American Dental Hygienists' Association

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- Measuring Oral Health Literacy of Refugees: Associations with Dental Care Utilization and Oral Health Self-Efficacy
- Oral Health-Related Quality of Life of Children: An Assessment of the Relationship between Child and Caregiver Reporting
- Evaluation of an Automated Digital Scoring System of Dental Plaque
- Knowledge, Attitudes and Practices of Dental Hygienists Regarding Diabetes Risk Assessments and Screenings
- The Additive Effects of Cell Phone Use and Dental Hygiene Practice on Finger Muscle Strength: A Pilot Study
- State Licensing Board Requirements for Entry into the Dental Hygiene Profession

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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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A message from the Editor

As part of our editorial theme for 2020, "Critical Issues Facing the Profession," we asked Dr. Ann Eshenaur Spolarich, to comment on the challenges we face in applying evidence-based research to clinical practice. Professor Spolarich is the Director of Research, Arizona School of Dentistry and Oral Health, A.T. Still University. While the examples used in the editorial were not drawn from our current pandemic, the application of current research findings to patient care has become even more significant as we navigate the challenges that lie ahead. It is vital that all oral healthcare professionals learn and utilize evidence-based decision making throughout their professional careers.

I wish you all safety and good health always…but especially during this challenging time!

Rebecca S. Wilder, RDH, MS
Editor-in-Chief, Journal of Dental Hygiene

Guest Editorial

Challenges with Adherence to Clinical Practice Guidelines: Lessons for Implementation Science

Ann Eshenaur Spolarich, RDH, PhD, FSCDH

In 1997, the American Dental Hygienists' Association (ADHA) House of Delegates approved a policy supporting that dental hygienists should adopt an evidence-based philosophy of practice.[1] Inherent in this philosophy is the emphasis placed on patient-centered care which requires practitioners to use and apply current research findings in clinical decision-making and for the planning and delivery of care. Since its inception, the model of evidence-based practice (EBP) has evolved tremendously, bringing together the clinical setting with patient preferences, healthcare resources, and the best available research evidence to reach a final course of action informed by clinical expertise.[2] The manner in which clinicians obtain current best evidence has also evolved, as depicted by the updated evidence pyramid known as the 6S pyramid.[3] (Figure 1) The hierarchy depicted in the 6S pyramid implies increased validity and applicability with synopses and summaries of pre-appraised evidence, as single studies are not likely useful to clinicians as they often lack the necessary skills to identify and appraise these studies for application to practice.[4] The highest levels of evidence integrate evidence-based information about specific clinical problems and include summaries which contain updated clinical practice guidelines (CPG) and clinical decision support systems for use at the point of care.[3]

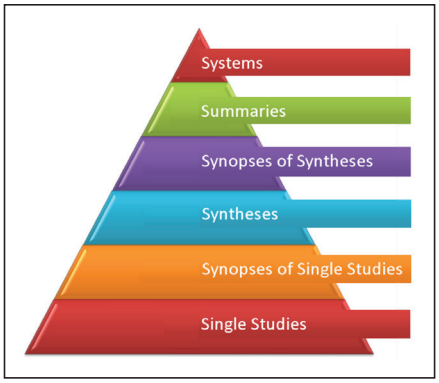

Figure 1. The 6S Pyramid[3]

The American Dental Association (ADA) Center for Evidence-Based Dentistry defines CPG as "the strongest resources to aid dental professionals in clinical decision making and help incorporate evidence gained through scientific investigation into patient care. Guidelines include recommendation statements intended to optimize patient care that are informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options."[5] CPG are widely available in the published medical literature for hundreds of health conditions, yet adoption of these guidelines is often poor and/or slow. Barriers to implementation and adherence are attributed to various practitioner, patient and environmental factors. There are far fewer published CPG in dentistry, yet similar problems with adoption and application can be observed.

There are good examples of barriers to implementation and adherence to published CPG by dental hygienists. Two studies have been published that document poor adherence to the ADA and US Food and Drug Administration (FDA) guidelines for Dental Radiographic Examinations.[6] First, a survey was done with a nationwide sample of practicing dental hygienists to assess their knowledge and practice behaviors related to the guidelines.[7] The majority of the 517 respondents reported that there were times when a clinical examination was not performed before imaging and that images were ordered based upon a set time interval, such as insurance reimbursement criteria, as opposed to determining need for imaging based on actual patient risk assessment data as outlined in the guidelines for frequency of exposure. Behaviors also differed by type of practice setting (general/private, corporate or academic).[7]

A second study with a convenience sample of 1,500 dental hygienists assessed practice behaviors related to respondents use of the guidelines, including use of patient selection criteria and radiation safety.[8] Most of the 566 study participants had an associate's degree (62%) and the majority had over 30 years of experience. Study findings revealed that dental hygienists with more years of experience were more likely to follow selection criteria from the guidelines, and those with higher levels of education (eg. bachelor's degree or higher) or who had recently taken continuing education about dental radiation safety were more likely to use techniques to reduce radiation exposure.[8] Both of these studies demonstrate provider barriers: poor knowledge about and failure to apply and adhere to CPG.

The Ask-Advise-Refer guideline has been widely used by healthcare professionals for smoking cessation, but implementation remains low.[9,10] A recent cross-sectional study examined to which extent 883 healthcare providers from different professions expressed their intention to implement a smoking cessation program with their patients and identified barriers to implementation; 58 participants were dental hygienists.[11] Hygienists scored as "average" on their intention to use the guideline compared to other professionals, but scored higher on intention than cardiologists and internists, and similarly to dentists. Sixty-four percent of hygienists reported "asking", 41% reported "advising" and 26% reported "referring" all patients for smoking cessation. Only 66% of the hygienists reported that they documented smoking status for all patients. For patients who were smokers, 45% reported assessing motivation to quit, 53% discussed barriers to quitting, 14% helped patients make a quit plan, 10% advised the use of pharmacotherapy, 12% arranged a follow-up discussion, but 41% reported doing some type of short, motivational intervention to assist with quitting. Half reported advising all new patients to quit, with higher rates of quit advice given to those patients who reported smoking-related complaints (64%), those who were about to undergo surgery (72%) and those who were pregnant (76%). Identified provider barriers to implementation were lack of formal training in the guidelines (59%) and the sensitive nature of the topic (60%). The largest environmental barrier identified was lack of time (40%).[11]

A qualitative study of 30 dentists, dental hygienists, dental assistants and dental practice managers examined factors that influenced implementation of the pit and fissure sealant guidelines in the Kaiser Permanente Dental Program.[12] Data from focus groups revealed that environmental barriers to implementation included a lack of infrastructure for guideline communication and dissemination, and resource constraints, including adequate space and materials. Provider confusion about their roles and responsibilities for implementing the guidelines was also attributed to the lack of infrastructure. The investigators concluded that establishing a robust infrastructure that contains standardized, predictable mechanisms for implementation is necessary for adoption of CPG in the dental setting.[12]

Several studies have been done to examine dental hygienists use of adjunctive screening devices for detection of oral cancer.[13-15] The ADA CPG for evaluating potentially malignant oral lesions concluded that none of these adjunctive devices demonstrate sufficient diagnostic test accuracy to support their use as triage tools for lesion evaluation.[16] Anecdotally, use of these devices continues in practice, despite strong evidence that these devices lack specificity and sensitivity.[17] No studies have been done to assess dental hygienists adherence to the published ADA CPG for assessing oral lesions in practice.

Compliance with well-established guidelines for antibiotic prophylaxis (AP) to reduce risk for infective endocarditis (IE) and prosthetic joint infection is an ongoing challenge despite the availability of updated consensus guidelines and clinical decision support tools.[18-20] Reasons for lack of compliance include but are not limited to fear of litigation, deference to a medical provider's opinion, perceived safety of a single antibiotic dose, lack of understanding of risk: benefit and patient selection criteria, confusion with conflicting guidelines, habitual prescribing habits, pressure from patients and peers, and apathy. Clinical decision-making is often hampered by these implementation barriers, as evidenced by several studies.[21,22] Of note, new CPGs recommend involving the patient in shared decision-making when discussing AP;[19,20] however, there is no data about whether dental hygienists engage in shared decision making (SDM) with patients when determining need for AP.

The premise of SDM is based on the concept that the clinician serves as expert about scientific evidence and the patient serves as expert on what matters most to them.[23] Numerous models of SDM have been proposed to identify key components and to better define who is responsible for which elements during information exchange.[24] Newer models place a greater emphasis on the patient who is facing the treatment decision, expanding patient-centered care to relationship-centered care or humanistic communication.[25,26] A recent systematic review examined 40 SDM models and identified critical components that are common to most models regardless of healthcare setting: *describe treatment options, make the decision,* and *patient preferences.*[24] Model components that differ between settings include *create choice awareness, provide recommendations,* and *offer time.*[24] Of note is that *patient expertise* and *healthcare professional expertise* are rarely present in any SDM models; however, *learning about the patient* is an important strategy when determining patient expertise.[24] SDM is especially important when treatment decisions are preference-sensitive, when benefits are limited or uncertain, or when potential harms may impact a patient's quality of life.[27] Dentistry faces the same dilemma as oncology: it is unknown if recommendations in current CPGs identify preference-sensitive decisions that require patient engagement in SDM and ultimately, for implementation.[27]

To illustrate the concepts of SDM and CPG adoption, 2 examples from the literature are presented here. The evidence-based National Institute for Health and Clinical Excellence (NICE) recommendations for AP before dental treatment were released in the United Kingdom in 2008, eliminating the need for AP to prevent IE in children and adults with structural heart disease when undergoing dental procedures.[28] One team of investigators conducted a qualitative study to identify patient attitudes and views about barriers and facilitating factors that could influence implementation of the new guidelines in nine patients who were at risk for IE and had a history of receiving AP.[29] Framework analysis[30] revealed that patient barriers to acceptance were related to fear of IE, which was strongest among those who had experienced IE. Personal experience with antibiotic side effects was an influencing factor more so than the scientific evidence presented. Beliefs that dental treatment was a cause of IE and that AP acts as "insurance" against developing IE with dental treatment made patient acceptance of the guidelines difficult. However, the other major barrier to acceptance was the lack of consensus among health professionals about the recommendations in the guideline which caused patient confusion. Patients understood that advances in science change the standard of care but preferred an individualized assessment over just following the guidelines alone for determining need for AP. The key take-away was that scientific information provided to the patients did not change their beliefs, who stated that information about a guideline recommendation should come from an expert clinician who was known and trusted. If the dentist and cardiologist reached consensus, then patients felt more confident in adopting the recommendation.[29]

A different study explored patient-related implementation barriers among individuals with total prosthetic joint replacement (TPJR).[31] An identical survey measuring compliance with recommendations for AP was given to 263 patients with TPJR: 143 at an orthopedic center and 120 at a dental center. The investigators identified the primary outcome as the percentage of patients who complied with their recommendations to take AP prior to undergoing a dental procedure. Their secondary outcome was to assess whether patients believe that antibiotics should be taken indefinitely or for a shorter, arbitrary duration. The practice environments were selected because clinicians in both settings always recommend AP prior to dental treatment for patients with TPJR. In the orthopedic clinic, 50% of the patients complied and in the dental setting, 21% complied. More than half of the patients in both groups reported that APs was "not applicable" to their condition. There were no differences in perceived necessity of use between the groups: approximately half of subjects in both groups deemed AP as appropriate after TPJR in some form, but perceptions about when and for how long AP was necessary varied considerably among patients in both groups. The investigators reported that all patients received consistent education about the need for prophylaxis from their orthopedic surgeon, but there was no mention on what information that education was based. No mention

was made as to whether patients participated in SDM; however, lack of compliance infers that patients made their own decision about AP independently from the education provided. The investigators also discussed that clinicians and patients are challenged by conflicting CPG between professional organizations, citing an older guideline[32] versus updated consensus guidelines, inadvertently illustrating their point.[20,32] Findings from these small studies underscore the importance of patient participation in SDM for guideline implementation as part of patient-centered care, where patients and clinicians negotiate application of the evidence on an individualized basis.[33]

Dental hygiene researchers have several unique opportunities to further explore the concepts presented in this paper. First, there is a need to study patient preferences and participation in SDM in response to treatment recommendations presented as part of the dental hygiene process of care. Attention should be paid to the selection of and reporting of the SDM models used in this research. Second, barriers to implementation of CPG in dental hygiene practice need further identification. Documentation of provider, patient and environmental factors that influence adoption and application of CPG should be consistently reported as new CPG evolve. Third, researchers require additional training in implementation science methods to conduct robust studies that will meaningfully contribute to the dental hygiene body of knowledge and support evidence-based practice. Finally, our academic institutions must model the implementation of CPG as they are released, including use of SDM with patients, so that dental hygiene students are socialized to practicing with current best evidence.[34]

Ann Eshenaur Spolarich, RDH, PhD, FSCDH is a professor and the Director of Research, Arizona School of Dentistry & Oral Health, A.T. Still University, Mesa, AZ.

References

1. ADHA: Policy 6-97. ADHA Policy Manual [Internet]. Chicago: American Dental Hygienists' Association; [cited 2020 Mar 27]. Available from: https://www.adha.org/resources-docs/7614_Policy_Manual.pdf
2. McMaster University. Resources for Evidence-Based Practice: About EBP [Internet]. Hamilton, Ontario: McMaster University; [cited 2020 Mar 27]. Available from: https://hslmcmaster.libguides.com/c.php?g=306765&p=2044668
3. McMaster University. Resources for Evidence-Based Practice: The 6S Pyramid [Internet]. Hamilton, Ontario: McMaster University; [cited 2020 Mar 27]. Available from: https://hslmcmaster.libguides.com/c.php?g=306765&p=2044794
4. Murad MH, Asi N, Alsawas M, et al. New evidence pyramid. Evid Based Med. 2016 Aug;21(4):125-7.
5. ADA Center for Evidence-Based Practice. Clinical Practice Guidelines [Internet]. Chicago: American Dental Association; [cited 2020 Mar 27]. Available from: https://ebd.ada.org/en/evidence/guidelines
6. ADA Council on Scientific Affairs and FDA. Dental radiographic examinations: recommendations for patient selection and limiting radiation exposure [Internet]. Chicago: American Dental Association; c2012 [cited 2020 Mar 27]. Available from: https://www.ada.org/~/media/ADA/Publications/ADA%20News/Files/Dental_Radiographic_Examinations_2012.pdf?la=en
7. Muzzin KB, Flint DJ, Schneiderman E. Dental radiography-prescribing practices: a nationwide survey of dental hygienists. Gen Dent.2019 Mar-Apr;67(2):38-53.
8. Lintag K, Bruhn AM, Tolle SL, et al. Radiation safety practices of dental hygienists in the United States. J Dent Hyg. 2019 Aug;93(4):14-23.
9. CDC. The Brief Tobacco Intervention: The 2As & R [Internet]. Atlanta: Centers for Disease Control and Prevention; [cited 2020 Mar 27]. Available from: https://www.cdc.gov/tobacco/campaign/tips/partners/health/materials/twyd-5a-2a-tobacco-intervention-pocket-card.pdf
10. Verbiest ME, Brakema E, van der Kleij R, et al. National guidelines for smoking cessation in primary care: a literature review and evidence analysis. NPJ Prim Care Respir Med. 2017 Jan 20;27(1):2. doi: 10.1038/s41533-016-0004-8.
11. Meijer E, Van der Kleij RMJJ, Chavannes NH. Facilitating smoking cessation in patients who smoke: a large-scale cross-sectional comparison of fourteen groups of healthcare providers. BMC Health Serv Res. 2019 Oct 25;19(1):750.
12. Gruß I, Pihlsrom DJ, Kaplan CD, et al. Stakeholder assessment of evidence-based guideline dissemination and implementation in a dental group practice. JDR Clin Trans Res. 2020 Feb 10:2380084420903999. [Epub ahead of print]
13. Paulis M. The influence of patient education by the dental hygienist: acceptance of the fluorescence oral cancer examination. J Dent Hyg. 2009 Summer;83(3):134-40.
14. Ayoub HM, Newcomb TL, McCombs, GB, et al. The use of fluorescence technology versus visual and tactile examination in the detection of oral lesions: a pilot study. J Dent Hyg. 2015 Feb;89(1):63-71.

15. Laronde DM, Corbett KK. Adjunctive screening devices for oral lesions: their use by Canadian dental hygienists and the need for knowledge translation. Int J Dent Hyg. 2017 Aug;15(3):187-94.

16. Lingen MW, Abt E, Agrawal N, et al. Evidence-based clinical practice guideline for the evaluation of potentially malignant disorders in the oral cavity: A report of the American Dental Association. J Am Dent Assoc. 2017 Oct;148(10):712-27.

17.Lingen MW, Tampi MP, Urquhart O, et al. Adjuncts for the evaluation of potentially malignant disorders in the oral cavity: Diagnostic test accuracy systematic review and meta-analysis-a report of the American Dental Association. J Am Dent Assoc. 2017 Nov;148(11):797-813.e52.

18. Wilson W, Taubert KA, Gewitz M, et al. American Heart Association. Prevention of infective endocarditis: guidelines from the American Heart Association. J Am Dent Assoc. 2008 Jan;139 Suppl:3S-24S. Erratum in: J Am Dent Assoc. 2008 Mar;139(3):253.

19. Sollecito TP, Abt E, Lockhart PB, et al. The use of prophylactic antibiotics prior to dental procedures in patients with prosthetic joints. Evidence-based clinical practice guideline for dental practitioners—a report of the American Dental Association Council on Scientific Affairs. J Am Dent Assoc. 2015 Jan;146(1):11-16.e8.

20. Rees HW. AAOS appropriate use criteria: management of patients with orthopaedic implants undergoing dental procedures. J Am Acad Orthop Surg. 2017 Jul;25(7):e142-e143.

21. Teixeira EC, Warren JJ, McKernan SC, et al. Prescribing practices for antibiotic prophylaxis in patients with prosthetic joints. Spec Care Dentist. 2020 Mar;40(2):198-205.

22. Jain P, Stevenson T, Shepperd A, et al. Antibiotic prophylaxis for infective endocarditis: knowledge and implementation of American Heart Association guidelines among dentists and dental hygienists in Alberta, Canada. J Am Dent Assoc. 2015 Oct;146(10):743-50. Erratum in J Am Dent Assoc. 2015 Dec;146(12):874.

23. Spatz ES, Krumholz HM, Moulton BW. Prime time for shared decision making. JAMA. 2017 Apr 4;317(13):1309-1310.

24. Bomhof-Roordink H, Gärtner FR, Stiggelbout AM, et al. Key components of shared decision making models: a systematic review. BMJ Open. 2019 Dec 17;9(12):e031763.

25. Clayman ML, Gulbrandsen P, Morris MA. A patient in the clinic; a person in the world. Why shared decision making needs to center on the person rather than the medical encounter. Patient Educ Couns. 2017 Mar;100(3):600-4.

26. Tomlinson JP. Shifting the focus of shared decision making to human relationships. BMJ. 2018 Jan 8;360:k53.

27. Gärtner FR, Portielje JE, Langendam M, et al. Role of patient preferences in clinical practice guidelines: a multiple methods study using guidelines from oncology as a case. BMJ Open. 2019 Dec 5;9(12):e032483..

28. Gould K F, Elliott T S J, Foweraker J, et al. Guidelines for the prevention of endocarditis: report of the working party of the British Society for Antimicrobial Chemotherapy. J Antimicrob Chemother. 2006 Jun;57(6):1035-42.

29. Soheilipour S, Scambler S, Dickinson C, et al. Antibiotic prophylaxis in dentistry: part II. A qualitative study of patient perspectives and understanding of the NICE guideline. Br Dent J. 2011 Jul 8;211(1):E2.

30. Pope C, Ziebland S, Mays N. Analysing qualitative data. BMJ 2000 Jan 8;320(7227):114-6.

31. Cochrane NH, Pachter CS, Garfinkel JH, et al. Patient perceptions of antibiotic prophylaxis for dental procedures after total joint arthroplasty. J Orthop. 2019 Aug 14;17:22-4.

32. Parvizi J, Della Valle CJ. AAOS Clinical Practice Guideline: diagnosis and treatment of periprosthetic joint infections of the hip and knee. J Am Acad Orthop Surg. 2010 Dec;18(12):771-2.

33. Krahn M, Naglie G. The next step in guideline development: incorporating patient preferences. JAMA. 2008 Jul 23;300(4):436-8.

34. Polk DE, Nolan BAD, Shah NH, et al. Policies and procedures that facilitate implementation of evidence-based clinical guidelines in U.S. dental schools. J Dent Educ. 2016 Jan;80(1):23-9.

Research

Measuring Oral Health Literacy of Refugees: Associations with Dental Care Utilization and Oral Health Self-Efficacy

Amira Elkerdany, RDH, MS; JoAnn Gurenlian, RDH, MS, PhD, AFAAOM;
Jacqueline Freudenthal, RDH, MS

Abstract

Purpose: The purpose of this study was to analyze associations between the oral health literacy of refugees and two oral health outcomes: dental care utilization and oral health self-efficacy.

Methods: A convenience sample of refugees in the greater Los Angeles area attending English as a second language (ESL) classes sponsored by two refugee assistance organizations was used for this cross-sectional, correlational study. Participants responded to a questionnaire using items from the Health Literacy in Dentistry (HeLD) scale, in addition to items concerning dental care utilization and oral health self-efficacy. Descriptive statistics, chi-square and Fisher's Exact tests were used to analyze results.

Results: Sixty-two refugees volunteered to participate (n=62). A majority of the respondents were female from Iraq or Syria, and selected the item "with little difficulty" for all oral health literacy tasks. In regards to dental care utilization, more than half of the respondents were considered high utilizers (63%, n=34) meaning they had visited a dental office within the last year; while a little more than one-third (37%, n=20), were low utilizers, indicating they had either never been to a dental office or it had been more than one year since they had dental treatment. Statistical analysis showed associations between oral health literacy and dental care utilization. However, few associations between oral health literacy and oral health self-efficacy were identified (p=0.0045).

Conclusions: Results support the provision of easily obtainable and understandable oral health information to increase oral health literacy and dental care utilization among refugee populations. Future research is needed to examine the oral health literacy among refugees resettling in the United States.

Keywords: oral health literacy, health literacy, dental care utilization, oral health self-efficacy, dental public health, refugees

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Introduction

There is a global crisis in regards to the number of people displaced from their homeland as a result of war and persecution. An estimated one in every 113 people around the world are fleeing for their lives,[1,2] marking the largest flow of refugees since the second world war.[1] Little has been reported in the literature regarding the oral health literacy of refugees. Identifying deficiencies in oral health literacy among refugees may help dental hygienists take the necessary steps to address this problem and in turn, have a positive impact on the overall oral health status of refugees. Dental care utilization and oral health self-efficacy may also be improved with increased oral health literacy.

