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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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Editorial

Rejection Hurts!

Rebecca S. Wilder, RDH, BS, MS

I am frequently asked to speak at conferences on the topic of "What Journal Editors Want?" The subject is very timely as many academicians are pressured to conduct scholarly activity and publish their work in a peer-reviewed journal. Since the *Journal of Dental Hygiene* is one of the few peer-reviewed, scholarly dental hygiene journals, submissions have increased in recent years.

Let me begin by saying, good writing takes time, perseverance and patience. I have had my work rejected and any experienced author or researcher will share similar experiences. Some people are even of the opinion that if one has not had their papers rejected occasionally that they are not submitting their work to high quality journals! However, I will not lie….it hurts to receive a rejection notice. When one has spent endless hours working on a research project to get it "just right", it is difficult to receive any negative feedback.

Below are a few tips I emphasize in my presentations about publishing. Following these suggestions may benefit both new and seasoned authors to have a successful manuscript submission.

1. Read the statement of purpose for the various journals that may be appropriate for your work. Once you have chosen the journal you wish to submit your manuscript to, READ the Guidelines to Authors. Continue to refer to the guidelines throughout the manuscript preparation process.

   I cannot tell you how many manuscripts never make it to the review process because the authors have not followed the author guidelines. Every journal is different and it is imperative to get the formatting, references, headings, tables and figures and word count correct. Failing to follow the directions gives the wrong impression. Editors do not want to waste reviewers' time by forwarding a manuscript that clearly does not follow the author directions. Volunteer reviewers are experts in their field and are the unsung heroes of the peer review process and their time is precious.

2. Ask yourself if your work is based on something that is new, innovative and advances the profession of dental hygiene? Does it contribute to a priority area of the National Dental Hygiene Research Agenda? Repeating existing work doesn't contribute to the unique body of knowledge and is not likely to generate a favorable review.

3. How is the English grammar and syntax in the manuscript? The majority of papers submitted to the *Journal of Dental Hygiene* have minor to major recommendations for editing the grammar. Before an author submits a paper for publication, he/she should have at least two other professionals read and comment on the paper. These individuals should be known for their attention to detail and honesty.

4. Most likely, the submission will come back with required revisions from the reviewers. It is rare for a manuscript to be accepted on the first submission and some revisions may require significant work. You may not like what the reviewers have written or suggested and you may want to write nasty comments back to the reviewers. STOP! Take a break for several days and then revisit the reviewers' comments. Authors must respond to EVERY comment in a logical, methodical manner. Follow the directions of the journal pertaining to the reviewer response format. If you are unsure, call or email the editor. Clarify this process so it does not delay a second review. What if the paper is rejected? Look at the comments from the reviewers and decide if you want to make the changes to the paper and resubmit it to the same journal or another publication. In almost every case, authors can benefit from the constructive criticism from a reviewer.

5. If the journal has requested that revisions be completed in a certain timeframe, remember to adhere to the guidelines. If not, the paper will be considered a new submission and new reviewers will be assigned. This scenario will only delay the potential of getting the paper accepted for publication.

6. If you have questions about the process, do not hesitate to contact the editor or editorial staff. All questions are welcomed.

7. Finally, once the paper is accepted for publication… start writing again! The only way to become proficient at this process is to keep doing it.

The challenge is great and the personal and professional rewards are even greater.

Good Luck!!

Sincerely,
Rebecca Wilder, RDH, BS, MS
Editor–in–Chief, *Journal of Dental Hygiene*

Use of a Self-Instructional Radiographic Anatomy Module for Dental Hygiene Faculty Calibration

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Abstract

Purpose: Dental hygiene educators often provide inconsistent instruction in clinical settings and various attempts to address the lack of consistency have been reported in the literature. The purpose of this pilot study was to determine if the use of a use of a self-instructional, radiographic anatomy (SIRA) module improved DH faculty calibration regarding the identifica-tion of normal intraoral and extraoral radiographic anatomy and whether its effect could be sustained over a period of four months.

Methods: A convenience sample consisting of all dental hygiene faculty members involved in clinical instruction (N=23) at the University of North Carolina (UNC) was invited to complete the four parts of this online pilot study: a pre-test, review of the SIRA module, an immediate post-test, and a four-month follow-up post-test. Descriptive analyses, the Friedman's ANOVA, and the exact form of the Wilcoxon-Signed-Rank test were used to an-alyze the data. Level of significance was set at 0.05. Participants who did not complete all parts of the study were omitted from data analysis comparing the pre to post-test performance.

Results: The pre-test response rate was 73.9% (N=17), and 88.2% (N=15) of those initial participants completed both the immediate and follow-up post-tests. Faculty completing all parts of the study consisted of: 5 full-time faculty, 5 part-time faculty, and 5 graduate teaching assistants. The Friedman's ANOVA revealed no statistically significant difference (P=0.179) in percentages of correct responses between the three tests (pre, post and follow-up). The exact form of the Wilcoxon-Signed-Rank test revealed marginal significance when comparing percent of correct responses at pre-test and immediate post-test (P=0.054), and no statistically significant difference when comparing percent of correct responses at immediate post-test and the follow-up post-test four months later (P=0.106).

Conclusions: Use of a SIRA module did not significantly affect DH faculty test performance. Lack of statistical significance in the percentages of correct responses between the three tests may have been affected by the small number of participants completing all four parts of the study (N=15). Additional research is needed to identify and improve methods for faculty calibration.

Keywords: calibration, clinical education, dental hygiene education, dental radiography, faculty development

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Introduction

Faculty calibration is a means of determining a standard that can be reproduced consistently.[1-3] Years of experience or educational background may contribute to the lack of consistency among faculty, which can be frustrating for students, become a distraction to learning, and impact overall satisfaction with the education experience. [1,4-11] Students have reported focusing on individual instructors' preferences in order to enhance their own grades.[9-11] Knowing that certain faculty emphasize clinical evaluation in specific areas, students may focus more attention on that area while overlooking other aspects of patient care. This alteration in clinical performance has also been noted by faculty and can have a negative and potentially harmful impact on patient care.[9-11] Calibration of faculty members is a means to reduce inconsistencies among instructors, especially in areas where there is room for subjectivity.[1-2]

Previous research has revealed low levels of agreement among dental educators in clinical decisions and performance. [1,2,5,7-15] Calibration in dentistry mainly focuses on educators working in clinical settings and calibration efforts have included a range of topics including cavity preparations, restorations, dental sealants, radiographic interpretation, and treatment planning.[5-7,15-17] Dental hygiene faculty calibration has been studied in the areas of calculus detection, scaling errors, and the writing of clinical notes.[1,8,12] Various efforts to calibrate dentists, dental hygienists and

graduate teaching assistants in radiology have focused on radiographic interpretation, periodontal diagnosis, quantifying bone loss, and detection of dental caries; however, calibration in the use of radiographic terminology and identification of anatomical landmarks has not been assessed.[4,5,7,13, 18, 19]

Radiographic interpretation is part of the dental hygiene process of care.[20-21] Radiographs provide significant information regarding the periodontal condition, prognosis, and long-term evaluation of treatment.[21] Moreover, dental radiology is an integral part of the dental hygiene curriculum, and is incorporated into both the written national board examination and clinical examinations.[20,22] Hence, radiology is of great importance to the practice of dental hygiene. Currently no studies have been identified on dental hygiene faculty calibration in radiology, specifically with respect to the identification of normal radiographic anatomy.

Dental Hygiene Faculty Challenges

Many dental and allied dental programs are utilizing distance education sites to address access issues. While these new teaching sites offer increased options in delivery of education as well as patient care, they also increase the number of faculty working with students. Increased faculty numbers and the inclusion of multiple sites can contribute to lack of consistency in teaching and student evaluation.

A shortage in dental educators has also been documented.[23-24] In an attempt to overcome this faculty shortage, recruitment of part-time faculty has become a trend with dental school part-time vacancies increasing by three percent. [24-25] Dental hygiene programs also utilize part-time faculty to help fill voids. While utilizing adjunct and part-time faculty members to support clinical needs can be advantageous, it can also lead to inconsistencies in faculty calibration.

There are many barriers for delivering and achieving faculty calibration. Subjective factors include: diverse backgrounds, educational levels, and work-related experiences. Preference for delivery of calibration sessions can alter faculty reception and success; some faculty may prefer face-to-face options and are more likely to attend and participate. Moreover, while it can be assumed that faculty with increased teaching and or clinical experiences are more calibrated than part-time for junior faculty, this is not necessarily accurate. Timing, methodology, and location of faculty calibration sessions can also impact success. If schools prefer face-to-face calibration sessions, then part-time faculty may not be available to come in on the specified dates, due to other jobs or obligations. For distance education sites, significant travel may be required for instructors to attend calibration sessions. Calibration sessions should also include a meaningful agenda and provide new and relevant information. Faculty members who fail to see the relevance of the session are less inclined to attend or participate.

With the addition of distance education, online teaching and increased numbers of part-time faculty, educators must explore innovative, flexible, and creative ways for faculty calibration. The use of self-instructional modules has been discussed in the dental education literature.[26] Several studies have evaluated the effects of self-instructional packages on student test performance and found them to be equal to other instructional formats. [27-32] Use of self-instructional packages for faculty development has also been explored, but to a lesser extent.[33] Implementation of online calibration modules to meet the needs of increasing numbers of adjunct or part-time faculty could prove to be a useful approach.

The importance of faculty calibration in education has been demonstrated in multiple studies.[2, 3, 34] The aim of this study was to identify a unique faculty calibration method. This study evaluated the effect of using a self-instructional radiographic anatomy (SIRA) module on dental hygiene faculty test performance regarding the identification of normal intraoral and extraoral radiographic anatomy and whether the effect was sustained over a period of four months. The study also assessed whether years of experience, preference of instructional method (face-to-face, and online), and faculty groupings (full-time, part-time, and graduate teaching assistants) affected test performance.

Methods

This pilot study adopted a repeated measures design that was exempt from review by the Institutional Review Board (IRB) at the University of North Carolina (UNC). A convenience sample of twenty-three clinical dental hygiene faculty members was identified through the UNC School of Dentistry online directory and consisted of six full-time, eleven part-time, and six graduate teaching assistants (GTAs). Qualtrics, a web-based survey research software program (Copyright © 2015, Version 614720.331s of the Qualtrics Research Suite, Qualtrics, Provo, UT, USA) was used to generate all emails sent to possible study participants and to administer the tests for the study. The identified clinical dental hygiene (DH) faculty members received a Qualtrics generated email informing them of the study purpose and design, and invited them to participate in the four parts of the online study: a pre-test, self-instructional radiographic anatomy (SIRA) module, immediate post-test, and a four-month follow-up post-test. Faculty implied consent to participate by using the link provided in the email invitation prompt to the Qualtrics pre-test instructions and questions. All pre and post-test questions were pilot tested prior to faculty testing by two non-clinical UNC DH faculty members.

The DH faculty members were provided a one-week time frame to complete the online pre-test.

The pre-test consisted of six demographic questions, and twenty multiple-choice questions requiring participants to identify normal radiographic anatomy from multiple radiographic images (intraoral periapical radiographs and extra-oral panoramic radiographs).

One week following the pre-test, a Qualtrics generated email was sent to the DH faculty members who had completed the pre-test. This email contained links to the online SIRA module, and the post-test instructions and questions. Participants had two weeks to review the online SIRA module and it could be accessed at any time during the two-week period. The online SIRA module consisted of text and visual aids introducing the identification of normal radiographic anatomy on intraoral and extra-oral radiographic images. The module allowed users to read explanations of the different anatomical landmarks, view images, and to take a self-quiz with projected images and anatomic landmarks to label. The length of time required for reviewing the module content was self-paced and allowed participants to scroll back and forth through the module text and view images as needed. Participants were instructed to complete the immediate post-test once they had completed reviewing the online SIRA module.

At the conclusion of the fall semester, four months following the initial viewing of the online SIRA module and completion of the immediate post-test, a Qualtrics generated email was sent to the DH faculty participants with a link to the Qualtrics follow-up post-test instructions and questions. Participants were instructed to complete the four-month follow-up post-test within a one-week time frame.

Questions on both post-tests (immediate post-test, and follow-up post-test) consisted of a single question regarding the preferred method of calibration (online self-instruction or face to face) and the same twenty multiple-choice questions pre-viously used on the pre-test; however, the questions were arranged in a different order.

Data Analysis

Data was downloaded from the Qualtrics server into an Excel spreadsheet and coded in numeric format. This data was then exported to a SAS program for statistical analysis (Version 9.3, SAS Institute, Cary, North Carolina, USA). Descriptive statistics of the group population were reported. The Friedman's ANOVA was used to determine whether there was a statistically significant difference in the percentage of correct responses between the three tests: pre-test, immediate post-test, and follow-up post-test. The exact form of the Wilcoxon-Signed-Rank test was used to determine whether there was a statistically significant difference in the percent change of correct responses from pre-test to immediate post-test, from immediate post-test to follow-up post-test, and from pre-test to follow-up post-test. Level of significance was set at 0.05. Participants who did not complete all parts of the study were omitted from data analysis comparing pre to post-test performance.

Results

Out of the twenty-three (N=23) UNC clinical DH faculty members identified as possible study participants, seventeen (N=17) completed the online pre-test resulting in a 73.9% initial response rate. Faculty members completing the online pre-test consisted of five full-time faculty (29.4%), six part-time faculty (35.3%), and six graduate teaching assistants (35.3%). Among the study participants, 29% or (N=4) had been practicing dental hygiene less than five years, 41% (N=7) had five to fifteen years of experience and 29% (N=5) had more than fifteen years of clinical experience. Regarding clinical teaching, 53% (N=9) of the participants had less than five years of experience. (Table I). Of the seventeen (N=17) participants who completed the online pre-test, 15 completed both the immediate and follow-up post-tests resulting in an 88.2% response rate. Faculty completing all parts of the study consisted of five full-time faculty (33.3%), five part-time faculty (33.3%), and five graduate teaching assistants (33.3%). (Table I).

Table I: Descriptive statistics of clinical dental hygiene faculty

	Pre-test		Immediate post-test		Follow-up post-test	
	N	%	N	%	N	%
Faculty group						
Full-time faculty	5	29.4	5	33.3	5	33.3
Part-time faculty	6	35.3	5	33.3	5	33.3
Graduate Teaching Assistant	6	35.3	5	33.3	5	33.3
Total	17	100.0	15	100.0	15	100.0
Dental hygiene practice						
<5 years	5	29.4	5	33.3	5	33.3
5 – 15 years	7	41.2	5	33.3	5	33.3
>15 years	5	29.4	5	33.3	5	33.3
Total	17	100.0	15	100.0	15	100.0
Clinical teaching experience						
<5 years	9	52.9	8	53.3	5	53.3
5 – 15 years	4	23.5	3	20.0	5	20.0
>15 years	4	23.5	4	26.7	5	26.7
Total	17	100.0	15	100.0	15	100.0

The majority of the faculty participants, 94% (N=16), felt that calibration of DH faculty in radiology and radiographic anatomy was necessary. When asked to choose a preferred method of instruction for faculty calibration in radiology 58.8% (N=10) indicated that face-to-face instruction was their preferred method.

The results of the pre-test demonstrated that faculty had knowledge of radiographic anatomy (45-90% with a median score of 65%). (Table II) The overall median test scores improved from pre-test (65%) to immediate post-test (75%), and then decreased to 70% for the follow-up post-test. However, the Friedman's ANOVA indicated no statistically significant difference (P=0.179) in the percentage of correct responses between the three tests. An overall median percent change of 5% was noted from pre-test to immediate post-test, with a corresponding P-value of 0.054 as indicated by the exact form of the Wilcoxon-Signed-Rank test. No overall median percent change was noted from pre-test to follow-up post-test, and from immediate post-test to follow-up post-test. The exact form of the Wilcoxon-Signed-Rank test indicated no statistically significant difference when comparing percent of correct responses at pre-test and follow-up post-test (P=0.665), and when comparing percent of correct responses at immediate post-test and follow-up post-test (P=0.106).

Table II: Dental hygiene faculty test performance for all pre and post-tests

	P25	Median	P75	P-value
Percentage of correct responses:				0.179*
Pre	60.0	65.0	70.0	
Immediate post	65.0	75.0	80.0	
Follow-up post	60.0	70.0	75.0	
Percent change between tests:				
Pre to immediate post	-5.0	5.0	15.0	
Pre to follow-up post	-10.0	0.0	10.0	
Immediate post to follow-up post	-15.0	0.0	0.0	

Table III: Percent change between the different tests according to faculty groupings

	N	Q1	Median	Q3
Percent change from pre-test to immediate post-test				
Full-time faculty	5	5.0	5.0	10.0
Part-time faculty	5	10.0	15.0	20.0
Graduate teaching assistant	5	-10.0	-5.0	5.0
Percent change from pre-test to follow-up post-test				
Full-time faculty	5	-10.0	5.0	10.0
Part-time faculty	5	-5.0	10.0	10.0
Graduate teaching assistant	5	-5.0	-5.0	0.0
Percent change from immediate post-test to follow-up post-test				
Full-time faculty	5	-15.0	0.0	0.0
Part-time faculty	5	-10.0	-5.0	0.0
Graduate teaching assistant	5	-10.0	0.0	5.0

Table III represents the percent change between the different tests according to faculty groupings: full-time, part-time, or GTA. Only the median percent change for the graduate teaching assistant group negatively decreased (-5%) from pre-test to immediate post-test, and from pre-test to follow-up post-test. Median percent change for full-time faculty was 5% for both the pre-test to immediate post-test, and pre-test to follow-up post-test intervals. Whereas median percent change for part-time faculty was 15% from pre-test to immediate post-test, and decreased to 10% from pre-test to follow-up post-test. Therefore, test performance of the GTA group decreased from the pre to post tests, and test performance improved for the full-time faculty group.

Faculty members with less than 5 years of clinical practice had a median percent change of (-5%) from pre-test to both post-tests. This indicates that the median percent change for this faculty group decreased both times. When comparing the median percent change for pre to immediate post and pre to follow-up post-tests, faculty with over five years of clinical practice had a positive median percent change at both intervals. Hence, median percent change for faculty with more than five years of practice improved by the same amount at both test intervals.

Median percent change according to years of clinical teaching experience among the study participants did not follow the same pattern however. Those with more than fifteen years of teaching experience had the lowest (5%) median percent change from pre to immediate post-test, compared to the 7.5% and 15% change in the less than five years, and five to fifteen years of teaching experience groups. This indicates that all faculty had a positive median percent change from pre to immediate post-test regardless of the amount of teaching experience, but the degree of change was not the same for each teaching experience group. Median percent change from pre to follow-up post-test according to years of teaching experience was -2.5% for less than five years, 10% for five to fifteen years, and 0% for more than fifteen years. Therefore, median percent change from pre to follow-up post-test decreased in comparison to the median percent change from pre to immediate post-test, with the less than five years of teaching experience group being the only group that had a negative percent change.

Although 60% of the faculty indicated they would prefer face-to-face instruction over online instruction for calibration, median percent change from pre to immediate post-test was equal for both instructional method choices regardless of the method they would choose (face-to-face or online). Table IV illustrates the percent change between the different tests according to the indicated preference of instructional method. The median percent change from pre to follow-up post-test was -5% for the faculty members who chose online instruction as their preferred method of calibration. This shows that preference for online instruction did not necessarily mean that faculty performed better given that they used an online module for this study.

Table IV: Percent change between the different tests according to indicated preference of instructional method

	N	Q1	Median	Q3
Percent change from pre-test to immediate post-test				
Preferred Face-to-face instruction	9	-5.0	5.0	10.0
Preferred Online instruction	5	5.0	5.0	15.0
Other	1	20.0	20.0	20.0
Percent change from pre-test to follow-up post-test				
Preferred Face-to-face instruction	9	-5.0	0.0	5.0
Preferred Online instruction	5	-10.0	-5.0	10.0
Other	1	20.0	20.0	20.0
Percent change from immediate post-test to follow-up post-test				
Preferred Face-to-face instruction	9	-10.0	0.0	0.0
Preferred Online instruction	5	-15.0	-10.0	-5.0
Other	1	0.0	0.0	0.0

DISCUSSION

Low levels of agreement among dental educators regarding clinical decisions and performance have been documented. [1,2,5,7-15] Poor faculty calibration has been shown to lead to student frustration, modification of patient care based on instructor grading patterns, and an overall decrease in effective clinical teaching and learning. Effective faculty calibration is critical to reduce teaching inconsistencies and enrich student learning.[10]

Attempts to reduce inconsistencies among educators through calibration or training have shown varied outcomes. Many studies that evaluated the effect of faculty calibration used face-to-face instruction, or interactive group sessions as the calibration intervention.[1,7,8,15] Research evaluating the use of self-instructional modules as a means to calibrate faculty has not been widely reported in the literature. This pilot study evaluated the effectiveness of a SIRA module on the improvement of test performance for DH faculty in the attempt to identify a possible calibration method.

Use of the online SIRA module as a calibration tool posed a few advantages: it was possible to include part-time faculty who are not frequently present at the university , information was available for review at any time and place, and it accommodated the preference for online instruction. Out of the twenty-three possible participants for this study, eleven (47.8%) were part-time faculty members; therefore, use of the online SIRA module enabled the inclusion of those faculty. Disadvantages of using the online self-instructional module include no way of monitoring if all content was reviewed by the faculty, the need for internet and computer access to view the module, and no choice of instructional preference. The online self-instructional module used for this study has been used with dental and DH students at UNC in the past. Both Ludlow et al. and Fleming et al. used this web-based module and compared it

to the use of slide/tape instruction of students. Both studies found that preference for web-based instruction did not necessarily mean that student test performance improved.[31-32] In agreement with their findings, the current study found that even though over half of the DH faculty would choose face-to-face instruction as their preferred method of instruction, the median percent change from pre-test to immediate post-test was equal regardless of what they prefer Therefore, preference for one method or another did not seem to make a difference in the success of the calibration. Age could have influenced the choice for an instructional method; however, this study did not inquire about the age of the participating faculty.

