prevent VAP, proper oral care of a ventilated patient, and the roles and responsibilities of each profession. At that time of the education module, the pre-IPE survey was emailed to the participants. All survey responses were anonymous, and no identifying information was collected.

The IPE activity was performed at the simulation lab at the college. Dental hygiene and nursing students were evenly divided into three labs. To avoid curriculum overload and scheduling conflicts, dental hygiene and nursing faculty agreed to incorporate the oral care component of the activity

into an existing simulation within the nursing curriculum. The simulation activity focused on an intubated burn patient. The standardized patient was a 35-year-old male with third-degree burns from a methamphetamine lab explosion. A briefing session was held prior to the simulation. Students discussed that due to the fact that the injuries were from a methamphetamine lab explosion, it was likely that the patient used methamphetamine; therefore, would have manifestations of meth mouth. Dental hygiene students were able to provide education to nursing students on the characteristics of meth mouth, how meth mouth could cause complications during intubation because of the possibility of tooth mobility and brittle teeth, as well as how poor oral health could compromise the patient's recovery. In addition to meth mouth manifestations, discussion centered on the importance of oral care to reduce the risk of VAP. Once the simulation started, the nursing students were expected to stabilize the patient before the dental hygiene students could perform oral care. The simulation was stopped several times for teaching and discussion during each session, allowing students to explain their roles and rationales for care. A de-briefing session was held immediately following the simulation.

Survey instrument and distribution

The IPEC model highlights four competency domains: values and ethics for interprofessional practice, roles and responsibilities, communication, and teamwork.[3] Using IPEC guidelines for validity, Dow et al[10] created the IPEC Competency Survey instrument in 2014. This 42-item survey is categorized by the four competency domains and can be used to structure curricula. The survey was designed to assess competency based IPEC objectives with a valid, reliable, and practical evaluation instrument.[10]

Lockeman et al. revised the original survey but retained its psychometric strengths in 2016.[11] The updated IPEC Competency Self-Assessment Survey version 3 was used with permission for this study. Unlike the original, this survey measures two domains: interprofessional interaction (e.g., communication and shared problem solving) and interprofessional values (e.g., embracing diversity in health professionals and patient-centered care). The revised survey can be used for multiple health professions and includes sixteen 5-point Likert scale items, where 1 point represents strongly disagree and 5 points represent strongly agree. Since the simulation lab did not involve direct patient care interactions, several items in the values and ethics domain of the original IPEC Competency Survey instrument would have been inappropriate. Other advantages of using the IPEC Competency Self-Assessment Survey version 3 included that the shorter version might encourage a higher response rate and that the attitudes of dental hygiene and nursing students had not been previously studied using this version.

Students completed the survey prior to (pre-IPE) and following (post-IPE) the simulation activity. Both versions were the same, except the post-IPE survey included the following open-ended questions: "What is the most significant lesson you learned from your interprofessional experience?" and "How has this experience influenced your interprofessional role development?" Participants were asked to address one or all of the following in their response: "Your roles and responsibilities for collaborative practice, interprofessional communication, interprofessional teamwork and team-based care." The final question was, "What could we do to improve the experience?" Participant demographic information (health profession, age, sex, and race) was also collected.

Two weeks before the simulation activity, students were e-mailed a link to an electronic version of the IPEC Competency Self-Assessment Survey version 3 (pre-IPE survey). Once all three simulation lab sessions were complete, students were again e-mailed a link to the survey (post-IPE survey). The survey was accessed using SurveyMonkey (San Mateo, CA).

Statistical analysis

Data were analyzed using SPSS version 25 statistical software (IBM Corp: Armonk, NY). Responses from dental hygiene and nursing students were analyzed together. Descriptive statistics were summarized using frequency and percentages and survey results were summarized using median and interquartile range. Responses for the two domains of the survey (interprofessional interaction and interprofessional values) were summarized using mean and standard deviation (SD) to calculate a domain score. Due to the small sample size, a Shapiro-Wilk test was used and determined that the data were not normally distributed. A Wilcoxon signed rank test, was used to compare pre-IPE and post-IPE survey responses. A $p<.05$, two-tailed, was considered statistically significant.

Results

A total of 61 students (48% dental hygiene, n=29; 53% nursing, n=32) consented to participate and completed the pre-IPE survey for a response rate of 73%. Participants were predominantly female (90%, n=55), aged 21 to 29 years (67%, n=40), and White (95%, n=58). Demographics of the participants who completed the pre-IPE survey are shown in Table I.