Oral health literacy has been defined as "the degree to which individuals have the capacity to obtain, process, and understand basic oral health information and services needed to make appropriate health decisions."[3] Reading, writing, numeracy, speaking, and listening are considered part of oral heath literacy.[3] For the purposes of this study, dental care utilization is defined as use of dental services (dental examinations and dental treatment), while oral health self-efficacy is defined as "an individual's confidence in knowing how to prevent dental caries and periodontal disease."[4]

Health literacy can be evaluated as functional or comprehensive. Functional health literacy is the ability

to read information and instructions about health,[5] while comprehensive health literacy is the ability to apply health knowledge in order to make appropriate judgments and decisions regarding one's health.[6] In a cross-sectional study of adult refugees from Syria, Somalia, Afghanistan and Iraq relocated to Sweden, Wångdahl et al. found about 80% of the participants had inadequate or limited functional health literacy and 62% had inadequate or low comprehensive health literacy.[7] Twelve months later, a second study was conducted during the refugees' health examinations to identify relationships between low health literacy (functional and comprehensive) and communication.[8] Associations were found between inadequate functional and comprehensive health literacy, and poor quality of communication between participants and providers.[8] Participants struggled with receiving new knowledge or help regarding their health problems, which presented a barrier to care.[8] Participants did not find the health examinations useful, nor did they feel they acquired new knowledge about their health as a result of having a health examination.[8]

The literature has shown that refugees have more oral diseases and limited access to oral health care services as compared to the most underprivileged populations within the host country.[9,-13] Geltman et al. studied adult Somali refugees residing in Massachusetts for ten years or less and found 74% of the study population to have low health literacy.[14] Further analysis revealed refugees living in the United States five or more years had higher health literacy scores and were more likely to utilize preventive dental care, while those participants with low health literacy scores were more likely to adopt a poor Western diet and were less likely to pursue preventive dental care.[14] Additionally, participants with low health literacy scores were more likely to be less acculturated, the process by which immigrants adopt the cultural practices of their host country.[14] However, lower literacy scores in this study population were not significantly associated with decayed teeth.[14]

After careful examination of the same data set one year later, Geltman et al. concluded health literacy was not the only predictor for seeking preventive dental care, and identified acculturation as the primary driving force for utilizing preventive care.[15] Participants with high acculturation levels reported significantly higher preventive dental care visits.[15] The authors hypothesized that the acculturation process exposes refugees to notions of preventive dental care prevalent within the United States.[15] Additional studies examining the relationship between acculturation, oral health status, oral health knowledge, and frequency of dental visits among Vietnamese immigrants living in Melbourne, Australia also revealed that immigrants with higher acculturation had less decay, better oral health knowledge, and were more likely to utilize oral health services in the past twelve months.[16]

In addressing oral health literacy, an Australian study examined refugee children from Iraq, Lebanon, and Pakistan.[17] Refugee mothers were surveyed to identify the relationship between sociocultural factors and oral health literacy on the oral health outcomes of their children. Results demonstrated a relationship between poor oral health literacy of the mother and the oral health outcomes identified in their children.[17] While all participants identified children's oral health as important, many stated their child's oral health status had worsened after being resettled in Australia, and many blamed the new diet as the cause.[17] The authors' hypothesized that the poor oral health status of the refugee children might be associated with a lack of awareness of dental disease and beneficial oral hygiene practices, combined with dietary changes.[17]

Similarly, a comprehensive review of the literature regarding the oral health status of immigrant and refugee children in North America, showed poorer oral health among children of recent immigrants compared with children of Canadian-born parents.[18] Low health literacy among parents was shown as a barrier to dental care for children and a possible reason for poorer oral health.[18] Recommendations for improving oral health literacy included making educational materials available in the immigrants' native language, and focusing oral health education on the parents.[18] Other barriers to care included language, cost of care, lack of dental insurance, and proximity of dental offices; all of which contribute to poorer oral health outcomes among refugees and immigrants.[18]

Perceptions of the importance of dental care during pregnancy were examined in a qualitative Australian study conducted with Afghan and Sri Lankan refugees.[19] Focus group questions included dental care during pregnancy, navigating dental services, and maternal oral health literacy.[19] Incorrect perceptions were identified in regards to dental care during pregnancy, the link between maternal oral health and infant oral health, in addition to difficulty navigating dental services.[19] While no specific tool was used to measure oral health literacy, the researchers identified the participants as having low maternal oral health literacy.[19]

Little has been reported in the literature regarding oral health literacy specifically in immigrant and refugee populations. However, currently available literature indicates a promising relationship between adequate oral health literacy and positive oral health outcomes. More research is needed to identify whether immigrants and refugees, regardless of

country of origin, possess lower oral health literacy skills, and whether their level of oral health literacy affects their oral health outcomes. The purpose of this study was to analyze the association between the oral health literacy of refugees resettled in the greater Los Angeles area and two specific oral health outcomes: dental care utilization and oral health self-efficacy.

Methods

This cross-sectional, correlational study used a convenience sample of refugees resettled within the past 10 years attending ESL classes at Interfaith Refugee and Immigration Services (IRIS), and Access California Services (ACS) in the greater Los Angeles area. The sample size consisted of 62 participants. This study was approved by the Human Subjects Committee, Institutional Review Board (IRB-FY2018-278) at Idaho State University.

Oral health literacy was assessed using a validated instrument known as the Health Literacy in Dentistry scale (HeLD).[20,21] The HeLD scale is an instrument that measures oral health literacy across seven domains: 1) communication, 2) access, 3) receptivity, 4) understanding, 5) utilization, 6) support, and 7) economic barriers.[20] The following subscales were relevant for this study: understanding, access, communication, and utilization. Each oral health literacy item was ranked on a 5-point Likert scale ranging from 0 to 4, with a possible score range of 0 to 44. Higher scores indicated minimal difficulty performing the task described by the subscale item, (suggestive of higher oral health literacy), while lower scores indicated difficulty performing the task, and thus, lower oral health literacy. One question was added regarding dental care utilization,[4] and four questions were added regarding oral health self-efficacy.[22] Demographic questions were limited to age, gender, country of origin, and year of resettlement. The principal investigator (PI) was advised by a Refugee Health Assessment Program Coordinator against asking highly personal questions such as level of education and employment, due to the possibility of triggering feelings of shame or overall insecurity regarding the participants' sense of safety as a refugee. Participants had been provided MediCal dental insurance as part of their refugee resettlement, therefore questions regarding dental insurance were not included in the demographics. A content validity index (CVI),[23] test, and re-test procedures were pilot-tested among experts in the field prior to administration of the survey. The survey items were found to be highly relevant and consistent. The 20-item instrument consisted of four demographic questions, eleven oral health literacy questions, one dental care utilization question, and four oral health self-efficacy questions and was designed to be administered on paper in English, Spanish, Arabic, and Farsi. Survey translations were completed by either a dental assistant or dental hygienist who was bilingual in English and the language of translation. Languages of translation were based on the California Department of Social Services' data indicating the greatest number of refugees resettled in Los Angeles County from 2012-2016 were from Iran (5,973) and Iraq (1,408).[24] Additional data from Access California Services' data indicated an influx of refugees from Central America during the same period of time.

Surveys were administered by the PI to refugees attending ESL classes offered through IRIS or ACS. Volunteer participants indicated their preferred language for informed consent and the 15-minute survey. Surveys completed in a language other than English were back-translated by dental professionals prior to data analysis. A brief oral health lesson was also presented by the PI following administration of the survey. Each attendee, regardless of whether they participated in the study, attended the oral health lesson and received information about locally available dental services and received an oral hygiene kit containing a toothbrush and fluoride toothpaste donated by Colgate®.

Demographic data was reported as descriptive statistics; chi-square tests were performed to evaluate associations of oral health literacy with dental care utilization and oral health literacy with oral health self-efficacy. The small cell frequencies presented a challenge with the inferential statistical analysis, therefore Fisher's Exact Test was performed. To correct for type-1 error, a family wise rate using a Bonferroni correction was made. The level of significance was established at $p = 0.0045$ to account for some of the low cell frequencies.

Results

Seventy-five attendees, between the two sites, were present and available to participate; 62 chose to participate yielding a response rate of 82.6% (n=62). All participants were over the age of 18 years, and most were female. The most common countries of origin represented were Iraq and Syria. No additional demographic variables were obtained, in order to preserve the participants' privacy. Demographic information is shown in Table I. Regarding oral health literacy, most respondents selected the item "with little difficulty" for all oral health literacy tasks. Oral health literacy responses are shown in Table II.

Dental care utilization was assessed by survey items inquiring when the last dental exam or treatment appointment (including a dental cleaning) occurred. Of the respondents to this item, over one-half (n=34, 63%) were considered high

Table I. Participant demographics

Gender	n=62	%
Male	26	41.90%
Female	36	58.10%
Country of Origin	**n=62**	**%**
Iraq	14	23.00%
Syria	14	23.00%
Afghanistan	6	9.80%
Egypt	6	9.80%
Iran	5	8.20%
Mexico	4	6.60%
Lebanon	3	4.90%
Jordan	2	3.30%
Vietnam	2	3.30%
Sudan	1	1.60%
Philippines	1	1.60%
Romania	1	1.60%
India	1	1.60%
Eritrea	1	1.60%

utilizers, meaning they had visited a dental office within the last year, while a little more than one-third (n=20, 37%) were low utilizers indicating they had either never been to a dental office or it had been more than one year since they had received any kind of dental treatment. The majority of respondents felt confident in their ability to clean their teeth properly and prevent tooth decay. Frequency of responses related to oral health self-efficacy are shown in Table III.

Chi-square associations between responses were statistically significant, with the exception of oral health literacy items 7 and 9, indicating assoc-iations between oral health literacy and dental care utilization among this population. Associations were found among those who responded at either end of the oral health literacy response choices, such as "I don't go to the dentist" or "with little difficulty" and response choices regarding dental care utilization. Associations of oral health literacy responses with dental care utilization responses are shown in Table IV.

Statistical significance was found between oral health literacy and confidence in knowing how to brush one's teeth, clean in between one's teeth, and confidence in knowing how to avoid foods that lead to tooth decay. Associations of oral health literacy responses with oral health self-efficacy are presented in Table V.

Discussion

Several studies have reported an association between oral health literacy and dental care utilization.[15,16,22,25-28] Low oral health literacy was not associated with the number of dental care visits or dental care utilization among adult patients seeking care at two private dental practices in North Carolina,[25,26] or with a group of Belarusian adult patients seeking dental care at an urban hospital,[27] nor among adult patients at two university-based dental clinics in Maryland and California.[22] Two additional studies examining refugees' oral health care practices identified acculturation as the primary predictor for dental care utilization, as opposed to oral health literacy.[15,16] Regarding oral health self-efficacy, one study identified an association between high oral health self-efficacy and high oral health literacy,[22] while another did not identify an association between oral health self-efficacy and oral health literacy.[28] Results from of this study of refugees in the greater Los Angeles area, contradict those previously presented in the literature, which do not indicate an association between oral health literacy and dental care utilization.

Associations between oral health literacy and dental care utilization were identified through statistical analysis, however there were few associations found between oral health literacy and oral health self-efficacy. Participants reporting high utilization of dental care services tended to have higher oral health literacy scores and those who reported visiting the dentist within the past year indicated little difficulty in completing the oral health literacy tasks. Conversely, participants who reported low utilization of dental care services tended to have lower oral health literacy scores and expressed greater difficulty in completing the oral health literacy tasks. Increased exposure to dental care services, including oral health education, appears to be linked to an increased ability to obtain, process, and understand the basic oral health information and services needed to make appropriate oral health decisions.

Similar to other studies found in the literature,[28] there were little to no associations identified between oral health literacy and oral health self-efficacy. No associations were found between oral health literacy and confidence in knowing how to use fluoride toothpastes and rinses properly, despite the findings that the majority of the participants indicated confidence in this specific oral health self-efficacy item. Of the few associations identified in this study, the ability to change to a different dentist to get better dental care was associated with the participants feeling confident in knowing how to brush and clean in between their teeth properly and knowing how to avoid foods that can cause tooth decay. The ability to change oral health care providers in order to receive better care demonstrates a more advanced level of oral health literacy that involves making appropriate decisions about one's health. It is understandable to see why an association may exist between this oral health literacy item, and the high level of confidence reported in the ability to prevent dental disease.

Table II. Oral health literacy

Survey Item and Responses	n	%
OHL1. Are you able to fill in dental forms (example: health forms)? (n=62)		
"I don't go to the dentist"	7	11.30%
"Unable to do so"	3	4.80%
"Very difficult"	1	1.60%
"With some difficulty"	8	12.90%
"With little difficulty"	43	69.40%
OHL2. Are you able to read information (example: brochures) given to you by your dentist? (n=60)		
"I don't go to the dentist"	6	10.00%
"Unable to do so"	4	6.70%
"Very difficult"	1	1.70%
"With some difficulty"	6	10.00%
"With little difficulty"	43	71.30%
OHL3. Do you know how to get a dentist's appointment? (n=62)		
"I don't go to the dentist"	6	9.70%
"Unable to do so"	3	4.80%
"Very difficult"	3	4.80%
"With some difficulty"	5	8.10%
"With little difficulty"	45	72.60%
OHL4. Do you know where you can see a dentist? (n=62)		
"I don't go to the dentist"	7	11.30%
"Unable to do so"	3	4.80%
"Very difficult"	3	4.80%
"With some difficulty"	7	11.30%
"With little difficulty"	42	67.70%
OHL5. Are you able to ask a dentist questions to help you understand dental information? (n=61)		
"I don't go to the dentist"	6	9.80%
"Unable to do so"	3	4.90%
"Very difficult"	3	4.90%
"With some difficulty"	8	13.10%
"With little difficulty"	41	67.20%
OHL6. Are you able to get the information you need when seeing a dentist? (n=60)		
"I don't go to the dentist"	7	11.70%
"Unable to do so"	2	3.30%
"Very difficult"	6	10.00%
"With some difficulty"	8	13.30%
"With little difficulty"	37	61.70%

Survey Item and Responses	n	%
OHL7. Are you able to change to a different dentist to get better dental care? (n=60)		
"I don't go to the dentist"	7	11.70%
"Unable to do so"	3	5.00%
"Very difficult"	1	1.70%
"With some difficulty"	10	16.70%
"With little difficulty"	39	65.00%
OHL8. Are you able to use information from a dentist to make decisions about your dental health? (n=60)		
"I don't go to the dentist"	6	10.00%
"Unable to do so"	3	5.00%
"Very difficult"	0	0.00%
"With some difficulty"	6	10.00%
"With little difficulty"	45	75.00%
OHL9. Are you able to discuss your dental or oral health with people other than a dentist? (n=59)		
"I don't go to the dentist"	6	10.20%
"Unable to do so"	11	18.60%
"Very difficult"	1	1.70%
"With some difficulty"	4	6.80%
"With little difficulty"	37	62.70%
OHL10. Are you able to understand instructions that a dentist gives you? (n=58)		
"I don't go to the dentist"	7	12.10%
"Unable to do so"	3	5.20%
"Very difficult"	2	3.40%
"With some difficulty"	6	10.30%
"With little difficulty"	40	69.00%
OHL11. Are you able to carry out instructions that a dentist gives you? (n=60)		
"I don't go to the dentist"	7	11.70%
"Unable to do so"	3	5.00%
"Very difficult"	1	1.70%
"With some difficulty"	4	6.70%
"With little difficulty"	45	75.00%

Table III. Oral health self-efficacy

Survey Item and Responses	n	%
SE1. How confident are you that you know how to brush your teeth properly? (n=61)		
"Unsure"	9	14.80%
"Not Confident"	8	13.10%
"Confident"	44	72.01%
SE2. How confident are you that you know how to clean in between your teeth properly? (n=61)		
"Unsure"	10	16.40%
"Not Confident"	12	19.70%
"Confident"	39	63.90%
SE3. How confident are you that you know how to properly use fluoride toothpastes or fluoride mouth rinses? (n=61)		
"Unsure"	5	8.20%
"Not Confident"	16	26.20%
"Confident"	40	65.60%
SE4. How confident are you that you can avoid foods that lead to tooth decay/cavities ("rotting teeth")? (n=61)		
"Unsure"	8	13.10%
"Not Confident"	17	27.90%
"Confident"	36	59.00%

Table IV. Oral health literacy and dental care utilization

Item	value	df	*p*-value
OHL1	14.88	4	0.00*
OHL2	13.76	3	0.00*
OHL3	14.09	4	0.00*
OHL4	13.43	4	0.00*
OHL5	12.64	4	0.00*
OHL6	13.10	4	0.00*
OHL7	11.69	4	0.01
OHL8	13.55	3	0.00*
OHL9	7.47	4	0.07
OHL10	12.66	4	0.00*
OHL11	16.57	4	0.00*

* Significance established at $p = 0.0045$

Table V. Oral health literacy and oral health self-efficacy

Item	SE1			SE2			SE3			SE4		
OHL	**value**	**df**	***p*-value**	**value**	**df**	***p*-value**	**value**	**df**	***p*-value**	**value**	**df**	***p*-value**
1	14.38	8	0.03	16.80	8	0.01	12.63	8	0.07	15.02	8	0.02
2	10.84	8	0.12	12.57	8	0.05	7.08	8	0.52	12.91	8	0.05
3	10.46	8	0.12	21.20	8	0.00*	11.62	8	0.09	14.78	8	0.02
4	10.09	8	0.22	15.41	8	0.01	11.69	8	0.09	14.28	8	0.02
5	14.75	8	0.02	18.46	8	0.00*	17.19	8	0.01	16.59	8	0.01
6	26.07	8	0.00*	17.00	8	0.01	14.40	8	0.03	17.40	8	0.01
7	24.70	8	0.00*	22.36	8	0.00*	16.63	8	0.01	19.42	8	0.00*
8	14.14	6	0.01	15.89	6	0.00*	10.46	6	0.05	18.64	6	0.00*
9	19.16	8	0.00*	15.66	8	0.01	14.31	8	0.03	16.92	8	0.01
10	14.53	8	0.02	18.46	8	0.00*	15.46	8	0.02	18.67	8	0.00*
11	15.64	8	0.02	15.28	8	0.01	9.22	8	0.25	14.50	8	0.02

* Significance established at $p = 0.0045$

Additionally, an association exists between feeling confident in knowing how to brush one's teeth and being able to get the information needed when seeing a dentist as well as discussing one's oral health with people other than a dentist. Associations also exist between feeling confident in knowing how to clean in between one's teeth and the following oral health literacy tasks: knowing how to get a dental appointment, being able to ask a dentist questions in order to better understand dental information, using information from a dentist to make decisions, and understanding instructions from a dentist. Finally, associations were found between the participants' confidence in knowing how to avoid foods that lead to tooth decay and using information from a dentist to make decisions in addition to understanding instructions from a dentist. It may be that learning how to brush and clean between one's teeth properly as well as avoiding foods that lead to tooth decay is a consequence of getting the information needed when seeing a dentist, which includes the ability to ask the dentist appropriate questions in order to fully understand the information being presented. It is logical to conclude that this could lead to improved decision-making skills and the ability to discuss one's oral health with others.

Study findings indicate that refugee participants who are able to obtain, process, understand, and act on oral health information with little difficulty, are also higher utilizers of dental care services; thus, they are more adept in managing oral disease and improving their oral health outcomes. Oral health care practitioners must provide easily obtainable oral health information that can be understood by these populations. There is a need for more educational materials available in the various languages spoken by refugees settling in any given geographic area. Oral health advocates are needed to work with refugee assistance organizations to help navigate the complicated oral healthcare delivery system in addition to educating refugees on disease prevention strategies. Developing relationships between refugee assistance organizations and Federally Qualified Health Centers providing dental services could be a natural first step in the process towards increasing oral health literacy, dental care utilization, and oral health self-efficacy among refugee populations.

Limitations of this study included refugees resettled within the past ten years, in the greater Los Angeles area of California. Refugees located in other regions, or who have been resettled for greater than ten years, were not studied. Additionally, this study was limited to refugees attending ESL classes, and refugees not affiliated with an adult education program such as ESL. Furthermore, attending an ESL class may suggest the individual is attempting to adapt or acculturate to society, and may have influenced the findings. Attempting to acculturate and adopt "Western" beliefs regarding oral health could explain why most of the participants selected the item "with little difficulty" for all oral health literacy tasks, in addition to reporting confidence in their ability to properly clean their teeth and prevent tooth decay. Acculturation may also explain why over one-half of the participants had visited a dental office within the last year, categorizing them as high utilizers of dental care. Demographic information was limited in order to reduce apprehension, security, and feelings of shame of the participants, particularly in regards to questions determining the level of education. However, concerns regarding the nature of the study discouraged some refugees from participating and impacted the sample size. The brevity and close-ended style of the survey instrument also acted as a limitation, preventing participants from providing additional answers or explanations. The survey instrument was only available in four languages: English, Spanish, Arabic, and Farsi; therefore, refugees who were unable to read these languages were excluded from the study.

Future research should include replicating this study to identify whether the results support the literature as well as further examining associations between dental care utilization and oral health self-efficacy. The majority of the study participants were originally from Iraq and Syria; expansion of this study should include a larger and more diverse refugee population. Additional considerations include intervention studies involving participation in an oral health program and its effect on oral health literacy, dental care utilization, and oral health self-efficacy. Additional qualitative studies could further explore aspects of oral health literacy, along with studies measuring participants' ability to properly carry out preventive behaviors such as toothbrushing and interproximal cleaning. Acculturation has been noted in the literature as a driving force for utilization of preventive services and developing preventive behaviors. Future studies should measure associations between acculturation, oral health literacy, and oral health outcomes among refugees. Finally, the need for culturally competent health care providers has driven research towards measuring the confidence of clinicians in treating culturally diverse refugee patients.[29] Future efforts should also focus on preparing dental hygienists to work with refugee patient populations.

Conclusion

The purpose of this study was to assess associations between oral health literacy, dental care utilization, and oral health self-efficacy among refugees living in the greater Los Angeles area. Associations were found between oral health literacy and dental care utilization. Few associations were found between

oral health literacy and oral health self-efficacy. Future research is needed to examine the oral health literacy and various oral health outcomes among refugees resettled in the United States. Findings from expanded research on these initial findings can be used to prepare dental hygienists to work with refugee populations to improve their oral health outcomes.

Amira Elkerdany, RDH, MS is an instructor in the Department of Dental Hygiene, Oxnard College, Oxnard, CA.