Studies that have evaluated student education using self-instructional modules in comparison to other instructional modalities have reported no difference in test performance according to instructional format, whereas, some have found self-instructional modules to be the most effective when combined with a didactic format.[27,30-32, 35] Jim et al. evaluated the use of a computer-assisted self-instructional module for continuing education of pharmacists and reported significant improvement and retention of knowledge from pre-test to immediate post-test and two-week post-test.[28] Therefore, self-instructional modules could be viable modes for faculty calibration, as well as adjuncts to other calibration methods.

The Friedman's ANOVA indicated no significant difference in the percentage of correct responses between the three tests. Although the Exact-Wilcoxon-Signed-Rank test indicated no statistical significance when comparing the percent change between the tests, the P-value of 0.054 when comparing the percent change from pre to immediate post-test could be considered marginally significant. This could be a Type II error due to lack of statistical power because of the fairly small sample size.

Pre-test scores ranged between 45-90% with a median score of 65%, demonstrating that faculty did have knowledge of radiographic anatomy. The overall median test scores improved by 10% from pre-test to immediate post-test, and then decreased by 5% at the four-month follow-up. This is in contrast to some studies that reported a longer effect of a calibration exercise.[7,8,15] Jacks et al investigated short and long term effects of training on the capacity of DH faculty to write patient chart entries according to a specific format. [8] Faculty were able to adhere to the desired format for approximately one year

Haj-Ali and Feil found that with calibration training, inter-rater agreement improved and was sustained for ten-weeks among educators of an operative preclinical lab when evaluating Class II amalgam preparations.[15] In the current study, the follow-up post-test was administered four months after faculty reviewed the online SIRA module. The retention of information may have decreased from immediate post-test to follow-up post-test due to the extended lapse between viewing the material of the online module and taking the follow-up post-test. Perhaps a one-time intervention for calibrating faculty is not adequate. Future research should address the question of how often faculty need to be calibrated to retain consistency.

Lanning et al. evaluated the accuracy and consistency of radiographic interpretation among a group of clinical instructors in conjunction with a three-part training program.[7] Faculty consecutively completed a pre-test, phase-I training, post-test 1, and phase-II training. Three months later, post-test 2 was administered and faculty attended phase-III training. The findings showed that faculty agreement improved over time, and it was concluded that lengthening a training program could result in further improvement.[7] In the current study, faculty were instructed to review the content of the online SIRA module once during a two-week period and the follow-up post-test was administered four months after, contrasting the three-part training program of Lanning et al. There was a decrease in DH faculty test performance from immediate post-test to follow-up post-test. If the study protocol allowed DH faculty to review the SIRA module content several times, follow-up test performance may have improved.

The GTA group seemed to score lower from pre-test to immediate post-test and from pre-test to follow-up post-test with a median percent change of -5%. Full-time faculty test performance however, indicated improvement at both intervals: pre-test to immediate post-test, and pre-test to follow-up post-test. Median percent change for part-time faculty showed a 15% improvement from pre-test to immediate post-test, and slightly less improvement of 10% from pre-test to follow-up post-test. GTAs are considered students as well as faculty so they are in the process of learning while carrying a student workload in addition to their teaching responsibilities. This could have affected their test performance negatively, especially if they did not have sufficient time to thoroughly review the SIRA module material. In contrast with the results of the current study, Firestone et al. reported that the diagnostic accuracy of dental students diagnosing dental caries from radiographs was similar to that of experienced clinicians.[36]

This study compared test scores according to years of DH practice and clinical teaching experience. Results indicated that those with more than five years of DH practice performed better than those with less than five years of DH practice when comparing pre to post-test performance. Those with more years of practice may have performed better on the tests as they have been exposed to a wider variety of clinical situations that include the examination of radiographs. Hinkelman et al. researched methods of decreasing subjective evaluation in a preclinical environment and reported that reliability of examiners was not

significantly affected by years of clinical experience.[37] In the current study, faculty evaluation practices were not assessed in comparison to their test performance. Hellén-Halme et al. evaluated whether educational level and dental practice effect the accuracy of diagnosing dental decay from radiographs in groups of dental and dental hygiene students, and dentists with more than five years of clinical practice. Findings indicated that both practice and experience were important for diagnostic accuracy as experience accumulates during clinical practice.[4]

When comparing years of clinical teaching experience, all participants scored better on the immediate post-test, regardless of the amount of teaching experience. Those with 5-15 years of teaching experience (N=3) had the most improvement. Only those with less than 5 years of teaching experience (N=8) had a negative percent change when comparing the pre-test to the four-month follow-up post-test scores. Experience with teaching dental radiology or clinical courses that include radiology could possibly explain why those with more teaching experience did not have a negative percent change when comparing pre to four-month post-test scores.

Lack of statistical significance may be attributed to the small number of participants. Additionally, participants were instructed to review the content of the SIRA module once on their own time over the period of two weeks prior to taking the immediate post-test. This could be considered a limitation as there is no way of knowing how often faculty reviewed the module, and if all of the module material was indeed reviewed or not. Faculty were instructed to refrain from using a smartphone to view the module as images may be distorted. Smartphones with internet access are often at hand and people often use them to quickly access information even when clarity is compromised. It can only be assumed that faculty members did not use a smartphone to view the module, and that test performance was not affected by distortion of images due to use of a smartphone.

Another limitation of the study is the small sample size. Future studies could duplicate the current design with a larger sample of faculty and with those from different institutional settings such as universities and community colleges.

Research findings have consistently shown the importance of faculty calibration in education.[2, 3,34] Identifying appropriate and affordable means for faculty calibration may have far-reaching benefits to both students and faculty. It is important to identify and research various methods for faculty calibration to adapt to different settings and reach all types of clinical teachers, including full-time, part-time, and those located at distance education sites. Implications from this research and additional studies may help to identify new and innovative ways of calibrating faculty to increase reliability, consistency, and effective teaching.

CONCLUSION

This study aimed to evaluate the effectiveness of using a SIRA module as a possible method of calibrating DH faculty in radiographic anatomy. Use of a SIRA module did not significantly affect dental hygiene faculty test performance. Test performance at four-months was lower in comparison to immediate post-test results, indicating a possible need for more frequent calibration interventions. DH faculty were receptive to using a SIRA module for knowledge enhancement; however, the preference for face-to-face instruction needs to be considered. Additional research should continue to be conducted to identify and improve methods for faculty calibration.

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A Comparison of Cognitive Presence in Asynchronous and Synchronous Discussions in an Online Dental Hygiene Course

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Abstract

Purpose: Many dental hygiene degree completion (34) and graduate (14) programs offer the majority or all of their course offerings online. While the concept of real-time video web-conferencing has been realized through advances in technology, only 5% of dental hygiene programs report utilizing real-time technologies. The purpose of this study was to use the Community of Inquiry Framework to observe and compare the development of cognitive presence and critical thinking between two different methods of online discussion; asynchronous discussion boards and synchronous video web-conferences.

Methods: Students in one online course were divided into two groups. Each week one group completed the course discussion questions through an asynchronous discussion board while the other group completed the same discussion questions via a synchronous video web-conference. Data were recorded and analyzed to compare total indicators of cognitive presence during the two discussion sessions, as well as comparing the various levels of cognitive presence.

Results: A total of 117 messages were recorded in the asynchronous discussion sessions and 260 messages in the synchronous discussion sessions. The synchronous video web-conferences achieved significantly more total cognitive presence than the asynchronous discussions (p=0.005). Furthermore, the synchronous discussions reached the highest phase of cognitive presence, the resolution phase, in 10.19% of the messages, while the asynchronous discussions reached the resolution phase significantly less often at 0.85% (p=0.005).

Conclusions: This study suggests that synchronous video web-conference in online discussions may create higher levels of cognitive presence in an online course. Higher levels of cognitive presence found in synchronous video web-conferencing may foster critical thinking skills in degree completion and graduate dental hygiene online courses.

Keywords: dental hygiene education, online discussion, synchronous, asynchronous, video web-conferencing, cognitive presence

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Introduction

Online education, and its development as an anytime, anywhere option for completing higher education, has become an attractive substitute to traditional face-to-face learning. Professional academic programs, such as dental hygiene, are not immune to the growing utilization of online education. In 2007, 66% of students enrolled in associate degree-granting institutions identified they were interested in completing a bachelor of science degree program.[1] Many factors motivate dental hygienists to pursue an online program, such as geographic barriers, flexibility for work and family schedules, and expanding career opportunities.[2] According to the American Dental Hygienists' Association, 84.9% of all dental hygiene degree completion programs have some online component, with 58.5% of the programs delivered exclusively online.[3] Additionally, 76.2% of dental hygiene master's degree programs have some portion of the curriculum online, and 42.9% of the master's degree programs are offered fully online.[4]

Research suggests that discussion may be the most critical aspect of online education, as it appears to be the central activity for interactive scholarship as students consider goals, reflect literature, apply methods, add knowledge, provide results, and critically reflect upon achievements, all in a safe community environment.[5] Online discussion can be categorized into synchronous and asynchronous, depending on the method of computer mediated communication (CMC). Asynchronous discussion

occurs with no set day or time, while synchronous discussion occurs in real time, on a scheduled day during a set time. Asynchronous discussion is by far the most popular discussion format, with 92% of online course offering institutions reporting that they used asynchronous formats in their online courses.[6] The majority of asynchronous discussions are conducted utilizing whole group discussion tools, usually on a threaded discussion board.

The Community of Inquiry theory, a well-known and researched theory in higher education, was developed by Garrison, Anderson, and Archer to examine the process of creating a deep and meaningful learning experience through developing three interdependent elements- social, cognitive and teaching presense.[7] Cognitive presence is defined as "the extent to which the participants in a community of inquiry are able to construct meaning through sustained communication."[7] Specifically, cognitive presence is a sign of higher-order knowledge acquisition and application, and it utilizes the practice inquiry model as a foundation for assessment of critical thinking.[7]

In the practical inquiry model, four phases of critical thinking are identified. These phases are considered the idealized logical sequence of critical thinking and include in ascending order: triggering event, exploration, integration, and resolution.[7] Garrison et al. developed a content analysis method for assigning data to the phases that includes descriptors and indicators, along with examples of each of the four phases of the practical inquiry model. The major concern regarding cognitive presence is the progression of a community of inquiry to the higher levels of cognitive presence in an online learning environment. Consistent findings in the literature, regardless of the CMC, report difficulty moving beyond the exploration phase.[8-10] After content analysis is completed, statistical analysis is used to reveal any significant differences in cognitive presence. A content analysis tool for cognitive presence is explained in Table I.[11]

The literature of asynchronous online discussion as a pedagogical tool for critical thinking is controversial. Examination of higher order critical thinking as defined by Bloom's Taxonomy of analysis, synthesis, and evaluation concluded that asynchronous online discussions can foster critical and higher order thinking.[12] Other researchers argue that asynchronous online discussion boards may not encourage the coherent and inter-active dialogue, which may "lead to disengaged learners who fail to acknowledge new ideas, skills and knowledge"[13] as students are just "playing the academic game because they are required to participate."[14] Noted limitations of asynchronous communication when compared to face-to-face interaction include fewer methods of communication and the lack of immediacy.[15] In research conducted using the Community of Inquiry framework, the higher-level integration and resolution of new information does not often result from the asynchronous online discussions as they are commonly practiced.[16]

An emerging concern in online education is that students report feelings of isolation, a sense of loneliness, or disconnectedness due to the lack of face-to-face interactions.[14] As new technologies continue to be developed, the idea of synchronous communication and discussion has become a reality. One synchronous discussion tool, Adobe Connect (Adobe Systems, www.adobe.com), includes video webcams, chat, interactive whiteboards, polls, breakout rooms for small-group discussions, and the option to record each discussion. This synchronous tool allows the student to establish visual and voice communication with the teacher and other course participants. Thus, this form of online pedagogy attempts to mimic the traditional brick and mortar classroom dynamic.[17] Research on synchronous web conferencing tools, especially Adobe Connect, found that meetings were helpful and allowed for opportunities to interact with the professor and other students as well as established a collaborative learning environment.[18] Online courses using synchronous web-conferencing have demonstrated significantly higher levels of cognitive presence and students in those classes have recommended the use of real-time web-conferences in other classes.[15, 19]

Currently, limited research exists on the comparison of cognitive presence in synchronous video web-conferencing and asynchronous discussion boards. Additionally, no research has been conducted on comparing synchronous video web-conferencing and asynchronous discussion boards in online dental hygiene courses. The purpose of this study was to measure and compare the level of cognitive presence achieved during asynchronous and synchronous discussions in an online dental hygiene course.

Materials and Methods

The context of the study was an undergraduate dental hygiene course on the topic of didactic teaching. This course was delivered exclusively online at a large research university during the 2014 fall semester, and used asynchronous (threaded discussion boards) and synchronous discussion formats (Adobe Connect video web-conferencing). Approval for the research was granted by the Institutional Review Board at The Ohio State University. A total of 15 (N=15) students, consisting of both entry-level and degree completion, were enrolled in the undergraduate dental hygiene course. All students accessed the same university Course Management System (CMS) to gain access to the course content. The course included weekly online discussions accounting for 25% of the student's overall grade. During the first week of the semester, all course participants met synchronously using Adobe Connect to discuss the course syllabus, expectations, learning activities, grading, and course schedule. During this video web-conference, all students were introduced

Table I. Cognitive Presence Coding Rubric

Phase	Descriptor	Indicator	Sociocognitive processes
Triggering event	Evocative	Recognizing the problem	Presenting background information that culminates in a question
		Sense of puzzlement	Asking questions Messages that take discussion in the new direction
Exploration	Inquisitive	Divergence--within the online community	Unsubstantiated contradiction of previous ideas
		Divergence-- within a single message	Many different ideas/themes presented in one message
		Information Exchange	Personal narratives/descriptions/facts (not used as evidence to support a conclusion)
		Suggestions for consideration	Author explicity characterizes message as exploration. e.g "Does that seem about right?
		Brainstorming	Adds to established points but does not systematically defend/justify/develop addition
		Leaps to Conclusions	Offers unsupported opinions
Integration	Tentative	Convergence-- among group members	Reference to previous message followed by substantiated agreement, e.g "I agree because..." Building on, adding to others' ideas
		Convergence--within a single message	Justified, developed, defensible, yet tentative hypotheses
		Connecting ideas, synthesis	Integrating information from various sources--textbook, articles, personal experience
		Creating Solutions	Explicit characterization of message as a solution by participant
Resolution	Committed	Vicarious application to real work	
		Defending Solutions	

to the learning activity of online discussion and were presented with discussion guidelines. Table II outlines the course discussion guidelines.

Each week, the 15 course participants were split into two smaller sub-groups to maximize student engagement during the online discussions.[20, 21] Both sub-groups, Team 1(n=7) and Team 2 (n=8), were given the same discussion topic and questions each week. However, each subsequent week the sub-groups alternated the discussion format between asynchronous discussion boards and synchronous video web-conferencing.

The asynchronous discussion boards, following recommendations in the literature, were open for discussion for a period of one week.[22, 23] During this week, students would write an initial thread on the CMS discussion board in response to a posed, written discussion prompt and replied or commented on other students' posts via written text. The instructor would periodically check on the discussion during the week, and make comments on the posts as needed.

The synchronous Adobe Connect video web-conferences were scheduled for Wednesday evenings, from 8:00-9:30 PM (EST). Although 1.5 hours were scheduled, the actual time of each discussion

session was dependent on the amount of student participation. The students were required to use a webcam during the discussion, and were also required to have a headset or earphones with a microphone in order to speak during the discussion. The instructor was present the entire time of each video web-conference, and facilitated the discussion by informing students when it was their turn to participate in the conversation. The instructor also added input throughout the discussion and summarized ideas before moving on to a new part of the discussion.

Data Collection

This study applied the use of transcript analysis for data collection. Out of the 16-week semester, there were 11 weeks of discussion. Because of the labor intensive nature of transcript analysis, 4 weeks of synchronous and asynchronous discussions were chosen to be transcribed and analyzed. The discussion weeks chosen to be transcribed and analyzed were weeks 3, 6, 9, and 12. This selection included an equal distribution of teams assigned to either synchronous or asynchronous. See Table II.

Table II. Discussion Guidelines

Discussion Board Post Guidelines	Webmeeting Discussion Guidelines
The discussion board, facilitated through Carmen, will serve as a means of communication and discussion amongst your peers. Your initial post will be due on the Tuesday of the week, and 2 responses to classmates will be due on the Friday of the week. A grading rubric for evaluation is posted on Carmen.	A synchronous (live) webmeeting through Carmen Connect will be held every other Wednesday from 8-9:30. This is a reserved time for the class and instructor to discuss and expand upon topics in the course, and also a time for you to ask questions. Grading rubric is available on Carmen.
Expectations: Your responses should be thoughtful and meaningful and fully answer all posed questions. You are expected to reference the text as a guide but also add your own opinions, ideas, and experiences. Responses to classmates should be intended to add to the discussion and provoke further questioning and exploration of the topic.	**Expectations:** You are expected to be familiar with that week's course content, as discussion questions will be posed and participation by all is required. Be ready to discuss that week's readings, as well as add your own opinions, ideas, and anecdotes.
Helpful Tip: It may be helpful to "subscribe" to the discussion board posting and receive instant notifications (text or email) to inform yourself when someone has posted to the discussion board.	**Helpful Tip:** To add to the conversation, use the "raise hand" button on Carmen Connect and wait to be called upon by the instructor. If you want to add a *small* thoughts or questions to the person discussing without interrupting , you can type them in the text message portion of Carmen Connect.

Each of the 4 discussion weeks included a transcription for the asynchronous discussion and the synchronous discussion, resulting in a total of eight transcripts. In this research study, the unit of analysis used to code was message unit. In the asynchronous discussion transcripts, a message was defined as an initial written post or comment by one participant. On the same basis, in the synchronous discussion transcripts, a message was defined as one complete spoken thought shared by one participant. After discussing the Community of Inquiriry indicators for cognitive presence, the researchers coded each message in the asynchronous and synchronous transcripts based on the coding book refined by Park.[11] Because multiple levels of cognitive presence can be found in a message, the researchers "coded up" to the highest level of cognitive presence found in the message.[24]

Inter-rater reliability between coders was calculated using Holsti's coefficient of reliability[25] for week 3 asynchronous and synchronous discussions. This provided an estimate of reliability between the coders before the adoption and advantage of a negotiated coding approach for the following six transcripts. In the negotiated approach, the researchers coded transcripts separately and then discussed their respective codes to reach at a final negotiation of the code. Negotiation provided a means for on-going training, refining the coding scheme, controlling for simple errors, and thereby increasing reliability.[26]

RESULTS

The average age of the respondents was 28.9, with a minimum age of 23 and maximum of 30 years old. All of the respondents indicated at least 4+ years experience of regular computer use, and 71.4% said they were very comfortable or comfortable with taking an online course. Seventy-one percent had previous experience using a discussion board, while

only 29% had previous experience using Carmen Connect video web-conferencing.

From the eight transcripts, a total of 117 messages were counted in the asynchronous discussions and a total of 260 messages were counted in the synchronous discussions. The asynchronous discussions averaged 29.25 messages in one week on the threaded discussion board, while the synchronous discussions averaged 111.5 messages in an average of 49 minutes.

Inter-rater reliability for cognitive presence coding was established in week 3 of asynchronous and synchronous discussions using Holsti's coefficient of reliability, with 90.3% and 90.4% respectively. The negotiated coding approach was employed for week 6, 9, and 12 discussions.

Out of the 29.25 average messages coded for cognitive presence in the asynchronous discussions, 100% of the message units indicated some phase of cognitive presence. Although the synchronous discussions yielded an average of 111.[5] messages per week, only 59.4% (66.25) of the messages indicated some phase of cognitive presence. The lowest level, triggering events, accounted for 9.43% (6.25) in the synchronous discussions and 3.42% (1) of the messages in the asynchronous discussions. The second level, exploration, compromised 70.94% (20.75) of the asynchronous messages, while only 55.09% (36.5) of the synchronous messages. Of the messages in the asynchronous discussions, 24.79% (7.25), were in the integration phase, compared to 23.40% in the synchronous discussions. The highest level of cognitive presence, the resolution phase, was found most often in the synchronous group, 10.19% (6.75), while the asynchronous discussions reached resolution phase in only 0.85% (0.25) of the messages. Figures 1, 2, and 3 show the complete results of the coding for cognitive presence.

The results were analyzed using ANOVA to compare total indicators of cognitive presence. The average number of messages coded for cognitive presence in the synchronous discussions was significantly more than in the asynchronous discussions ($p=0.03$). A chi-square test was used to analyze the percent of messages in the four phases of cognitive presence. The synchronous group achieved the highest phase, resolution, significantly more than the asynchronous group ($p=0.005$).