A total of 38 students completed the post-IPE survey for a response rate of 47% (n=61). Eight participants who

Table I. Pre- IPE participant demographics (n=61)

Demographic Characteristic	n (%)*
Health profession	
Dental hygiene	29 (48.0)
Nursing	32 (53.0)
Age, y	
18-20	6 (10.0)
21-29	40 (67.0)
30-39	8 (13.0)
40-49	5 (8.0)
50-59	1 (2.0)
Prefer not to answer	1 (2.0)
Sex	
Male	5 (8.0)
Female	55 (90.0)
Prefer not to answer	1 (2.0)
Race	
Asian or Asian American	1 (2.0)
Black	1 (2.0)
White	58 (95.0)
Other	1 (2.0)

*Percentages may not equal 100% because of rounding.

completed the post-IPE survey had not completed the pre-IPE survey and were excluded. Two participants began the survey but did not complete it and were also excluded, leaving a total of 28 participants (n=15 dental hygiene and n=13 nursing) in the analyses.

Overall, participants demonstrated a high initial regard for interprofessionalism (Median=4, Agree) and showed an improvement in attitudes following the simulation activity (Median=5, Strongly Agree). Responses by item to the pre- and post-surveys are presented in Table II. The mean and median were used to display data; the mean provides an average of the scores, whereas the median provides an accurate depiction of scores without being affected by extreme scores in an ordinal scale.

Domain scores (interprofessional values and interprofessional interactions) for the pre-IPE and post-IPE surveys are presented in Table III. Participant scores (dental hygiene and nursing) were grouped together for both domains. The median was used as the measure of central tendency because the results were skewed. When comparing the pre-IPE and post-IPE domain scores, a difference was found for the interprofessional interaction domain (p<.001) but not for the interprofessional values domain (p<.18).

Open-ended responses

Student responses to the open-ended questions of the post-IPE survey were mostly positive. In response to the question about the most significant lesson learned from the interprofessional experience, one nursing student wrote, "It wouldn't have occurred to me to include a dental hygienist on an ICU, but it makes perfect sense. I also hadn't realized how much need there is in our community for access to appropriate dental care."

To the same question, a dental hygiene student responded with, "I've realized that my job is much more than just educating patients. I hope to attend and be involved in more interprofessional team-based care in years to come. As I do that, I will need to educate not only my patients, but other healthcare professionals that I am around. I hope they will do the same for me." Another nursing student shared, "I believe dental hygienists are a valuable tool that many hospitals are missing out on. While working in the hospital I can attest that many patients are underserved with relation to oral care, even though there is high emphasis being put on its completion by management during routine chart audits. I believe this would be solved by the utilization of skilled dental hygienists."

Responses to the open-ended question regarding how the experience influenced professional role development showed insight into the students' commitment to professional roles and responsibilities for collaborative practice, interprofessional communication, and teamwork and team-based care. One nursing student wrote, "I believe that this experience has allowed me to strengthen my teamwork/team-based care because I better understand what other professions can do within their scope of practice." Another reported, "I have realized that the oral care I provide for my patients that I have been taking for granted is much more important that I realized. Yes, I knew this information but in participating in this experience the importance of even the most basic care that you and I do twice a day without thinking is critical and crucial for our patients' condition while in the hospital." Another straight forward, but poignant statement was, "Everyone works very hard in their profession and not to take anyone for granted."

Discussion

The effect of a simulation activity on dental hygiene and nursing students' attitudes about IPC were assessed using the IPEC Competency Self-Assessment Survey version 3. Scores for individual survey items for the pre-IPE survey were relatively high and improved for the post-IPE survey, which suggested students had a high regard for IPC prior to the simulation activity and were