JoAnn Gurenlian, RDH, MS, PhD, AFAAOM is a professor and graduate program director; ***Jacqueline Freudenthal, RDH, MS*** is a professor and program chair; both in the Department of Dental Hygiene, Idaho State University, Pocatello, ID.

Corresponding author: Amira Elkerdany, RDH, MS; amira_elkerdany1@vcccd.edu

References

1. United Nations High Commissioner for Refugees (UNHCR). Global trends: forced displacement in 2015 [Internet]. Geneva: United Nations High Commissioner for Refugees; 2016 Jun [cited 2018 Jul 28]. 68 p. Available from: http://www.unhcr.org/en-us/statistics/unhcrstats/576408cd7/unhcr-global-trends-2015.html
2. Miliband D. Rescue: refugees and the political crisis of our time. New York: TED Books; 2017. 136p
3. NICDR. The invisible barrier: literacy and its relationship with oral health. J Public Health Dent. 2005 Summer;65(3):174-82.
4. Macek MD, Atchison KA, Watson MR. Assessing health literacy and oral health: preliminary results of a multi-site investigation. J Public Health Dent. 2016 Apr 29: 76(4):303-13.
5. Nutbeam D. The evolving concept of health literacy. Soc Sci Med. 2008 Dec;67(12):2072-8.
6. Sorensen K, Broucke SV, Fullam J. Health literacy and public health: a systematic review and integration of definitions and models. BMC Public Health. 2012 Jan 25;12(1):80-93.
7. Wångdahl J, Lytsy P, Mårtensson L. Health literacy among refugees in Sweden - a cross-sectional study. BMC Public Health. 2014 Oct 3;14(1):1030-43.
8. Wångdahl J, Lytsy P, Mårtensson L. Health literacy and refugees' experiences of the health examination for asylum seekers - a Swedish cross-sectional study. BMC Public Health. 2015 Nov 23;15(1):1162-74.
9. Keboa MT, Hiles N, Macdonald ME. The oral health of refugees and asylum seekers: a scoping review. Global Health. 2016 Oct 7;12(1):59-70.
10. Singh HK, Scott TE, Henshaw MM. Oral health status of refugee torture survivors seeking care in the United States. Am J of Public Health. 2008 Dec;98(12):2181-2.
11. Ghiabi E, Matthews DC, Smith Brilliant M. The oral health status of recent immigrants and refugees in Nova Scotia, Canada. J Immigr Minor Health. 2013 Jan 31;16(1):95-101.
12. Okunseri C, Yang M, Gonzalez C. Hmong adults self-rated oral health: a pilot study. J Immigr Minor Health [Internet]. 2007 Jun 2;10(1):81-8.
13. Mattila A, Ghaderi P, Tervonen L. Self-reported oral health and use of dental services among asylum seekers and immigrants in Finland--a pilot study. Eur J Public Health. 2016 Aug 18;26(6):1006-10.
14. Geltman PL, Adams JH, Cochran J. The impact of functional health literacy and acculturation on the oral health status of Somali refugees living in Massachusetts. Am J Public Health. 2013 Aug;103(8):1516-23.
15. Geltman PL, Adams JH, Penrose KL. Health literacy, acculturation, and the use of preventive oral health care by Somali refugees living in Massachusetts. J Immigr Minor Health. 2007 Jun 2;10(1):81-8.
16. Mariño R, Stuart GW, Wright FA. Acculturation and dental health among Vietnamese living in Melbourne, Australia. Community Dent Oral Epidemiol. 2001 Apr;29(2):107-19.
17. Riggs E, Gibbs L, Kilpatrick N. Breaking down the barriers: A qualitative study to understand child oral health in refugee and migrant communities in Australia. Ethn Health. 2014 Apr 17;20(3):241-57.
18. Reza M, Amin M, Sgro A. Oral health status of immigrant and refugee children in North America: A scoping review. J Can Dent Assoc. 2016 Feb;82(g3):1-18.
19. Riggs E, Yelland J, Shankumar R. "We are all scared for the baby": promoting access to dental services for refugee background women during pregnancy. BMC Pregnancy Childbirth. 2016 Jan 21;16(12):1-11.
20. Jones K, Parker E, Mills H. Development and psychometric validation of a Health Literacy in Dentistry scale (HeLD). Community Dent Health. 2014 Mar;31(1):37-43.

21. Ju X, Brennan DS, Parker E. Confirmatory factor analysis of the Health Literacy in Dentistry scale (HeLD) in the Australian population. Community Dent Health. 2018 Aug 30;35(3):140-7.

22. Macek MD, Atchison KA, Chen H. Oral health conceptual knowledge and its relationships with oral health outcomes: findings from a multi-site health literacy study. Community Dent Oral Epidemiol. 2017 Aug;45(4):323–9.

23. Wynd CA, Schmidt B, Schaefer MA. Two quantitative approaches for estimating content validity. West J Nurs Res. 2003 Aug; 25(5):508-518.

24. CDSS. Refugee arrivals into California by country/region of origin [Internet] Sacramento: California Department of Social Services; 2017 Aug [cited 2018 July 28]. 1 p. Available from http://www.cdss.ca.gov/Portals/9/Refugee/Arrivals/2012-2016_Arrivals_by_Region_and_County.pdf?ver=2017-08-18-104902-680

25. Jones M, Lee JY, Rozier RG. Oral health literacy among adult patients seeking dental care. J Am Dent Assoc. 2007 Sep;138(9):1199-1209.

26. Burgette JM, Lee JY, Baker AD. Is dental utilization associated with oral health literacy? J Dent Res. 2016 Feb;95(2):160–6.

27. Blizniuk A, Ueno M, Zaitsu T. Association of oral health literacy with oral health behavior and oral health status in Belarus. Community Dent Health. 2015 Sep; 32(3):148-52.

28. Lee JY, Divaris K, Baker AD. The relationship of oral health literacy and self-efficacy with oral health status and dental neglect. Am J Public Health. 2012 May;102(5):923-9.

29. Capozzi BM, Giblin-Scanlon LJ, Rainchuso L. Treatment of a culturally diverse refugee population: dental hygiene students' perceptions and experiences. J Dent Hyg. 2018 Apr;92(2):50-6.

Research

Oral Health-Related Quality of Life of Children: An Assessment of the Relationship between Child and Caregiver Reporting

Renee Wall, MS, RDH; Lori Rainchuso, DHSc, MS, RDH; Jared Vineyard, PhD; Lory Libby, MS, RDH

Abstract

Purpose: Oral and craniofacial conditions or diseases can impact an individual's health and quality of life. The purpose of this study was to assess the perceived oral health related quality of life (OHRQoL) of children, and evaluate the reported level of agreement between caregivers and their children.

Methods: Purposive sampling was used to recruit children ages 8-15, and their caregivers from a dental clinic in a pediatric hospital for this descriptive, cross-sectional study. A modified version of a validated measure, Child Oral Health Impact Profile-Short Form (COHIP-SF), was used for a 22-item questionnaire encompassing three subscales: oral health, functional well- being, and social emotional well-being. Two additional items were included to assess child/caregiver's level of agreement. A dental chart review was also conducted to assess the child's overbite, overjet, and decayed surfaces. Data were analyzed through descriptive statistics and examined for assumptions of normality and linearity.

Results: Sixty child/caregiver pairs (n=120) participated in this study. Overbite, overjet and decayed surfaces were not found to be related to any OHRQoL variable, including child/caregiver ratings and overall agreement (p>.05). Average OHRQoL scores for caregivers found to be more positive those of their children (p=.02). Agreement between caregivers and the child's gender was shown to be significant (p=.01). Female child scores differed significantly from males with respect to their caregiver responses (p=.02). Caregivers rated a higher OHRQoL for female children, thus overestimating their female child's reported OHRQoL.

Conclusions: The moderate level of agreement found between children and caregivers reinforces the importance of including the child, as well as the caregiver, when assessing OHRQoL.

Keywords: oral health, pediatric oral health, oral health related quality of life, public health, child/caregiver concordance

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Introduction

In 1948, the World Health Organization redefined the term "health" to incorporate aspects of physical, mental, and social well-being.[1] Physical well-being encompasses an individual's ability to perform everyday activities. Mental well-being suggests that an individual acknowledges their ability to manage stressors, anxieties, and undesirable emotions. Social well-being acknowledges an individual's capability to be involved in society and their connections with others.[1] This expanded definition acknowledged health as a more complex concept, implying that it is more than simply being free of disease.[1]

Oral and craniofacial conditions or diseases can impact an individual's health. Any disorder or condition impacting an individual's oral health has the potential for physical, social, and physiological repercussions. [2,3] Some individuals may experience physical pain associated with everyday activities such as eating, speaking, and sleeping. Others may feel embarrassed or insecure, leading to self-confidence issues which can hinder interactions with others in social environments. Research suggests that oral and craniofacial conditions or diseases can potentially diminish an individual's oral health-related quality of life (OHRQoL).[3]

Oral health-related quality of life is a complex model consisting of an individuals' perceptions of oral health in relation to their functional, psychological, and social well-being.[3,4] Historically, researchers had focused on measuring oral health based on traditional clinical assessments, solely signifying disease or lack thereof.[3,5] However, researchers have identified that traditional dental indices and clinical assessments of oral disease lack the ability to consider this multidimensional concept of health, as they overlook patients' subjective evaluation.[6,7]

To address this gap, self-assessment measurement instruments have been developed to analyze the physical, psychological, and social effects of oral conditions, known as oral health-related quality of life (OHRQoL). These OHRQoL instruments study the impact of numerous conditions, including but not limited to, dental caries, malocclusion, and craniofacial anomalies,[8] and have been customized to measure OHRQoL in specific populations, including individuals with specific conditions.[6] OHRQoL instruments have implications for clinical practice, oral health research, and public policy. Specifically, the OHRQoL instrument includes the patient in the decision-making process, potentially improving treatment outcomes. OHRQoL instruments can aid researchers in gaining a greater insight on how oral conditions may affect overall health in addition to impacting health policy by objectively examining oral health disparities.[4,6] Although OHRQoL instruments were originally designed for adult populations, recently multiple instruments have been developed and validated to measure the OHRQoL of children.[5,8,9]

In 2000, the Surgeon General's workshop and conference, "*The Face of The Child,"* recognized the many unmet oral health needs of children and the need to develop OHRQoL assessments for children.[10,11] Pediatric and adolescent stages of life, characterized by rapid cognitive and physical growth, are crucial developmental periods, and it has been difficult for researchers to create suitable OHRQoL instruments for these populations.[10] To create an appropriate instrument, the child's competence in reading and abstract thinking, as well as the World Health Organization's definition of health must be taken into consideration.[11,12]

The Child Oral Health Impact Profile (COHIP), developed in 2007, is a validated, self-reported instrument aimed to assess the OHRQoL of children ages 8-15 with various clinical conditions.[12] The COHIP was the first instrument to assess both positive and negative impacts of oral conditions including five subscales as well as a parallel form for caregivers.[11,12] A condensed version of the COHIP, the COHIP-short form (COHIP-SF), was developed to improve its efficiency and practical application in clinical settings.[13] The COHIP-SF contains 20-items, and upholds the reliability and validity of the original questionnaire.[13] The COHIP-SF displays a 3.2 grade reading level, and as been shown to be useful in clinical and epidemiological settings.[13]

Researchers have questioned whether children have the ability to accurately report their quality of life, and whether a caregiver's report regarding their child's OHRQoL should be used as a substitute or in addition to their child's report.[13] Although previous studies have found that caregivers are aware of their children's OHRQoL, study results suggest low agreements between children and their caregivers'.[14,15] The literature suggests that these low agreements may be due to a variety of reasons including the hypothesis that children and caregivers may simply have dissimilar viewpoints.[15] It has also been suggested that because caregivers do not observe their children while in school or at other social settings, that they may lack full awareness of their children's OHRQoL.[15] Research also suggests there are other potential variables that may provide rationale for children and caregivers reporting different oral health-related OHRQoL scores. Caregivers may overrate or underrate specific aspects that are significant to a child, such as the way they look and how the child feels; in addition the gender of the child and caregiver may also influence OHRQoL scores.[13,14]

Additional research is needed to explore the relationship between caregiver and child OHRQoL responses to determine the influence of specific variables on their level of agreement. To date, few studies have been conducted in the United States using the COHIP-SF measure as a survey instrument. Despite the original assumptions that children were unable to accurately report their OHRQoL, the COHIP has been shown to be a valid and reliable OHRQoL assessment tool for children experiencing a variety of oral conditions.[12,14] Assessing a child's OHRQoL is critical, as oral health issues have both short-term effects, including eating and sleeping, and long-term repercussions that can hinder social abilities and self-confidence.[3]

Identifying the specific aspects of oral health influencing a child's OHRQoL score can assist oral health professionals in creating a more comprehensive patient care plan to help improve a child's oral health and overall quality of life. Assessing a child's OHRQoL may also help identify emotional and social aspects that caregivers may not be aware of regarding their child's feelings about their oral health. The purpose of this study was to assess the perceived OHRQoL of children at a pediatric hospital, and evaluate the level of agreement between child and caregiver reports of OHRQoL.

Methods

This study was approved by the Boston Children's Hospital Institutional Review Board (IRB #P0028991 and the Massachusetts College of Pharmacy and Health Sciences University (IRB #082518R). Non-probability, purposive sampling was used to recruit children, ages 8-15, and their caregivers from a dental clinic in a pediatric hospital for this quantitative, cross-sectional study. Inclusion criteria for the child sample was limited to children between the ages of 8-15; children identified as having intellectual or developmental disabilities, or children with orthodontic appliances, were excluded. Caregivers under the age of 18 or those with intellectual or developmental disabilities were also excluded from the study population. Children and caregivers who spoke languages other than English, were not excluded. However, they were required to utilize the hospital's interpreter services to complete the questionnaire in order to participate.

The validated COHIP-SF questionnaire was used with permission. The questionnaire was modified with two additional items at the end of the questionnaire. The parallel child and caregiver questionnaires were in English, and contained a total of 22 items. The first 19 items encompassed three subscales: oral health (5 items), functional well-being (4 items), and social emotional well-being (10 items). Items 1-19 were scored using a 5-point Likert-scale ranging from "never" to "almost all of the time." Item 20 was scored using a 5-point Likert-scale with responses ranging from "poor" to "excellent." Item 20, a global health perception item, assessed the perceived overall oral health. Since this item was highly correlated with the previous COHIP items (1-19) it was excluded from the overall OHRQoL score. Overall scores ranged from 0-76 with higher scores is indicative of a more positive OHRQoL, and lower scores indicative of a lower OHRQoL.

Additional items, 21-22, assessed the level of child/caregiver agreement and were used as a focal point to draw assumptions and conclusions regarding levels of agreement. These questions were added to address the gaps suggested in the literature regarding possible variables impacting child-caregiver agreement, aiding researchers in gaining a better understanding of how much children and their caregivers believe that they are in agreement with one another.

COHIP-SF item 21 addressed how similar the child or caregiver thought their responses would be to one another. Caregivers were asked, "On a scale of 1-10 how similar do you think your child's responses will be to your responses on the questionnaire?" Caregiver responses were based on a numerical scale of 1-10, with 1 being no similarity, and 10 being the same. Similarly, children were asked, "Do you think that your caregiver (mom, dad, or legal guardian) gave the same answers as you on the COHIP questionnaire?" To adjust for age appropriate comprehension, child responses included: yes, no, maybe, and unsure. Item 22 questioned how confident the child or caregiver was regarding their response to the previous question. Children's responses ranged from "I'm extremely sure" to "I'm not sure at all". Caregiver responses ranged from "25% confident" to "100% confident." Caregivers were also asked to provide demographic information including their age, relationship to their child, and their ethnicity as well as their child's age, gender, and ethnicity.

This study also included a review of dental chart records. Items assessed from chart data included number of decayed surfaces (DS), overjet (OJ), and overbite (OB). The number of DS at the most recent dental visit and the amount of OJ were chosen as clinical variables of interest to be consistent with one of the first reliability and validity studies of the COHIP questionnaire.[16] The additional variable, OB, was added to the chart review as a means of assessing the impact of OB in relationship to a child's QoL score. Previous research has suggested that repercussions of oral and craniofacial conditions can impact children's overall well-being.[11]

Both children and their caregivers were approached for potential recruitment during their scheduled dental care appointments. A scripted dialogue was presented to eligible child patients and their caregivers to gain consent to participate. Documentation was obtained from caregiver's acknowledging their consent to take part in the study and providing permission to allow their child to participate. A separate assent procedure was used for child participants.

The respective forms of the COHIP-SF were then distributed to the child participant and their caregiver. All participants were provided with verbal and written instructions describing how to complete the questionnaires. Definitions of quality of life and oral health-related quality of life were explained to the participants. Children and their respective caregiver completed the questionnaires in the same room. However, all participants were required to complete the questionnaires independently. All participants were encouraged to ask the principal investigator (PI) for clarification, as necessary. Participants were directed to read each item and choose the most appropriate answer that represented their respective experiences in regards to their teeth, face, or mouth, over the past three months.

Data were analyzed using SPSS23 software (IBM; Armonk, NY). Tests of association included Pearson correlations. A test of internal reliability, Cronbach's alpha, assessed the interrelationships of the items for each subscale. A Wilcoxon

Signed Rank test was used to compare caregiver and child OHRQoL responses. Alpha levels of .05 and 95% confidence intervals (95%CI) were used for hypothesis testing. Linear regression was used to determine the predictive relationship between subscales of caregiver and child responses.

Results

A total of 60 child-caregiver pairs participated in the study (n=120). Pediatric participants included males (n=27, average age of 10.7 years) and females (n=33, average age of 10.6 years) who primarily self-identified as Hispanic/Latino (45%) and African American (31%). The caregiver sample population was predominately mothers (n=46, average age of 41.7 years) and fathers (n=14), average age of 36.8 years.

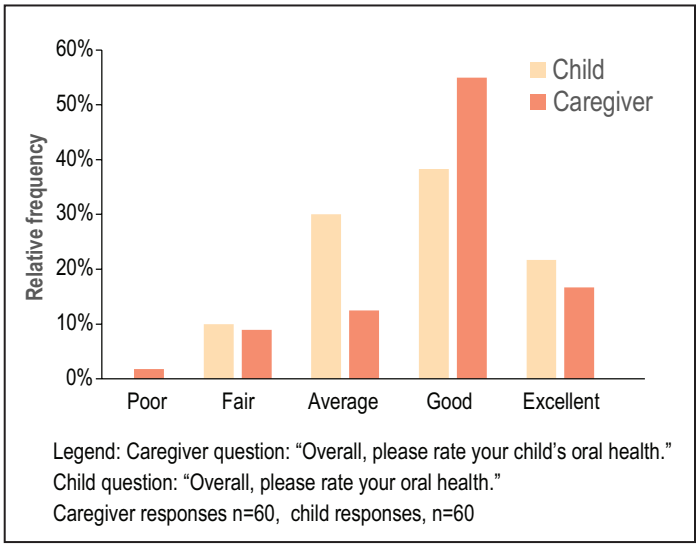
COHIP-SF quality of life (QoL) Likert scales for each question were coded as: 0=almost all of the time, 1=fairly often, 2=sometimes, 3=almost never, and 4=never. Items 8 and 15 were reverse coded for interpretation to equate higher values with increased QoL. Internal reliability for each of the children's COHIP-SF subscales was found to be poor (oral health, Cronbach's=.60, functional well-being, Cronbach's=.61, socio-emotional well-being, Cronbach's=.63), as well as the caregivers' subscales (oral health, Cronbach's=.66, functional well-being, Cronbach's=.36, socio-emotional well-being, Cronbach's=.63). Therefore, all analyses were conducted at the item level or for the total QoL score, which was normally distributed.

Slightly less than one-third of the children (n=18, 30%) said they had crooked teeth or spaces between their teeth and slightly more than one-third of the caregivers (n=21, 36%) agreed. One-third (n= 20; 33%) of the children agreed they had been confident because of their teeth, mouth, or face almost all of the time or fairly often, while more than one-third of the caregivers (n=21, 39%) agreed. Similarly, a little more than one-third of the children (n=21, 36%) felt they were attractive because of their teeth, mouth or face as compared to over one- half of their caregivers (n=35, 58%). Nearly three-quarters of the caregivers rated their child's oral health as good or excellent, as compared a little more than one-half with their children. Frequencies associated with each COHIP-SF item response for children and caregivers are displayed in Table I.

All questions were summed for children and caregivers to create new variables for the total QoL score and then averaged to create the mean QoL per question. Overall, the children's total QoL mean score was 59.1 (SD=9.5), with an average of 3.1 (SD=.5). The caregiver's total QoL score was higher than their child's (M=63.0, SD=7.81), with an average QoL of 3.3 (SD=.4). A Wilcoxon Signed Rank test of means, showed that the mean total QoL score between caregivers and children was significantly different (z=-.2.4, p=.02). Spearman's rank order test was used to test the relationship between each indication of oral health percentage, overbite OB, OJ, and number of decayed surfaces DS, and the average QoL scores for children, parents, and agreement. Children with no oral health problems reported similar OHRQoL as compared to those with oral health problems. All tests of correlation were non-significant (p>0.05), indicating no relationships were found between oral health indicators and QoL scores.

When asked how often they believed that their caregiver agreed with their responses on the COHIP-SF, 27% of the children (n=16) indicated fairly often, 7% (n=4) said sometimes, 48% (n=29) said almost never, and 18% (n=11) said never. Caregivers were asked to rate how similar they thought their answers would be to those of their child on a range from 1 (not similar at all) to 10 (very similar). On the average, caregivers thought that their answers would be similar to their child's (M=7.5, SD=2.3). Spearman's rank order test was used to test the relationship between responses to overall oral health questions, as well as OB, OJ, DS, and average QoL scores for children, parents, as well as agreement. Children with no oral health problems had reported similar OHRQoL compared to those with oral health problems. All tests of correlation were non-significant (p>0.05), indicating no relationships between oral health indicators and QoL scores. Child and caregiver responses to the questions about regarding oral health are shown in Figure 1.