DISCUSSION

Although both discussion formats asked the same question each week, the findings of this study show the average number of messages generated in the synchronous discussions were significantly more than the average number of messages in the asynchronous discussions. There are several possible reasons for this finding. First, the nature of the medium must be considered. Synchronous discussions occur in real-time, and oral communication tends to be fast-paced, spontaneous, and less structured when compared to text-based communication.[22] The spontaneous, more informal environment provided by the synchronous discussion may encourage more participation in the community of inquiry. Second, the teacher involvement was low in the asynchronous discussion boards. Previous literature suggests that increased teacher interaction can have a positive correlation with student participation.[27] If the teacher had been more active in the discussion boards, the number of messages generated may have been higher. On the other hand, the teacher was present during the entire synchronous video-conference. Finally, the discussion boards had specific guidelines for how many posts and comments were required to receive full credit. The students were aware that one initial thread and three comments were required. This may contribute to the fact in the four weeks that were analyzed, the number of messages posted in the discussion boards was relatively similar, ranging from 27-31 messages. In contrast, the synchronous discussions had no exact number for how many times they were required to speak during the video-conference. It would be impractical for the instructor to count the number of times each student spoke for grading purposes, so instead of giving a specific number of how many times the student had to speak, the students were simply encouraged to participate. As a result, the numbers of messages in the four weeks of synchronous discussions were varied,

Figure 1. Average Number of Messages with Indicators of Cognitive Presence Categories

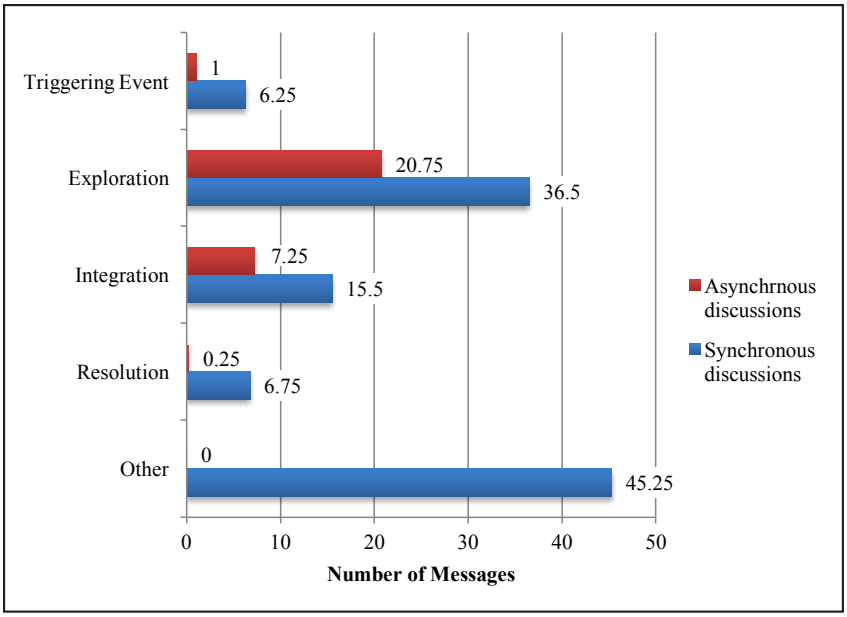


Figure 2: Distribution of Cognitive Presence Phases in Asynchronous Discussions

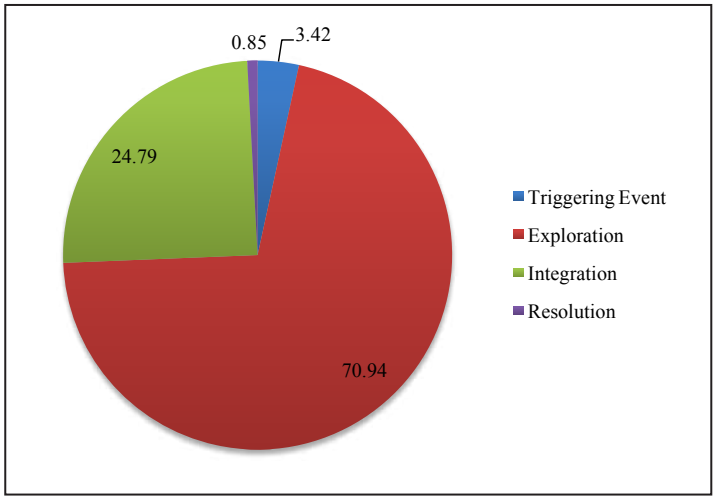
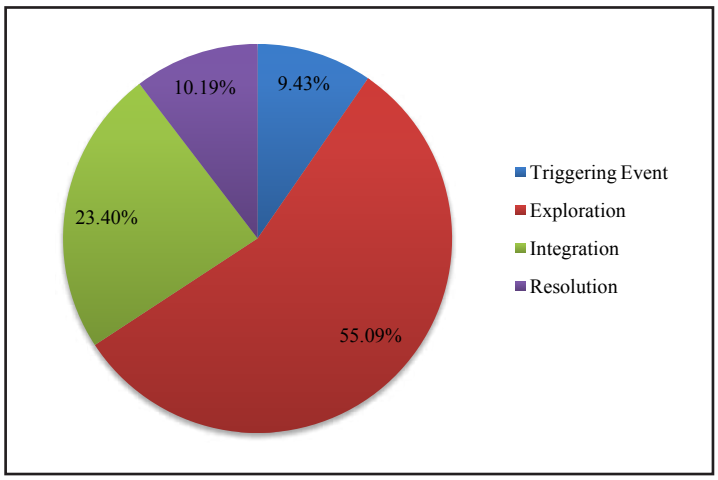


Figure 3: Distribution of Cognitive Presence Phases in Synchronous Discussions



ranging from 73-155 messages. The specific number requirement in the asynchronous discussion could have limited the participation, as the students may have not been motivated to participate any more than the required number. The different guidelines for the discussion formats, as well as the difference in teacher involvement, are seen as a limitation of this research study.

The amount of time required to complete a discussion were very different between the two formats. The asynchronous discussions occurred during one week, while the synchronous discussions averaged 49 minutes. It is interesting that although the asynchronous discussions took place for a much greater amount of time, the synchronous discussion still generated more message units. The instructor dedicated the same amount of time preparing for both formats, but due to the asynchronous nature of discussion boards, the instructor would have to sign in several days a week to check in with the discussion. In this course, the instructor read and responded to posts on average of twice a week, as well as once again after they were due to grade them and check for required peer comments. This averaged to at least 2 hours a week devoted to discussion boards, which produced little interaction between the instructor and the students. Many dental hygiene faculty have reported that the greater amount of time and labor intensive demands that need to be devoted to an online learning environment are a disadvantage when considering online teaching. An unexpected outcome of this research was the finding that synchronous discussions may be a good option for those faculty wishing to produce high quality discussion in a lesser or more condensed time frame.

It is important to note that the sheer volume of messages generated in a discussion does not correlate with the quality of the discussion. The Community of Inquiry framework was used in this research study to identify the different elements present in the discussions, as well as evaluate the quality of the discussions. The previous literature on comparing cognitive presence in asynchronous and synchronous formats is limited, and overall the findings are inconsistent. Previous research on cognitive presence in asynchronous discussions showed a difficulty progressing the discussion to the two higher levels of cognitive presence, with most posts indicating the exploration phase.[22, 28]

Our research indicated that both discussion formats produced high levels of cognitive presence. The exploration phase was indicated most often in the asynchronous discussion, which is consistent with previous literature. However, the synchronous discussions achieved the highest phase of cognitive presence, the resolution phase, more often than the asynchronous discussions. Two considerations for this result could be the increased levels of social and teaching presence that were indicated in the synchronous discussions, as well as the increase of teacher interaction. Teaching presence is seen to be the binding factor between the three elements of the Community of Inquiry framework.[29] The increased indicators of teaching presence found in the synchronous discussion may have fostered higher levels of learning. Also, the increased involvement of the teacher may have prompted the students to achieve higher levels of learning by providing direct instruction as a subject matter expert. Social presence has also been shown to increase levels of cognitive presence[29], as it sets the tone of the community and allows for students to feel more comfortable expressing their ideas and opinions in a discussion. This lays the foundation for higher-levels of learning, and it has been shown that the perceptions of social presence significantly predict perceptions of cognitive presence.[29] In this study, the

higher levels of social presence in the synchronous discussions may be correlated with the higher levels of cognitive presence. Finally, the students in this sample were undergraduate students that may not be able to achieve high levels of learning without specific coaching. In courses that used solely asynchronous, threaded discussion boards, significant teaching presence and social presence must be established to foster high levels of cognitive presence. This could be achieved by increased teacher participation, the teacher initially setting the tone for establishing social presence, and being specific to what level of cognitive presence is expected to be achieved by the students (e.g. "I want you to come to a solution and test your hypothesis").

The limitations of the research design also include a small sample size. This research was conducted in one online dental hygiene course with a limited number of student participants. Due to the small-N involved in this research study, it is possible that some of the basic assumptions for common statistical techniques such as ANOVA may have been violated. Also, the study population had a 7 year age range and differences in their experience with computer use and online courses. Twelve of the 15 students in this class were traditional, entry-level dental hygiene students who were well acquainted with each other from face-to-face interactions outside of this online course. These experiences could have affected the results.

Conclusion

Time commitment is a concern with online educators, as most admit to online teaching as labor and time intensive.[30] In this study, synchronous video web-conference discussions averaged less time on the instructor than asynchronous discussion, while producing higher levels of cognitive presence. Synchronous discussion may be an option for faculty looking to decrease the amount of time required to facilitate a discussion without compromising the student-teacher interaction and collaboration. The findings from this study also suggest that synchronous video web-conferencing may allow for higher levels of cognitive presence to develop in an online course. Critical thinking skills are identified as an important core competency[31] and accreditation standards[32] in both undergraduate and graduate dental hygiene education. A higher level of cognitive presence may help dental hygiene programs meet the critical thinking accreditation standard and core competency of their program. More research is needed to compare these two formats of discussion. Future research should include equivalent guidelines for participation, equivalent teacher involvement in the both equivalent teacher involvement in both discussion formats, and a larger sample size.

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The Impact of Community Rotations on the Cultural Competence of Dental Hygiene Students in the State of Texas

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Abstract

Purpose: Culturally competent health care providers understand cultural attitudes, values, beliefs and practices and are able to use this knowledge to guide patient care. Rising oral health disparities among racial and ethnic minorities require that dental educators emphasize the attainment of cultural competence in order to prepare students to effectively care for patients with backgrounds different from their own. This study investigated the role of community rotations on the cultural competence of second-year Texas dental hygiene students.

Methods: A modified version of the validated self-assessing Clinical Cultural Competency Questionnaire (CCCQ) was given to students at twelve Texas dental hygiene programs with a 100% response rate (239/239). Data analysis was performed using the Kendall tau correlation for associations and Kruskal-Wallis and Mann-Whitney U tests for differences among and between groups.

Results: Students scored highest in attitude (86th percentile). Time spent in community rotations ($p=0.009$), number of community rotations ($p=0.028$), racial/ethnic diversity of program clinic patients ($p=0.042$), and training hours ($p=0.044$) were associated with increased cultural competence scores. Students with over 50 community rotation hours ($p=0.006$) scored significantly higher than students with less than 50 hours. Generally, those with four rotations ($p=0.002$) scored highest. Those with public clinic ($p=0.049$) and school ($p=0.044$) rotations scored significantly higher than those without these experiences. Those with nursing home ($p=0.009$) and hospital ($p=0.026$) experience scored lower than those without these experiences. Students seeing the most racially/ethnically diverse patients in program clinics scored higher ($p=0.014$) than students seeing less diverse patients. Those with 6-10 training hours scored higher ($p=0.013$) than those with other training levels. Hispanics scored significantly higher than whites in skill and overall cultural competence ($p\leq 0.005$).

Conclusion: Dental hygiene programs should invest time in cultural competence training and choose a robust program of community rotations, while considering the diversity of the student body and clinic patient pool to enhance graduates' cultural competence.

Keywords: cultural competence, cultural diversity, community rotations, dental hygiene education

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Introduction

A culturally competent health care provider understands cultural attitudes, values, beliefs, and practices and uses them to guide care for patients, taking into consideration their specific history and needs and avoiding the use of stereotypes and personal biases.[1] Betancourt et al. report that the health care workforce is not sufficiently diverse or culturally competent.[2] The rising oral health disparities among racial and ethnic minority groups require that dental educators emphasize attainment of cultural competence (CC) so that students are prepared to effectively treat and communicate with patients with backgrounds different from their own. Standard 2-15 of the Commission on Dental Accreditation (CODA) mandates that dental hygiene graduates "be competent in interpersonal and communication skills to effectively interact with diverse population groups and other members of the health care team".[3] Many dental hygiene programs currently meet this standard through clinical service-learning, however clinical service-learning is not required by CODA or consistently used.[4]

The oral health care disparities between minorities and mainstream populations in the United States could be improved by CC training.[5] Multiple studies have shown that participation in training

results in improved CC for health care providers.[6-10] Other studies of health profession students have demonstrated that students' CC increased upon completion of a community rotation program.[6,11,12,13]

Although there is a recognized need for CC education, the content of these cultural education programs is not standardized.[1] In a literature review of cross-cultural education in US health professional schools, Gregorczyk and Bailit found that available assessment instruments were lacking in validity and reliability and were limited regarding cultural biases and stereotyping risks.[14] They also identified faculty as a barrier, because there are a limited number of minority faculty to serve as role models.[15]

Multiple commercial inventories have been used to measure CC.[16] The Cross-Cultural Adaptability Inventory (CCAI) assesses changes in one's cross-cultural effectiveness and assesses strengths and weaknesses in emotional resilience, flexibility/openness, perceptual acuity, and personal autonomy.[17] Two studies used the CCAI to determine whether their dental hygiene students' cross-cultural effectiveness improved upon completion of their two year curriculum and found no significant improvement.[18,19] Tavoc et al. compared the cross-cultural adaptability of Texas licensed dental hygienists to dental hygiene students and found no significant differences.[20]

Chen et al. conducted a pre- and post-survey using the Inventory for Assessing the Process of Cultural Competence among Healthcare Professionals-Student Version (IAPCC-SV) to measure the increase of CC of nursing students involved in a service-learning project.[6] They found a significant increase in CC upon completion of the project. The Knowledge, Efficacy, and Practices Instrument for Oral Health Providers (KEPI-OHP) is a more recently developed instrument specifically for oral healthcare providers and might prove useful for dental educators to strengthen their cultural curricula.[21]

Originally developed for physicians, the Clinical Cultural Competency Questionnaire (CCCQ) has been used in many healthcare professions, [22] and it has been found to be highly valid and reliable.[23-25] Knowledge, skills, attitudes, and comfort level associated with the delivery of culturally competent healthcare are measured through eighty-six items distributed across six domains: Demographics, Knowledge, Skills, Comfort with Encounters/Situations, Attitudes, and Education and Training. These are self-assessed by the participant with a five point Likert scale.[26] Evans and Hanes used a modified version of the CCCQ to evaluate the effectiveness of an interactive online CC course at Georgia Regents University and found significant improvements in the areas of self-awareness, knowledge, attitude and skills among dental and radiology students.[22]

The CC of Texas dental hygiene students has not been assessed nor has a direct link been established with community rotations experiences and CC. The curriculum for dental hygiene students in Texas could be greatly improved with information about how to develop culturally competent clinicians who are able to improve the oral health of their patients despite cultural differences or disparities. Thus, the purpose of this study was to assess the CC of Texas dental hygiene students and the impact of participation in clinical community rotations on their CC, using a modified version of the CCCQ.[26]

Methods

Study Population and Sampling Plan

The participants in this study were second-year dental hygiene students from the twenty-six dental hygiene programs in Texas. First-year students were excluded, because they do not usually participate in community rotations. The programs and their contact information were identified from the Texas State Board of Dental Examiner's website. Fourteen of the twenty-six programs responded, but only twelve programs actually participated. This sample size of 239 represented almost half of the dental hygiene programs in Texas with a full range of community experiences and patient diversity.

Project Procedures

The Texas Dental Hygiene Program Inventory (TDHPI) was emailed to program directors to identify the number of hours students spent in different types of community rotations, number of hours of CC training, and the race/ethnic proportions of students and patients. Twelve directors completed the TDHPI and returned a signed site authorization letter, granting permission for their program to participate in the study. Approval was granted by the Texas A&M College of Dentistry Institutional Review Board (#2015-0555-BCD-EXM) and each individual program's Institutional Review Board, where required.

Each responding program was then mailed a packet that contained the Clinical Cultural Competency Questionnaire Modified (CCCQM) for each second-year dental hygiene student with a self-addressed envelope for survey returns by the program directors. The program directors distributed the surveys to the second-year students (n=239) during their last semester of the program. To ensure survey compliance, five contacts were made with the directors: (1) emailing of TDHPI, (2) emailing of survey invitation and site authorization, (3) mailing of cover letters and CCCQM packets, (4) reminder emails to directors and (5) thank you emails after receipt of surveys.

Modified Clinical Cultural Competency Questionnaire

The anonymous questionnaire contained twenty-three questions adapted from the CCCQ that measured their self-assessment of CC in regards to knowledge, skill, comfort, and attitude, yielding an overall CC score and also two demographic and two open ended questions. This survey was used with permission from Robert C. Like, who developed the original CCCQ at the Center for Healthy Families and Cultural Diversity, Department of Family Medicine, Rutgers Robert Wood Johnson Medical School.[26] The instrument uses a 5-point Likert-scale that allows dental hygiene students to self-assess their knowledge, skill, comfort, and attitude regarding culturally competent patient care. The survey was modified for ease of completion and to better answer the research questions of this project.

The CCCQM was reviewed by a committee of experts in study design, data analysis, and cultural diversity at Texas A&M College of Dentistry. Prior studies established a high level of reliability and validity for the original CCCQ.[23-25] In this study, Cronbach's alpha showed that the CCCQM was highly reliable overall (α=0.908) as well as each of the four scales of knowledge (α=0.844), skill (α=0.863), comfort (α=0.856), and attitude (α=0.708).

Data Analysis

Data analysis was performed using IBM SPSS Statistics, Version 22 software. The basic findings of the CCCQM, including demographics, were summarized by descriptive statistics. Hypotheses about differences among and between groups were tested using the Kruskal-Wallis test and pairwise Mann-Whitney U tests respectively. Kendall's tau correlation was used to test associations. These non-parametric procedures were more appropriate since the data were non-normally distributed, and there were numerous ties in the data. A significance level of less than 0.05 was used. Specifically, these statistical tests were used to look for the relationship between various factors and the knowledge, skill, comfort, attitude, and overall CC score of Texas dental hygiene students. The four scales were also combined to yield an overall CC score.

Results

All 239 CCCQM surveys were returned yielding a 100% response rate. The race/ethnicities of student respondents, as reported by program directors, are displayed in Figure 1a. The majority of students were white/Caucasian (65%), followed by Hispanic/Latino (22%), Asian (10%), African American (1%), Native American (1%), and "other" (1%). Due to sparsity in some of the original six groups, students were collapsed into four categories: white, Hispanic, Asian, and "other" which included the remainder (Figure 1b). The racial/ethnic percentages of the patient populations for the community rotations and program clinics, as estimated by program directors, are shown in Figure 2. The largest population in the community rotations was Hispanic/Latino (45%), while the largest population in the program clinics was white/Caucasian (43%).

Figure 1a: Race/Ethnicity Demographics of Student Respondents

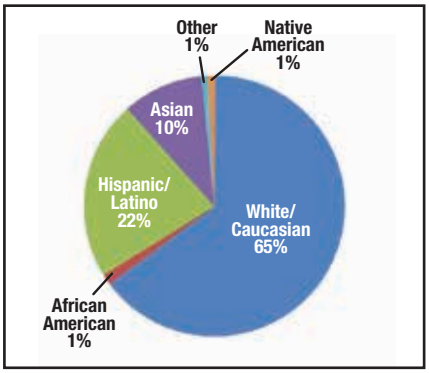


Figure 1b: Collapsed Race/Ethnicity Demographics of Student Respondents

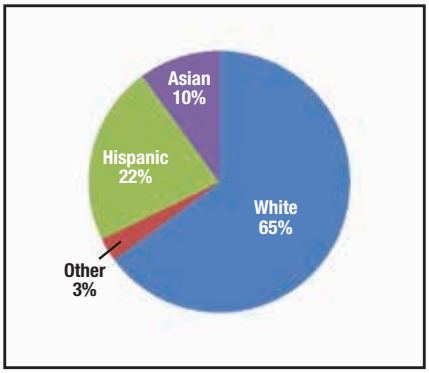
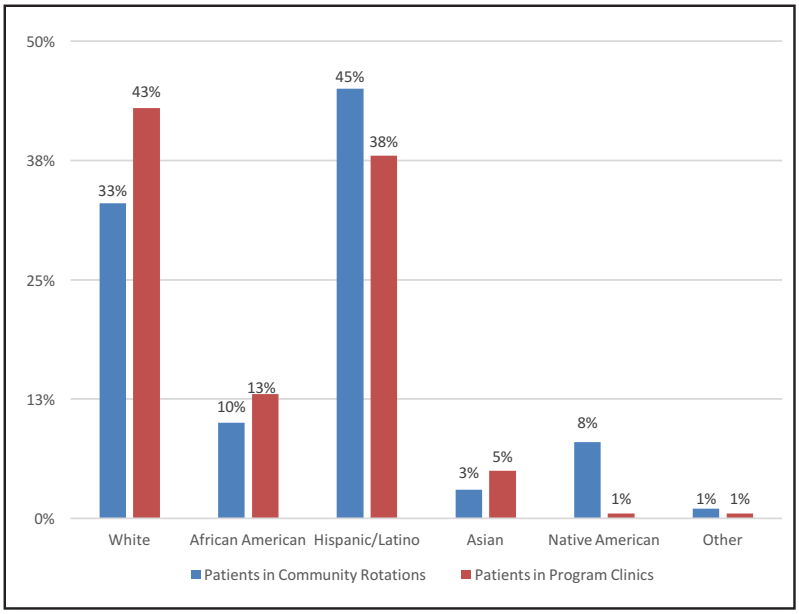


Figure 2: Racial/Ethnic Proportions of Patients in Community Rotations and Program Clinics



Community Rotation Experiences

The types and characteristics of the community rotations in which the students participated are shown in Table I. The dental hygiene programs participated in eleven different types of rotations. At least four or more of the programs participated in a combination of rotations including jails, hospitals, schools, public clinics, and nursing homes. A variety of other clinical rotations were only used by a single dental hygiene program and included a religious affiliated clinic, state school, VA dental clinic, Head Start, health fair, and Air Force dental clinic. Overall time spent in community rotations ranged from 0 to 108 hours, depending on the program. Each program participated in anywhere from 0 to 5 community rotations. At least half of the programs spent time in schools and nursing homes, but the highest average number of hours was spent in public clinics.