Table II. Pre- and Post- IPE participant responses*

Survey Item	Pre-IPE (n=61)		Post-IPE (n=28)	
	Median (IQR)**	Mean (SD)**	Median (IQR)	Mean (SD)
I am able to choose communication tools and techniques that facilitate effective team interactions.	4.0 (1)	3.9 (.994)	4.0 (1)	4.5 (.582)
I am able to place the interests of patients at the center of interprofessional health care delivery.	4.0 (1)	4.1 (.813)	5.0 (1)	4.7 (.485)
I am able to engage other health professionals in shared problem-solving appropriate to the specific care situation.	4.0 (2)	3.6 (1.129)	4.0 (1)	4.4 (.643)
I am able to respect the privacy of patients while maintaining confidentiality in the delivery of team-based care.	5.0 (1)	4.5 (.637)	5.0 (1)	4.7 (.471)
I am able to inform care decisions by integrating the knowledge and experience of other professions appropriate to the clinical situation.	4.0 (1)	3.7 (.983)	5.0 (1)	4.7 (.496)
I am able to embrace the diversity that characterizes the health care team.	4.0 (2)	4.1 (.900)	5.0 (1)	4.7 (.846)
I am able to apply leadership practices that support effective collaborative practice.	4.0 (2)	3.9 (.994)	5.0 (1)	4.5 (.582)
I am able to respect the cultures and values of other health professions.	4.0 (1)	4.4 (.629)	5.0 (1)	4.7 (.471)
I am able to engage other health professionals to constructively manage disagreements about patient care.	4.0 (2)	3.5 (1.071)	5.0 (1)	4.6 (.504)
I am able to develop a trusting relationship with other team members.	4.0 (1)	4.2 (.772)	5.0 (1)	4.7 (.485)
I am able to use strategies that improve the effectiveness of interprofessional teamwork and team-based care.	4.0 (2)	3.7 (1.090)	5.0 (1)	4.6 (.504)
I am able to demonstrate high standards of ethical conduct in my contributions to team-based care.	4.0 (1)	4.2 (.833)	5.0 (1)	4.6 (.852)
I am able to use available evidence to inform effective teamwork and team-based practices.	4.0 (1)	3.7 (1.013)	5.0 (1)	4.4 (.917)
I am able to act with honesty and integrity in relationships with other team members.	5.0 (1)	4.4 (.737)	5.0 (1)	4.7 (.846)
I am able to understand the responsibilities and expertise of other health professions.	4.0 (2)	3.8 (1.056)	5.0 (1)	4.6 (.578)
I am able to maintain competence in my own profession appropriate to my level of training.	4.0 (1)	4.2 (.568)	5.0 (1)	4.6 (.496)

*Responses based on a 5-point Likert scale, where 1=strongly disagree and 5=strongly agree.

** interquartile range; standard deviation

Table III. Post-IPE participant domain scores* (n=28)

Domain	Median	Minimum	Maximum
Interprofessional Interactions			
Pre-IPE	3.9	2.1	5.0
Post-IPE	4.7	3.8	5.0
Interprofessional Values			
Pre-IPE	4.3	2.8	5.0
Post-IPE	5.0	2.8	5.0

*IPEC survey version 3

already aware of the importance of interprofessional skills and collaboration. When comparing the pre-IPE and post-IPE survey domain scores, the interprofessional interaction domain significantly improved following the simulation activity; however, the interprofessional values domain remained about the same. These findings support those of Lockeman et al., who also found a negative correlation between these domains. [11] Lockeman et al., noted that this negative correlation may be because as students began to understand the importance of the interprofessional model they also recognized the challenges of collaborative teams.[11]

Open-ended questions were included in the survey, because Lockeman et al[11] suggested that such self-reflective content from students adds depth to quantitative results as shown in the selected quotes from the participants. Overall, the collaborative experience was successful on several levels and met core competencies laid out by IPEC.[3] First, students were able to use the knowledge of one's own role and those of other professionals to appropriately assess and address the health care needs of the simulation scenario as demonstrated by the dental hygiene and nursing students in this study. Second, students were able to apply relationship-building values and the principles of team dynamics to perform and communicate effectively in different team roles to plan, deliver, and evaluate patient-centered care for a ventilated simulated patient. Lastly, significant changes were noted in the attitudes of dental hygiene and nursing students and the participants' statements indicated increased understanding of the role of interprofessional communication and a deeper understanding of both professions was shown. Findings from this study corroborate with previous literature demonstrating the importance of incorporating IPE into curricula to improve students' attitudes of working in interprofessional teams. [6,12]

Self-assessment

Student attitudes about working in multidisciplinary teams were assessed as part of the IPEC survey. Bose et al. stated that knowledge was related to self-assessment, which was defined as observation and evaluation of behavior in addition to one's reaction and interpretation of that behavior.[13] In another study by Cole et al.[14] individuals with low knowledge tended to overrate their knowledge, whereas those with high knowledge tended to underrate their knowledge. Both studies[13,14] emphasized the need to incorporate several IPE activities into the curricula for students to develop self-assessment skills and be able to identify knowledge gaps and stay current in practice.[15] Even though the validity of self-assessment can be problematic, the information gathered from these assessments can be an effective means for students to reflect on their performance and formulate ways for improvement. Further, research suggests that self-assessment during training encourages sustainable behaviors.[13] Questionnaires are the most common way to conduct self-assessments,[13] but feedback from a supervisor, which can be obtained during de-briefing sessions as in this study, can also be beneficial.