Figure 1. Relative frequency of child and caregiver responses rating oral health



Legend: Caregiver question: "Overall, please rate your child's oral health."
Child question: "Overall, please rate your oral health."
Caregiver responses n=60, child responses, n=60

Table I. COHIP-SF OHRQoL responses

	Almost all of the time		Fairly Often		Sometimes		Almost Never		Never	
COHIP Item	***Child**	****Parent**	***Child**	****Parent**	***Child**	****Parent**	***Child**	****Parent**	***Child**	****Parent**
1. Had pain in your teeth/toothache.	0	2 (3.3%)	1 (1.7%)	3 (5.0%)	22 (36.7%)	8 (13.3%)	11 (18.3%)	11 (18.3%)	26 (43.3%)	36 (60.0%)
2. Had crooked teeth or spaces between your teeth.	12 (20.0%)	14 (24.1%)	6 (10.0%)	7 (12.1%)	15 (25.0%)	12 (20.7%)	8 (13.3%)	4 (6.7%)	19 (31.7%)	21 (35.0%)
3. Had discolored teeth or spots on your teeth.	0 (0)	2 (3.4%)	3 (5.0%)	4 (6.9%)	9 (15.0%)	6 (10.3%)	13 (21.7%)	7 (12.1%)	35 (58.3%)	39 (65.0%)
4. Had bad breath.	2 (3.4%)	1 (1.7%)	3 (5.0%)	2 (3.3%)	19 (32.8%)	20 (33.3%)	18 (31.0%)	15 (25.0%)	16 (27.6%)	22 (36.7%)
5. Had bleeding gums.	2 (3.3%)	1 (1.7%)	1 (1.7%)	2 (3.4%)	15 (25.0%)	12 (20.3%)	15 (25.0%)	12 (20.3%)	27 (45.0%)	32 (54.2%)
6. Been unhappy or sad because of your teeth, mouth, or face.	0	0	1 (1.7%)	4 (6.7%)	11 (18.3%)	6 (10.0%)	12 (20.0%)	9 (15.0%)	36 (60.0%)	41 (68.3%)
7. Missed school for any reason because of your teeth, mouth, or face.	0	1 (1.7%)	2 (3.3%)	0	8 (13.3%)	2 (3.3%)	4 (6.7%)	2 (3.3%)	46 (76.7%)	55 (91.7%)
8. Been confident because of your teeth, mouth or face.	14 (23.3%)	17 (28.3%)	6 (10.2%)	6 (10.2%)	16 (26.7%)	9 (15.3%)	7 (11.7%)	11 (18.6%)	17 (28.3%)	16 (27.1%)
9. Had difficulty eating foods you would like to eat because of teeth, mouth, or face.	2 (3.4%)	1 (1.7%)	2 (3.4%)	1 (1.7%)	12 (20.3%)	7 (11.7%)	6 (10.2%)	9 (15.0%)	37 (62.7%)	42 (70.0%)
10. Felt worried or anxious because of your teeth, mouth, or face.	4 (6.7%)	1 (1.7%)	2 (3.3%)	2 (3.3%)	8 (13.3%)	6 (10.0%)	9 (15.0%)	10 (16.7%)	37 (61.7%)	41 (68.3%)
11. Not wanted to speak/ read out loud because of teeth, mouth, or face.	1 (1.7%)	0	2 (3.3%)	0	5 (8.3%)	2 (3.3%)	6 (10.0%)	4 (6.7%)	46 (76.7%)	54 (90.0%)
12. Avoided smiling or laughing with other children because of your teeth, mouth, or face.	2 (3.3%)	0	2 (3.3%)	0	6 (10.0%)	3 (5.1%)	7 (11.7%)	8 (13.6%)	43 (71.7%)	48 (81.4%)
13. Had trouble sleeping because of your teeth, mouth, or face.	0	0	1 (1.7%)	1 (1.7%)	3 (5.1%)	1 (1.7%)	8 (13.3%)	2 (3.3%)	47 (79.7%)	55 (93.2%)
14. Been teased, bullied or called names by other children because of your teeth, mouth, or face.	0	0	1 (1.7%)	1 (1.7%)	1 (1.7)	3 (5.0%)	3 (5.0%)	3 (5.0%)	54 (90.0%)	53 (88.3%)
15. Felt that you were attractive (good looking) because of your teeth, mouth or face.	16 (27.1%)	32 (53.3%)	5 (8.5%)	3 (5.0%)	13 (22.0%)	10 (16.7%)	12 (20.3%)	10 (16.7%)	13 (22.0%)	5 (8.3%)
16. Felt that you look different because of your teeth, mouth or face.	1 (1.7%)	0	2 (3.3%)	2 (3.3%)	9 (15.0%)	5 (8.3%)	5 (8.3%)	6 (10.0%)	43 (71.7%)	47 (78.3%)
17. Had difficulty saying certain words because of your teeth, mouth, or face.	1 (1.7%)	0	1 (1.7%)	0	6 (10.0%)	1 (1.7%)	5 (8.3%)	1 (1.7%)	47 (78.3%)	58 (96.7%)
18. Had difficulty keeping your teeth clean.	2 (3.3%)	0	1 (1.7%)	4 (6.7%)	20 (33.3%)	15 (25.0%)	15 (25.0%)	16 (26.7%)	22 (36.7%)	25 (41.7%)
19. Been worried about what other people think about your teeth, mouth or face.	2 (3.3%)	1 (1.7%)	3 (5.0%)	2 (3.3%)	13 (21.7%)	5 (8.3%)	5 (8.3%)	8 (13.3%)	37 (61.7%)	44 (73.3%)

*child (n=60); **parent/caregiver (n=60)

Caregiver/Child Agreement

Caregiver and child agreement on COHIP-SF items were assessed by exploring the bi-variate relationships with correlations, item level, and overall differences. Participant responses were positively correlated with the following items: "Had difficulty eating foods you would like to eat because of your teeth, mouth or face" (r=.41, p<.001), "Missed school for any reason because of your teeth, mouth, or face" (r=.42, p<.001), and "Overall, please rate your/your child's oral health?" (r=0.40, p<0.001). Caregiver and child correlations between COHIP-SF items and the overall oral health item are shown in Table II.

Table II. Correlations between caregiver and child responses (n=60)

COHIP-SF items	Pearson's Correlation
Had pain in your teeth/toothache.	.31*
Had crooked teeth or spaces between your teeth.	.33*
Had discolored teeth or spots on your teeth.	.34**
Had bad breath.	.36**
Had bleeding gums.	.36**
Been unhappy or sad because of your teeth, mouth, or face.	.37**
Missed school for any reason because of your teeth, mouth, or face.	.42**
Been confident because of your teeth, mouth or face.	-.03
Had difficulty eating foods you would like to eat because of your teeth, mouth or face.	.41**
Felt worried or anxious because of your teeth, mouth, or face.	.24
Not wanted to speak/ read out loud in class because of your teeth, mouth, or face.	.09
Avoided smiling or laughing with other children because of your teeth, mouth, or face.	.10
Had trouble sleeping because of your teeth, mouth, or face.	.18
Been teased, bullied or called names by other children because of your teeth, mouth, or face.	.31*
Felt that you were attractive (good looking) because of your teeth, mouth or face.	.13
Felt that you look different because of your teeth, mouth or face.	-.04
Had difficulty saying certain words because of your teeth, mouth, or face.	.14
Had difficulty keeping your teeth clean.	.09
Been worried about what other people think about your teeth, mouth or face.	.02
Overall, please rate your oral health.	.40**

*p<.05, **p<.001

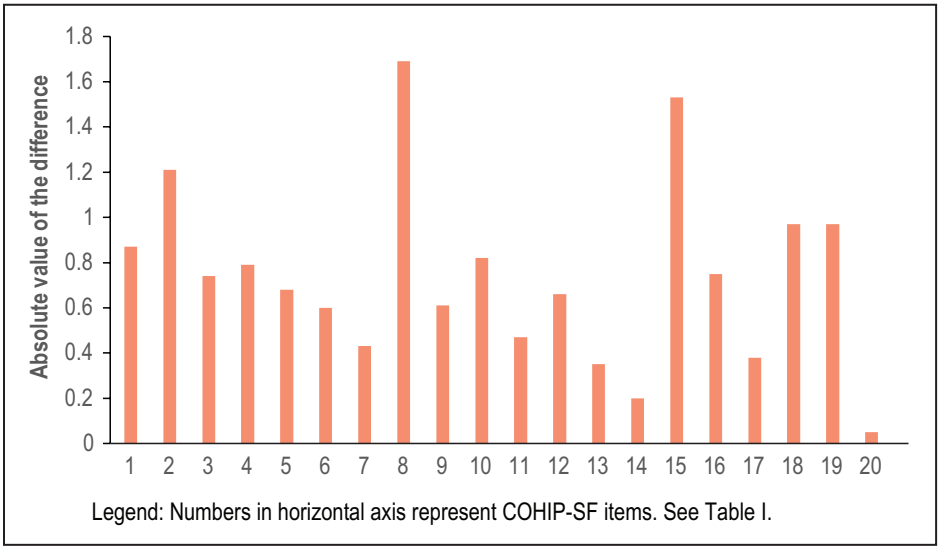
The amount of difference between a caregiver and child score was calculated as $Score_d = Score_p - Score$. Overall differences between caregivers and children across all 19 items were calculated by using the absolute value. The overall difference is a normally distributed variable, with an average of 14.5 (SD=6.8). The average total QoL score for caregivers (M=63.0, SD=7.8) was higher than the children's (M=59.1, SD=9.5) score (Wilcoxon Signed Rank, z=-2.4, p=.02, r=.33). The effect size indicated a medium effect according to Cohen's convention. The degree of the caregivers over or underestimation of their child's responses was further examined at the item level. Evaluating differences using the original value instead of the absolute value allowed identification of items caregivers tended to overestimate, underestimate, or agree with their children on average. Figure 2 shows the total differences for each item.

Potential predictors of differences between caregiver and child responses were evaluated using linear regression. The sum total differences between items was regressed onto caregiver age, gender of child, child's rating of how similar their caregivers' responses would be to theirs, and the caregiver's rating of the same. The model was a good fit for the data (R^2=.26, F(4, 58)=4.7, p=.002) with gender (β=.32, p=.01), child similarity (β=-.24, p=.05), and caregiver similarity (β=.37, p=.003) as significant predictors. Caregiver age was not a significant predictor (β=.08, p=.53).

A Wilcoxon sign rank test was conducted to further explore the role of gender in relationship to differences in caregiver/child responses, Females had significantly higher (z=-2.4, p=.02) average difference scores (M=6.5, SD=8.3) than male children, (M=.81, SD=10.5) with a medium effect size r=.30. The positive value from the

average female difference indicates caregivers responded with a higher rating of quality of life than their female children, possibly over estimating their child's self-reported QoL.

Figure 2. Absolute value of difference scores for each item of the COHIP-SF between parent/caregiver and child.



Legend: Numbers in horizontal axis represent COHIP-SF items. See Table I.

Discussion

Caregiver and child ratings correlated on almost all questions with a medium effect, a finding consistent with previous studies comparing caregiver/child agreement using the standard COHIP questionnaire.[13,14] Items with the strongest correlations were considered to be more objectively verifiable, such as missing school for any reason or having difficulty eating foods you would like to eat, because of your teeth, mouth or face. In contrast, some items related to social or emotional aspects of QoL did not show any correlation, such as being confident or feeling that you are attractive (good looking) because of your teeth, mouth or face. These findings are of interest as it may be possible that caregivers respond more accurately to their child's responses on items that are portrayed as more physical versus emotional, or regarding the child's own feelings.

Caregivers in this study were more likely to overrate their child's OHRQoL. The greatest areas of disagreement were noted in regard to confidence and feeling attractive because of one's teeth, mouth and face. This lack of correlation may be due to dissimilar viewpoints between children and caregivers. Furthermore, caregivers may be unaware of the specific aspects of oral health that are impacting their child's wellbeing. Caregivers may also overestimate the social elements of their child's OHRQoL, while they have agreement regarding aspects that can be visibly seen (i.e. spaces, or discolorations).

There were significant differences of agreement between caregivers and the gender of their child. Male children and their caregivers had a fairly high agreement, however female children and their caregivers had significantly lower levels of agreement. Caregiver's overestimated their female child's QoL by an average of 6.46 points of difference, meaning that female children rate their own QoL significantly lower than their caregiver's, as compared to their male cohorts. This finding is similar to those of a study by Broder et al. suggesting that female children with craniofacial clefts may report a lower OHRQoL during adolescence due to body image and self-esteem issues.[15] Although the inclusion criteria for this study differed from that of Broder et al.,[15] the findings associated with gender are similar. Gender disagreement is likely impacted by female children reporting a significantly lower OHRQoL, as consistency was demonstrated with male child and caregiver agreement. Additional studies should focus on female children and on psychological changes throughout childhood and into adolescence (i.e. body image, self-esteem), to further analyze discrepancies found between female and male children, and their caregivers.

This study indicated that children with multiple DS and greater amounts of OB and OJ reported similar OHRQoL as compared to those with no DS and lesser amounts of OB and OJ. No significant differences were found regarding OB, OJ, and DS in relation to QoL variables, including caregiver and child ratings and caregiver/child overall agreement. These findings are in contrast to those of Broder et al. who found that children with higher numbers of DS and greater OJ reported lower OHRQoL.[16] No significant differences were identified between the clinical variables in this study, suggesting that dental issues such as DS, OB, and OJ, do not strongly influence a child's reported QoL. This finding may support the conclusion that OHRQoL reports from children may rely more on psychological and emotional elements versus physical disease or irregularities. However, because this study did not assess other clinical variables, such as filled surfaces or missing teeth, it is unknown if other significant differences exist. Future studies to investigate psychological/emotional versus physical associations with OHRQoL among children should be explored.

This study had limitations. Data was only collected from one location site, lending itself to purposive sampling and a smaller sample size. Additionally, self-reporting and volunteer bias may have occurred, limiting the external reliability of findings. This was the first study to assess child/caregiver agreement specifically with the COHIP-SF, therefore the results could only be compared to previous studies utilizing the original COHIP survey instrument. Unlike previous COHIP research, this study focused on pediatric children in general, rather than children with craniofacial and orthodontic conditions. The use of dental charts to assess oral conditions was another limitation. Oral examinations conducted by calibrated examiners may have produced more accurate and comprehensive clinical data. The exclusion of clinical variables such as filled and missing teeth limited the study findings. However, this was not an oversight, but a decision based on limitations found in the dental chart review process.

Conclusion

Results from this study suggest that caregivers may not accurately report their child's actual OHRQoL. The moderate level of agreement found between children and caregivers reinforces the importance of including the child, as well as the caregiver, when assessing OHRQoL. Gender differences and clinical variables should be further explored to determine their impact on OHRQoL and caregiver/child concordance. Assessing the level of agreement between the child and caregiver should be considered for inclusion in future studies utilizing the COHIP-SF.

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Renee Wall, MS, RDH is a graduate of the Forsyth School of Dental Hygiene, MCPHS University, Boston, MA; ***Lori Rainchuso, DHSc, MS, RDH*** is an associate professor, School of Healthcare Business, Doctor of Health Sciences Program, MCPHS University, Boston, MA; ***Jared Vineyard, PhD*** is a post-doctoral fellow at St. Lukes Applied Research, Boise, ID and adjunct faculty member at MCPHS University, Boston, MA; ***Lory Libby, MS, RDH*** is an assistant professor, Forsyth School of Dental Hygiene, MCPHS University, Boston, MA.

Corresponding author: Lori Rainchuso, DHSc, MS, RDH; Lori.rainchuso@mcphs.edu

References

1. U.S. Department of Health and Human Services. Oral health in America: a report of the Surgeon General [Internet]. Rockville (MD): U.S. Department of Health and Human Services. 2000 [cited 2019 June17]. Available from: https://profiles.nlm.nih.gov/ps/access/NNBBJT.pdf
2. McGrath C, Broder H, Wilson-Genderson M. Assessing the impact of oral health on the life quality of children: implications for research and practice. Community Dent Oral Epidemiol. 2004 Apr 4; 32(2):81–5.
3. Alzoubi E, Hariri R, Mulligan K, Attard N. An evaluation of oral health related quality of life in orthodontic patients treated with fixed and twin blocks appliances, J Orthod Sci. 2017 Apr-Jun;6(2):65-70.
4. Shisco L, Broder HL. Oral health related quality of life-what, why, how, and future implications. J Dent Res. 2011 Mar 21;90(11):1264–70.
5. Piovesan C, Batista A, Ferreira FV, Ardenghi TM. Socioeconomic inequalities in the distribution of dental caries in Brazilian preschool children. J Public Health Dent 2010 Fall:70(4):319-26.
6. Bennadi D, Reddy CVK. Oral health related quality of life. J Int Soc Prev Community Dent. 2013 Jul 26; 3(1):1–6.
7. Allen PF. Assessment of oral health related quality of life. Health Qual Life Outcomes. 2003 Sep 8;1:40.
8. Gilchrist F, Rodd H, Deery C, Marshman Z. Assessment of the quality of measures of child oral health-related quality of life. BMC Oral Health. 2014 Apr 23;14:1.
9. Genderson M, Sischo L, Markowitz K, et al. An overview of children's oral health-related quality of life assessment: from scale development to measuring outcomes. Caries Res. 2013 Oct 7;47(s1):13–21.
10. Broder HL. Children's oral health related quality of life. Community Dent Oral Epidemiol. 2007 Jul 3;35(S1): 5-7.
11. Mouradian WE. The face of a child: children's oral health and dental education. J Dent Educ. 2001 Sep;65(9): 821–31.
12. Broder HL, McGrath C, Cisneros GJ. Questionnaire development: face validity and item impact testing of the Child Oral Health Impact Profile. Community Dent Oral Epidemiol. 2007 Jul 3;35(s1):8–19.

13. Wilson-Genderson M, Broder HL, Phillips C. Concordance between caregiver and child reports of children's oral health-related quality of life. Community Dent Oral Epidemiol. 2007 Jul 3;35(s1):32–40.

14. Vashisth S, Devi A. An assessment of agreement between child and caregiver's report of child's oral health related quality of life. JCMD. 2015; 4(1):12.

15. Broder HL, Wilson-Genderson M, Sischo L, Norman RG. Examining factors associated with oral health–related quality of life for youth with cleft. Plast Reconstr Surg Glob Open. 2014 Jun;133(6):828e–834e.

16. Broder HL, Wilson-Genderson M. Reliability and convergent and discriminant validity of the Child Oral Health Impact Profile (COHIP Child's version). Community Dent Oral Epidemiol 2007 Aug;35(s1):20–31.

Research

Evaluation of an Automated Digital Scoring System of Dental Plaque

Cindy L Munro, PhD, RN; Zhan Liang, PhD, RN; Nnadozie Emechebe, MPH; Xugheng Chen, MS; Paula L Cairns, PhD, RN; Priyashi Manani, MPH; Lucia Hamilton, BSN, RN; Gwendolyn Good, BSN, RN, RDH; Kevin Kip, PhD

Abstract

Purpose: Measurement of dental plaque is frequently used as an indicator of overall oral health. The purpose of this study was to compare a manual (visual) plaque scoring system (University of Mississippi Oral Hygiene Index, UM-OHI) with an innovative automated digital scoring system.

Methods: Mechanically ventilated, intensive care unit (ICU) patients (n=79) were the study population. Informed consent was given by the subject's legally authorized representative. Digital images of dental plaque were taken using an intraoral camera; and the quantity of dental plaque was scored using the UM-OHI and with a digitized automated scoring system. Distributions of dental plaque scores from both methods were plotted. Pearson correlation coefficients and intra-class coefficients were calculated between the two methods.

Results: Participant mean age was 57.3 years; respiratory failure was the most prevalent admission diagnosis (55.7%). The mean percentage of dental plaque calculated by the manual method was found to be remarkably higher (67.3% $\pm$ 18.7%) than the percentage of dental plaque calculated by the automated scoring method (23.7% $\pm$ 15.2%) (p<0.0001). Despite remarkably different distributions of plaque scores, both the automated and manual scoring systems demostrated relatively high correlation (r=0.62) and good reliability (ICC=0.63).

Conclusion: The automated digital scoring system resulted in a significantly lower overall percentage of total dental plaque as compared to the UM-OHI manual scoring system. While the automated digital scoring system may be more precise than a manual (visual) scoring system, its use should be weighed against the added effort, cost, and expertise required for the method. Further study is needed to determine whether an automated digital scoring system can be commercialized and is warranted for use outside of research settings.

Keywords: dental plaque, plaque indices, ventilated patients, oral hygiene, healthcare acquired infections

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Introduction

Good oral health is associated with maintaining optimal general health.[1] The normal oral flora of healthy individuals includes gram-positive organisms and dental pathogens; good oral hygiene, including brushing and flossing, helps to keep bacteria within the oral cavity under control. In contrast, lack of proper oral hygiene practices leads to an increase in microbial flora within the oral cavity and subsequent dental and periodontal diseases. Abundance of these microbial flora leads to accumulation of dental plaque, a biofilm that provides a microhabitat for organisms with opportunity for adherence either to the tooth surface or to other microorganisms. Organisms in dental plaque ferment carbohydrates within the oral cavity leading to dental caries, contribute to inflammation of the gingiva and underlying tissues, and have a potential for pathogenicity.[2-4] Involvement of underlying tissues within the oral cavity further deteriorate oral health and allow the microbes to enter the blood stream.[5] This can contribute to debilitating general health including endocarditis,[6,7] and has also been associated with a variety of systemic diseases including but not limited to atherosclerosis

and vascular disease,[8-10] poor glycemic control in diabetes,[11] preterm birth,[12] and dementia.[13]

Critically ill, hospitalized patients are susceptible to hospital-acquired infections which may be related to poor oral health.[14,15] Oral health in the intensive care unit (ICU) may be compromised by ICU equipment, medical conditions or treatments, and the patient's inability to attend to their own self-care.[16] Within 48 hours of hospital admission, the composition of oral flora in the critically ill adult can change to predominantly gram-negative and virulent gram-positive organisms, including the potential ventilator associated pneumonia (VAP) pathogens *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Acinetobacter baumanii*, *Haemophilus influenzae* and *Pseudomonas aeruginosa*.[16-18] Moreover, the risk of developing pneumonia is 6-20 fold higher in ventilated as compared to non-ventilated ICU patients,[16,19] with the highest risk occurring early in the course of hospitalization.[20,21]

Mechanically ventilated hospitalized patients are dependent upon ICU nurses to perform their oral hygiene due to their critical illness.[14] The placement of endotracheal and other tubes through the oral cavity, puts these patients at high risk for aspiration and subsequent VAP. Oral care administered by ICU nurses in ventilated patients includes effective elimination of evolving gram-negative organisms and prevention of overall bacterial growth in the mouth.[22-25] ICU nurses also provide a variety of oral interventions designed to address patients' comfort, rather than solely focusing on oral hygiene and dental plaque removal.[16,26-28] Oral care intervention research in the ICU has been challenged due to the complicated nature of measuring dental plaque in critically ill, mechanically ventilated subjects, which has prompted this particular investigation of a valid and reliable asynchronous automated plaque scoring system.