Table I Community Rotation Experiences

Type of Community Rotation	# Programs Participating	Average Hours Spent by Participating Programs
Public Clinic	5	40
VA dental	1	36
Hospital	4	19
Religious Clinic	1	16
State School	1	16
Jail	4	13
School	6	12
Head Start	1	10
Health Fairs	1	8
Nursing Home	6	5
Air Force dental clinic	1	4
None	1	0

Table II Cultural Competence Training

Type of Training	# Programs Participating	Average Hours Spent by Participating Programs
Lectures & Full Course	1	11
Multiple Lectures	7	6
Lectures & Special Training Module	2	5
Single Lecture	1	2
None	1	0

Cultural Competence

Table II displays the types of CC training programs in which the students participated and the amount of time spent in each. All but one program offered some type of CC training. Dental hygiene programs offering CC training either provided lectures, a course, and/or a specific training program to train their students in CC.

Descriptive statistics for the CCCQM scale scores as well as the range of possible scores are shown in Table III. With the exception of overall CC, none of these variables were normally distributed. Therefore, they are summarized here using medians and interquartile range (IQR). In the interest of completeness, means and standard deviation are also displayed. The median overall CC score was 88 and scores ranged from 52-115. Students scored between the 60th and 65th percentile for knowledge, skill, and comfort. Students scored highest in attitude, at the 86th percentile.

Factors Influencing Cultural Competence

Community Rotations

The amount of time spent, the number and the type of rotations all significantly affected CC scores. In terms of time spent, there was a small but highly significant association between the hours spent in community rotations and knowledge (tau=0.154, p=0.001) and overall CC scores (tau=0.124; p=0.009). The amount of time was then divided into two categories, 0 to 50 hours and over 50 hours. Students spending over 50 hours in community rotations scored significantly higher in knowledge (median scores 18 vs. 17; p=0.001) and overall CC (median scores 89 vs. 85; p=0.006) than the students with ≤ 50 hours in community rotations.

Differences were identified among the groups of students in CC performance with regard to the number of community rotations. Students were divided into six groups according to the number of rotations (0-5), yielding the following overall significant differences among the groups: knowledge ($p<0.001$), skill ($p<0.001$), comfort ($p=0.004$), attitude ($p=0.002$), and overall CC ($p<0.001$). Post-hoc tests revealed that students with four rotations consistently out-performed students with fewer rotations across all scales ($p \leq 0.002$) with three exceptions; four rotations outperformed five rotations in the skill, comfort and overall CC scales ($p < 0.001$).

Certain types of community rotations resulted in better CC performance. Clinical rotations in which only one program participated were grouped into the "other" rotation

Table III CCCQM Scores and Descriptive Statistics

Cultural Competence Scale	N*	Range of Possible Scores	Mean	Standard Deviation	Median	IQR
Knowledge	238	5-25	17.45	3.35	17	15, 20
Skill	236	7-35	25.05	5.09	25	22, 28
Comfort	238	4-20	15.82	2.99	16	14, 18
Attitude	236	7-35	28.87	3.67	29	27, 32
Overall Cultural Competence	231	23-115	87.28	11.89	88	79, 96

*Not all Ns are equal to 239 due to some questions not being answered by all subjects

category (see Table I). Students who participated in public clinic rotations scored significantly higher than non-participants with regard to comfort (p=0.049), attitude (p=0.007), and overall CC (p=0.040). Those participating in school rotations scored significantly higher in knowledge than non-participants (p=0.044). Students with the "other" rotation exper-ience scored significantly higher in knowledge than non-participants (p<0.001), skill (p=0.001), attitude (p=0.003), and overall CC (p<0.001).

Some community rotation experiences were negatively associated with CC performance; students with hospital and nursing home experience scored lower than those without experience in those rotations. Those with nursing home experience scored lower in knowledge (p=0.009), skill (p=0.001), comfort (p<0.001), attitude (p=0.001), and overall CC (p<0.001). Those with experience in hospital rotations scored lower in skill (p=0.020) and overall CC (p=0.026).

Race/Ethnic Diversity of Patient Pools

For analysis purposes, the extent of diversity of patients in program clinics and community rotations were categorized as: least, somewhat, or most diverse. The patient pools were considered least diverse if at least 60% belonged to a single race/ethnicity. Those in which at least one race/ethnicity made up 50-59% of the pool were designated "somewhat diverse." Those in which at least two of the race/ethnicities did not exceed 50% were designated as "most diverse." No significant relationships were found between the extent of diversity of patients seen in community rotations and CC scores. However, small but significant associations were found between the diversity of patients seen in program clinics and skill (tau=0.189, p=0.001), overall CC (tau=0.181, p=0.001), and attitude (tau=0.114, p=0.042).

Significant differences in performance were identified among students seeing varying levels of diversity in their program clinic patient pools: overall CC (p<0.001), skill (p<0.001), knowledge (p=0.010), comfort (p=0.023), and attitude (p=0.005). Post-hoc tests revealed that students who saw the *most* diverse patient population scored higher in overall CC, skill, comfort, and attitude than those students seeing *least* and *somewhat* diverse patient pools (p ≤ 0.014). For knowledge, there was only a difference in scores between those seeing a *most* and *somewhat* diverse patient population in program clinics.

Cultural Competence Training

CC training hours ranged from 0-11 hours. To test for differences, training hours were divided into three groups: 0-5 hours, 6-10 hours, and over 10 hours. Small but significant associations were found between the number of CC training hours students received and overall CC (tau=0.113, p=0.032), attitude (tau=0.112, p=0.036), and knowledge (tau=0.107, p=0.044). Students with 6-10 hours of CC training scored significantly higher than students with 0-5 hours of CC training in every category (p≤ 0.002) except for comfort (p>0.05). One anomaly was students with 6-10 hours of CC training scored significantly higher than students with over 10 hours of training in overall CC (p=0.013) and skill (p=0.008).

Student Race/Ethnicity

Statistical analysis of student race/ethnicity was performed based on the collapsed categories (Figure 1b). Students of "other" race/ethnicity scored significantly higher than whites in overall CC and knowledge (p=0.020) (Table IV). Hispanics scored significantly higher than whites in skill and overall CC (p≤ 0.005).

Open-Ended Responses

Of the 239 students, 153 students provided 208 comments on at least one of the two open-ended questions regarding their significant educational experiences in program clinics, community rotations, or CC training. The five themes represented in the data were cultural learning experiences (n=73), language barriers (n=42), hands-on learning of CC (n=40), CC training (n=36) and the need to be culturally competent (n=17).

One student described the importance of hands-on, diverse patient experiences with, "I feel that they do a great job teaching us about cultural competency and sensitivity, but there's nothing like actually

having a patient with different beliefs to teach you how to interact and plan their treatment." Another student stated, "I learned to work with all different types of patients in rotations." One student reiterated the importance of this study, "Every dental hygienist should know how to communicate and understand every other culture out there especially in the United States, because it is a multi-cultural country." Table V highlights specific comments made by respondents related to the five themes.

Discussion

This study found that the self-assessment of CC by dental hygiene students in Texas was significantly enhanced by participation in community rotations. These findings parallel previous studies showing increased CC with service-learning and community rotation experiences.[6,11-13] Student self-assessment of CC was also influenced by having CC training and a diverse patient pool in the program clinics. Racial/ethnic diversity within their own class also contributed to their CC. These results also parallel previous findings that the race/ethnicity of students, patients, and faculty should be considered when implementing any type of CC training, whether it be a community rotation or a training module.[9,14,15,27, 28] These results have significant implications for dental hygiene curricula and the design of patient care experiences.

Community Rotation Experiences

This study found CC scores were higher with community experiences and were linked to the time spent, the number of rotations and the type of community experiences. Students participating in more rotations generally scored higher than those participating in fewer rotations. Furthermore, participation in public clinics, schools, and "other" rotations resulted in higher CC scores. One of the themes of the open-ended responses was that while training helped, it was the actual patient interactions that substantively strengthened the students' CC. Based on these findings, dental hygiene programs should evaluate the amount of time their students are spending in community rotations and the diversity of those experiences when reflecting on ways to improve the CC of their students.

There are two possible explanations for why skill, comfort, and overall CC were lower for programs with five rotations versus four rotations. The single program participating in four rotations spent the most time in community rotations, totaling 108 hours, thus increasing the overall patient exposure time. Also, the two programs participating in five rotations had the least amount of CC training, 0-5 hours, which could have influenced the students' skill and comfort level.

Two specific types of community rotation experiences resulted in lower CCs scores; hospitals and nursing homes. It is possible that factors unique to these types of experiences negatively impacted the development of CC. Other explanations for these results could be that the four programs with hospital rotations also had the least CC training (0-5 hours). Also, although six programs participated in nursing homes, this rotation was one of the shortest, totaling just five hours. Dental hygiene programs should look at these types of sites carefully to evaluate the quality of those experiences and try to identify factors that might negatively influence the student experience.

Cultural Competence and Training

Students scored highest (86th percentile) in their attitude towards CC. This is certainly a good foundation for producing culturally competent dental hygienists. However, these results also indicate a need for enhancing CC in the areas of knowledge, skill, and comfort where students scored between the 60th and 65th percentile.

Training has been shown to improve CC knowledge, self-awareness and attitudes.[6-10] This study supports the importance of training as students demonstrated increased scores for every CC scale except comfort. The one anomaly, 6 to 10 training hours resulting in higher scores than >10 hours, could be explained by the fact that the two programs (29 students) with > 10 training hours had little actual experience, spending < 50 hours in community rotations. The results of this study do not afford any evidence that > 10 hours of training improves CC or any of its components. Regarding the fact that training did not improve "comfort," student comfort with diverse patients might be more related to actual experience than training; in this study, comfort scores were improved with an increasing number of rotations.

Table IV Significant Differences in Cultural Competence Scores Based on Student Race/Ethnicity

Cultural Competence Scale	Ethnicity	Median Scores	p-value*
Skill	Hispanics vs. Whites	27 vs. 24	0.005
Overall Cultural Competence	Hispanics vs. Whites	93 vs. 85	0.008
	"Other" vs. Whites	93 vs. 85	0.020
Knowledge	"Other" vs. Whites	21 vs. 17	0.020

*All are significant differences using pairwise Mann-Whitney U tests

Table V Qualitative Themes with Student Comments (n=208 comments)

Theme	Responses	N
Hands-on Learning of CC	"All of my experience with cultural competency came from hands on learning with my own patients in clinic and almost all of my patients out on rotations. All of my experience in clinic but MOSTLY out on rotations was ALL significant experience that I never really encountered before dental hygiene school." "There's nothing like actually having a patient with different beliefs to teach you how to interact and plan their treatment." "I learned to work with all different types of patients in rotations." "Best way to answer this is to say that the ONLY experience I received related with cultural competency was in CLINIC and on rotations. Different cultures were only briefly talked about and not a part of any full lecture. Most of the patients I saw out on rotations were from ethnic, cultural, racial, minorities and the elderly. This "on hands" experience is the best way to learn, so I have no complaints about not having an instructor actually TEACH us this stuff."	40
Cultural Learning Experiences	"I saw a female patient who could not be seen by my male instructor due to religious views." "I had an experience where a patient grew up in a different country where toothbrushes and other oral hygiene products were not readily available. Once the patient moved to the states they learned how to somewhat properly care for their teeth, but were surprised to hear there were different ways to brush and floss their teeth." "Yes, I have had a patient that needed to wear a head piece so I had to adjust to their cultural beliefs and was not able to do a proper extra/intra oral exam."	73
Language Barriers	"I wish I was able to communicate effectively with Spanish only patients. I also think it is important to have someone on faculty be able to communicate too…" "During clinic I treated an Asian woman and I had a hard time treating her due to a language barrier. I had to modify my treatment for her by using many visual resources…" "(My) patient was part of the deaf culture. I was able to introduce myself and knew enough to realize you have to look directly at them when speaking. It also helped that I knew some American Sign Language (ASL). But this experience made me want to learn more dentistry ASL.	42
CC training	"I feel our dental hygiene program prepares us well for culturally diverse patients. Sometime we are given simulation patients that give us experiences that we may have not had otherwise."	36
Need to be Culturally Competent	"I believe cultural competency is very important in our profession, because we will encounter many patients with a variety of backgrounds and we need to be prepared." "Every dental hygienist should know how to communicate and understand every other culture out there especially in the United States, because it is a multi-cultural country."	17

Racial/Ethnic Diversity of Patient Pools

Significant relationships were noted between the diversity of patients in the program clinics and every CC scale. In contrast, the diversity of patients seen in community rotations did not have a significant impact on CC. The fact that students generally spend much more time in their program clinics than in community rotations may explain these contrasting findings. Although it is a difficult variable to control, dental hygiene programs should make sure their students are seeing the most diverse patient pool possible.

Race/Ethnicity of Students

There were differences among the student racial/ethnic groups with regard to CC scores. Although the

majority of the sample (65%) was white, Hispanics significantly outperformed them in skill and overall CC. The smallest category of "other" (African and Native American & other non-whites) scored higher than whites in knowledge and overall CC. The majority group can often be unaware of the minority perspective and experiences. Perhaps this means that white students need more community rotation experience and training when it comes to CC. These findings support the idea that student race/ethnicity is a factor for consideration when designing a CC curriculum. Although faculty diversity was not a variable in this study, Connolly et al. identified the lack of minority faculty members as another barrier to CC.[15] This should be considered as well as the race/ethnicity of the students and patients.

Limitations and Future Research

The CCCQM is a self-assessment instrument, therefore it is not a standard measure of knowledge or other aspects of CC performance. Another limitation, as reported by the program directors, was the diversity of patients seen in the program clinics was easier to track than the diversity of the patients in community rotations. Finally, selection bias cannot be ruled out; program directors who opted out (14 of 26) may have been those least comfortable with their community rotations.

Future cohort studies that examine student CC over time in relation to rotations may better our understanding of causality and help dental hygiene programs identify the strengths and weaknesses of their CC training and community rotation programs. While this study only evaluated the time spent in CC training, it would be beneficial to evaluate the type of training in future studies. Future researchers may also want to develop or use a measure of CC performance instead of a self-assessment. It is a difficult and controversial task to define the body of knowledge, skills and attitudes necessary for a person to be considered "culturally competent."

Dental hygiene programs not participating in community rotations should consider developing rotations to improve students' cultural experience and better prepare them for current societal needs. Programs already participating in community rotations should use an assessment tool similar to the CCQM to evaluate the impact of their community rotation program on students' CC.[18-19] If scores are found unsatisfactory, dental hygiene programs should analyze the time spent, number and type of community rotations as well as the diversity of students, patients, and faculty in addition to the quality of CC training.

Conclusion

This study is the first to evaluate the impact of community rotation experiences on dental hygiene students in the state of Texas. Results from nearly half of the Texas dental hygiene programs demonstrated an unambiguous link between the extent of community rotation experiences and self-assessment of CC. This study also found that the amount of time spent in community rotations, number of community rotations, types of community rotations, diversity of patient pools, diversity of students, and CC training were associated with increased CC scores. Based on these findings, it is recommended that dental hygiene programs have their students receive training, spend more time in a variety of community rotations and treat diverse patients to assure they graduate with the CC necessary to treat diverse patient populations.

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Public Health Dental Hygienists in Massachusetts: A Qualitative Study

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Abstract

Purpose: The aim of this qualitative, phenomenological study was to explore the attitudes and perceptions of public health dental hygienists on providing preventive care to underserved populations in Massachusetts.

Methods: Non-probability purposive sampling was used for initial participant recruitment, and snowball sampling occurred thereafter. Data collection occurred through semi-structured interviews. Qualitative analysis was conducted using Pitney and Parker's eight-step CREATIVE process.

Results: Data saturation occurred with 10 participants (n=10), one-third of the public health dental hygienists who are practicing in Massachusetts. The majority of practice settings included school-based programs (70%), while programs for children with special needs (10%) were the least common. Two major themes emerged from the data; (a) the opportunity to be an oral health change agent and (b) barriers to practice. Six subcategories emerged from the data and are reviewed within the context of their associated themes. Additionally, career satisfaction emerged as an unintended theme, and was reported as the driving force for the majority of participants.

Conclusion: This study revealed a better understanding of the public health dental hygiene workforce model in Massachusetts. Public health dental hygienists in Massachusetts perceive themselves as change agents within the health care profession, and although barriers to practice are plentiful, these oral health care professionals are committed to improving access to dental care.

Keywords: access to care, dental hygienists, public health, oral health disparities, preventive oral health care.

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Introduction

Most oral diseases are preventable; however, millions of Americans go without routine preventive dental care every year.[1] Oral health disparities are most common among racial and ethnic minorities, specifically Hispanics and blacks, as well as populations of low socioeconomic status.[2] There are a reported 47 million Americans living in designated dental provider shortage areas.[3] An estimated 17 million children of low socio-economic status received no dental care in 2009.[3] In 2011, an estimated 37% of children 2–8 years of age had experienced dental caries in primary teeth.[4] Ninety-one percent of adults 20-64 years of age had dental caries in permanent teeth, and 27% had untreated dental caries.[5] Additionally, 96% of adults 65 and older had dental caries, and one in five had untreated dental caries.[5]

The *National Call to Action to Promote Oral Health* document called for initiatives to improve oral health in America by reducing barriers to oral care delivery and workforce expansion.[6] A specific workforce approach addressed state practice act changes for alternative delivery models.[6] The growing rate of oral health disparities and dental professional shortages throughout the United States[3,7] has led to the establishment of various alternative dental workforce models to address access to oral healthcare. The 2014 National Governors Association (NGA) report discussed the innovative actions taken by some states, including Massachusetts, to leverage dental hygienists in expanded public health capacities.[8]

To improve access to oral health care, the scope of dental hygiene practice has advanced in many states. Due to the varied state legislative regulations and terms for a dental hygienist practicing in an alternative role, the American Dental Hygienists' Association has designated the term *direct access* and established the following definition:

"The ability of a dental hygienist to initiate treatment based on their assessment of a patient's needs without the specific authorization of a dentist, treat the patient without the presence of a dentist, and maintain a provider-patient relationship." [9]

Direct access for dental hygienists is allowed in 39 states, 13 of which use the term public health dental

hygienist (PHDH).[10] Other states simply refer to the method of having direct access ability, such as an extended care permit, collaborative agreement, and extended access endorsement.[10] The actual number of dental hygienists practicing in a direct access role throughout the United States is unknown. Requirements for direct access providers to register or provide dental surveillance information vary between states. Massachusetts identifies practicing public health dental hygienists through required reporting of services rendered and those enrolled as providers in the Medicaid-reimbursement program.[11]

In 2009, the *Status of Oral Disease in Massachusetts* was released and reported 53 dental health professional shortage areas, representing approximately 1,292,643 residents.[12] The Office of Oral Health concluded that Massachusetts needed to do more to improve the oral health of its residents.[12] That same year, legislation was passed in Massachusetts allowing a registered dental hygienist with 3 years of clinical experience to practice in a direct access role, as a public health dental hygienist.[11] The legislation permits a public health dental hygienist to provide primary preventive services in a public health setting to at-risk populations without the supervision of a dentist. However, the legislation states that a public health dental hygienist must have a written collaborative agreement with a practicing dentist or a public health agency.[11] According to the Massachusetts' Public Health Dental Hygienist statute guidelines, a dental hygienist is required to attend a four-hour didactic course and a six-hour clinical observation in an alternative dental setting.[11] In 2013, the Department of Public Health reported 33 public health dental hygienists were practicing,[13] less than 2% of the dental hygiene workforce in the Commonwealth. Although small in number, public health dental hygienists reportedly treated 6,900 Medicaid recipients in 2012.[8]

The alternative dental providers' perception of their role in rendering preventive services to underserved populations is vital to gaining direct knowledge needed to promote alternative dental workforce development and implementation, thereby improving oral health access to care. The purpose of this study was to explore the attitudes and perceptions of public health dental hygienists regarding their role in providing preventive care services to underserved populations in public health settings throughout Massachusetts.

Methods

A qualitative, phenomenological study was used to conduct the research. This research study was approved by the Massachusetts College of Pharmacy and Health Sciences (MCPHS) University's Institutional Review Board. Non-probability purposive sampling was used for initial participant recruitment. To enhance credibility and data trustworthiness, inclusion criteria were specific to Massachusetts' public health dental hygienists practicing in alternative healthcare settings. Participants were invited to take part in the study via an initial email. The initial participants were two public health dental hygienists with experience in the alternative oral health field, which led to further recruitment using the snowball sampling method. This sampling method relies on study participants' recommendations of other participants meeting inclusion criteria.[14]

To ensure trustworthiness of data, interview questions were adapted from two published qualitative studies regarding direct access dental hygiene providers. The interview guide was adapted with permission from interview questions previously developed in the Battrell et al.[15] and Delinger et al. studies.[16] Triangulation was also employed to ensure quality and credibility of the study.[14] As a public health dental hygienist, the principal investigator was able to utilize her expertise to interpret data regarding the phenomena and compare the differing viewpoints of study participants. Additionally, member checking was used to enhance data dependability. Member checking is when the researcher asks study participants to review the transcript from their interview, for accuracy.[14] Three participants elected to provide brief modifications to their interview transcript.