Since attitudes influence behaviors, health care educators should work to understand the attitudes of their students regarding IPC to strengthen the collaborative spirit of future health care providers. As demonstrated in this study, using the IPE model to emphasize the oral-systemic connection to students outside of dentistry can be a powerful method for establishing a strong commitment to team-based care in future practice. This study also highlighted the urgent necessity of promoting medical-dental integration as the new norm. Viewed through the Health Professions Accreditors Collaborative competencies,[5] findings from this study demonstrated the benefits of using a standardized patient to increase dual identity development, contribute to professional expertise in team-based care, with the ultimate goal of improving the quality of health care delivery and patient safety.

Research suggests that health care professional students generally have positive attitudes toward IPC at baseline.[11,12.] Studies investigating IPE activities based on IPEC competencies have also found improvements in attitudes towards collaborative care[12,16,17] and results from this study appear to corroborate these findings. Other studies investigating IPC have also included open-ended questions and de-briefing sessions to the design to add depth to the quantitative results.[16,17] Clinical exposure, interprofessional experience, and professional values have been shown to significantly influence the ability of students to collaborate in clinical practice.[16,17.] The mostly positive responses the open-ended questions in this study also support these findings.

As IPE research moves to measure other health outcomes (i.e., behavior/skills, teamwork, organizational culture), it

is beneficial to gain an understanding of student's attitudes regarding IPE. Groessl and Vandenhouten[18] found that student's initial attitudes towards IPE and collaboration were positive, however experience led to an early reduction in attitude scores. This can be alluded to the "reality check" as students begin to experience the challenges and stereotypes that are accompanied with working in interdisciplinary teams. Although, attitudes have also been shown to improve steadily over time as students understand the overarching goal of improving patient outcomes.[11,12,18]

Limitations and future research

This study had limitations. The response rates for the pre-IPE and post-IPE surveys were relatively low; this study can serve a pilot study for future research. The timing of the simulation activity within the curriculum may have been a barrier and limitation to the findings. The IPE simulation occurred at the end of the semester, so students could apply concepts learned over the semester to the activity. This may have inflated positive survey responses. The timing of the simulation may have also contributed to the lower post-IPE survey response rate because the dental hygiene students were taking finals and nursing students were preparing for graduation.

Student attitudes were assessed after a single IPE activity, which may affect the generalizability of results. Future studies should include assessment of student attitudes after multiple IPE activities throughout the curriculum and could include other health professions students, such as respiratory therapy and pre-medicine students, for a larger sample size. Such designs would increase the validity of study results. Also, while the IPEC Competency Self-Assessment Survey version 3 has internal validity, response bias is always a potential limitation of self-reported data. As no other studies using IPEC Competency Self-Assessment Survey version 3 to assess dental hygiene student attitudes about IPC have been reported in the literature, it was not possible to compare results from this study to previous research in dental hygiene.

Although open-ended questions were included as part of the post-IPE survey, future studies should consider using a true mixed-methods approach to obtain a more comprehensive view of student attitudes. From an education perspective, the simulation preceptor could use quantitative and qualitative data to provide formative feedback based on observations of the students' collaborative behavior during the activity.[11] Health care educators should also consider implementing a design like the simulation in the hospital setting as part of a clinical rotation, so students can experience the integrative care firsthand. Such an experience would likely add definitive value to interprofessional attitudes. Ideally, IPE activities should be implemented throughout an entire curriculum. Results from this study could also be used as a baseline for incorporating more IPE into curriculum for early learners, so educators can better understand how attitudes evolve during a student's academic career. In addition to suggestions for increased IPE activities, the importance of faculty development should be considered, especially because health care faculty members are often the driving force behind IPE activities. Effective training and faculty calibration are required to create authentic and meaningful educational experiences across interdisciplinary boundaries.[3]

Conclusion

The dental hygiene and nursing students in this study had positive attitudes towards IPC prior to participating in an IPE simulation activity. Attitudes towards IPC were shown to improve significantly following the simulation, while values remained the same. Structured interactions among health professions students, such as IPE activities, can allow educators to break down barriers associated with profession-specific learning and prepare students to be leaders and collaborators within interprofessional teams. As the demand for more collaborative health care providers continue to grow along with the increasing evidence regarding the relationship between oral and systemic health, it is crucial for dental hygiene educators to take advantage of the IPC framework to establish a defined role for dental hygienists as members of primary health care teams.

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