Measurement of dental plaque is frequently used as an indicator of overall oral health. Quantification of dental plaque is critically important in clinical practice, as well as in research studies. Commonly used visual scoring systems of dental plaque include: University of Mississippi Oral Hygiene Index (UM-OHI),[29] Oral Hygiene Index (OHI),[30] Simplified Oral Hygiene Index (OHI-S),31 Turesky Plaque Index,[32] and Silness and Loe Index.[33] While all of these instruments are relatively straightforward to use in terms of assessing oral health, limitations on evaluating plaque levels exist, including variable number of teeth that are assessed, the relatively crude coding of binary values of 0 (No) and 1 (Yes) for tooth segments, the presence versus absence of plaque, the subjective nature of the process, the lack of reliability within and between assessors, personnel burden, and differing plaque level scoring properties.

The purpose of this study was to compare the psychometric properties of an automated versus a more traditional manual plaque scoring method (UM-OHI) to gain insight into whether an automated method may be warranted for both research and clinical practice purposes.

Methods

Data used in this cross-sectional analysis are from a subgroup of critically ill, mechanically ventilated patients (n=79) enrolled in a prospective, randomized controlled trial designed to determine the optimal frequency (once, twice, or three times daily) of ICU nurse delivered tooth brushing. Informed consent was obtained from the subject's legally authorized representative, in accordance with the University of South Florida IRB approval process (Pro 00016479). The first research aim of the parent clinical trial, was to evaluate the clinical equivalence (non-inferiority) of three tooth brushing frequencies on oral health (dental plaque and mucosal inflammation). All tooth brushing interventions were delivered by study personnel using a standardized tooth brushing protocol, performed with a compact head adult tooth brush and Biotene® (GSK; Philadelphia, PA) fluoride toothpaste.[34] Subjects received scheduled toothbrushing interventions for the first 7 days of intubation, or until extubation within a 7-day period. All subjects received standard clinical care for mechanically ventilated patients, as per clinical and agency guidelines.[35] The trial was registered at Clinical Trials.gov (NCT02289131); a detailed description of the parent study protocol has been previously published.[36]

Dental plaque assessment

Digital images of all teeth (buccal and lingual) were obtained with the use of an intraoral camera (Soprocare, Acteon Inc.; Mount Laurel, NJ). For this study, dental plaque levels were assessed from the digital images in two ways. The first method utilized the well-established UM-OHI instrument (as specified in the parent study protocol) and was completed by the same dental hygienist. The dental hygienist evaluator was experienced in evaluating oral health of critically ill mechanically ventilated patients. Concurrently, a software code was used to obtain and score images of every tooth. Both methods used video and photographs taken of the subject's entire oral cavity while in the ICU. Assessment was blinded by random group assignment. No disclosing dyes were used in either scoring system; the intraoral camera included fluorescence and chromatic amplification to highlight dental plaque.

Manual plaque assessment scoring procedure

The UM-OHI had been selected as the manual, visual plaque scoring method for the parent study because every available tooth in the mouth is scored as compared to certain representative teeth as in other plaque scoring systems. The dental hygienist evaluator reviewed digital photos of the oral cavity, divided into 12 regions: left and right posterior teeth and anterior teeth in each arch, further subdivided into buccal and lingual surfaces.[29] Each individual digital photo was divided into five sections for the buccal and lingual surfaces and included the mesial, distal, and middle sections which were further subdivided horizontally into gingival, middle, and occlusal sections. Each section, a total of 10 per tooth, was scored for presence or absence of plaque. If a section was determined to have plaque present, it was scored as 1; if no plaque was present, the section received a value of 0. Each tooth was scored from 0 (no plaque in any section) to 10 (plaque in every section). The mean plaque score for the subject was calculated by dividing the total score by number of teeth.

Automated plaque assessment scoring procedure

A patented, algorithm-based, automated scoring system was used to quantify extent of dental plaque. The automated system used video and photographic images, selected based on overall clarity, from digital images taken with an intraoral camera of all teeth (buccal and lingual surfaces).[37] Specifically, all images used in the assessment had a 640*480 resolution, and were cropped to leave only the tooth in the picture. The final cropped image had at least 10,000 pixels in resolution and was imported into a computer software program which scored the value of a specific pixel to produce a three-dimension point (x, y, z) that uniquely defined the color of the pixel. The software used two digits for each color dimension and each digit used a hexadecimal system to count the numbers. There were 256 possible values to score each color dimension. Since plaque typically presents as yellow in color, the automated scoring system was developed and used to judge whether each pixel should be classified as yellow (plaque) or not (no plaque).

To identify the right combination of the three colors leading to the determined yellow color, the color dimension was divided into four categories: (0,64), (64,128), (128,192), (192,255). These four categories were chosen with the rationale of being an acceptable balance between accuracy and computational difficulty and there were 4*4*4 = 64 categories in total. Next, the middle point of each range was chosen, namely 32, 96, 160, 224, and used the color of that specific combination to represent the color for that category. For example, for the category (0,64) in red, (0,64) in blue and (0,64) in green, the color point, 32 in red, 32 in blue, and 32 in green was used to represent the color for that category. After scoring all 64 categories, several common properties shared by categories were identified as yellow. These properties included: value of the red dimension must be between 0.75 to 2.5 times the value of the green dimension; the value of both the green and red dimensions must be at least 1.2 times of the value of the blue dimension; and the value of the red dimension must be at least 60. Therefore, if values of the pixel met these requirements, they were classified as yellow (plaque), otherwise they were classified as non-yellow (normal). From the binary results of each pixel, the percentage of yellow (dental plaque) was calculated by the number of yellow pixels divided by the total number of pixels in the picture. Selected examples of this coding system are depicted in Table I.

Statistical Analysis

Demographic and clinical characteristics of the patient sample were described using means and standard deviation (SD) for continuous variables and percentages for categorical variables. The distribution of dental plaque scores along with their interquartile range and the 5th and 95th percentiles from both scoring methods were plotted side-by-side and mean differences were compared using paired *t* tests. Analyses were also stratified by period of assessment (during intervention vs. post-extubation), number of pictures used for automated scoring (<15 vs. ≥15), and number of pixels used for automated scoring (<150,000 vs. ≥150,000). Pearson correlation coefficients were calculated between manual and automated dental plaque scores, including stratified analyses. Furthermore, the intra-class coefficient (ICC) was computed between both methods using their respective transformed z-score values. Finally, a Bland-Altman plot was constructed to examine the manner (direction and magnitude) in which dental plaque scores differed between the manual and automated scoring methods. A 2-sided *p*-value of <0.05 was used to define statistical significance for all analyses and 95% confidence intervals for the mean difference were reported. The sample size (n=79) was based on the goal of having a minimum of 50 subjects with non-missing data for reliable estimation of correlation coefficients and confidence intervals. Methods and results are presented using the strengthening the reporting of observational studies in epidemiology (STROBE) guidelines for reporting observational studies.

Results

The patient sample consisted of critically ill, intubated ICU patients (n=79), with a mean age of 57.3 (SD=16.5), Sample population demographics are shown in Table II. The most prevalent admission diagnosis was respiratory failure (55.7%), and sepsis was present in 24.1% of the sample. The mean

Table I. Examples of color system used in automated dental plaque scoring method

Normal	Normal	Normal	Normal
Normal	Normal	Normal	Normal
Normal	Normal	Normal	Normal
Normal	Normal	Normal	Normal
Normal	Normal	Normal	Normal
	Normal	Normal	Normal
Normal	Normal	Normal	Normal
Normal	Normal	Normal	Normal
Normal	Normal	Normal	Normal
	Normal	Normal	Normal
		Normal	Normal
Normal	Normal	Normal	Normal
Normal	Normal	Normal	Normal
	Normal	Normal	Normal
		Normal	Normal
			Normal

Table II. Patient demographic and cinical characteristics (n=79)

Characteristic	Prevalence (%)
Age in years	
18 to 49	34.2
50 to 59	11.4
60 to 69	26.6
70 to 79	19.0
80 or older	8.9
Female gender	43.0
Race and presenting conditions	
White	67.1
Black/African American	19.0
Other	13.9
Hispanic ethnicity	12.7
History of smoking	50.6
History of diabetes	34.2
Bacteremia present	7.6
Sepsis present	24.1
Antibiotic therapy >=48 hrs-past 10 days	56.6
Location of ICU admission	
Medical	67.9
Surgical/trauma	10.3
Neurological	21.8
Reason for intubation	
Airway control: AMS or procedure	22.8
Hypoxemic Respiratory failure	55.7
Both hypoxemic & vent failure	10.1
Respiratory distress: high work	11.4
Intubation status	
Elective: no patient distress	16.5
Urgent: non-elective	38.0
Emergent: immediate	45.6
Discharge outcome/location	
Home	39.2
Rehabilitation center	5.1
Assisted living facility	17.7
Expired	38.0

number of decayed/missing/filled teeth (DMFT score) was 13.7 (SD= 9.4) and was distributed as follows: decayed: (2.2 ± 3.0); missing (7.4 ± 7.6); filled (4.0 ± 4.5). Patient mortality during the ICU stay was 38%, and the mean Acute Physiology and Chronic Health Evaluation (APACHE-IV) score[38] was 70.6 ± 20.3.

Calculation of Automated Digital Plaque Scores

The number of pictures used in the automated digital plaque scoring (based on clarity and number of teeth assessed) was highly variable and ranged from 2 to 58, with a mean of 13.5 (SD= 8.9) and a median of 13 (IQR=10). The total number of pixels used in the automated digital plaque scoring ranged from 10,272 to 586,433 with mean of 139,778 (SD= 93,229) and median value of 130,130 (IQR= 105,801). The Spearman rank correlation between the number of pictures and pixels evaluated was 0.96, indicating a near perfect correlation, with a mean of 10,391 ± 2,159 pixels evaluated per tooth.

Comparison of Plaque Scoring Methods

Plaque assessment distribution by scoring method (manual vs. automated) and stratified by subgroups are shown in Figure 1. As depicted, dental plaque scores calculated by the manual method were remarkably higher (mean = 67.3 ± 18.7) than those calculated by the automated scoring method (mean = 23.7 ± 15.2). The mean difference between manual and automated dental plaque scores was 43.6 (95% confidence interval: 40.2 – 46.9, $p<0.0001$). In stratified analyses, the disparity between manual and automated dental plaque scores was most evident for the subjects (n=32) whose automated assessment involved ≥15 pictures (mean difference = 47.8 95% confidence interval: 44.1 – 51.6, $p<0.0001$), and the subjects (n=32) whose automated assessment involved 150,000 or more pixels (mean difference =

Figure 1. Plot of distributions of total dental plaque scores using the manual (UM-OHI) assessment method (fully shaded rectangles) and the automated digital scoring method (partially shaded rectangles).

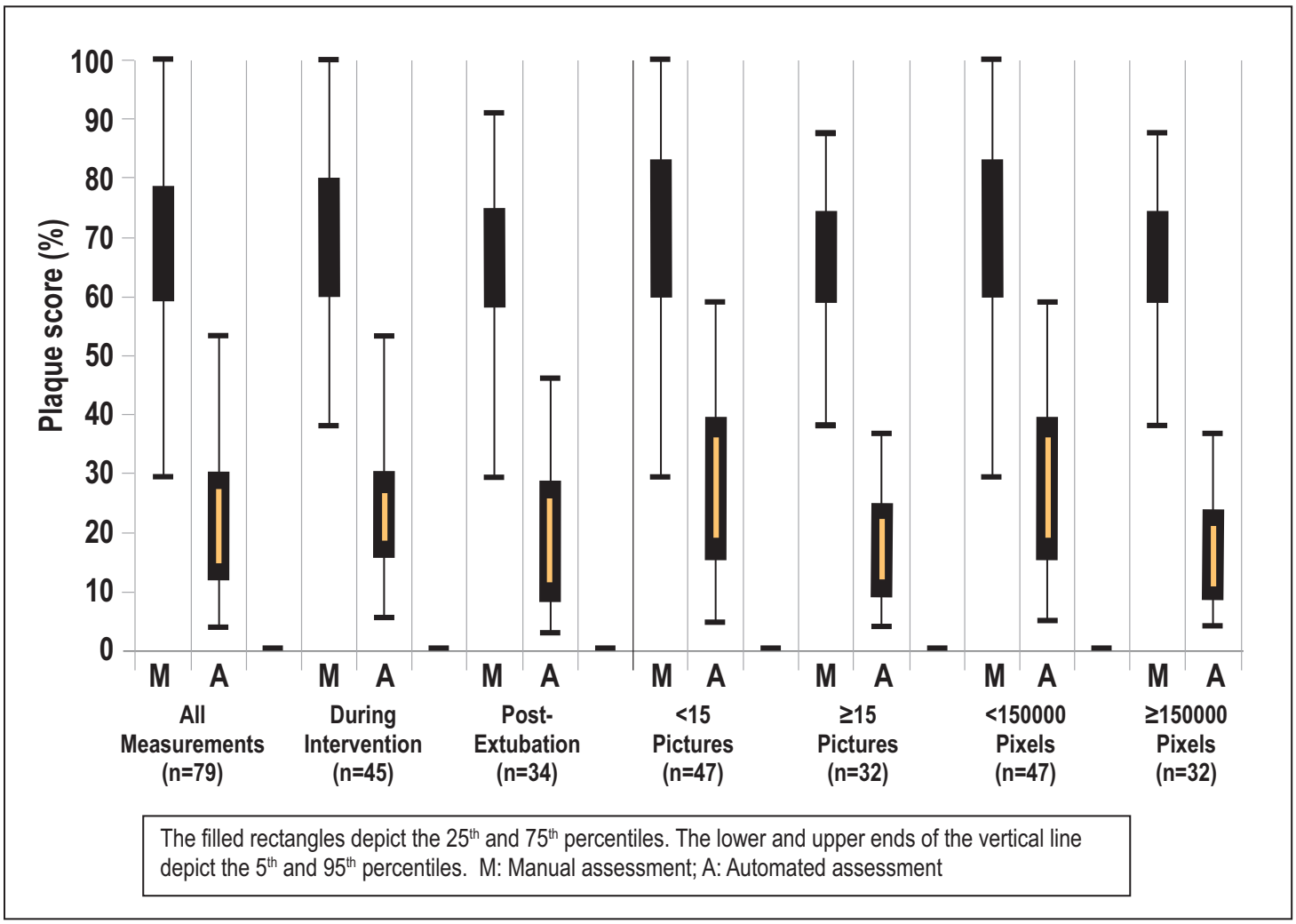
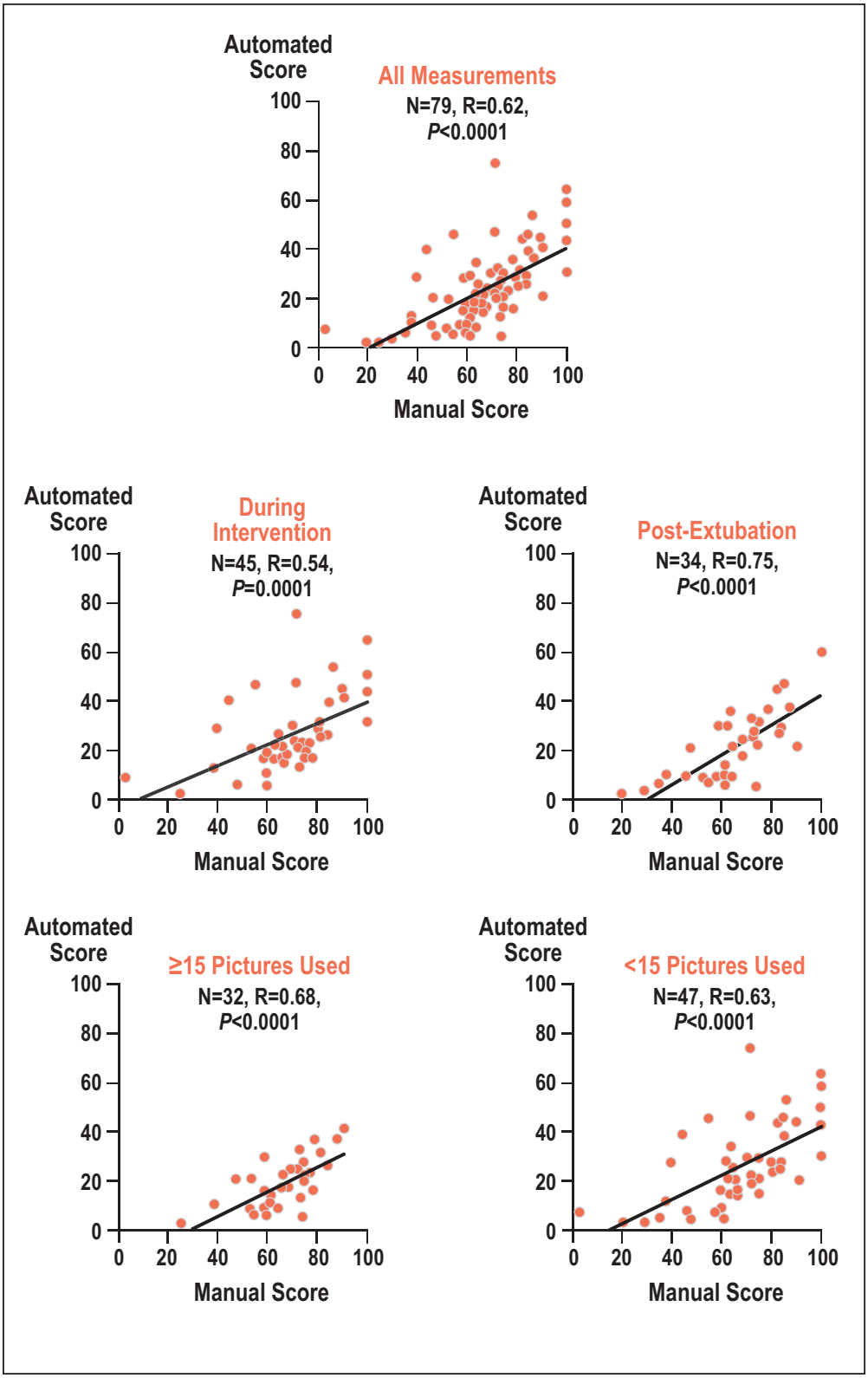


Figure 2. Plot of manual dental plaque scores (x-axis) by automated dental plaque scores (y-axis), including best fitting regression line. The upper figure depicts all participants; middle and lower left and right figures depict results for selected patient subgroups.

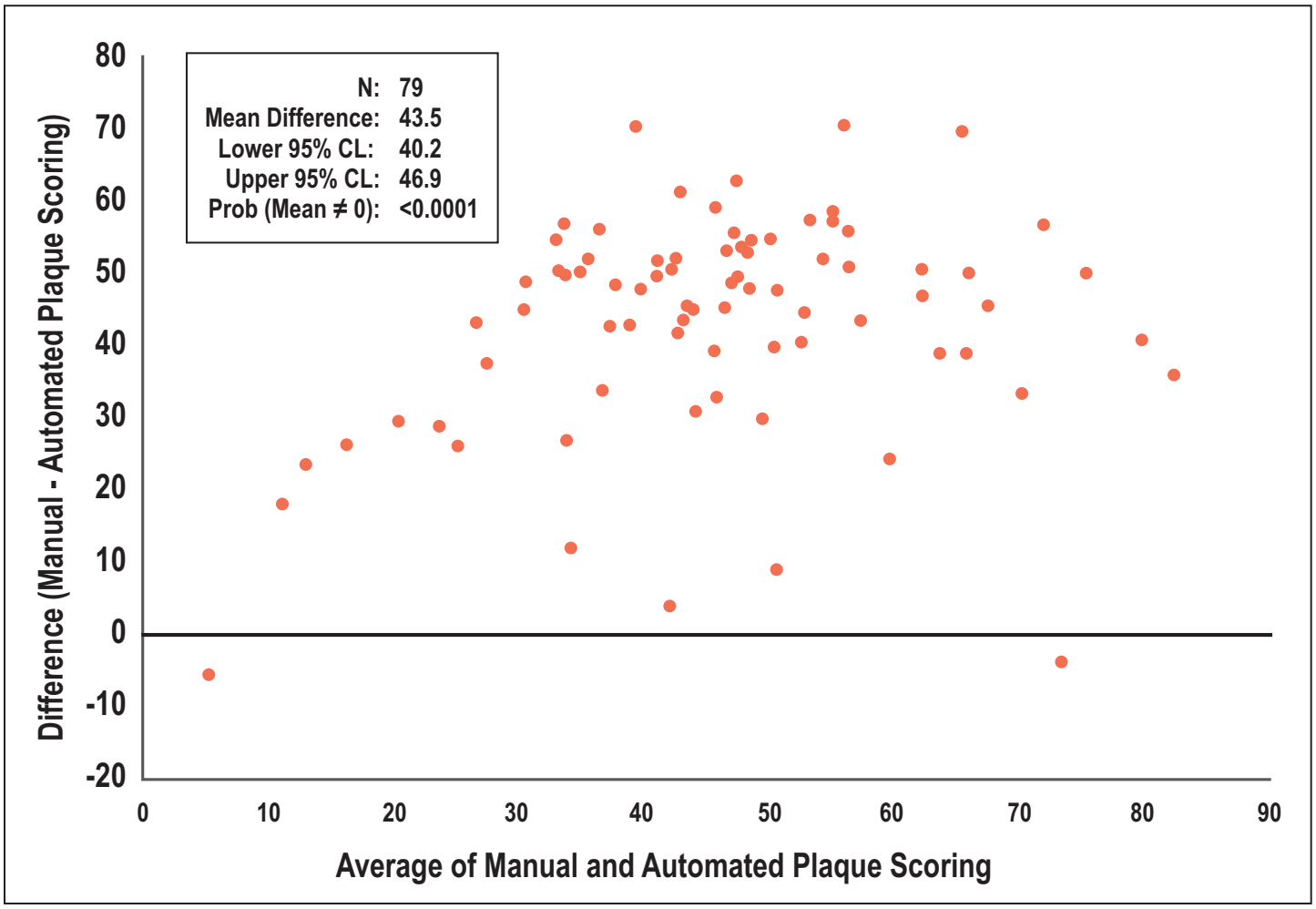


48.3, 95% confidence interval: 44.6–52.1, $p<0.0001$). Nonetheless, in all subgroups examined, mean manual dental plaque scores were significantly higher ($p<0.0001$) than mean automated dental plaque scores.