Qualitative analysis was conducted using Pitney and Parker's eight-step *CREATIVE* process. While *considering* the research questions and purpose of study, the interview transcripts were thoroughly *reviewed* to gain a complete overview.[14] Subsequently, to identify patterns, study information was *examined* to uncover meaningful relationships between the research questions and the interview transcripts.[14] Once patterns were organized and highlighted within the data, label *assignment* of similar sections was completed.[14] *Thematization* followed in the analysis process, during which themes were *interpreted* as they emerged from the data, while *verifying* data as it related to the purpose of the study and the research questions. Lastly, the principal investigator *engaged* data to effectively describe the findings.[14]

Results

Data saturation was achieved through interviews with 10 public health dental hygienists, comprising one third of all public health dental hygiene providers in Massachusetts. Descriptive statistics were employed to describe demographic characteristics. The mean age of participants was 50 years. Dental hygiene practice experience ranged from 7 to 38 years, with a mean of 19.3 years. Participants reported practicing as a public health dental hygienist for a minimum of 3 years to a maximum of 4.5 years. Table I depicts study participant demographic information. Participants reported taking the required public health dental hygiene course in 2010 (70%) and 2011 (30%). The 6-hour required public health

observation was reported as taking place at a variety of alternative settings. Due to prior public health employment, 30% of participants reported being exempt by the Massachusetts Board of Dentistry from the 6-hour observation requirement. Study participants identified practicing as public health dental hygienist in a variety of settings with diverse populations. The majority of settings included providing care for children at school-based programs (70%), while special needs population programs (10%) was the least commonly reported setting.

Table I.. Study Participant Demographics (n=10)

Variable	n	%	M
Age (years)			50
RDH practice (years)			19.3
PHDH practice (years)			
PHDH practice:			
Part time	3	30	
Full time	7	70	
PHDH observation sites[a]:			
DPH school-based	1	10	
WIC	2	20	
CHC	1	10	
Summer camp program	2	20	
PHDH school-based	1	10	
PHDH practice settings[a]:			
School-based	7	70	
WIC	4	40	
YMCA/BGC	4	40	
Daycares/ Headstart	4	40	
Housing Authority	4	40	
Homeless shelters	4	40	
Health fairs	4	40	
Rehabilitation sites	2	20	
Foster/group homes	2	20	
Geriatric	2	20	
Special needs	1	10	

Note. [a]RDH=Registered Dental Hygienist; PHDH=Public Health Dental Hygienist; DPH=Department of Public Health; WIC=Women, Infant, and Children; YMCA= Young Men's Christian Association; BGC=Boys and Girls Club.

Themes

The qualitative data analysis yielded categorical themes and subcategories related to both research questions. Subsequent sections include explanations of themes and participant quotations. Pseudonyms were employed to preserve the anonymity of participants' responses.

Two major themes emerged from data associated with the attitudes and perceptions of public health dental hygienists regarding their role in providing services to underserved populations in public health settings. These were (a) oral health change agent and (b) barriers to practice. Additionally, six subcategories emerged from the data and are reviewed in the context of the associated theme. Lastly, an unintended theme emerged from the data associated with career satisfaction.

Theme 1: Oral Health Change Agent

Data revealed that Massachusetts public health dental hygienists perceived themselves as a change agent within the communities they serve, with the subcategories of (a) community and professional networking, (b) community integration, and (c) improving access to dental care, as key components in the promotion of this role.

Participants discussed the role of the public health dental hygienist in the community as different from that of traditional dental practice. As change agents, participants shared their experiences with changing the public's perception of oral health by implementing and sustaining oral health programs in non-dental settings to improve access to preventive dental services and assist the population with finding a *dental home,* defined as an ongoing patient-provider relationship inclusive of comprehensive dental care that is routinely accessible using a family-centered approach.[17] Participant D stated, "It is almost like being a dental hygienist and a social worker…working with kids and helping them with their [dental] fears and… find a dental home." Participant J added, "Recognizing unmet need, and the simplicity of prevention, and my belief that we can do more… drove me to leave [private practice] and start…my own PHDH practice… if you build it they will come…last year we saw [approximately] 7000 kids." Participant E added, "It's hard because you see a lot of decay…parents that don't speak English as their first language, so it's harder for [the kids] to receive care…[but] by being in the schools…we know we are going to see those children." Participant A commented:

"Our main goal is not only to screen the child but to educate the parent …Changing the whole public perception [is a challenge], …So I explain to the parent it isn't only about seeing your child, it is about meeting you and helping you to understand…your child's teeth…It's huge when parents don't get that and you can help them…"

Community and Professional Networking

The ability to network was a central aspect identified in the strategies employed for public health dental hygiene practice. Community networks included relationship building within school systems and various public agencies. Participant E stated: "…it has been my building those relationships with people in the schools, and fostering those relationships…It takes letting the staff get to know who you are, and… once they trust you, and know what you are doing, they appreciate what you do, because they know the need in the schools is so great."

Most of the participants (90%) cited the importance of networking with the staff in public health settings to ensure follow-up dental care for patients. Participant C noted: "When I am in the shelters, they have staff that stay on top of that … with of course the patient's permission, and then they follow up to make sure that it is taken care of. In some of the daycare centers the providers will do the same thing, [working with] parents to make sure they get the treatment."

Other networking aspects included relationship building with area dentists to establish dental homes for those in need. Participant F said: "When we go to a facility, we contact…dentists within the radius… we are providing the services. We try to find dentists that accept [Medicaid] or sometimes private paying patients…so if…an urgent case [occurs] we have… prearranged relationships with…dentists to accept these kids…[dentist and PHDHs] have to work as a team."

Community Integration

Building relationships and changing perceptions within the communities in which public health dental hygienists serve were identified as integral to gaining community acceptance. Participant F noted, "It is good to be someone who is entrenched in the community, and is well known within the community." Through community integration, public health dental hygienists believe they are changing public perceptions of dental care and educating society on oral health prevention. Participant B commented, "[In] the beginning…people were…resistant, but if we could get in and meet them in person, they would like us. …after they met us they loved us! It is really that face to face contact…that makes the difference." Participant G added, "We make ourselves available to [the community]. We…provide [preventive care], and provide the parent with oral health instruction… and we direct them to places for [continued dental] care…we…help get them interested in oral health."

Improving Access to Dental Care

Most of the participants (90%) interviewed stated their role as a public health dental hygienist has improved access to care for underserved populations. Participant C said, "I definitely think it has increased…access to care…The knowledge too… more people…seem to be more accepting of having care in non-traditional settings." Similarly, Participant D commented, "… it has made a big difference, from …when they didn't have a program and where it is now. It has brought whole families to the dentist… they didn't realize [the importance] of oral health… because they learned it from their parents..."

Theme 2: Practice Barriers

Barriers that impeded the participants' ability to practice effectively as a public health dental hygienist were revealed. The subcategories included (a) removal of Medicaid benefits, (b) third party reimbursement, and (d) losing collaborative dentists.

Removal of Medicaid Benefits

The majority of participants (80%) discussed the financial loss after the elimination of deciduous dental sealants from the state Medicaid program as a reimbursable procedure. Participant A said, "We [had to reach] out to…other locations last year to ensure that we could keep the program going…based off the funding loss of deciduous sealant reimbursement which [previously] helped us maintain our program..."

Third Party Reimbursement

The public health dental hygienist legislation does not permit third party reimbursement. This often limits care to underserved populations such as older adults in nursing homes who carry private insurance. Participant C said, "…seniors were a group that needed care… I see about 50% of places with seniors, [and] …a few…shelters with [adults]…It has to be a mix to sustain you…typically seniors do not have dental insurance… they pay out of pocket." Similarly, Participant G added, "…I am just seeing the kids; but the adults and the elderly, it is just mind boggling…the need that is out there…a lot of people… fall between the cracks that don't have [Medicaid]."

Loss of Collaborative Dentists

Several of the participants (40%) discussed recently losing their written collaborative agreement with their dentists, which is a state requirement for a public health dental hygiene practice. The participants reported that dentists were being threatened by their malpractice insurance carrier with losing professional malpractice insurance if they had a collaborative agreement with a public health dental hygienist, thus threatening their ability to practice. Participant A commented on her recent experience, "…we lost the collaborative with our dentist, [and had to find] another collaborative dentist." Similarly, Participant B stated, "The collaborative dentist problem needs to get straightened out [for sustainability of the PHDH profession]." Although this directly affected only some of the participants, the majority (60%) acknowledge their concern regarding this dilemma.

Unintended Theme: Career Satisfaction

An unintended, yet emergent theme of career satisfaction arose from data not associated with the research question, and was noted in the responses of the majority of participants (80%). Participant A commented, "When you are passionate about something and believe… and it shows, it is contagious, and people want to be a part of it." Participant F added, "When you are passionate…and making a difference…I don't feel like it is work…although I am working all the time. You never work a day in your life, if you love your job…I can't imagine doing anything else." Similarly, Participant D commented, "It is so rewarding…I love the hands on. Seeing the kids, talking to the parents, working with the nurses. I love it and couldn't be happier with what I am doing."

Discussion

This study expanded knowledge on an alternative dental hygiene workforce model in Massachusetts. Additionally, barriers associated with direct access providers' success and sustainability were revealed. Increased awareness of the direct access dental hygienist, such as public health dental hygienists, may enhance utilization of this alternative provider, thus potentially improving access to preventive dental services, and oral health outcomes.

Results support the findings of previous research regarding comparable direct access providers in Oregon and Kansas. The characteristics of populations and practice settings were similar to both the Battrell et al[15] and Delinger et al[16] studies, primarily serving those with no dental home or limited access to a dental provider. Similar to findings in Battrell et al[15] and Delinger et al,[16] networking and relationship building in specific communities were reported as key to the success of the direct access providers' role in providing oral health care. Additionally, this study concurred with findings of Coplen and Bell[18] in identifying reimbursement challenges as a barrier to being successful in an independent practice setting. The collaboration legislative requirement was a noted barrier in both the Coplen and Bell[18] study and this study. However, the issues regarding collaborative agreements varied, from reporting inability to secure a collaborative dentist because of scarce dentist interest,[18] to Massachusetts' dentists threatened with losing their malpractice insurance by their carriers if they engaged in a collaborative agreement with a public health dental hygienist.

Limitations of this qualitative study were the reliability of the self-reporting from participants, low number of public health dental hygienists in the state from which to draw for study participation, low response rate and inability to generate results beyond Massachusetts public health dental hygienists. Although the investigator had interviewing experience, it is acknowledged that researcher-induced bias may have occurred during delivery of the questions.

Conclusion

This qualitative, phenomenological study highlighted the attitudes and perceptions of public health dental hygienists on providing preventive oral health care to vulnerable populations in Massachusetts. Public health dental hygienists in Massachusetts consider themselves as change agents within the health care profession, and while the barriers are plentiful, these providers continue to believe in their mission of improving access to dental care. Although knowledge has been gained regarding Massachusetts public health dental hygienists, it is recommended that other states with direct access dental hygiene providers' further investigation to facilitation and barriers of alternative dental hygiene workforce models as an approach to understanding and improving access to oral health care throughout the United States.

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Perceptions of Oral Cancer Screenings as Compared to Other Cancer Screenings: A pilot study

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Abstract

Purpose: The purpose of this pilot study was to compare public perceptions of Idaho adults regarding oral cancer (OC) screening with other common cancer screenings including breast cancer (BC), prostate cancer (PC), and colon cancer (CC) screenings.

Methods: This study utilized a convenience sample (N=100) of Idaho residents. A self-designed, validated interview-administered questionnaire was administered by a data collection service using computer-assisted telephone interview software to assess consumer perceptions about cancer screenings. Data were analyzed using descriptive statistics, frequencies, and Pearson's Chi-Square tests.

Results: Participants were predominantly white (90%) with a mean age of 52.7 years with some post-high school education (80%) and the majority had received OC screenings (54%).The majority of participants perceived benefits of each specific cancer screening as very helpful: (a) OC screening (60%), (b) BC screening (79.2% females), (c) PC screening (63.8% males), and (d) CC screening (84%), and also reported no perceived risks regarding OC (80%), BC (60.4%), PC (66%) screening. Only 11% reported fear of finding cancer with an OC screening. The study findings supported significant associations ($p<0.05$) between consumer perceptions of cost and time as barriers to accessing all of the selected cancer screenings.

Conclusion: This study identified associations between consumer perceptions of OC screening when compared with BC, PC, and CC. Concerns about cost and time for cancer screenings may reflect low consumer awareness regarding differences between OC and other cancer screenings. Future studies including larger samples representing more diverse populations are recommended to further explore the basis of participants' perceptions of cancer screenings and to identify ways to minimize barriers to cancer screenings.

Keywords: oral cancer, cancer screening, oral neoplasms, cancer prevention, cancer control, health attitudes

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Introduction

The National Cancer Institute (NCI) indicates over 300,000 men and women are living with a prior diagnosis of cancer of the oral cavity and pharynx in the United States (US).[1] Additionally, the American Cancer Society (ACS) estimated over 48,000 new cases would be diagnosed in 2016.[2] Approximately one in 100 men and women will be diagnosed with oral/pharyngeal cancer in their lifetimes.[1] OC has a high five-year survival rate (83.3%) when detected early in a localized stage. Unfortunately, most cases are detected after metastasis, when the survival rate can drop by more than half.[1]

Although evidence regarding the efficacy of the OC screening in reducing mortality exists, it is inadequate.[3-4] An American Dental Association (ADA) expert panel developed evidence-based clinical recommendations for OC screening which concluded, while community-based screenings may not reduce the mortality rate of OC in the general population, such screenings may reduce the mortality rate in high risk individuals. Further, the ADA panel concluded community-based screenings may result in detection of OC in earlier stages.[5] NCI data indicate OC has an 83.3% five-year survival rate when detected early. However, the survival rate falls to 63.3% once cancer has spread to regional lymph nodes, and drops further to 38% with metastasis.[1] Accordingly, the ADA guidelines supported OC screening as part of the visual and tactile oral examination for community-based and dental office settings, noting clinicians should also consider patient history and assess OC risk.[5] These

evidence-based clinical guidelines identified potential risks and benefits of OC screenings, including the psychological risk of false positives creating fear among patients, yet concluded that the benefit of early detection of treatable malignant lesions outweighed the risk of potential harms. In contrast, recommendations from the United States Preventive Services Task Force (USPSTF) indicate insufficient evidence exists to recommend for or against OC screening in asymptomatic adults in primary care settings, despite benefits of early detection.[6]

Similarly to OC, the risk of psychological harms was identified by the USPSTF (2016) as a risk of breast cancer (BC) screening.[7] This review noted patients frequently report adverse experiences, including pain during screening, anxiety about the procedure, and apprehension about results. Psychosocial barriers identified regarding colon cancer (CC) screening included fear of the procedure, concern regarding preparation for the exam, and fear/apprehension of results.[8-9] Despite the risk for these fears and concerns, screenings for breast and colon cancer continue to be recommended by the USPSTF.[7,10] None of the studies included in the latest review of evidence from the USPSTF for prostate cancer (PC) screening provided information on potential psychological harms.[11] The USPSTF recommendation for PC screening states research does not currently support the benefits of PC screening over potential harms; however, the NCI attributes the high five-year relative survival rate for PC to its early detection as a result of screening.[12]

In addition to psychosocial risks, cost has been consistently identified as a barrier to BC, CC, and cervical cancer screening utilization among consumers; cost as a barrier to OC screening has not been reported.[8,13] Other attributes of these screenings, including time to perform the screening, efficacy, and the screening process itself, also have been identified. Factors including preparation prior to screening, discomfort/pain, and risk of complications have been cited as significant determinants of choice when deciding whether or not to have a screening performed.[8-9]

USPSTF screening recommendations for various cancers differ based on research available at the time of the recommendation. For many cancers, current ACS screening guidelines meet or exceed those of the USPSTF for average-risk individuals, particularly regarding screenings for BC and CC.[7,10.14] The ACS recommendations for OC screening also exceed those of the USPSTF. The ACS recommends, in addition to the regular exam by a dental professional, physicians also examine the mouth and throat as part of a routine checkup, whereas USPSTF recommendations did not recommend for or against routine OC screening by primary care providers.[6,15] While the USPSTF recommendations regarding OC screenings in the primary care setting do not apply to the dental setting, seemingly conflicting recommendations for screening from the ADA, ACS, and USPSTF may be confusing for the general public and oral health professionals, and result in fewer people being screened. Although most oral healthcare providers report regularly performing OC screenings, approximately half do not perform head and neck palpations and, therefore, are not performing a comprehensive exam.[16-18]

Some evidence indicates OC awareness is lacking among consumers, as multiple studies show low overall knowledge of OC, OC risk factors, and clinical signs in populations throughout the US and other countries. Previous studies have indicated consumers were largely unaware of the benefits of OC screenings, many were unaware that their oral healthcare providers screen for OC, and most reported never having received an OC screening.[19-24] This low awareness may result from lack of communication from oral healthcare providers, as only half of those who report performing regular OC screenings report discussing the screening with their patients.[17]

Information regarding perceptions of the risks, benefits, and barriers to OC screening in relation to other cancer screenings is limited. Therefore, the purpose of this pilot study was to explore perceptions of Idaho adults regarding OC screenings as compared to other common cancer screenings including BC, PC, and CC screenings.

Methods

This quantitative pilot study was conducted using computer-assisted telephone interview software (CATI) due to a higher likelihood of an adequate response rate versus questionnaires distributed through an online format.[25] An experienced survey firm was employed to conduct the survey.

A non-probability, convenience sample of Idaho adults (N=100) was utilized. The sample size was determined based on feasibility and cost. The random sample was purchased from a large sampling supplier. Inclusion criteria consisted of adults aged 18 years and older residing in Idaho. Exclusion criteria were non-English speaking individuals, those with a history of OC, and those respondents with cellular telephone numbers originating in Idaho but living out-of-state.

The study protocol was approved by the Idaho State University Human Subjects Committee based on expedited review (IRB-FY2015-86). At the onset of the telephone call to each participant, an introduction stating the purpose of the study and participants' rights was provided, and verbal informed consent was obtained prior to administering the survey. Anonymity was maintained as no personally identifiable information was gathered in the interview or stored with participants' responses.

The instrument was a self-designed, interview-administered questionnaire. A Content Validity Index was used to establish validity of the questionnaire

using five experts in OC and/or health screenings. Questions deemed not relevant or only somewhat relevant by a majority of the experts were eliminated or revised. Each of the questions in the final instrument were deemed relevant or very relevant by the experts. Pilot testing then was conducted on the final instrument with a convenience sample (N=5) that met the inclusion and exclusion criteria. The survey was administered twice to these subjects, one week apart, to establish test-retest reliability, yielding agreement of 95%.

Trained, experienced interviewers were briefed by a supervisor regarding the project content prior to implementation using information supplied by the primary investigator. The interview-administered questionnaire was programmed into the CATI software and tested by the interviewers prior to implementation to ensure correct data were collected and assess whether the instrument was user-friendly for interviewers. Minor modifications were made and approved by the IRB. Landline numbers were programmed through a predictive dialer, which filtered the purchased sample and pre-coded numbers associated with faxes, computer phones, no-answers, etc. (any calls that were not "live") before sending live calls to the interviewers to administer the survey. Cellular telephone numbers from the sample do not use the predictive dialer and were dialed by interviewers on a one-to-one basis per federal regulations. Participants' survey responses required approximately five to ten minutes.

Demographic data were analyzed using descriptive statistics and frequencies. Categorical data from closed-ended questions were analyzed using Pearson's Chi-Square test for association to examine distribution differences and relationships between variables. To minimize the likelihood of a Type I error due to multiple comparisons analyzed in each set of tests (i.e., OC compared to BC, CC, and PC), a Bonferroni strategy was used to maintain the family-wise error rate of 0.05, calculated by dividing the 0.05 error rate by the number of tests, in this case four, which indicated an alpha level of .0125 should be used for statistical significance for each chi-square test within the sets. A phi coefficient was used to determine the magnitude of effect size, or strength of significant associations, identified in the crosstabs according to the following scale: .1 weak, .3 moderate, .5 strong.[26]

Results

The pilot study sample included a total of 100 subjects, 47 males and 53 females. Participants were predominantly white (90%) and had a mean age of 52.7 years with a median age of 58 years. The majority of participants had some post-high school education (n=80) with most having completed a certificate (n=7) or degree (n=48) program (Table I).

Table II summarizes participants' responses regarding OC and other cancer screenings. For each of the selected screenings, the interviewer briefly described in layman's terms what the screening may entail. When asking whether the participant ever had each screening, open-ended responses were coded as yes, no, or unsure/don't know. No participants selected unsure/don't know for any of the screenings. Over half of the respondents reported ever having had each of the following cancer screenings: (a) an OC screening (54% of all participants), (b) BC screening (94.3% of females), (c) PC screening (59.6% of males), and (d) CC screening (56% of all participants). The majority of respondents reported believing that cancer screenings were very helpful: (a) OC screening

Table I. Demographic Characteristics of Sample of Idaho Adults (N=100)

Variable	Characteristic	N
Gender	Male	47
	Female	53
Age	Mean	52.7
	Median	58
	Range	18-93
	Under 40	23
	Over 40	74
	No Answer	3
Race	White	90
	Hispanic	5
	Native American	1
	Asian/Pacific Islander	1
	Other	2
	No Answer	1
Highest Level of Education	Some High School	2
	High School Diploma/GED	14
	Some College/No Degree	25
	Technical/Trade Certificate	7
	Associate Degree	9
	Bachelor's Degree	25
	Master's Degree	14
	No Answer	4

(60% of all participants), (b) BC screening (79.2% of females), (c) PC screening (63.8% of males), and (d) CC screening (84% of all participants). The majority of participants reported having had no fears or concerns regarding screenings for OC (86% of all participants), BC (60.4% of females), or PC (66% of males); however, only 35% of all participants reported having no fears or concerns regarding CC screenings. The most frequently reported barrier to any screening was cost: (a) OC screening (57% of all participants), (b) BC screening (51% of females), (c) PC screening (40.4%), and CC screening (61% of all participants).