Despite the automated dental plaque scores being systematically substantially lower than manual dental plaque scores, the Pearson correlation coefficient between the two methods was relatively strong ($r = 0.62$, $p < 0.0001$); shown in the upper plot in Figure 2. In stratified analyses, the highest correlations between the manual and automated dental plaque scoring methods were observed for subjects (n= 34) with measurements obtained post-intubation ($r = 0.75$, $p < 0.0001$), and those (n = 32) whose automated assessment involved ≥15 pictures ($r = 0.68$, $p < 0.0001$); illustrated in the middle and lower plots of Figure 2. Similarly, the automated scoring method showed good reliability with the manual method, as shown by an ICC value of 0.63.

In the Bland-Altman plot (Figure 3), with both manual and automated dental plaque scores averaged on the x-axis, the substantial difference in scores between the two methods (y-axis) was consistently present (i.e. irrespective of magnitude of plaque burden). However, there was an indication that as plaque burden increased, the disparity between the 2 scoring methods increased. Only a very small percentage of subjects (n=2, 2.5%) had a lower manual dental plaque score compared to the corresponding automated dental plaque score.

Figure 3. Bland-Altman plot of manual and automated dental plaque scores averaged on the x-axis, and the difference of the two methods on the y-axis.



Discussion

In this study, distributions of estimated total plaque scores varied dramatically between using a manual method of plaque assessment (UM-OHI, mean score of 67.3 ± 18.7) versus an automated system (patented algorithm-based system, mean score 23.7 ± 15.2). Profound differences (mean difference of 43.6) in the distributions of plaque scores were observed across patient subgroup analyses; only a small number of subjects (n=2, 2.5%) had lower manual dental plaque scores compared to their corresponding automated dental plaque score. Despite the dramatic differences in scores, the Pearson correlation coefficient (0.62) and intra-class correlation coefficient (0.63), were quite strong between the two methods, indicating that both methods measured overall plaque burden, yet with substantially different numerical properties.

An obvious question that arises is "which method is more accurate?" Empirically, this question cannot be definitely answered with the data at hand. However, it can be postulated that the automated method is likely to be more accurate simply based on numerical properties of each method. Specifically, with the tooth "section-based" method used with the UM-OHI, even a small amount of plaque observed in a section results in a value of 1.0 for the entire section. Therefore, tooth sections with small versus large amounts of plaque receive the same value and cannot be differentiated with this particular scoring method. In contrast, the automated scoring method evaluated each pixel from each tooth for presence versus absence of plaque which conceptually, allows for fine gradation (on a continuous scale) between teeth with small, versus medium, versus large amounts of plaque. However, the automated method is only as accurate as the binary algorithmic-based determination of plaque (yellow color) versus absence of plaque. Correlation coefficients between the methods were highest under more favorable assessment conditions (post-extubation, with the

availability of a larger number of clearer images) which again suggests the validity of both methods (i.e. both are measuring the same quantity of plaque burden).

The automated digital scoring system used in this study is not the only method previously proposed to objectively measure dental plaque. Bellamy et al. developed a digital plaque image analysis (DPIA) system designed to capture images of healthy subjects' teeth via an external digital computer-controlled camera, under white light without disclosing agents, as well as image processing and image analysis software that identifies color differences indicative of dental plaque.[39] The accuracy of the Bellamy et al. system versus the automated digital scoring system, utilizing algorithms from the red-green-blue color spectrum used in this study, cannot be directly compared. However, the DPIA systems used in dental research, designed for healthy subjects, are not appropriate for populations of critically ill, mechanically ventilated, patients. DPIA systems require a cooperative subject, sitting upright, and positioned in a cephalometric head restraint apparatus in order to obtain external images. As technology progresses, a major emphasis will be on systems that can capture images in a comprehensive, minimally invasive manner and across a range of clinical settings, and ideally with real time scoring feedback.

Considering both research and clinical practice relevance, there are strengths and limitations to both an established manual method of assessment (UM-OHI) and this algorithm-based automated scoring system. The UM-OHI method has been used for decades, and is well known and accepted by dental health professionals. However, the current analysis suggests that it likely overestimates the percentage of total plaque burden in a given individual, can be time-consuming to score, and has an inherent degree of subjectivity in interpretation of presence versus absence of plaque by the evaluator. Due to the ordinal and compressed (0-10 per tooth) nature of the scoring algorithm, it is insensitive to all but large changes in the amount of dental plaque present. The automated scoring system offers the advantages of being entirely objective and reproducible, and digital dental images result in archival raw data which can be retested and used to refine the scoring algorithms to enhance validity. New objective measures may add value as documented evidence to support diagnostic criteria for procedures to be approved for insurance coverage. However, the automated scoring system requires selection of appropriate images of acceptable visual quality, and images that are exclusive to the areas suitable for plaque assessment (e.g. teeth only and not gums). These conditions and the refinement of the color-coding algorithms to represent full assessment exclusively of plaque remain challenges for future use in both research and clinical settings. Results from this study are specific to mechanically ventilated patients and may not generalize directly to other clinical settings, including primary care practice.

Conclusion

Automated digital systems have been postulated to be more precise than conventional visual methods of assessing and scoring dental plaque. In this study, an automated digital scoring system resulted in much lower overall dental plaque scores as compared to those from the an established manual scoring system (UM-OHI). While the objective automated digital scoring system may be more precise than the manual or visual scoring of dental plaque, its use should be weighed against the added effort, cost, and expertise required to use the method. Further study is needed to determine whether an automated digital scoring system can be commercialized and is warranted for use outside of research settings.

Conflict of Interest Disclosure

Drs. Munro, Cairns, and Kip, and Mr. Chen and Ms. Good are co-owners of co-owners of USF-Standardized Oral Health Assessment and Scoring Using Digital Imaging, Patent Number: 10,405,754 B2. Date of patent: September 10, 2019; the automated method of plaque measurement used in the study.

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Cindy L. Munro, Ph.D., RN is Dean of the University of Miami School of Nursing and Health Studies, Miami, FL; ***Zhan Liang, Ph.D., RN*** is an assistant professor at the University of Miami School of Nursing and Health Studies, Miami, FL; ***Nnadozie Emechebe, MPH*** is a Ph.D. student in epidemiology at the University of South Florida, College of Public Health, Tampa, FL; ***Xusheng Chen, MS*** is a data manager and statistician at the University of Miami School of Nursing and Health Studies, Miami, FL; ***Paula L. Cairns, Ph.D*** is an assistant professor at the University of South Florida, College of Nursing, Tampa, FL; ***Priyashi Manani, MPH*** is a recent graduate in epidemiology at the University of South Florida, College of Public Health, Tampa, FL; ***Lucia Hamilton, BSN, RN*** is a research coordinator at the

University of South Florida, College of Nursing, Tampa, FL; ***Gwendolyn Good, BSN, RN, RDH*** is a registered dental hygienist in Sarasota, FL; ***Kevin E. Kip, Ph.D*** is a distinguished health professor at the University of South Florida, College of Public Health, Tampa, FL.

Corresponding author: Kevin Kip, PhD; kkip@usf.edu

References

1. CDC. Oral health. [Internet]. Atlanta (GA): Centers for Disease Control; 2019 [accessed 2019 January 17]. Available from: https://www.cdc.gov/oralhealth/index.html.
2. Munro C, Michalek SM, Macrina FL. Cariogenicity of streptococcus mutans v403 glucosyltransferase and fructosyltransferase mutants constructed by allelic exchange. Infect Immun.1991; Jul;59(7):2316-23.
3. Poole DF, Newman HN. Dental plaque and oral health. Nature. Dec. 10;1971; 234(5328):329-31.
4. Stralfors A. Studies of the microbiology of caries; the buffer capacity of the dental plaques. J Dent Res. 1948; Oct;27(5):587-92.
5. Holt R, Roberts G, Scully C. ABC of oral health. dental damage, sequelae, and prevention. BMJ. 2000; Jun. 24;320(7251):1717-19.
6. Cahill TJ, Prendergast BD. Infective endocarditis. Lancet. 2016 Feb. 27;397: 882-93.
7. Munro CL, Macrina FL. Sucrose-derived exopoly-saccharides of streptococcus mutans v403 contribute to infectivity in endocarditis. Mol Microbiol. Apr 8;1993; 8(1):133-42.
8. Aarabi G, Thomalla G, Heydecke G, Seedorf U.Chronic oral infection: an emerging risk factor of cerebral small vessel disease. Oral Dis. 2018; Jun 7.
9. Carrizales-Sepúlveda EF, Ordaz-Farías A, Vera-Pineda R, Flores-Ramírez R. Periodontal disease, systemic inflammation and the risk of cardiovascular disease. Heart Lung Circ. 2018; Nov; 27(11):1327-34.
10. Pereira LC, Nascimento JCR, Rego JMC, et al. Apolipoprotein e, periodontal disease and the risk for atherosclerosis: a review. Arch Oral Biol. Feb; 2019; 98:204-12.
11. Simpson TC, Weldon JC, Worthington HV, et al. Treatment of periodontal disease for glycaemic control in people with diabetes mellitus. Cochrane Database Syst Rev. 2015; Nov. 6;(11):Cd004714.
12. Ren H, Du M. Role of maternal periodontitis in preterm birth. Front Immunol. 2017; Feb. 13;8:139.
13. Gil-Montoya JA, Sanchez-Lara I, Carnero-Pardo C, et al. Oral hygiene in the elderly with different degrees of cognitive impairment and dementia. J Am Geriatr Soc. 2017; Mar;65(3):642-7.
14. CDC. Healthcare-associated infections - ventilator-associated pneumonia (vap) [Internet]. Atlanta (GA): Centers for Disease Control; 2019. [accessed 2019 January 17]. Available from: https://www.cdc.gov/hai/vap/vap.html.
15. Munro C. Oral care for acutely and critically ill patients. Crit Care Nurse. 2017; Jun;37(3):e19-e21.
16. Munro CL, Grap MJ. Oral health and care in the intensive care unit: state of the science. American journal of critical care. Am J Crit Care. 2004; Jan;13(1):25-33; discussion 34.
17. Abele-Horn M, Dauber A, Bauernfeind A, et al. Decrease in nosocomial pneumonia in ventilated patients by selective oropharyngeal decontamination (SOD). Intensive Care Med. 1997; Feb;23(2):187-95.
18. Johanson WG, Jr., Seidenfeld JJ, de los Santos R, et al. Prevention of nosocomial pneumonia using topical and parenteral antimicrobial agents. Am Rev Respir Dis. 1988; Feb;137(2):265-72.
19. Safdar N, Crnich CJ, Maki DG. The pathogenesis of ventilator-associated pneumonia: Its relevance to developing effective strategies for prevention. Respir Care. 2005;50(6):725–39.
20. American Thoracic Society. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. Am J Respir Crit Care Med. 2005;171:388–416.
21. Chastre J, Fagon JY. State of the art: ventilator-associated pneumonia. Am J Respir Crit Care Med. 2002;165(7): 867–903.
22. de Melo Neto JP, Melo MS, dos Santos-Pereira SA, et al. Periodontal infections and community-acquired pneumonia: a case-control study. Eur J Clin Microbiol Infect Dis. 2013;32(1):27–32.
23. Türk G, Kocaçal Güler E, Eser I, Khorshid L. Oral care practices of intensive care nurses: a descriptive study. Int J Nurs Pract. 2012;18:347–53.
24. Jones DJ, Munro CL, Grap MJ. Natural history of dental plaque accumulation in mechanically ventilated adults: a descriptive correlational study. Intensive Crit Care

Nurs. 2011;27(6):299–304.

25. Munro CL, Grap MJ, Elswick RK, Jr, et al. 3rd Oral health status and development of ventilator-associated pneumonia: a descriptive study. Am J Crit Care. 2006; 15(5):453–60.
26. Feider LL, Mitchell P, Bridges E. Oral care practices for orally intubated critically ill adults. AmJ Crit Care. 2010; Mar;19(2):175-83.
27. Fitch JA, Munro CL, Glass CA, Pellegrini JM. Oral care in the adult intensive care unit. Am J Crit Care. 1999; Sep;8(5):314-8.
28. Grap MJ, Munro CL, Ashtiani B, Bryant S. Oral care interventions in critical care: Frequency and documentation. Am J Crit Care. 2003; Mar;12(2):113-8; discussion 119.
29. Silberman SL, Le Jeune RC, Serio FG, et al. A method for determining patient oral care skills: The university of mississippi oral hygiene index. J Periodontol. 1998; Oct;69(10):1176-80.
31. Greene JC. The oral hygiene index--development and uses. J Periodontol. 1967; Nov-Dec;38(6):Suppl:625-37.
31. Greene JC, Vermillion JR. The simplified oral hygiene index. J Am Dent Assoc. 1964; 68:7-13.
32. Turesky S, Gilmore ND, Glickman I. Reduced plaque formation by the chloromethyl analogue of victamine C. J Periodontol. 1970; Jan;41(1):41-3.
33. Loe H, Silness J. Periodontal disease in pregnancy II. Correlation between oral hygiene and periodontal condition. Acta Odontol Scand. 1964; 22:121-35.
34. Munro CL, Grap MJ, Jablonski R, Boyle A. Oral health measurement in nursing research: state of the science. Biol Res Nurs. 2006; Jul;8(1):35-42.
35. Munro CL, Grap MJ, Jones DJ, et al. Chlorhexidine, toothbrushing, and preventing ventilator-associated pneumonia in critically ill adults. Am J Crit Care. 2009; Sep;18(5):428-37; quiz 438.
36. Munro CL, Liang Z, Cairns P, et al. Optimal frequency of tooth brushing in mechanically ventilated adults: study protocol for a randomized controlled trial. Res Nurs Health. 2018; Dec;41(6):511-8.
37. Munro CL, Kip KE, Cairns PL, et al., Inventors. 2016; standardized oral health assessment and scoring using digital imaging. United States patent 15B142.
38. Zimmerman JE, Kramer AA, McNair DS, Malila FM. Acute physiology and chronic health evaluation (APACHE) IV: hospital mortality assessment for today's critically ill patients. Crit Care Med. 2006; May;34(5):1297-1310.
39. Bellamy PG, Jhaj R, Mussett AJ, et al. Comparison of a stabilized stannous fluoride/sodium hexametaphosphate dentifrice and a zinc citrate dentifrice on plaque formation measured by digital plaque imaging (DPIA) with white light illumination. J Clin Dent. 2008; 19(2):48-54.

Research

Knowledge, Attitudes and Practices of Dental Hygienists Regarding Diabetes Risk Assessments and Screenings

Christina DeBiase RDH, MSDH; Lori Giblin-Scanlon RDH, DHSc;
Linda D. Boyd RDH, RDN, LD, EdD; Jared Vineyard, PhD

Abstract

Purpose: Untreated and poorly controlled diabetes causes increased levels of blood glucose associated with poor periodontal disease outcomes. Dental hygienists can play a significant role in screening patients for diabetes mellitus, leading to referral and early diagnosis. The purpose of this study was to determine the knowledge, attitudes, practices, and barriers faced by clinical dental hygienists regarding diabetes risk assessment and screenings.

Methods: A mixed method design was used with a convenience sample of dental hygienists in clinical practice (n=316). A 32 item, electronic survey was validated at item-level, and participants were recruited through multiple dental hygiene Facebook groups. Descriptive statistics were used to analyze the data. The survey also included two open-ended attitude questions that were interpreted using thematic analysis to pinpoint common patterns within the data.

Results: Dental hygienists had high knowledge scores regarding diabetes and oral health, although many were unaware of their states' specific statutes and regulations for screening practices. Nearly all (95.9%), were likely to educate and refer patients (82%), although fewer than half (40.9%), were likely to perform chairside screening for diabetes. Emergent themes for barriers to screening were time, money, patient acceptance/willingness, lack of education, not having the proper tools, and states' rules and regulations.

Conclusion: Despite high knowledge scores regarding diabetes and oral health, there is a gap in regards to dental hygienists' willingness to perform diabetes screenings in a clinical setting. Dental hygienists should be capable of integrating chairside diabetes screening practices into the process of care with proper training.

Keywords: diabetes mellitus, diabetes risk assessment, diabetes screening, dental hygienists, HbA1c testing

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Introduction

Diabetes is the seventh leading cause of death in the United States and the estimated financial burden related to the disease in 2017 was 327 billion dollars.[1] There are 1.5 million Americans diagnosed with diabetes annually. Of the 30.3 million adults currently living with diabetes, 7.2 million are undiagnosed, and 84.1 million Americans over the age of 18 had pre-diabetes in 2015.[1] Untreated or poorly controlled diabetes can result in elevated glucose levels, leading to complications including cardiovascular disease, vision loss, and renal disease.[2] Evidence from meta-analyses indicate that poor glycemic control is also associated with poorer periodontal health and outcomes.[3,4] According to the Centers for Disease Control and Prevention (CDC), 47.2% of American adults, or 64.7 million people, have mild, moderate, or severe periodontitis.[5] Periodontal disease is more common in men than women, in those living below the federal poverty level, in individuals with less than a high school education, and in individuals who use tobacco.[5]

Left untreated, periodontal disease can lead to tooth loss, periodontal infection, and poor blood glucose control.[5] Evidence from a meta-analysis indicates periodontitis significantly impacts glycemic control in patients with and without type 2 diabetes mellitus (T2DM).[3] There is a suggested bidirectional relationship between T2DM and periodontal disease, as

evidenced by improved glycemic control following periodontal treatment of chronic periodontitis in patients with T2DM.[4,6]

The evaluation of patients' risk for pre-diabetes and T2DM during dental hygiene patient assessment is recommended in the Standards for Clinical Dental Hygiene Practice.[7] Chairside screening using the American Diabetes Association Diabetes Risk Test has been positively correlated with HbA1c levels in periodontal maintenance patients.[8,9] Additionally, the consensus guidelines from the European Federation of Periodontology (EFP) and the International Diabetes Federation (IDF) report "the oral healthcare team have a role to play in identifying both prediabetes and undiagnosed diabetes mellitus, and physicians need to be aware of periodontal diseases and their implications for glycemic control in people with diabetes."[4] Since dental hygienists encounter periodontal patients who may be at risk for diabetes, they are encouraged to screen these patients for pre-diabetes, and T2DM.[7] Previous research demonstrates that dental hygienists are confident and knowledgeable in utilizing chairside caries risk assessments during patient care, therefore it should not be unfamiliar for dental hygienists to also perform diabetes risk assessments.[10,11]

More recent findings from a workshop co-sponsored by the American Academy of Periodontology (AAP) and the EFP published in 2018 presented an overview of a new classification system for properly diagnosing periodontal diseases and conditions.[12] This system employs a multidimensional staging and grading system that utilizes risk factors, including the individual's HbA1c level as a means of tracking the potential for progression of periodontal disease.[12] Uncontrolled diabetes can negatively modify the course of periodontitis, making the HbA1c level a crucial factor in comprehensive case management.[12]

Due to the recognition of an association between T2DM and periodontal disease, in 2017, the American Dental Association (ADA) developed code D0411 for hemoglobin A1c (HbA1c) in-office point of service testing.[13] This code enables dental professionals to provide chairside testing for dysglycemia via the finger-stick method in accordance with providers' state rules and regulations.[13] Additionally, in 2018, the ADA developed code D0412 for in-office blood glucose testing, using a glucose meter.[13] Similar to caries risk testing, diabetes risk testing is relevant to dentists in regards to overall treatment planning.[13] Moreover, the ADA encourages oral health care providers to determine patients' risk for disease by utilizing resources such as the Center for Disease Control Pre-diabetes Screening Test and the American Diabetes Association Type 2 Diabetes Risk Test, which identify patients at risk and candidates for in-office glucose and HbA1c testing.[13–15]

Despite evidence suggesting a bidirectional relationship between elevated glucose levels and periodontitis, and the development of code D0411 and D0412, dentists and dental hygienists may not screen patients for pre-diabetes or T2DM. By assessing a patient's risk for diabetes in the dental setting, oral health care providers are creating opportunities for referral and formal evaluation. This practice can ultimately support early diagnosis and potentially lessen the economic burden of T2DM in the United States.[16] The purpose of this study was to assess the knowledge, attitudes, and practices of dental hygienists in clinical practice regarding diabetes risk assessment and screening. Perceived barriers and obstacles faced, along with the perceived roles of dental hygienists may help identify a need for further education and practice changes.

Methods

A descriptive, cross-sectional survey research design was used with a convenience sample of dental hygienists in clinical practice. MCPHS University Institutional Review Board (IRB) gave this study an exempt status and assigned it protocol number IRB100118G. Inclusion criteria consisted of registered dental hygienists who provided direct patient care and were licensed in the United States and Canada. Exclusion criteria consisted of dental hygiene students and dental hygienists who are not currently licensed or are not providing clinical patient care.

Survey instrument

The survey instrument assessed knowledge, attitudes, and practices (KAP) using the 2018 American Diabetes Association Standards of medical care in diabetes, and the guidelines from the EFP and the IDF joint workshop on periodontitis and systemic diseases.[12] The final instrument consisted of 32 items divided into five sections: demographics (6 items); knowledge of T2DM and periodontal disease (5 items); knowledge of diabetes screening (5 items); attitudes towards diabetes screening in practice (8 items); and frequency of practicing diabetes screening (7 items). A 5-point Likert scale ranging from strongly agree to strongly disagree was used for the responses. Two additional open-ended questions were included to explore dental hygienists' perceived role regarding diabetes assessments and screenings, along with barriers faced.

Procedure

The survey was validated by 5 experts in the field of dental hygiene and diabetes. Item-level content validity index (CVI) was used to calculate the relevance of each item. Items that yielded ≥0.78 were considered to have good content validity

and were included in the survey.[17] The survey was piloted among 5 dental hygienists of various ages and education levels, who were practicing clinically, to ensure clarity of the survey questions. Following the pilot test, an invitation to participate in the survey was posted to Facebook groups that were dental hygiene related for recruitment of participants with an explanation of the purpose and link to the web-based survey. The invitation was reposted two weeks later as a reminder. Participants had the option of including email addresses of other dental hygienists who may have been interested in completing the survey. These individuals were emailed a link to participate in the survey.

Dats analysis

Data were explored using descriptive statistics. Frequencies were calculated for all categorical data and means plus standard deviations were calculated for continuous variables. Knowledge questions were coded as correct or incorrect. Neither agree nor disagree responses were interpreted as guesses and coded as incorrect. Correct responses were summed for each participant to create a total number of correct variables. The question, "My states rules and regulations do not allow me to perform HbA1c screenings on my patients" was recoded from a 5-point Likert (strongly agree to strongly disagree) to a dichotomous variable with aware=1 and unaware=0. Responses with either agree or disagree were interpreted as being aware of the state regulations; while neither agree nor disagree was interpreted as being unaware of the regulations. Attitude question responses used a five-point Likert scale (-2=strongly disagree, -1=disagree, 0=neither agree nor disagree, 1=agree, 2=strongly agree).