Data regarding associations between participants' responses regarding OC screenings and other cancer screenings are found in Table III. Crosstabs were calculated by gender of respondents because some of the screenings included in the chi-square analyses only applied to one gender (BC for females and PC for males). Although CC screenings are indicated for both groups, analyses were conducted by gender to maintain equality in sample size and statistical power. Crosstabs regarding ever having OC or other cancer screenings indicated the only statistically significant association was between OC and PC screenings ($p=.007$) with the phi coefficient indicating a moderate to large effect size ($\phi=.391$). A statistically significant association regarding participants' opinions on whether or not screenings were helpful was found between OC and BC screenings ($p=.006$, $\phi=.484$) and between OC and CC screenings for both females ($p=0.010$, $\phi=.563$) and males ($p=.000$, $\phi=.725$) with a large effect size.

Further analysis examined associations between OC and other cancer screenings regarding participants' fears and concerns (Table III). Fear of finding cancer was significantly associated with a large effect size when comparing OC and BC

Table II. Summary of Responses Regarding Oral Cancer and Other Cancer Screenings

Screening	Responses	Oral Cancer (OC) (N=100)	Breast Cancer (BC) (N=53)	Prostate Cancer (PC) (N=47)	Colon Cancer (CC) (N=100)
Ever Had	Yes	54 (54%)	50 (94.3%)	28 (59.6%)	56 (56%)
	No	46 (46%)	3 (5.7%)	19 (40.4%)	44 (44%)
	Unsure/Don't Know	0	0	0	0
Helpful	Very	60 (60%)	42 (79.2%)	30 (63.8%)	84 (84%)
	Somewhat	21 (21%)	11 (20.8%)	12 (25.5%)	12 (12%)
	No Opinion	17 (17%)	0	4 (8.5%)	4 (4%)
	Not Very	1 (1%)	0	1 (2.1%)	0
	Not	1 (1%)	0	0	0
***Fears/ Concerns**	Finding Cancer	11 (11%)	11 (20.8%)	5 (10.6%)	16 (16%)
	Embarrassing	2 (2%)	7 (13.2%)	13 (27.7%)	25 (25%)
	Pain	2 (2%)	11 (20.8%)	5 (10.6%)	15 (15%)
	Prep for Exam	NA	NA	NA	54 (54%)
	Other	2 (2%)	1 (11.9%)	0	2 (2%)
	None	86 (86%)	32 (60.4%)	31 (66%)	35 (35%)
***Barriers**	Cost	57 (57%)	27 (51%)	19 (40.4%)	61 (61%)
	Time	33 (33%)	18 (34%)	17 (36.2%)	47 (47%)
	Other	13 (13%)	9 (17%)	5 (10.6%)	13 (13%)
	None	20 (20%)	10 (19%)	18 (34%)	18 (18%)

*Total may be greater than 100% of population due to "select all that apply" option

(p=.000, ϕ=.564), OC and PC (p=.001, ϕ=.474), and OC and CC for females (p=.000, ϕ=.605); for males, OC and CC were significantly associated (p=.004) with a moderate to large effect size (ϕ=.422). Fear of pain was significant only when comparing OC and CC screenings for females (p=.001, ϕ=.438). Responses indicating no fears or concerns were only significant when comparing OC and BC (p=.003) with a moderate to large effect size (ϕ=.413).

Crosstabs between OC and other cancer screenings were also examined in relation to participants' responses regarding barriers to screenings (Table III). Cost of screenings was significantly associated with a large effect size when comparing OC and BC (p=.000, ϕ=.492), OC and PC (p=.000, ϕ=.531), and OC and CC for females (p=.000, ϕ=.579) and males (p=.001, ϕ=.500). When comparing time as a barrier to cancer screenings, significant associations with a large effect size were found between OC and PC (p=.000, ϕ=.674) and OC and CC for males (p=.000, ϕ=.528); a significant association also was found when comparing OC and CC for females (p=.006) with a moderate effect size (ϕ=.377). Other barriers reported by respondents were statistically significant with a large effect size for OC and CC for females (p=.001, ϕ=.473) and males (p=.000, ϕ=.515). Additional barriers specified by participants included lack of awareness regarding need for OC screening and lack of opportunities for OC screening outside of the dental setting, concerns regarding radiation for BC screening, accuracy and risk of false positives for PC screening, and embarrassment, fear, and the preparation process for CC screening. Associations between responses of participants reporting no barriers to OC and no barriers to other cancer screenings were statistically significant with a moderate to large effect size when comparing OC and BC (p=.002, ϕ=.424) and OC and PC (p=.007, ϕ=.392).

When comparing perceptions of OC and BC screenings, a significant association was found between participants' opinions on whether screenings were helpful (p=.006), fear of finding cancer as a concern (p=.000), and cost as a barrier (p=.000). When comparing perceptions of OC screening and PC screening, a significant association was found between participants' fear of finding cancer as a concern (p=.001), and cost (p=.000) and time (p=.000) as barriers; therefore, the null hypothesis predicting no association between Idaho adults' perceptions of OC screening and PC screening was rejected. When comparing perceptions of OC screening and CC screening, a significant association was found between male participants' opinions on whether or not screenings were helpful (p=.000), both male and female participants' fear of finding cancer as a concern (p=.004 and p=.000), female participants' fear of pain (p=.001), and male and female participants' perception of cost (p=.001 and p=.000) and time (p=.000 and p=.006) as barriers.

Discussion

Ninety percent of the respondents included in this pilot study were white; however, this proportion is reflective of the 93.5% white racial majority in the population of Idaho.[27] Additionally, over half of the respondents in the sample reported having completed a trade/vocational certificate or degree, with four out of ten earning a bachelor's degree or higher, whereas 24.4% of the Idaho population reportedly has earned a bachelor's degree or higher.[27] These respondents' perspectives may have been influenced by being more highly educated than the general population. These sample characteristics are important considerations for this discussion of the findings. More diverse populations need to be included in larger national studies.

Slightly over half of these respondents self-reported ever having received an OC screening. This screening rate was high when compared to previous studies which indicated a rate of less than 30% despite the fact that all of these studies provided a description of the OC screening procedure.[21,24] This higher screening rate may be due to the predominantly white, more highly educated, English-speaking population. Previous studies appear to indicate individuals with a lower socioeconomic status, blacks, and Hispanics are less likely to have received an OC screening.[21,24]

Data also indicated the vast majority of respondents reported perceiving no risks related to OC screenings. The most recent USPSTF report indicated no studies have reported harms from OC screenings; thus, it appears that these consumers had accurate perceptions regarding the low potential for risk of harms due to OC screenings. Self-reported rates for PC and CC screenings were comparable to those for OC at just over half; however, more than nine out of every ten females reported having had BC screening.

Similar to perceptions of OC screenings, the majority of respondents reported believing that all of the other cancer screenings were helpful and perceiving no risks regarding screenings for BC and PC. One in three participants, however, reported perceiving risks regarding CC screening, specifically mentioning in open-ended, follow-up questions preparation for the exam, embarrassment, pain, and fear of the unpleasant experience of the exam itself. These findings support those of Young and Womeldorph[8] which identified embarrassment, pain, and fear of invasive procedures, and Mansfield et al.[9] which identified preparation and discomfort as barriers to CC screening.

The most frequently reported barrier to all of the selected cancer screenings was cost, despite large differences in cost among the various screenings. Cost has been reported in the literature as a significant determinant in BC, CC, and cervical cancer screening

Table III. Chi Square Analysis for Comparison of Respondents' Perspectives of Oral Cancer Screenings and Other Cancer Screenings

Crosstabs (N)	OC/BC Female (53)	OC/PC Male (47)	OC/CC Female (53)	OC/CC Male (47)
Ever Had	c^2= .026 ϕ = -.022 p = .871	c^2= 7.204 ϕ =.391 p = .007**	c^2=.561 ϕ =-.103 p = .454	c^2= 5.071 ϕ =.328 p = .024
Helpful	c^2=12.402 ϕ =.484 p =.006**	c^2=17.684 ϕ =.613 p =.039	c^2= 16.777 ϕ = .563 p =.010	c^2= 24.692 ϕ = .725 p =.000**
Fears/ Concerns*	**Finding Cancer**			
	c^2= 16.857 ϕ = .564 p =.000**	c^2= 10.582 ϕ = .474 p =.001**	c^2=19.394 ϕ =.605 p =.000**	c^2= 8.360 ϕ = .422 p =.004**
	Pain			
	c^2=1.081 ϕ =.143 p =.299	c^2=n/a ϕ =n/a p =n/a	c^2=10.161 ϕ =.438 p =.001**	c^2=n/a ϕ =n/a p =n/a
	Other			
	c^2=n/a ϕ =n/a p =n/a	c^2=n/a ϕ =n/a p =n/a	c^2=n/a ϕ =n/a p =n/a	c^2=n/a ϕ =n/a p =n/a
	None			
	c^2=9.028 ϕ =.413 p =.003**	c^2= 3.260 ϕ = .263 p =.071	c^2=2.758 ϕ =.228 p =.097	c^2= 2.866 ϕ = .247 p =.090
Barriers*	**Cost**			
	c^2=12.814 ϕ =.492 p =.000**	c^2=13.231 ϕ =.531 p =.000**	c^2=17.790 ϕ =.579 p =.000**	c^2=11.750 ϕ =.500 p =.001**
	Time			
	c^2=4.020 ϕ =.275 p =.045	c^2=21.352 ϕ =.674 p =.000**	c^2=7.526 ϕ =.377 p =.006**	c^2=13.125 ϕ =.528 p =.000**
	Other			
	c^2=5.233 ϕ =.314 p =.022	c^2=2.782 ϕ =.243 p =.095	c^2=11.848 ϕ =.473 p =.001**	c^2=12.461 ϕ =.515 p =.000**
	None			
	c^2=9.532 ϕ =.424 p =.002**	c^2=7.204 ϕ =.392 p =.007**	c^2=2.814 ϕ =.230 p = .093	c^2=5.012 ϕ =.327 p =.025

* Chi-Square (c^2) Tests df = 1; Phi Coefficient (ϕ); Magnitude of effect size: Small (.1-.299), Medium (.3-.499), Large ($\geq$.5)

** $p < 0.0125$ (based on < 0.05 FWE)

preferences.[8,13] This pilot study is the first to identify cost as a potential barrier to OC screening.

Findings supported an association between consumer perceptions of benefits, risks, and barriers between OC and each of the selected cancer screenings. Respondents' perceptions of the helpfulness of OC compared to BC and OC and CC for both males and females were significantly associated; however, perceptions of the benefits of OC compared to PC were not significantly associated. This finding is interesting because the majority of these respondents perceived all of the screenings as very helpful. There were statistically significant associations between respondents' fear of finding cancer when comparing OC with BC, PC, and CC screenings, with the majority not experiencing fear of finding cancer as a concern for any of these screenings. This finding appears to indicate oral healthcare providers' reported concern regarding the potential for fear or anxiety among patients by using the word 'cancer' when discussing OC screening may be unfounded.[17] In fact, despite low consumer awareness regarding OC overall, consumers have indicated they would like their oral healthcare provider to tell them they are being screened and would like to receive more information from their provider about how to reduce their risk of developing OC.[19-24]

Significant associations were identified in participants' responses regarding barriers to OC and other cancer screenings. When comparing time as a barrier to cancer screenings, significant associations were found between OC and PC and OC and CC for both males and females, but not when comparing OC and BC. These associations may be related to a comparable amount of time for receiving OC and PC screenings; however, it appears that consumers were not aware of the significant difference in time required for OC screenings in comparison to CC screenings. OC screening takes minutes to perform as part of a routine dental examination, which typically requires one hour, whereas colonoscopy involves preparation the day before the procedure, sedation the day of the procedure, and the procedure time of approximately 30 minutes.

Cost as a barrier was significantly associated when comparing OC and BC, OC and PC, and OC and CC for both males and females. This finding implies a potential lack of consumer awareness regarding the cost of OC screening in comparison to other cancer screenings. The OC screening is commonly included with no additional cost in the comprehensive dental examination at $35-65, and the cost of a dental examination is low in comparison to costs of other cancer screenings.[28] Cost Helper Health[29] estimates the average cost of cancer screenings for uninsured and insured individuals. BC screenings average $102 for the uninsured, with an out-of-pocket cost of $10-35 for insured individuals. Estimates for PC screenings were $20-50 for a home PSA screening, increasing to as much as $120 in a hospital setting;a digital rectal exam ranges from $15-215, with co-pays of $0-30. The cost of CC screening, specifically colonoscopy, varies widely from $2010 to over $3000 with an average cost of $3081 for the uninsured. Out-of-pocket costs for insured individuals ranges from $0-1000 on average.[29] The association between consumers' concerns regarding the cost of OC and other cancer screenings may be related to insurance and reimbursement, as only 50% of the U.S. population was reported as having private dental insurance in 2010.[30] In comparison, the CDC reported that 95% of U.S. adults had medical insurance including 67.3% with private insurance and another 17.7% with public health plan coverage in 2014.[31] Clearly, there is a need for consumer education regarding the fact that OC screenings are low cost in comparison with other cancer screenings.

Opportunities for increasing OC screening rates will require consumer education regarding the need for regular screenings, increasing access, and addressing concerns about cost and time. Education is necessary, and begins with oral healthcare professionals informing patients about the procedure while it is being performed. The provision of OC screenings by advanced practitioners or dental hygienists in alternative settings may provide less expensive options for receiving OC screenings.[32] Seeking broader healthcare coverage for preventive screenings, creating lower cost options, and better reimbursement options may also improve accessibility. Improving OC screening accessibility could lead to earlier detection, and earlier detection prior to metastasis has been shown to result in decreased mortality.[1]

Limitations of this study include the small, non-probability sample, which precludes generalizability of the results beyond the sample of Idaho adults; however, the purpose of the study was to explore potential associations between consumers' perceptions of OC with other exams so a broader study could be designed for a larger population. The primarily white, English-speaking sample may have had different perceptions than more diverse or underserved populations. The volunteer nature of the sample and the higher level of education of respondents also potentially influences the findings of the study as participants may have been more interested, knowledgeable, or motivated than the general population. Age may also be a limitation, as 23% of respondents were under 40, the minimum age at which some screenings (with the exception of oral cancer screening) are recommended. An older population could influence the number of respondents with screening experiences. Nonetheless, the protocol, validated instrument, and the insights gained regarding consumer perceptions of OC screenings in comparison to other cancer screenings can be used to inform subsequent studies.

Telephone surveys are becoming less representative of the general population due to a decrease in landlines and increased use of cellular telephones as the primary method of telephone communication. An attempt to compensate for this decrease in landline use was to purchase a sample consisting of a fifty-fifty combination of landline and cellular telephone numbers originating from Idaho, which is representative of the estimated 56.1% of Idaho homes with only wireless telephone service as reported by the CDC.[33]

Recommendations for future studies include a larger randomized sample representing a more diverse population, and the addition of a qualitative aspect to investigate reasons for selecting various options or why they were associated. The telephone would be the best method for survey administration; however, focusing on qualitative exploration of the basis of participants' perceptions. Information regarding the timing of the most recent cancer screening(s) would also be beneficial.

Conclusion

This study of Idaho adults was conducted to compare perceptions of OC screenings to other cancer screenings using a self-designed interview-administered questionnaire. Results indicated the vast majority of participants perceived each of the cancer screenings as very helpful, and reported having no fears or concerns regarding screening. Lack of consumer awareness regarding differences between the selected cancer screenings was apparent based on perceptions of cost and time, the most commonly reported barriers identified for each of the screenings. This pilot study highlights the need to educate the public regarding the OC screening as it is embedded in the relatively inexpensive cost of the dental examination, takes minutes to perform, and is noninvasive and not painful. Future studies including a larger nonprobability sample representing a more diverse population are recommended to further explore the basis of participants' perceptions and identify ways to minimize barriers to cancer screening.

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RESEARCH

Effects of Instrument Handle Design on Dental Hygienists' Forearm Muscle Activity During Scaling

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Abstract

Purpose: The purpose of this study was to determine the effects of 4 different commercially available instrument handle designs (A. 16 grams and 12.7 mm diameter, B. 23 grams and 11.1 mm diameter, C. 21 grams and 7.9 mm diameter and D. 18 grams and 6.35 mm diameter) on the muscle activity of four forearm muscles during a simulated scaling experience.

Methods: A convenience sample of 27 (n=27) dental hygienists used a Columbia 13/14 curet with four different instrument handles to scale artificial calculus from typodont teeth. Each participant's muscle activity was measured using surface electromyography (sEMG).

Results: Similar muscle activity was generated when scaling with instruments at 16, 18, and 21 grams with varying diameter handles. Instrument B generated significantly more muscle activity when compared to each of the other instrument handle designs (p=0.001, p=0.002, p=0.039). The lower left quadrant displayed significantly less muscle activity during scaling than the upper and lower right quadrants (p=0.026, p=0.000), although no significant interaction effect was found with instruments within quadrants. Most participants (62.96%) preferred instrument A, which was rated more comfortable based on weight when compared to the other instruments tested.

Conclusions: Instrument handle design has an effect on forearm muscle activity when scaling in a simulated environment. The heaviest instrument with a relatively large diameter (B 11.1 mm and 23 g) generated significantly more overall mean muscle activity compared to the other three instruments. Similar amounts of muscle activity were produced by instruments weighing between 16 and 21 g. Participants' instrument preferences were more affected by handle diameter than weight. Results support the need for further research to determine the impact of these findings on muscle load related to risk of musculoskeletal disorders in a real-world setting.

Keywords: instrument design, musculoskeletal disorders, cumulative trauma disorders, ergonomics

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Introduction

The high prevalence rate of musculoskeletal disorders (MSDs) among dental professionals presents a significant occupational health hazard for oral care practitioners.[1,11] According to the Bureau of Labor and Statistics, 79% of dental hygienists are exposed to repetitive motion and 65% of dental hygienists report having carpal tunnel syndrome.[7, 12] Several studies concluded that dental hygienists are experiencing occupation risk factors that increase their tendency to have musculoskeletal disorders, especially carpal tunnel syndrome (CTS).[12-18] Lalumandier and McPhee also found that the number of years the dental hygienist had worked in clinical practice was the most influential risk factor for diagnosing CTS, especially among clinicians who scaled "heavy calculus patients" on a daily basis.[16]

Designing instruments to address the ergonomics of periodontal instrumentation and to decrease cumulative trauma disorders in dental hygienists is an ongoing area of research and development. Contemporary periodontal instrument handles vary in diameter, shape, weight and material in an attempt to address ergonomic concerns. However minimal quantitative data are available to support the use of one design over another. While changing the diameter of the instrument handle has been promoted as a way to reduce stress on the practitioner, minimal research has actually been conducted in this area. Dong et. al used surface electromyography (sEMG) to evaluate the effects of changing the weight and diameter of periodontal handles on muscle load and pinch force in simulated dental scaling. Results suggested significant differences in muscle load depending on the instrument handle design.[19,20] However, only

one tooth was scaled and subjects used investigator designed instruments, not instruments currently available to practitioners. Clearly more research is needed to quantitatively address the ergonomic benefits of periodontal instrument handle design on the practice of dental hygiene. The purpose of this study was to compare the effects of four commercially available periodontal instrument handle designs on arm muscle activity during a simulated periodontal scaling experience that included working on multiple teeth and in all four quadrants of the mouth.

Methods

A convenience sample of 27 (n=27) registered dental hygienists was used in this IRB approved study. The sample size of this study was based on previous studies that focused on sEMG measures of the upper limbs. Power statistics showed that a minimum of 24 subjects were needed to achieve a 95% confidence interval and a 90% power.[19, 21, 22]

Participants were recruited by advertisements on social media and given a $50.00 gift card incentive. Random assignment of participants to the various trials controlled for sequence effects, selection bias, investigator bias, and any unanticipated participant-relevant variable. Inclusion criteria included registered dental hygienists that were right-handed, had no previous musculoskeletal disorders, and no previous surgeries due to musculoskeletal disorders.

The study used a counterbalanced 4 x 4 factorial design with participants acting as their own controls. Dental chair-mounted typodonts equipped with an artificial face were used to simulate a client's oral cavity during scaling. Using a template, permanent first molars (#3, 14, 19, 30 typodont teeth) in each quadrant were coated with one cc of artificial calculus on the mesiobuccal surfaces. Four different typodonts were set up for each participant with a different instrument handle randomly assigned for use on each of the typodonts. Table I shows the ranking of instruments from heaviest to lightest and their associated diameters for ease of interpreting the results. Written informed consent was obtained for each participant and standardized instructions were given. New Columbia 13/14 curets with one of four different commercially available handles were used by participants to hand scale the mesiobuccal surface of the first molars in each quadrant of the mouth for up to one minute per tooth. One-minute rest periods occurred between the scaling of each tooth in the assigned typodont and between each instrument. The counterbalanced design of instrument assignment should have also eliminated any systematic error that fatigue might cause. Considering the pace at which dental hygienists normally practice, the rest period was considered to be generous.

Table I. Instrument Ranked by Weight, Heaviest to Lightest

	Weight	Diameter
Instrument B	23 g	11.1 mm (2nd largest)
Instrument C	21 g	7.9 mm (2nd smallest)
Instrument D	18 g	6.35 mm (smallest)
Instrument A	16 g	12.7 mm (largest)

Surface electromyography (sEMG) was used to measure muscle activity on four superficial muscles, *Flexor digitorum superficialis, Flexor pollicis longus, Extensor digitorum communis, Extensor carpi radialis brevis,* which give feedback independent of each other. Physical therapy consultants revealed that these four muscles were appropriate because they are responsible for gripping and manipulating manual instruments and sEMG muscle crosstalk susceptibility was minimal. Surface electromyographyis is a valid and reliable measure of real-time muscle activity and has been used in multiple studies evaluating musculoskeletal disorders.[23-26] For all four muscles, wireless bilateral surface EMG sensors (Delsys, Boston, MA) were attached to each subject to measure muscle activity during scaling and were placed by physical therapy examiners. All sEMG data were sampled at 1,000 Hz and synchronized using a 64-channel Delsys Trigno data collection system (Delsys, Boston, MA).

Data from the sEMG readings were collected during maximum voluntary isometric contraction (MVIC) for each of the muscles following standard manual muscle testing procedures. The MVIC values were considered 100% activity for that muscle. The EMG activity that was measured during the scaling processes was then expressed as a percentage of MVIC activity. This is a standard method that has been recently re-evaluated and found to be reliable for use with surface electrodes.[23-26] It also controlled for any baseline activity/noise; because this noise was present in both the MVIC readings and the scaling activity readings, it is thus cancelled out.[23-26]

Prior to the study, a pilot study was conducted to test and refine the research methods. Pilot data was collected using two participants to test the sEMG equipment and software. At the conclusion of the study, participants completed an end user survey rating each instrument. Participants rated each instrument on a 5-point Likert scale, with 1 being not comfortable and 5 being very comfortable, in regards to weight and diameter. Additionally, participants were asked to choose which instrument they preferred the most and the least.

Statistical Anaysis

EMG measures were analyzed using a two-way repeated measures multivariate analysis of variance (RMANOVA) with 4 different instruments and 4 different quadrants. If the results were significant, a Sidak post

Table II. Group Mean and Standard Errors for 10th, 50th, and 90th Percentile Levels of Activity for the *Flexor Digitorum Superficialis, Flexor Pollicis Longus, Extensor Digitorum Communis* and *Extensor Carpi Radialis Brevis* Muscles During Scaling With Four Different Instrument Handles

	10th Percentile				50th Percentile				90th Percentile			
	Inst-A	Inst-B	Inst-C	Inst-D	Inst-A	Inst-B	Inst-C	Inst-D	Inst-A	Inst-B	Inst-C	Inst-D
Flexor digitorum superficialis	11.4 ±1.9	10.6 ±1.9	11.1 ±1.9	10.8 ±1.9	19.3 ±3.4	18.9 ±3.4	18.6 ±3.4	18.3 ±3.4	29.7 ±5.2	30.2 ±5.2	28.7 ±5.2	28.6 ±5.2
Flexor pollicis longus	6.7 ±0.6	7.0 ±0.6	6.7 ±0.6	6.7 ±0.6	12.0 ±1.4	13.0 ±1.4	12.3 ±1.4	12.5 ±1.4	21.4 ±3.0	24.6 ±3.0	22.6 ±3.0	23.5 ±3.0
Extensor digitorum communis	22.8 ±3.5	24.6 ±3.5	22.7 ±3.5	23.4 ±3.5	34.6 ±5.5	37.5 ±5.5	34.3 ±5.5	35.5 ±5.5	51.2 ±8.5	56.7 ±8.5	50.7 ±8.5	53.5 ±8.5
Extensor carpi radialis brevis	17.2 ±2.0	18.0 ±2.0	17.1 ±2.0	17.0 ±2.0	29.0 ±3.2	30.8 ±3.2	29.0 ±3.2	29.0 ±3.2	47.3 ±5.0	51.2 ±5.0	47.8 ±5.0	48.4 ±5.0

hoc test was used to evaluate one instrument handle in comparison to another instrument handle or one quadrant to another. A Friedman test was employed to analyze qualitative scaled survey responses. If the results were significant, a Wilcoxon signed rank test with Bonferroni correction was used to evaluate one instrument handle compared to another ($p<0.0083$). Statistical analysis for the EMG measures and qualitative survey responses were performed using SPSS 19 software and the significance level was set to $p<0.05$.

Results

Twenty-seven registered dental hygienists (26 females and 1 male) participated in this study. Thirteen participants (48%) were between ages 20 and 29, 10 (37%) were between ages 30 and 39, 2 (7.5%) were between ages 40 and 49, and 2 (7.5%) were 50 or older. Among the 27 participants, 15 (55.5%) had 1-5 years of clinical hygiene practice, 6 (22%) had 6-10 years of clinical hygiene practice, 4 (15%) had 11-15 years of clinical hygiene practice, and 2 (7.5%) had 21 or more years of clinical hygiene practice.

The impact of instrument handle design on sEMG measures at three intervals: 10th percentile, 50th percentile and 90th percentile are shown in Table II. The 10th percentile is the static muscle load recorded during EMG recording, the 50th percentile is the median muscle load and the 90th percentile is the peak muscle load. A two-way RMANOVA revealed significant interaction effects at the 50th and 90th percentiles for instrument handles and muscle activity ($F=6.243$, $df=3$, $p=0.000$); therefore, the null hypothesis was rejected. Data analysis revealed no significant effects for instrument and muscles at the 10th percentile. Pairwise comparisons with Sidak post hoc test revealed Instrument B generated significantly more muscle activity when compared to instruments A and C ($p=0.016$) ($p=0.041$) at the 50th percentile affecting the *flexor pollicis longus* and *extensor digitorum communis*, respectively. Similarly, at the 90th percentile Instrument B generated significantly more muscle activity when evaluating the *flexor pollicis longus* ($p=0.008$) when paired with instrument A and the *extensor digitorum longus* ($p=0.039$, $p=0.016$) when paired with instruments A and C.

Combined muscle activity mean scores and standard deviations were determined for each instrument handle design (Table III, Figure 1). Two-way RMANOVA revealed statistically significant differences ($F=6.243$, $df=3$, $p=0.000$). Pairwise comparisons revealed only the heaviest instrument (B) generated significantly greater muscle load when compared to all other instruments (A; $p=0.001$, C; $p=0.002$, D; $p=0.039$). Results indicate no statistically significant differences in overall muscle activity when comparing instruments weighing 16 g, 18 g and 21 g. Significant differences in overall muscle activity were not generated until the instrument weighed 23 g.

In addition to comparing sEMG among handle types, overall mean scores for muscle activity were calculated for each of the four quadrants of the mouth: upper right (UR-1), upper left (UL-2), lower left (LL-3) and lower right (LR-4) (Table IV, Figure 2). The highest mean was found when participants were scaling the lower right quadrant ($x=28.7$) and the lowest mean was produced in the lower left quadrant ($x=26.2$). When comparing overall muscle activity for each quadrant, two-way RMANOVA results revealed statistically significant differences ($F=6.802$, $df=3$, $p=0.000$) in muscle activity

Table III. Descriptive Statistics of the Combined Muscle Activity for Each Instrument*

Instrument	Number of observed trials	Number of observations used	Mean Muscle Activity	Standard Deviation	Minimum	Maximum
A, 12.7 mm 16 g	108	100	27.5	13.3	10.86	86.19
B, 11.1 mm 23 g	108	106	28.7	15.5	11.7	94.7
C, 7.9 mm 21 g	108	107	26.9	12.7	11.59	72.8
D, 6.35 mm 18 g	108	108	27.4	14.3	11.7	85.6

*Some observed trials were not used due to the files being corrupted.

Figure 1. Overall Mean Muscle Activity (Means and Standard Deviation Error Bars) of the Four Instrument Handles

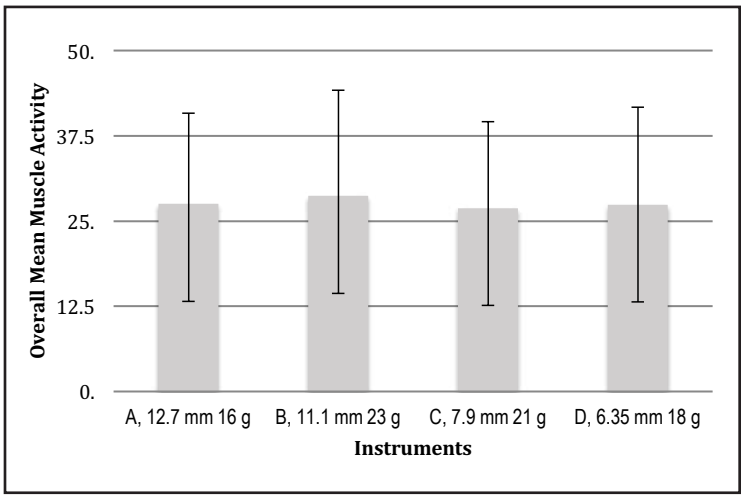
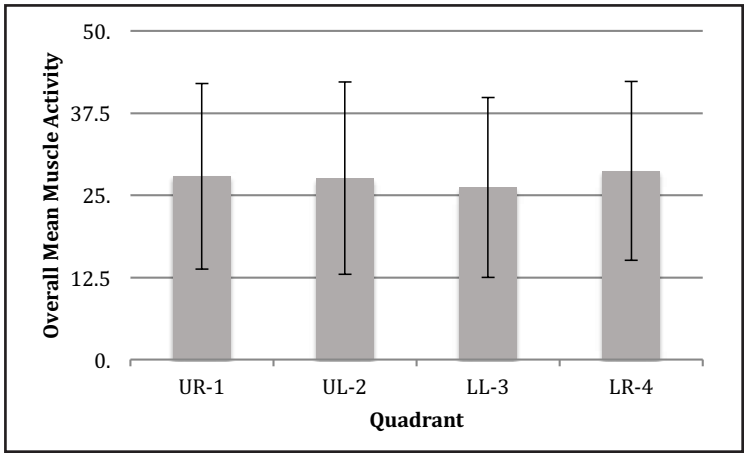


Figure 2. Overall Mean Muscle Activity (Means and Standard Deviation Error Bars) of the Four Quadrants Scaled



generated. Data from pairwise comparisons using Sidak post hoc tests revealed that when scaling, regardless of the instrument used, the lower left quadrant generated significantly less muscle activity when compared to both right quadrants (UR-1 p=0.026, LR-4 p=0.000). However, there was no significant interaction of instrument and quadrant on average muscle activity (F (1,9) = 0.49, p=0.881).

Subjective evaluations of the comfort of the various handle designs were collected to determine if muscle load generated was correlated with participants' preferences. Results reveal 62.96% of participants (n=17) preferred the instrument with the largest diameter and lightest weight: instrument A. Approximately one fourth of the participants (25.9%, n=7) preferred the heaviest instrument with second largest diameter: instrument B (Figure 3). When participants were asked which of the four instruments they liked the least, 77.78% (n=21) of respondents chose the smallest diameter instrument (D).

Figure 3. Results From Which of the Four Instruments Do You Like Best?*

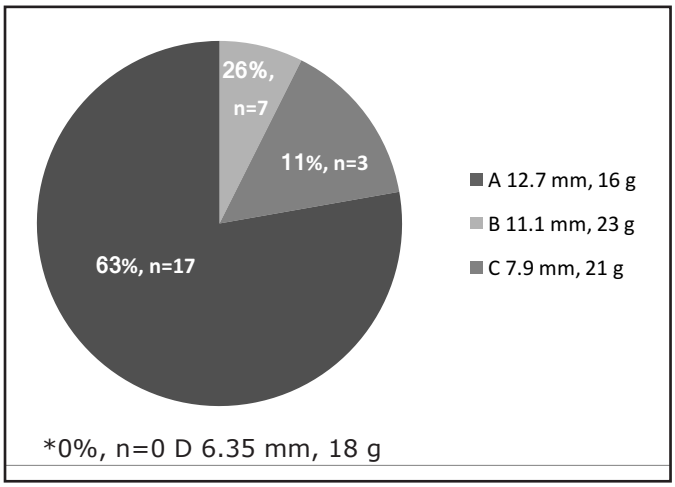


Table IV. Descriptive Statistics of the Combined Muscle Activity for Each Quadrant*

Quadrant	Number of observed trials	Number of observations used	Mean Muscle Activity	Standard Deviation	Minimum	Maximum
UR-1	108	106	27.9	14.1	12.6	86.2
UL-2	108	106	27.6	14.6	10.86	94.72
LL-3	108	104	26.2	13.7	11.59	84.3
LR-4	108	105	28.7	13.6	12.6	77.0

*Some observed trials were not used due to the files being corrupted.

A Friedman test was used to determine significant differences related to participants' perceptions of the four instrument handles in relation to the weight and diameter. The test revealed statistically significant differences between instruments in participants' opinion of diameter ($x^2(3)=50.584$, p=0.000) (Figure 4) and weight ($x^2(3)=24.650$, p=0.000) (Figure 5). The pairwise comparisons with a Wilcoxon signed rank test determined that instrument A was rated significantly more favorably when compared to the other three instruments in the category of weight (B z=2.643, p=0.008; C z=3.708, p=0.000; D z=3.819, p=0.000). Instrument B was rated more positive based on comfort related to weight when compared to instrument D (z=2.840, p=0.005). Wilcoxon signed rank tests also revealed that instruments A, B and C were rated more comfortable in diameter than instrument D (A z=4.398, p=0.000; B z=4.023, p=0.000; C z=3.333, p=0.001). Additionally, participants rated instruments A and B more favorably for diameter than instrument C (A z=3.974, p=0.000; B z=3.521, p=0.000).

Discussion

Cumulative trauma disorders continue to be negative stressors affecting dental hygienists working in the clinical environment. Quantifying muscle workload during scaling through sEMG studies may assist dental hygienists in practicing more ergonomically and decreasing risk of musculoskeletal disorders. The present study compared the effects of four commercially available periodontal instrument handle designs on forearm muscle load during a simulated periodontal scaling experience.

Results demonstrate that instrument handle designs had a significant effect on forearm muscle activity when performing periodontal scaling. The heaviest instrument with a relatively large diameter (B 11.1 mm and 23 g) generated significantly more overall mean muscle activity compared to the other three instruments. This finding was also supported when evaluating individual muscles as instrument B resulted in significantly more muscle load at the median and peak percentiles for both the *extensor digitorum longus* and the *flexor pollicis longus* muscles when compared to the other instruments. The most likely explanation for these findings is the higher weight of instrument B when compared to the other instruments.

Results suggest that instruments weighing less than 23 g did not significantly vary in the amount of muscle activity produce because similar muscle

Figure 4. Results From Participants' Opinions of Diameter

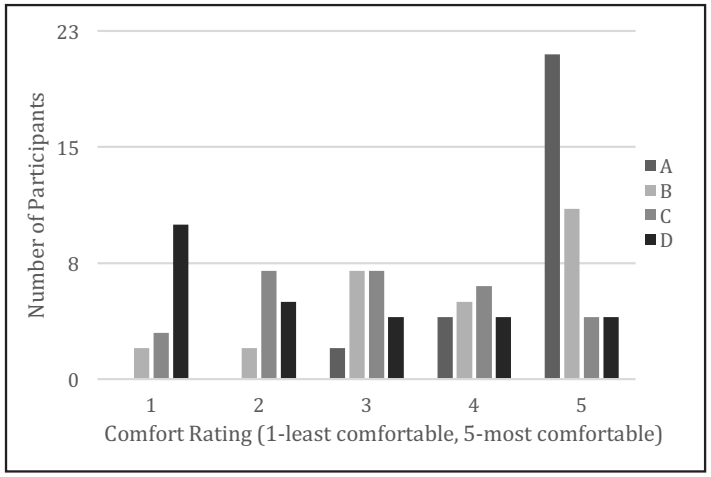
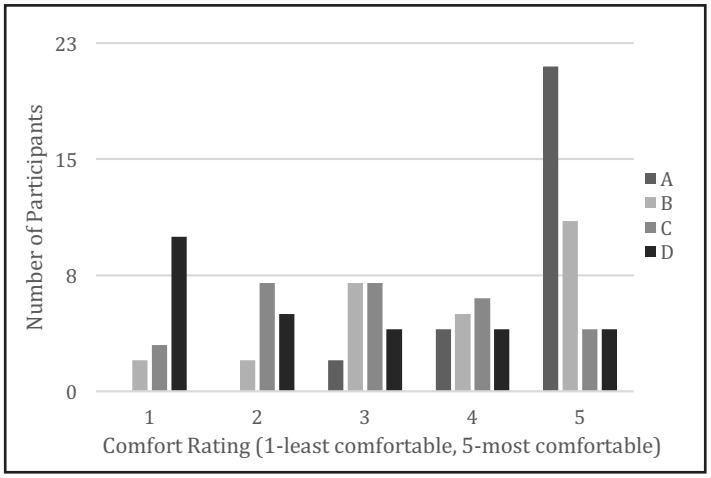


Figure 5. Results From Participants' Opinions of Weight



activity was produced for instruments weighing 16 g, 18 g and 21 g. These findings may indicate there is minimal ergonomic benefit when changing the weight of an instrument in these ranges. Muscle load during scaling only increased significantly when the instrument weighed 23 g. Other studies revealed the lighter the weight and larger the diameter of an instrument, the less muscle activity generated and this was partially supported by this study.[7, 20-22] Results from this study suggest muscle load was more affected by weight than instrument diameter. For example, while instrument A had the largest diameter (12.7 mm) and lightest weight (16 g), mean scores were almost the same for instrument A (x=27.5) when compared to instrument D with the smallest diameter (6.35 mm) and a relatively low weight (18 g)(x=27.4) as demonstrated in Table III.

Dong et al. studied self-made instruments weighing 15 to 24 grams and found that instruments with the lightest weights (15 g) demonstrated the lowest muscle load.[19, 20] However, results from this study did not find that the lowest weight instrument produced significantly less muscle activity. Differences between the two studies might be attributed to only one tooth (number 29) being scaled in the Dong study compared to four first molar teeth being scaled in each quadrant of the mouth in this study. Differences might also be due to differences in diameter sizes of the instrument handles in the two studies. Dong et al. also found a significant increase in muscle activity generated and pinch force with heavier instruments.[19, 20] This study did not evaluate pinch force, but found no significant increase in muscle activity among the test instruments until the instrument weighed 23 g.

This study used commercially available instruments so the findings on muscle load could apply to instruments currently used by practicing dental hygienists in real world practice. Results suggest clinicians might consider using instruments weighing less than 23 grams for ergonomic benefits, but they may not experience additional ergonomic benefits when using instruments in the 16-21 gram range. While this research supports that lighter weight instruments produce less muscle load, results suggest clinicians electing to scale with an instrument weighing 16 grams would likely experience the same benefits in terms of reduced muscle load as an instrument weighing 21 grams. However, diameter of the handle may also affect workload due to pinch force, but this variable was not evaluated in the present study. Further research may be indicated to examine the effects of pinch force generated during scaling using commercially available instruments.

The present study also measured overall mean muscle activity produced for each quadrant of the mouth while scaling: upper right (UR-1), upper left (UL-2), lower left (LL-3) and lower right (LR-4). Regardless of which instrument was used, the lower left quadrant had significantly less overall muscle activity than both quadrants on the right side. These results might be explained by the position of the fingers, wrists and forearm when scaling the right side of the mouth. The position for the scaling the right quadrants of the mouth may require more movement and positions that deviate from an ergonomic neutral wrist and forearm positions. Dental hygienists may be able to modify their work pattern by first scaling on the right side of the mouth since more muscle activity was generated when scaling these areas regardless of which instrument was used. This might minimize the probability of muscle fatigue that could lead to poor scaling outcomes. Because the lower left quadrant produced the least amount of muscle activity, a practical ergonomic suggestion may be to scale this area last or when the hygienist is feeling fatigued.

Results from the end user survey indicate the majority of participants preferred the instrument with the largest diameter and lightest weight (A 12.7 mm, 16 g) reinforcing ergonomic suggestions for ideal instrument handle size. Interestingly, results found that one fourth of the participants still preferred the heaviest instrument (B 11.1 mm, 23 g) despite an increase in muscle load, suggesting that diameter has more effect on preference than weight. The diameter size of the instrument could have provided a more comfortable grip for participants when scaling, therefore making diameter more influential than weight. The instrument handle that had the smallest diameter and was the second lightest instrument (D 6.35 mm, 18 g) was least preferred by the participants; this also supported diameter was more of a preference indicator than weight. The smallest diameter instrument might have been more difficult to comfortably grasp, even though it only weighed 18 g.

When asked to rate instruments on weight and diameter alone, the majority of participants found the largest diameter and lightest weight instrument (A) was more comfortable and did not prefer either of the smaller diameter instruments (C and D). Again, this can most likely be attributed to the larger diameter and lighter weight being easier to grasp and producing less muscle activity when scaling.

These results reinforce that dental hygienists might improve ergonomics of instrumentation by using lightweight instruments with larger diameter handles. According to the current study, clinicians preferred instruments with larger diameters and relatively lighter weight handles when scaling. Additionally, instruments weighing less than 23 g may be utilized to decrease forearm muscle activity while scaling, therefore possibly reducing the clinician's risk for MSDs.

While dental hygienists use a variety of instruments to provide therapy, there has been limited research on sound ergonomic theory to support

use of specific instrument handle designs. This research expands evidenced-based knowledge concerning which commercially available instrument handles may be least traumatic to the hand, wrist and forearm muscles during scaling all quadrants of the mouth. While powered instruments have been recommended to reduce cumulative trauma disorders, there are many instances where dental hygienists must use hand instruments for optimal client care and calculus removal. Results from this study may benefit dental hygiene educators, future clinicians and current practitioners since it provides quantitative information revealing the comparative effects of commercially available hand instruments of different weights and diameters. Results may also assist practitioners and educators in making more educated decisions regarding selection of scaling instruments for ergonomic benefit.