Bi-variate analysis using Spearman's Rank Order Correlations was used to determine the relationship between all study variables. The Mann-Whitney U test was used to determine rank order differences in the number of correct knowledge responses and the Likert scale questions between being aware or unaware of state regulations. The Kruskal-Wallis H test was used to determine rank order differences in the number of correct knowledge responses and the Likert scale questions between different education level categories. All hypothesis testing used an alpha=.05 as the cut off for statistical significance. All analysis was conducted using the Statistical Package for the Social Sciences, SPSS 23 (IBM; Armonk, NY).

The responses from the two open-ended questions were organized and prepared for data analysis. The data was read and re-read to gather the meaning and then coded into common words and phrases. The words and phrases were generated into themes to describe the overall findings.

Results

A total of 332 participants attempted the survey, and 316 completed the survey (n=316), for a completion rate of 95%. The final sample consisted predominantly of females (98%) and males (2%). The median age of the respondents was 38 years, and ranged from 22 years to 72 years. Participant demographics are shown in Table I. Of the study sample (n=316), there were 269 responses to the open-ended questions regarding barriers to performing screenings. Common themes included time, money, patient acceptance/willingness, lack of education, not having the proper tools, and states rules and regulations.

Table I. Respondent demographics

	n	%
What is your gender? (n=316)		
Female	310	98.1%
Male	6	1.9%
Other	0	0.0%
What is the highest level of education you have completed? (n=313)		
Associates Degree	154	49.2%
Bachelor's Degree	133	42.5%
Master's Degree	25	8.0%
Doctoral Degree	1	0.3%
	Mean	**SD***
What is your age?	40.7	12.6
How many years has it been since you graduated from an entry level dental hygiene program?	14.6	12.3
How many years of dental hygiene clinical practice do you have?	14.4	11.9
How many hours do you provide direct patient care per week?	29.5	10.0

* **SD=standard deviation of the mean.**

Knowledge

Nearly three-fourths of the respondents (71%) were unaware of their state's regulations regarding HbA1c screenings. Most participants (70%), correctly answered the knowledge question regarding oral health and diabetes. The question "People with periodontitis have an increased risk of developing pre-diabetes and type 2 diabetes mellitus" had the highest percentage of incorrect responses (30%) from the oral health knowledge questions. For the remaining questions about diabetes, the highest number of incorrect responses

were in regards to gender differences (41%) and high blood pressure (43%. Knowledge responses are shown in Table II.

The median number of correct responses for the ten knowledge questions was eight. In regards to questions about oral health and diabetes only, 79% of participants answered four or more, out of five questions correctly, while 73% answered four or more, out of five, questions about diabetes correctly. The median number of correct responses for participants awareness of their state regulations and those who were unaware, were nine and eight, respectively. A Mann-Whitney's U test was conducted to evaluate the difference in the total number of correct responses. Participants who were aware of their state regulations had a higher median number of correct responses (Mdn=9) than participants who were unaware (Mdn=8); ($Z = -2.83$, $p=0.005$, $r = 0.16$).

Table II. Knowledge response frequencies

		n	%
People with periodontitis have an increased risk of developing pre-diabetes and type II diabetes mellitus.	Incorrect	94	29.7%
	Correct	222	70.3%
People with diabetes have an increased risk of developing gum disease.	Incorrect	4	1.3%
	Correct	312	98.7%
People with diabetes and periodontitis may have an increased risk for kidney and cardiovascular diseases.	Incorrect	11	3.5%
	Correct	305	96.5%
People with periodontitis have increased levels of HbA1c, when compared to people with better periodontal health.	Incorrect	77	24.4%
	Correct	239	75.6%
Treatment of chronic periodontitis may modestly improve glycemic control in patients with type 2 diabetes mellitus.	Incorrect	51	16.2%
	Correct	264	83.8%
Men have a higher risk of undiagnosed diabetes than women.	Incorrect	130	41.1%
	Correct	186	58.9%
Family history of diabetes can increase the risk for diabetes.	Incorrect	9	2.8%
	Correct	307	97.2%
Physical activity can decrease the risk for diabetes.	Incorrect	21	6.7%
	Correct	294	93.3%
High Body Mass Index (BMI) can increase the risk for diabetes.	Incorrect	13	4.1%
	Correct	303	95.9%
High blood pressure can contribute to an increased risk for diabetes.	Incorrect	135	43.0%
	Correct	179	57.0%

Attitude

When asked about whether it was their professional responsibility to screen patients for diabetes, a little more than one-half (56%) agreed, while a little less than one-half (47%) agreed that performing a diabetes screening was an integral part of dental hygiene treatment planning. Nearly one-third (32%), indicated that they were not comfortable performing diabetes screening. Most participants (91%), felt the need for continuing education for diabetes screening and assessment, while a little more than one-half (53%) reported not having enough knowledge to perform the screening. Participant attitudes are shown in Table III.

Practice

Various questions related to diabetes screening and assessment practice were asked. Overall, the practice question most often endorsed by dental hygienists was referring patients for a medical follow-up to ensure proper diabetes management (96%), while the least endorsed was using a glucose meter chairside to obtain HbA1c levels (24%). Practice question responses are shown in Table IV.

Knowledge, Attitude, Practice Question Relationships

Each attitude and practice question response variable was correlated with the total number of correct responses to explore the relationship between all study responses. Spearman correlations were calculated for all continuous demographic variables and Likert scale questions. There were no significant correlations between demographics and attitude, practice, or knowledge ($p>.05$). A Kruskal-Wallis test was performed to identify differences in median values for attitude and practice items as well as correct knowledge question between different education levels. All results were non-significant ($p>.05$).

Table III. Attitude responses

		n	%
It is not my professional responsibility to screen my patients for diabetes.	Strongly Agree	10	3.2%
	Agree	49	15.5%
	Neither Agree nor Disagree	79	25.0%
	Disagree	121	38.3%
	Strongly Disagree	57	18.0%
Performing diabetes screening is an integral part of dental hygiene treatment planning.	Strongly Agree	47	14.9%
	Agree	102	32.3%
	Neither Agree nor Disagree	122	38.6%
	Disagree	41	13.0%
	Strongly Disagree	4	1.3%
I do not feel comfortable performing HbA1c screenings on my patients.	Strongly Agree	25	8.0%
	Agree	83	26.4%
	Neither Agree nor Disagree	104	33.1%
	Disagree	66	21.0%
	Strongly Disagree	36	11.5%
I feel the need for continuing education courses on diabetes risk assessment and screening.	Strongly Agree	128	40.5%
	Agree	159	50.3%
	Neither Agree nor Disagree	18	5.7%
	Disagree	9	2.8%
	Strongly Disagree	1	.3%
I do not have enough knowledge on diabetes screening tools.	Strongly Agree	27	8.6%
	Agree	138	43.8%
	Neither Agree nor Disagree	46	14.6%
	Disagree	77	24.4%
	Strongly Disagree	27	8.6%
I do not have enough time to perform diabetes risk assessments or screenings when applicable.	Strongly Agree	58	18.4%
	Agree	124	39.2%
	Neither Agree nor Disagree	59	18.7%
	Disagree	59	18.7%
	Strongly Disagree	16	5.1%
My office is not equipped to perform HbA1c screenings.	Strongly Agree	149	47.2%
	Agree	133	42.1%
	Neither Agree nor Disagree	13	4.1%
	Disagree	17	5.4%
	Strongly Disagree	4	1.3%
My states rules and regulations do not allow me to perform HbA1c screenings on my patients	Unaware	223	70.8%
	Aware	92	29.2%

Discussion

Dental hygienists are primary preventative specialists and are in a unique position to implement diabetes risk assessments and screenings in clinical settings. This study provides information on the current knowledge, attitude, and practices regarding diabetes risk assessments and screenings. Data from this study found dental hygienists have high knowledge scores regarding the suggested relationship between diabetes mellitus and periodontal disease. The significant relationship between high knowledge scores and being unaware of statutory rules and regulations for diabetes screenings suggests dental hygienists are knowledgeable but unaware of their state's rules and regulations regarding HbA1c screenings. Additionally, while nearly all dental hygienists felt the need for continuing education courses on HbA1c screenings, over one-half (67.5%) of respondents felt they were not comfortable performing them. This is notably a smaller percentage as compared to a similar study conducted in 2008, where 91.7% of hygienists reported being unlikely to perform HbA1c screenings.[18]

In addition to HbA1c and glucose screenings, diabetes risk assessment tests such as the American Diabetes Association diabetes risk test and the CDC Pre-diabetes test are suitable assessments for evaluating a patient's risk for disease.[14,15] The American Dental Hygienists' Association (ADHA) Standards for Clinical Dental Hygiene Practice guidelines recommends the evaluation of a patients' overall risk for disease when treatment planning.[7] However, only 56.3% of respondents in this study felt it was their professional responsibility to screen patients for diabetes mellitus, and only 47.2% identified diabetes screenings as an integral part of dental hygiene treatment planning. While many respondents felt it was not their role to screen for diabetes, past studies have shown that evaluating a patients risk for diabetes and concurrently assessing their HbA1c level, led to the identification of pre-diabetes-diabetes in asymptomatic patients.[8,9,19–22]

Moreover, when asked how likely the respondent was to use a chairside questionnaire, only 40.9% were in agreement. When asked

Table IV. Practices

		n	%
How likely are you to ask a patient with pre-diabetes or diabetes for their most recent HbA1c level?	Very likely	149	47.2%
	Likely	67	21.2%
	Neither likely nor unlikely	41	13.0%
	Unlikely	47	14.9%
	Very unlikely	12	3.8%
How likely are you to use a chair-side diabetes risk assessment questionnaire?	Very likely	40	12.7%
	Likely	89	28.2%
	Neither likely nor unlikely	71	22.5%
	Unlikely	85	26.9%
	Very unlikely	31	9.8%
How likely are you to use a glucose meter chair-side to obtain HbA1c levels?	Very likely	29	9.2%
	Likely	48	15.2%
	Neither likely nor unlikely	61	19.3%
	Unlikely	95	30.1%
	Very unlikely	83	26.3%
How likely are you to educate patients with diabetes about the association between oral health and diabetes management?	Very likely	223	70.6%
	Likely	80	25.3%
	Neither likely nor unlikely	8	2.5%
	Unlikely	5	1.6%
	Very unlikely	0	0.0%
How likely are you to refer a patient for medical follow-up to ensure proper diabetes management?	Very likely	149	47.2%
	Likely	110	34.8%
	Neither likely nor unlikely	40	12.7%
	Unlikely	13	4.1%
	Very unlikely	4	1.3%
How likely are you to collaborate with health professionals about a patient's diabetes management?	Very likely	82	25.9%
	Likely	99	31.3%
	Neither likely nor unlikely	76	24.1%
	Unlikely	47	14.9%
	Very unlikely	12	3.8%

about time constraints, 57.6% of respondents felt there was not enough time to perform diabetes risk assessments or screenings, an improvement over responses from a previous study finding indicating that 70.6% of the dental hygienists survey felt that they had insufficient time to perform screenings.[18]

The ADHA recommends dental hygienists collaborate with health professionals for definitive diagnoses and treatment referrals as a means of evaluating patient outcomes.[7] Most respondents reported that they were likely to educate patients about the association between oral health and diabetes management (95.9%) and refer a patient for medical follow up to ensure proper diabetes management (82%). This finding is consistent with previous findings from 2008 with 90% of dental hygienists reporting being likely to educate, and 80% being likely to refer.[18] Regarding respondents perceived role regarding diabetes risk assessment and screening in the current study, the most common response was educating patients on the oral-systemic link between diabetes and periodontitis and giving referrals.

It is highly likely for dental hygienists to educate their patients and give referrals when appropriate. Unfortunately, if dental hygienists are not screening for T2DM, they are not properly referring high risk individuals for medical follow up. This gap may be the result of a lack of education regarding proper tools to assess a patient's risk for T2DM, which, when integrated into the dental hygiene process of care, may ultimately lead to referral and diagnosis. These findings suggest the need for continuing education courses on the relationship between diabetes and periodontal disease, including valid and reliable forms of diabetes risk assessments/screening tools. This finding is similar to other studies which have recommended continuing education courses on oral conditions and systemic diseases.[18,23] Hands-on training of diabetes assessment/screening tools may be beneficial for dental hygienists, along with information on current ADA codes such as D0411 and D0412, which allow for in-office glucose and HbA1c screening. Future studies should be conducted to evaluate patient willingness for glucose and HbA1c screening by dental hygienists in a clinical dental setting to support the advancement of the dental hygiene scope of practice and to increase the proportion of persons with diabetes whose condition has been diagnosed.

This study had limitations. The social media platform "Facebook" was used to deliver the survey limiting to individuals who use Facebook, and members of various online dental groups. Thus, the non-probability sample cannot be generalized to the total population. Self-reporting bias may have occurred due to participants' propensity for participation correlating with an interest in the topic of study. Additionally, respondents may have given a response that represents the average and not

necessarily their own behavior. While this study was targeted at all clinical practicing dental hygienists, the type of practice settings were not gathered and also limits the generalization of the findings.

Conclusion

Results indicate that dental hygienists had high knowledge scores on the oral-systemic link between diabetes mellitus and periodontal disease. While dental hygienists perceive themselves to be educators of the oral-systemic link and would likely educate and refer, most felt they did not possess the proper education on the current diabetes risk assessment/screening tools. There is a need to improve dental hygienists' willingness to include diabetes screening into the process of care, while also increasing their confidence in doing so. Additionally, ongoing professional development courses on the use of established diabetes risk questionnaires, and time management should be designed to influence practice behaviors.

Christina DeBiase RDH, MSDH is an adjunct professor at New York City College of Technology, Brooklyn, NY; ***Lori Giblin-Scanlon RDH, DHSc,*** is an associate professor and the Associate Dean of the Forsyth School of Dental Hygiene, MCPHS University, Boston, MA; ***Linda D. Boyd RDH, RDN, LD, EdD*** is a professor and the Associate Dean of Graduate Studies, Forsyth School of Dental Hygiene; MCPHS University, Boston, MA; ***Jared Vineyard, PhD*** is a post-doctoral fellow, Idaho State University, Pocatello, ID.

Corresponding author: Lori Giblin-Scanlon RDH, DHSc; Lori.giblin@mcphs.edu

References

1. American Diabetes Association. Statistics about diabetes [Internet]. Arlington: American Diabetes Association; 2018 [cited 2019 Feb 23]. Available from: http://www.diabetes.org/diabetes-basics/statistics/.
2. CDC. Diabetes statistics report [Internet]. Atlanta (GA): Centers for Disease Control and Prevention; 2017 [cited 2019 Feb 23]. Available from: https://www.cdc.gov/diabetes/pdfs/data/statistics/national-diabetes-statistics-report.pdf.
3. Graziani F, Gennai S, Solini A, Petrini M. A systematic review and meta-analysis of epidemiologic observational evidence on the effect of periodontitis on diabetes. An update of the EFP-AAP review. J Clin Periodontol. 2018;45(2):167–87.
4. Sanz M, Ceriello A, Buysschaert M, et al. Scientific evidence on the links between periodontal diseases and diabetes: Consensus report and guidelines of the joint workshop on periodontal diseases and diabetes by the International Diabetes Federation and the European Federation of Periodontology. J Clin Periodontol. 2017 Aug 24;45(2):231–41.
5. CDC. Periodontal disease [Internet]. Washington, DC: US Department of Health and Human Services: 2013 Jul 10 [cited 2019 Feb 23]; [1screen]. Available from: https://www.cdc.gov/oralhealth/conditions/periodontal-disease.html.
6. Elangovan S, Hertzman-Miller R, Karimbux N, Giddon D. A framework for physician-dentist collaboration in diabetes and periodontitis. Clin Diabetes. 2014 Oct;32(4):188–92.
7. ADHA. Standards for clinical dental hygiene practice [Internet]. Chicago (IL): American Dental Hygienists' Association; [modified 2016; cited 2019 Feb 23]; Available from: https://www.adha.org/resources-docs/2016-Revised-Standards-for-Clinical-Dental-Hygiene-Practice.pdf.
8. Bossart M, Calley KH, Gurenlian JR, et al. A pilot study of an HbA1c chairside screening protocol for diabetes in patients with chronic periodontitis: the dental hygienist's role. Int J Dent Hyg. 2016 May;14(2):98–107.
9. Genco RJ, Schifferle RE, Dunford RG, et al. Screening for diabetes mellitus in dental practices: a field trial. J Am Dent Assoc. 2014 Jan;145(1):57–64.
10. Francisco EM, Johnson TL, Freudenthal JJ, Louis G. Dental hygienists' knowledge, attitudes and practice behaviors regarding caries risk assessment and management. J Dent Hyg. 2013 Dec 1;87(6):353–61.
11. Urban RA, Rowe DJ. Knowledge, attitudes and practices of dental hygienists regarding caries management by risk assessment. J Dent Hyg. 2015 Feb;89(1):55–62.
12. Caton JG, Armitage G, Berglundh T, et al. A new classification scheme for periodontal and peri-implant diseases and conditions - introduction and key changes from the 1999 classification. J Periodontol. 2018 Jun;89:S1–8.
13. American Dental Association. D0411 and D0412 – ADA Quick guide to in-office monitoring and documenting patient blood glucose and HbA1c level [Internet]. Chicago: American Dental Association; 2019 [cited 2019 Feb 23]. Available from: https://www.ada.org/~/

media/ADA/Publications/Files/CDT_D0411_D0412_Guide_v1_2019Jan02.pdf?la=en

14. American Diabetes Association. Diabetes risk test [Internet]. Arlington: American Diabetes Association; 2019 [cited 2019 Feb 23]. Available from: http://main.diabetes.org/dorg/PDFs/risk-test-paper-version.pdf
15. CDC. Take the test prediabetes [Internet]. Atlanta: Centers for Disease Control and Prevention; 2019 [cited 2019 Feb 23]. Available from: https://www.cdc.gov/prediabetes/takethetest/
16. US DHHS. Diabetes|Healthy People 2020 [Internet]. Washington D.C.: U.S. Department of Health and Human Services; 2014 [modified 2019 Oct 8; cited 2019 Feb 23]. Available from: https://www.healthypeople.gov/2020/topics-objectives/topic/diabetes
17. Polit DF, Beck CT, Owen SV. Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. Res Nurs Health. 2007;30(4):459–67.
18. Boyd L, Hartman-Cunningham M, Calomeni J. Survey of diabetes knowledge and practices of dental hygiensts. J Dent Hyg. 2008 Aug;82(5):43–43.
19. Lalla E, Kunzel C, Burkett S, et al. Identification of unrecognized diabetes and pre-diabetes in a dental setting. J Dent Res. 2011 Jul;90(7):855–60.
20. Giblin LJ, Rainchuso L, Rothman A. Utilizing a diabetes risk test and A1c point-of-care instrument to identify increased risk for diabetes in an educational dental hygiene setting. J Dent Hyg. 2016 Jun 1;90(3):197–202.
21. Bould K, Scott SE, Dunne S, Asimakopoulou K. Uptake of screening for type 2 diabetes risk in general dental practice; an exploratory study. Br Dent J. 2017 Feb 24;222(4):293–6.
22. Sibyl S, Bennadi D, Kshetrimayum N, Manjunath M. Correlations between gingival crevicular blood glucose and capillary blood glucose: A preliminary report. J Lab Physicians. 2017 Sep 11;9(4):260–3.
23. Faden AA, Alsalhani AB, Idrees MM, et al. Knowledge, attitudes, and practice behavior of dental hygienists regarding the impact of systemic diseases on oral health. Saudi Med J. 2018 Sep 26;39(11):1139–47.

Research

The Additive Effects of Cell Phone Use and Dental Hygiene Practice on Finger Muscle Strength: A Pilot Study

Jessica R. Suedbeck, RDH, MS; Cortney N. Armitano-Lago, PhD, LAT, ATC ; Emily A. Ludwig, RDH, MS

Abstract

Purpose: The purpose of this study was to determine strength of muscles involved with instrumentation (scaling) by dental hygienists and the additive effects of cellular (mobile) phone usage, as indicated by measurements of muscular force generation.

Methods: A convenience sample of licensed dental hygienists currently in clinical practice (n=16) and an equal number of individuals not currently using devices/tools repetitively for work (n=16), agreed to participate in this pilot study. All participants completed a modified cell phone usage questionnaire to determine their use pattern and frequency. Upon completion of the questionnaire, participants' force production in six muscle groups was measured using a hand-held dynamometer. Descriptive statistics were used to analyze the data.

Results: A total of 16 licensed dental hygienists (n=16) and 16 participants with no history of using tools/devices repetitively for work (n=16), comprised the experimental and control groups, repectively. The control group generated greater muscle force than the experimental group for the *abductor pollicis longus* (p=0.045). Significant differences were identified when comparing the low mobile phone users in the experimental group to the control group for the *flexor pollicis brevis* (p=0.031), *abductor pollicis longus* (p=0.031), and *flexor digitorum* (p=0.006), with the control group demonstrating higher muscle force. Years in clinical practice and mobile phone use was shown to have a significant effect on muscular force generation for the *flexor pollicis brevis* (F=3.645, df=3, p=0.020) and *flexor digitorum* (F=3.560, df=3, p=0.022); subjects who practiced dental hygiene the longest produced the least amount of muscle force.

Conclusion: Results from this pilot study indicate there are no significant additive effects of cell phone use and dental hygiene practice on finger muscles used for instrumentation. However, results indicate that dental hygiene practice demonstrated significant effects on muscular strength as compared to individuals who do not use tools/devices repetitively for work. The small sample size may have impacted results and the study should be repeated with a larger sample.

Keywords: musculoskeletal disorders, cumulative trauma disorders, dental hygienists, cell phone use, instrumentation,

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Introduction

Musculoskeletal disorders (MSDs), injuries to muscles, bones, joints, and their associated ligament and tendon attachments, have been identified as an occupational risk factor for dental hygienists.[1] There are two classifications of MSDs based on the etiology and duration of the disorder; acute MSDs (i.e. an injury associated with a traumatic event), and chronic MSDs (i.e. an injury that develops over time and is persistent).[1] A high incidence of work-related, chronic MSDs in dental professionals have been attributed to the repetitive motions associated with instrumentation in clinical practice.[1-11] These repetitive motions place strain on the musculoskeletal system that can lead to pain in the affected areas known as cumulative trauma disorders (CTDs).[1-4] Dental hygienists use instruments throughout the day requiring precise movements of the thumb and index fingers during scaling and polishing procdures.[7] On average, a dental hygienist spends about 70% of their work-week performing repetitive finger and hand motions that can lead to CTDs.[8] In addition, reports have shown dental professionals hold their fingers and hands in positions outside

of neutral for long periods of time, further increasing the risk for CTDs.[7] Development of CTDs contribute to early retirement, reduced income and productivity, increased medical care costs, and decreased overall health in dental hygienists.[1-13] While extensive research has been conducted to examine potential strategies to reduce the effects of CTDs in dental hygiene practice,[7,14-21] little is known about the additive effects of repetitive tasks outside of the workplace.