Several limitations may have influenced findings of this research. The minimal time participants used each instrument might not have been long enough to reflect their true preferences. The instrument handles had various textures, which could influence grasp and possible muscle workload. The study used a simulated periodontal scaling experience of a shorter duration than a dental hygienist scales in a typical day; muscle activity could vary over a longer workday. Therefore, future studies in a real world setting on instrument handle designs of similar textures are suggested. Safe muscle workload levels are undetermined and need to be investigated. Future studies are also needed to determine whether the reductions in muscle activity found in this study are enough to make a clinical difference. Finally, future research may also want to evaluate pinch force generated by various commercially available instrument handles in order to determine its impact on ergonomic practices.

Conclusions

Results from this study suggest a similar amount of muscle activity was generated during scaling with instrument handles at 16 g and 12.7 mm diameter, 18 g and 6.35 mm diameter or 21 g and 7.9 mm diameter. Once the handle weight increased to 23 grams with a diameter of 11.1 mm, a significant increase in muscle activity occurred. Therefore, using instruments weighing less than 23 grams may reduce the muscle activity required for periodontal scaling with manual instruments. Regardless of which instrument was used less muscle activity was required to remove artificial calculus in the lower left quadrant. Subjective analysis indicated participants' instrument preferences were more affected by diameter than weight. The findings in this study emphasize the need for further research to more fully conceptualize the impact of instrument design on forearm muscle activity related to risk of cumulative trauma disorders.

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Child Care Providers' Knowledge About Dental Injury First Aid in Preschool-age Children

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Abstract

Purpose: The aim of this study was to assess child care providers' level of knowledge of first aid management and attitudes towards dental injuries among preschool-age children within Fairfield County, Connecticut and Boston, Massachusetts.

Methods: This descriptive cross-sectional study used a web-based, validated questionnaire adapted from several studies with permission from authors. A panel of 5 dental experts determined the relevance of the questions and overall content (I-CVI range 0.8-1; S-CVI = 0.95). The 28 question survey included demographics, level of knowledge, attitudes about traumatic dental injuries, emergency management, and 2 case study questions on management of luxation and tooth fracture. Survey data was coded and analyzed for associations and trends using STATA® statistics/data analysis software v. 11.2.

Results: A total of 100 child care providers completed the online questionnaire. Eighty-four percent self-reported little to no knowledge about dental injury management. Sixty percent of child care providers agreed that they are responsible for managing dental injuries. Approximately two-thirds of child care providers reported not feeling adequately informed about dental injuries, with 77% expressing interest in receiving more information.

Conclusions: The majority of child care providers' do not have the knowledge to perform adequate first aid following a dental injury. Professional development on first aid for dental injuries is recommended among this workforce population.

Keywords: child care providers, dental trauma, pre-school children, first aid

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Introduction

In 2011, the United States Census Bureau on Child Care Arrangements reported that 12.5 million (61%), of the 20.4 million US children under age 5, were in some type of regular child care arrangement over the course of a typical week.[1] Findings also indicate that this age group spent most of their time with a child care provider when not with their parents.[1,2] Dental injuries among preschool-age children has been reported with a prevalence as high as 30%; generally occurring as a result of falls.[3] Eighty percent of these injuries occur in the home and are particularly due to poor muscle coordination between the ages of 12 to 24 months.[3,4-12] Risk of dental trauma peaks at age four due to increased physical activity, with twice the average incidence within this age group as compared to all other age groups.[3,5,10] In the instance of dental injury, first aid measures include: compressing the injured area with cotton or gauze for five minutes to stop bleeding, use of a cold cloth or ice pack to reduce swelling and seeking emergency treatment from a pediatric dentist.[13,14]

Existing research shows first aid provided by parents and teachers following dental injury is inadequate.[15-17] Previous studies investigating parent/teacher knowledge, attitudes, and management regarding dental injuries have had a number of limitations including underpowered sample sizes comprised of convenience samples, low response rates, and selection bias. There is currently little information in the literature regarding child care provider knowledge, attitudes, and management of dental injuries in preschool-age children. Given the high likelihood of being the first responders to preschool-age dental injuries, it is important that child care providers understand the significance of prompt first aid measures.

The purpose of this study was to assess child care providers' level of knowledge, attitudes, and first aid management of dental injury among preschool-age children.

Materials and Methods

This descriptive, cross-sectional study design used a non-probability, convenience sample of twenty child care centers in Fairfield County, Connecticut and in Boston, Massachusetts. The questionnaire was developed by modifying previous research survey instruments.[16-19] The questionnaire was composed of 4 sections; Section I: demographics including gender, age, race, employment status, years of experience as a child care provider, level of education, and number of children for the respondent; Section II: multiple choice questions on level of dental injury knowledge, experiences with dental injuries, and first aid training; Section III: five-point Likert response questions scaled from "strongly agree" to "strongly disagree" on attitudes towards dental injuries; Section IV: multiple-choice questions regarding dental injury first aid and 2 case study questions with images (See Table I). Case studies were developed based on American Academy of Pediatric Dentistry Dental Trauma Guidelines.[20]

Table I. Case Study Questions

Case Study Question #1	Case Study Question #2
A 14-month old falls from her high chair causing her front tooth to dislocate and appear pushed back towards the palate. What should you do next?	**One of your five year old children is playing outside and knocks his tooth on the slide. You see the tooth is fractured and a piece is missing. What should you do next?**
a. Place a cold, damp cloth to the injury site and inform the child's parents/ caregivers	a. Find the piece, call the child's parents/caregivers and place a cold, damp cloth to the injury site
b. Place a cold, damp cloth to the injury site, inform the child's parents/ caregivers and take the child to the hospital immediately	b. Find the piece, call the child's parents/caregivers, place a cold, damp cloth to the injury site and take the child to the hospital immediately
c. Place a cold, damp cloth to the injury site, inform the child's parents/ caregivers and take the child to the pediatrician immediately	c. Find the piece, call the child's parents/caregivers, place a cold, damp cloth to the injury site and take the child to the pediatrician immediately
Correct Response: d. Place a cold, damp cloth to the injury site, inform the child's parents/caregivers and take the child to the pediatric dentist immediately	*Correct Response: d. Find the piece, call the child's parents/caregivers, place a cold, damp cloth to the injury site and take the child to the pediatric dentist immediately*

During the development of the survey questionnaire, content validity index (CVI) was assessed by a panel of 5 dental experts.[21] Three of the dental experts were authors of related research and were initially contacted in the development phase of the questionnaire.[16-18] The two other dental experts were specialists in pediatrics. Individual question relevance (I-CVI) as well as the overall content of the questionnaire (S-CVI) were quantitatively assessed by the expert panel. Items with an I-CVI of 0.78 or higher for 3 or more experts are considered evidence of good content validity; S-CVI of 0.90 or higher is considered acceptable.[21] For the present study I-CVI question scores ranged from 0.8-1. The S-CVI for the survey was 0.95. The questionnaire was then pilot tested with a group of 6 child care providers at a child care center that met inclusion criteria, for comprehension and feedback only. The Massachusetts College of Pharmacy and Health Sciences (MCPHS) University Institutional Review Board oversaw the protection of all human subjects in this research study.

Forty child care centers in Connecticut and Massachusetts were solicited for study participation with 20 centers agreeing to participate. Directors of the centers were contacted and given a flyer providing information about the study including an electronic link to the survey instrument via Survey Monkey®. Directors were asked to disseminate the survey link to the child care providers in the facility. The principal investigator was blinded to the number of child care providers within the centers solicited for study participation by the center directors. Therefore, a response rate could not be accurately enumerated.

The statistical analysis included descriptive statistics using frequency percentiles. Non-parametric Spearman Rank Correlation tests were performed to test for statistical associations between independent and dependent variables.[22] Independent variables were age, years of experience as a child care provider, if the child care provider had children of their own, prior experience with dental injuries and history of first aid training with or without dental injury first aid. Dependent variables were level of knowledge regarding dental injury, attitudes regarding dental injury, and first aid management knowledge following dental injury. An alpha threshold of 0.05 was set for all statistical testing. All statistical analyses were performed in STATA® statistics/ data analysis software, version 11.2.

Figure 1: Self-Reported Assessment of knowledge level of traumatic dental injuries in preschool-age children (n=100)

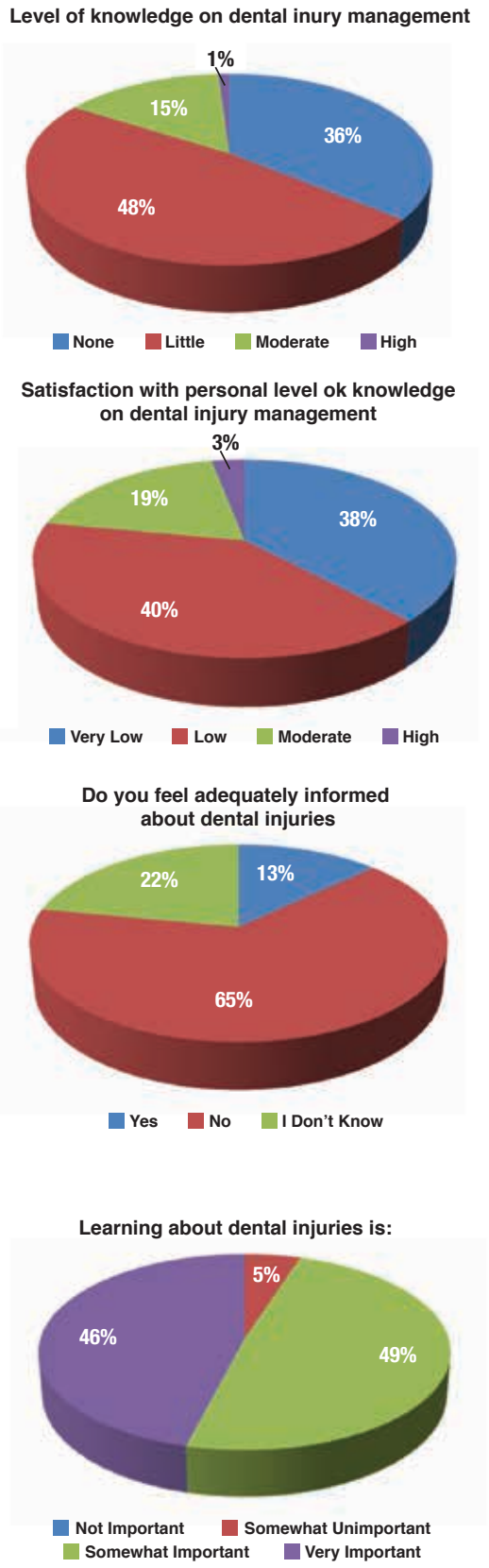
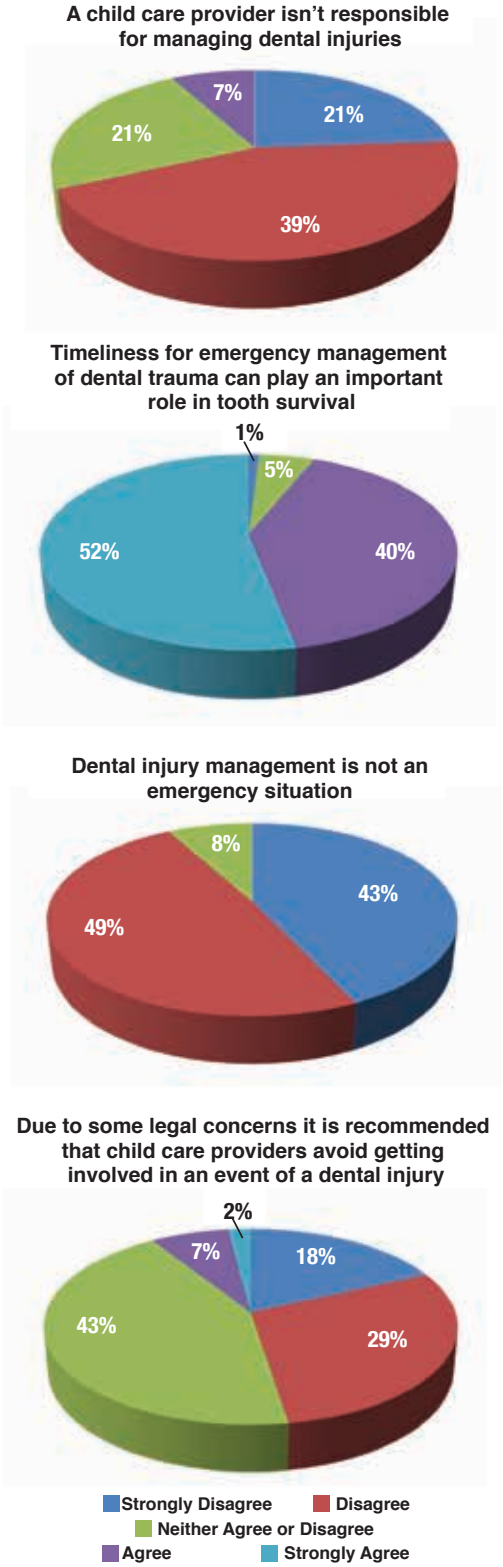


Figure 2: Self-Reported Assessment of knowledge level of management of traumatic dental injuries in preschool-age children (n=100)



Results

A total of 100 child care providers completed the web-based questionnaire. Age categories of study respondents were as follows: 19-29, 30-39, 40-49, 50-59 and ≥60 years old. Figures 1 and 2 show descriptive statistics of participant knowledge and attitudes about dental injury, respectively. Of the respondents, 84% self-reported little to no knowledge about dental injury management, suggesting lack of education and training on the subject. Similarly, 78% of child care providers reported very low to low satisfaction with their personal level of knowledge about dental injury management. Nearly two-thirds of child care providers reported not feeling adequately informed about dental injuries, with 77% expressing interest in receiving more information. Of the respondents, 60% agreed that child care providers are responsible for managing dental injuries. However, when asked to respond to the question, "Due to some legal concerns, it is recommended that child care providers avoid getting involved in the event of a dental injury," 43% of respondents were undecided whether they agreed or disagreed.

Table I shows the two case study questions asked of the participants. In case I, a 14-month-old girl falls from her high chair causing her front tooth to dislocate and appear pushed back towards the palate, 61% of child care providers chose the appropriate action which included bringing the child to the dentist immediately. When asked about their advice upon the arrival of the child's

Table II b: Selected correlation trend tests between management of traumatic dental injuries and demographics

	Spearmen's Rank Correlation Coeffecient (ρ)				
	Age	**Child care provider experience**	**Have children (0:no, 1:yes)**	**Personally witnessed a dental injury (0:no, 1:yes)**	**Had any training on dental injury management (0:no, 1:yes)**
"A child care provider isn't responsible for managing dental injuries" (strongly disagree, disagree, neither agree or disagree, agree, strongly agree)	-0.18	-0.16	-0.03	-0.22*	-0.26*
"Timeliness for emergency management of dental trauma can play an important role in tooth survival" (strongly disagree, disagree, neither agree or disagree, agree, strongly agree)	0.19	0.23*	0.21*	0.16	0.15
"Dental injury management is not an emergency situation" (strongly disagree, disagree, neither agree or disagree, agree, strongly agree)	-0.31**	-0.29**	-0.16	-0.04	-0.10
"Due to some legal concerns it is recommended that child care providers avoid getting involved in an event of a dental injury" (strongly disagree, disagree, neither agree or disagree, agree, strongly agree)	0.32**	-0.30**	-0.14	0.01	-0.10

* $p < 0.05$ for trend ** $p < 0.01$ for trend

parents following the event of a traumatic dental injury, 87% recommended referring the parents and child to their dentist. In case II, regarding the 5-year-old boy knocking his front tooth and fracturing it on the slide, 57% gave the correct response on how to manage the injury. When asked about replanting a primary tooth, 76% chose the correct response not to replant. Two-thirds of the child care providers were aware that immediate emergency action was needed for the treatment of traumatic dental injuries.

Table II (a and b) show the results of Spearman Rank Correlation Tests between select demographic variables and dental injury knowledge and management questions respectively. Self-reported level of knowledge on dental injury management was found to have a statistically significant direct correlation with increasing age ($p<0.05$), increasing child care provider experience ($p<0.01$), having children of their own ($p<0.05$), witnessing a dental injury ($p<0.05$), and having training on dental injury management ($p<0.01$). These predictors suggest age, training and personal experiences with dental injuries prepare child care providers for dealing with dental injury events.

Level of satisfaction with knowledge on dental injury management was found to have a statistically significant direct correlation with witnessing a dental injury ($p<0.05$), and training on dental injury management ($p<0.01$), further suggesting confidence in knowledge with increased exposure to dental injury management. Results indicated that providers who had previously witnessed a dental injury or had training in dental injury management were more likely to recognize child care providers are responsible for managing dental injuries. Experienced providers with children of their own were more likely to agree timeliness plays an important role in tooth survival.

Table II a: Selected correlation trend tests between knowledge level of traumatic dental injuries and demographics

	Spearmen's Rank Correlation Coeffecient (ρ)				
	Age	**Child care provider experience**	**Have children (0:no, 1:yes)**	**Personally witnessed a dental injury (0:no, 1:yes)**	**Had any training on dental injury management (0:no, 1:yes)**
Level of knowledge on dental injury management (none, little, moderate, high)	0.21*	0.26**	0.23*	0.21*	0.48**
Satisfaction with personal level of knowledge on dental injury management (very low, low, moderate, high)	0.01	0.10	0.08	0.22*	0.46**
"Learning about dental injuries is" (not important, somewhat unimportant, somewhat important, very important)	0.16	0.09	0.07	0.12	0.17

* $p < 0.05$ for trend ** $p < 0.01$ for trend

Regarding legal concerns, older providers were more likely to agree that legal concerns prevented them from getting involved in the event of a dental injury, while more experienced providers were likely to disagree. However, additional analyses showed no significant associations between age and legal concern response. Lastly, the 43% of "undecided" responses to the question surrounding legal concerns suggests child care providers' lack an understanding about their legal role in such an event.

Discussion

Past research regarding knowledge and management of dental injury has been conducted among teachers and caretakers, primarily concerning injury to the permanent dentition.[15-19,23-35] However, regarding the primary dentition, there is a lack of research regarding knowledge and first aid management of child dental injury among child care providers.[1,2,5,10,36] This study provided insight on child care providers' knowledge regarding dental injury, and first aid management concerning the primary dentition. Permanent dentition is seen as more urgent since parents' do not understand the importance of primary teeth. However, primary dentition help permanent teeth to grow in the proper position and if injured, underlying damage may occur to the permanent teeth leaving significant risk of infection, decay, long lasting aesthetic affects or even tooth loss.[19,20,26] As with most dental diseases, prevention is key. There is a general lack of information about this subject.

Similar to this study, Fux-Noy et al. found elementary school teachers had limited knowledge about emergency care of dental injuries, and revealed comparable predictors of greater knowledge about dental injuries to the current study: being parents to children, previous experience with dental injuries, and increased age.[17] Likewise, Fux-Noy et al. reported 81% of elementary school teacher respondents were aware that replantation of primary dentition is not recommended[17], corresponding to the 76% found in this study.[17] However, Fux-Noy et al. reported that participants demonstrated less interest (42%) in receiving more information on the subject, compared to the 78% within this study, suggesting a lack of awareness on the importance of dental injury first aid among the elementary school teachers in Tel-Aviv, Israel.[17] Fux-Noy et al. also allowed participants to withdraw from the survey if respondents had a lack of knowledge on the subject, resulting in possible outcome bias.[17]

Level of satisfaction with knowledge on dental injury management was found to have a statistically significant direct correlation with witnessing a dental injury and training on dental injury management. These same predictors of knowledge on the management of dental injuries were found within previous studies.[16,17,23,24]

As per the results of the Spearman Rank Correlation analysis, there are some key findings from this study that could help inform future education in dental injury management. The finding that providers with less experience and no children were less likely to realize timeliness plays an important role in tooth survival suggests early education and training is essential. Additionally, this study's findings indicated that older providers were more likely to allow legal

concerns to prevent them from involvement in dental injury management, suggesting targeted education to older providers on the legalities of emergency dental intervention may be useful. Staff education and training on dental injury management should also aim to include a risk management component since participants' indicated uncertainty regarding their specific role of responsibility in such an event.

This study had several limitations. The effective sample size of the study (100 respondents) may lack sufficient statistical power to detect important associations. In addition, survey participants were drawn from a convenience sample which may affect generalizability of the results to a broader population of child care providers. Furthermore, study findings may have been skewed due to the large percentage of white/Caucasian respondents and participants within the 19-29 year old age group. Lastly, due to the logistics used to solicit participants, the total number of potential respondents asked to partake in the study could not be enumerated, leaving the study response rate unknown.

Regarding generalizability of results, it is important to note that Connecticut and Massachusetts require a health or dental consultant be available regarding health and dental advice, to make quarterly visits (CT), as well as to review safety measures at child care centers.[37,38] *The 50 State Child Care Licensing Study of 2011-2013* reported that only 19 states within the US require health consultants (including dental consultants) be available to staff at child care centers.[39] These states are Colorado, Connecticut, Delaware, Hawaii, Indiana, Maryland, Maine, Massachusetts, Minnesota, North Carolina, North Dakota, New Jersey, Nevada, New York, Oklahoma, Rhode Island, Washington, Wisconsin and West Virginia.[39] The availability of a dental consultant could enhance health promotion education to child care providers and parents alike. A dental consultant could proactively address children's oral health needs in a timely manner, and assist families with establishing a dental home.[40]

Conclusion

The findings from this study suggest a need for additional education on dental injury first aid for daycare providers. A dental injury management module could be included in conjunction with the required annual first-aid training for the day care center directors and staff, to promote professional development and oral health awareness. Further investigation on successful outcomes of these types of oral health interventions could be beneficial.

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