Cell or mobile phone use has increased worldwide, especially among younger individuals over the last two decades.[22] The use of cell phones for texting, scrolling, gaming, and various applications leads to repetitive motions similar to those found with scaling and root debridement by dental hygienists.[22-30] Observed conditions resulting from cell phone use include pain and inflammation of the fingers, hands, wrists, and forearm muscles, tendons, and surrounding ligaments.[22-30] Previous studies have reported on the presence of CTDs in individuals using cell phones frequently with the extent of the disorder dependent on the pattern of usage.[22] Texting has been linked to detrimental muscular effects especially in the thumb resulting in pain, De Quervian repetitive strain injury, stenosing tenosynovitis, and other inflammatory conditions and/or disorders.[23-27,29] With the increased susceptibility to overuse injuries of the thumb and fingers due to texting, it is important to explore the risk for developing CTDs in dental hygiene clinicians who frequently use a cell phone for text communications. Assessment of the additive effects of repetitive cell phone use and dental hygiene practice have not been reported in the literature. The purpose of this novel, experimental, pilot study was to determine the muscular strength of the muscles involved with scaling and root debridement by dental hygienists in clinical practice, as well as the additive effects of cell phone usage on those muscles, as indicated by muscular force generation.

Methods

A convenience sample of licensed dental hygienists, currently in clinical practice (n=16), and an equal number of individuals not currently using devices/tools repetitively for work (n=16), agreed to participate in this this IRB-approved (Old Dominion University IRB 18-192) pilot study. Power statistics indicated a minimum of 16 subjects per group were needed to achieve a 95% confidence interval and a 95% power.[31] The inclusion criteria for the experimental group of the study were right-hand dominant, licensed dental hygienists working in clinical practice, and ownership of a a smartphone mobile device. Inclusion criteria for the control group were that the participants were right-hand dominant, not dental hygienists, did not use tools/devices repetitively for work, and owned a smartphone mobile device.

Following informed consent, participants were asked to complete a modified Cell Phone Usage Questionnaire (CUQ) prior to muscle force measurements. The questionnaire provided information with regards to the types of tasks performed with a cell phone as well as perceptions on the average amount of time these tasks were performed each day.[32] The modified CUQ utilized six questions pertaining to e-mail, Internet browser, mobile games, and application use on smartphone devices each day. Additionally, the survey had two items identifying cell phone use while using the fingers, hands, wrists, and/or forearms for other tasks simultaneously, such as texting and driving. Questionnaire items were rated on a 6-point Likert scale with 1 being "never" and 6 being "constantly." Total scores on the modified CUQ ranged from 6-36. Low cell phone use was identified as scores within the range of 6-16, moderate cell phone use ranging from 16.1-26, and high cell phone use ranging from 26.1-36. The modified CUQ also included demographic questions related to gender, age, race, and years in dental hygiene practice (experimental group).

After completing the modified CUQ, participants performed a series of tests that measuring force production of muscles identified as being associated with cell phone use as well as dental hygiene practice (Table I, Figures 1-4). A MicroFET 2 hand-held dynamometer (Hoggan Industries, Inc., UT, USA), a valid instrument for measuring muscular force production, was used to test each muscle group. Following an explanation and demonstration of the measurement process, each participant was asked to push against the dynamometer as possible for a total of three seconds (Figure 5). Each muscle of the dominant (right) hand was tested individually three times with a minute of rest between each trial. The average amount of force produced for the individual muscles was used to determine differences between the experimental (dental hygienist) and the control group. Data on self-reported cell phone use collected with the modified CUQ was also used to identify differences in muscle strength between the identified low, moderate, and high cell phone users in both groups, as well as among dental hygienists individually. The effects in muscle force production based on years in dental hygiene practice was also evaluated.

Data analysis

Independent samples t-tests were used to assess differences in force between the experimental and control groups for each individual muscle. One-way ANOVA was utilized to

Table I. Muscles evaluated for force generation with the force transducer*

Muscle	Action	Association with cell phone use	Association with dental hygiene practice
Flexor pollicis longus	Thumb flexing	Scrolling, texting, and gripping cell phones	Scaling and root debridement, polishing, and gripping instruments
Flexor pollicis brevis	Thumb flexing		
Adductor pollicis	Moving the thumb side-to-side		
Abductor pollicis longus	Moving the thumb side-to-side		
Extensor pollicis brevis and *Extensor pollicis longus* (measured together)	Thumb extension		
Flexor digitorum	Index finger flexing		

*See Figures 1-4.

Figure 1.

Neutral Thumb Position

Thumb Flexion

compare mean muscle force generation for the experimental and control groups, based on three levels of cell phone use: low, moderate, and high. If the results were significant, a Bonferroni post hoc test was used to evaluate the differences between the six groups. To address the effect of years in practice for dental hygienists and cell phone use on muscular force generation, a one-way ANOVA test was used. If the results were significant, a Bonferroni post hoc test was used to evaluate the differences between years in practice. Statistical analyses were performed using SPSS statistical software, version 24 (IBM, Armonk, NY) with the significance level set to $p<0.05$.

Results

A total of 16 licensed dental hygienists and 16 participants with no history of using tools/devices repetitively for work, comprised the experimental and control groups, respectively.

Figure 2.

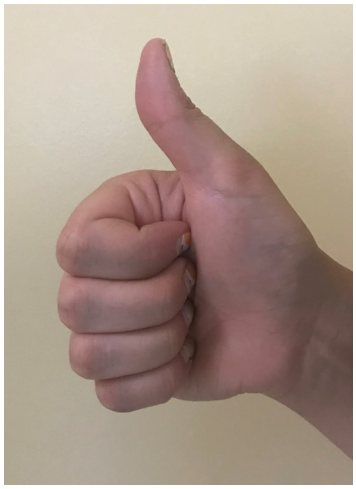
Neutral Thumb Position

Thumb Abduction

Thumb Adduction

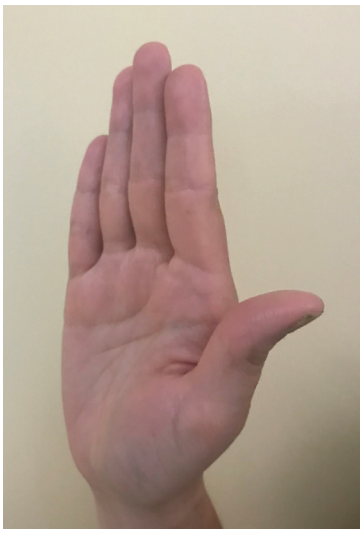
Figure 3.

Neutral Thumb Position

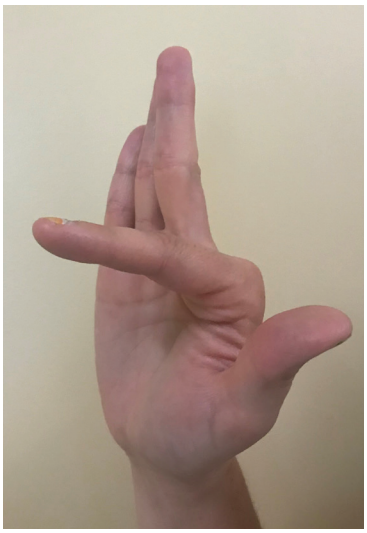


Thumb Extension

Figure 4.



Neutral Index Finger Position



Index Finger Flexion

Equal numbers of males (n=3) and females (n=13) participated in each group. This distribution was intentional in order to ensure accurate averaging of force measurement results. The majority of participants were female (81.25%, both groups) and between the ages of 18-44 (81.25%, experimental group and 87.5%, control group). Participants in the experimental group had varying levels of experience in clinical practice with the majority practicing for ten years or less. Participant demographics are shown in Table II.

A total of three measurements were taken per participant for each individual muscle group, resulting in a total of 288 readings per group and 576 readings overall. Muscle strengths were compared between the experimental and control groups to determine differences between in muscle forces between the experimental and control groups. Independent samples t-test

Figure 5: Handheld dynamometer for measuring muscle force production

Table II. Participant demographics

Characteristics	Experimental group n (%)	Control group n (%)
Gender		
Female	13 (81.25%)	13 (81.25%)
Male	3 (18.75%)	3 (18.75%)
Cell Phone Use (CUQ Score)		
Low	2 (12.5%)	1 (6.25%)
Moderate	12 (75%)	12 (75%)
High	2 (12.5%)	3 (18.75%)
Age Range		
18-29	4 (25%)	8 (50%)
30-44	9 (56.25%)	6 (37.5%)
45-59	2 (12.5%)	0 (0%)
60+	1 (6.25%)	2 (12.5%)
Years in Practice		
1-5 years	8 (50%)	N/A
6-10 years	4 (25%)	N/A
11-15 years	2 (12.5%)	N/A
16+ years	2 (12.5%)	N/A

revealed statistically significant differences between the experimental and control group for the *abductor pollicis longus* (p=0.045), indicating the mean muscle force generated was greater for the control group. The average muscle force generation for each muscle tested is shown in Table III.

The experimental group and control groups were broken up into low, moderate, and high cell phone user groups. To

identify the effects of cell phone use and dental hygiene practice on overall finger muscle force, one-way ANOVA was used to determine statistically significant differences between the groups. Means and standard deviations for the amount of force generated for each of the muscles were determined for each group of cell phone users are shown in Table IV. Significant differences were found when comparing low cell phone users in both the experimental and control groups for the following muscles: *flexor pollicis brevis* (p=0.031), *abductor pollicis longus* (p=0.031), *and flexor digitorum* (p=0.006). For these muscles, the control group had higher muscle force generation when compared to the experimental group. For moderate and high cell phone users, while the control group generated more muscle force, the results were not significant.

Muscle force generation and cell phone use was compared for each individual muscle based on years in clinical practice in the experimental group (Figure 6). The results of the one-way ANOVA test indicated a significant effect related to years in practice for the *flexor pollicis brevis* (F=3.645, df=3, p=0.020) and *flexor digitorum* (F=3.560, df=3, p=0.022) muscles; with with subjects who had practiced the longest producing the least amount of muscle force. Post hoc tests showed that participants practicing 1-5 years produced significantly higher muscle force for the *flexor pollicis brevis* as compared to those practicing 6-10 years (x=10.53 and x=6.48, respectively; p=0.028). Additionally, post hoc tests indicated participants practicing 1-5 years produced significantly higher muscle force for the *flexor digitorum* as compared to participants practicing 6-10 years (x=9.82 and x=6.85, respectively; p=0.026). No other statistically significant differences were identified in muscle force generation based on years in practice for the individual muscles examined.

Table III. Descriptive statistics for muscle force generation

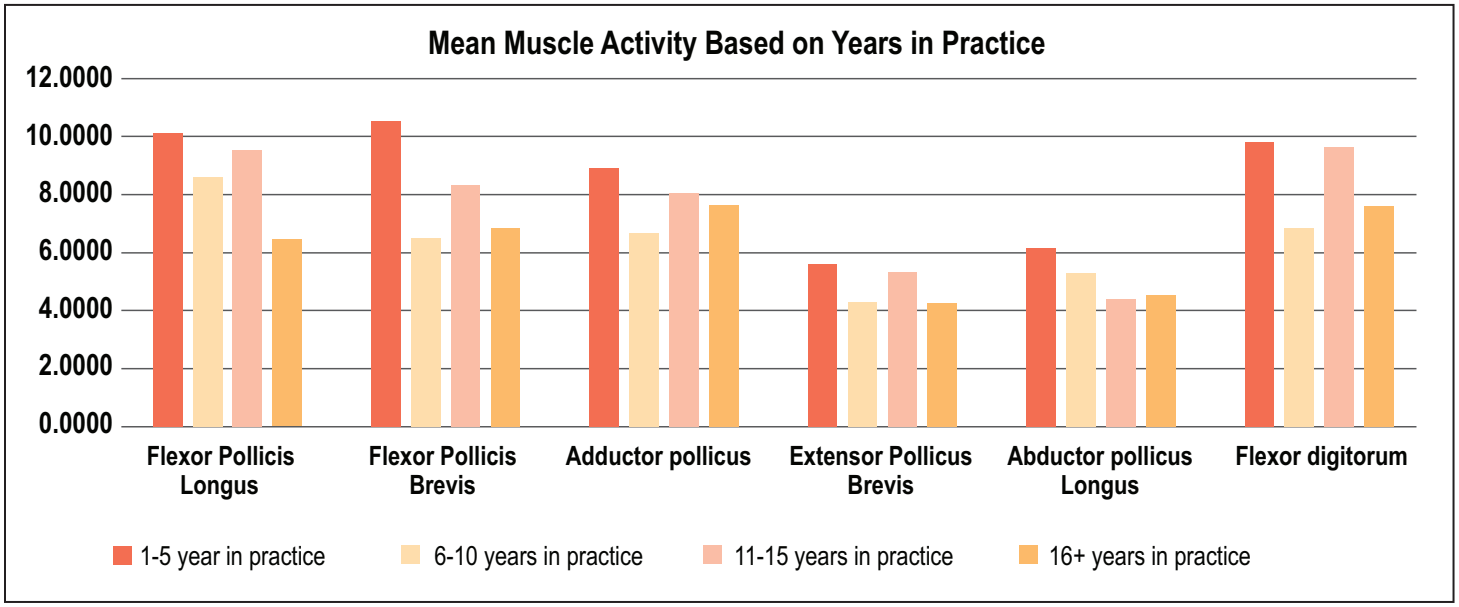
Muscle	Mean (lbs)	Standard Deviation	*p-value**
Flexor pollicis longus			
Experimental	9.20	4.05	*0.868*
Control	11.22	3.89	
Flexor pollicis brevis			
Experimental	8.78	4.15	*0.085*
Control	11.38	4.76	
Adductor pollicus			
Experimental	8.09	3.71	*0.187*
Control	9.15	4.05	
Extensor pollicis brevis			
Experimental	5.07	1.76	*0.202*
Control	6.12	1.81	
Abductor pollicus longus			
Experimental	5.51	1.98	*0.045**
Control	6.57	2.48	
Flexor digitorum			
Experimental	8.78	3.01	0.879
Control	10.88	2.43	

*p<0.05

Table IV: Mean and standard deviations for muscular force generation

	Experimental group, low cell phone use (n=2)	Experimental group, moderate cell phone use (n=12)	Experimental group, high cell phone use (n=2)	Control group, low cell phone use (n=1)	Control group, moderate cell phone use (n=12)	Control group, high cell phone use (n=3)
Flexor pollicis longus	7.75 ± 2.87 lbs	9.27 ± 4.36 lbs	10.28 ± 2.96 lbs	9.10 ± 0.62 lbs	10.98 ± 4.37 lbs	12.86 ± 0.71 lbs
Flexor pollicis brevis	8.15 ± 1.33 lbs	8.93 ± 4.71 lbs	8.50 ± 1.98 lbs	8.83 ± 0.15 lbs	11.03 ± 5.27 lbs	13.62 ± 1.60 lbs
Adductor pollicus	7.13 ± 1.11 lbs	8.51 ± 4.04 lbs	6.58 ± 3.04 lbs	6.50 ± 1.59 lbs	8.97 ± 4.28 lbs	10.77 ± 3.13 lbs
Extensor pollicis brevis	4.27 ± 0.52 lbs	5.30 ± 1.94 lbs	4.50 ± 0.92 lbs	4.60 ± 0.36 lbs	5.89 ± 1.84 lbs	7.56 ± 1.07 lbs
Abductor pollicus longus	4.90 ± 0.95 lbs	5.76 ± 2.18 lbs	4.57 ± 0.93 lbs	5.53 ± 0.50 lbs	6.45 ± 2.73 lbs	7.37 ± 1.56 lbs
Flexor digitorum	7.93 ± 1.74 lbs	9.01 ± 3.34 lbs	8.27 ± 1.65 lbs	11.27 ± 0.25 lbs	10.44 ± 2.58 lbs	12.49 ± 1.29 lbs

Figure 6: Means for muscular force generation and years in clinical practice



Discussion

Cumulative trauma disorders are common injuries found among dental hygienists as well as among individuals identified as high cell phone users.[1-12, 20-29] Quantifying the additive effects of cell phone use and dental hygiene practice on force production may aid dental hygienists in identifying risk factors associated with CTDs. This pilot study aimed to compare dental hygienists with a comparable control group to determine the effects of cell phone use on muscle force generation for several muscles used in dental hygiene practice for instrumentation. This study also compared the additive effects of cell phone use and dental hygiene practice on the strength of these muscles, in addition to the effects based on years of clinical practice.

The results indicate that dental hygiene practice had a significant effect on muscle force generation as compared to the control group. The control group had significantly higher mean muscle force at the *abductor pollicis longus,* which aids the thumb in side-to-side movement, indicating that dental hygienists have reduced *abductor pollicis longus* strength as compared to individuals who do not use tools/devices repetitively for work. The use of dental instruments has been demonstrated to increase muscle activity in the forearm and wrist.[9,14-16,20-21] It is possible that the repetitive motions specifically at the *abductor pollicis longus* in clinical practice has a negative effect on the force produced on this muscle. Future research should determine whether there are preventative measures aimed at reducing the impact of dental hygienist work factors contributing to this reduced strength. The average dental hygienist in clinical practice, spends roughly 22 hours a week performing repetitive tasks with instruments and devices (i.e. scaling and polishing), and a high prevalence of CTDs amongst this population is not surpising.[8]

Results of this pilot study reveal dental hygienists who are categorized as low cell phone users produced significantly less muscle force than low cell phone users in the control group. However, no other statistically significant differences were found between the experimental and control group as cell phone use increased to moderate and high levels. These results indicate there may not be any additive effects of cell phone use on specific muscle strength, rather clinical dental hygiene practice (i.e. scaling and polishing) effects muscle strength. Low cell phone users are not using their devices repetitively for the long durations as seen with moderate and high cell phone users, indicating that the differences noted may be due to dental hygiene practice rather than cell phone use.

Results from this pilot study also suggest years in clinical practice for dental hygienists may also negatively impact the muscular force generated in the thumb and index finger. There is a natural degeneration of overall musculoskeletal strength with over time.[32-34] Age, in combination with the muscular stress placed on clinicians over years of practice, may play a large role in comorbidities related to the dental hygiene profession. Clinicians in practice for five years or less generated higher muscular forces for each of the muscles tested and significantly more for the *flexor pollicis brevis* and *flexor digitorum* when compared to clinicians practicing for 6-10 years, indicating years in clinical practice requiring repetitive motions may reduce the muscular force generated

for muscles. Dental hygienists who have been practicing longer periods of time may need to be cautious of additional repetitive behaviors and activities of longer duration of the fingers, hands and wrists, such as cell phone use.

Previous studies have indicated that the repetitive motions of dental hygiene practice impact the wrist and hand muscles and risk for developing CTDs.[1-20] Additional studies outside of dentistry have indicated that the repetitive motions of cell phone use can also lead to disorders in the fingers, hands, wrists, and forearms.[20-28] However, there is a gap in the literature regarding the additive effects of these two repetitive practices and how they may be quantified in muscle force produced by individual muscles. Findings from this study indicate that cell phone use does not have an additive effect on muscle strength production for dental hygienists. However, these findings reinforce the need for awareness of the repetitive motions of dental hygiene practice and how they may impact the risk for developing CTDs and career longevity. This is especially noteworthy given that average muscle force generation was reduced in participants after five years in clinical practice. Further research should be conducted with larger samples to better quantify the effects of repetitive cell phone use and dental hygiene practice, by further examining muscle activity production in regards to specific tasks associated with cell phone use with the addition of the muscles in the wrist and forearm used for clinical dental hygiene. Studies should also examine other repetitive practices that may have additive effects on muscles (e.g. playing the piano and e-gaming) and risk for CTDs. Results from this pilot study could impact dental hygienists by increasing awareness among dental hygiene educators, future and current clinicians of the risk factors associated with all types of repetitive practices and CTDs.

This pilot study had several limitations. The small, convenience sample may have impacted the results and limited the generalizability of findings. Cell phone use was determined by self-reporting questionnaires and may inaccurately represented the amount of time participants actually used cell phones for repetitive tasks and the exact duration of cell phone use per day was not determined for each participant. Additionally, information on other extracurricular activities that may impact muscular strength produced by the muscle groups studied was not collected and may have impacted the muscle force generation measurements. The type and size of the cell phone used may have impacted the effects on muscular strength produced as well. Future studies are needed to look at the type and size of cell phones used, the exact daily duration of use, and ways to reduce the risk of the additive effects on development of musculoskeletal disorders. Additionally, future research should evaluate muscle activity generation with the use of surface electromyography to determine the additive effects of cell phone use and dental hygiene practice on the forearm and wrist muscles that are used for both activities. Muscles in the wrist and forearm have been identified for repetitive motions in dental hygiene practice and may also be used for cell phone activities as well.[13-15, 20-21]

Conclusion

Results from this pilot study indicate there are no significant additive effects of cell phone use and dental hygiene practice on finger muscles used for instrumentation. However, results indicate that dental hygiene practice had significant effects on muscular strength as compared to individuals who do not use tools/devices repetitively for work. These results suggest dental hygiene practice impacts muscular force generation and risk for developing CTDs. Future research should be conducted to examine these effects and ways to reduce overall risk for CTDs in larger samples of dental hygienists, as well as the additive effects of prolonged, repetitive tasks performed outside the workplace.

Jessica R. Suedbeck, RDH, MSDH is an assistant professor in the School of Dental Hygiene, Old Dominion University, Norfolk, VA; ***Cortney N. Armitano-Lago, PhD, LAT, ATC*** is a postdoctoral research associate in the Department of Exercise and Sport Science, the University of North Carolina, Chapel Hill, NC; ***Emily A. Ludwig, RDH, MSDH*** is a visiting lecturer in the School of Dental Hygiene, Old Dominion University, Norfolk, VA.

Corresponding author: Jessica R Suedbeck, RDH, MSDH; jsuedbec@odu.edu

References

1. Hayes M, Cockrell D, Smith DR. A systematic review of musculoskeletal disorders among dental professionals. Int J Dent Hyg. 2009 Aug;7(3):159-65.
2. Hayes MJ, Smith DR, Cockrell D. Prevalence and correlates of musculoskeletal disorders among Australian dental hygiene students. Int J Dent Hygiene. 2009 Aug;7:176-81.
3. Hayes MJ, Taylor JA, Smith DR. Predictors of work-related musculoskeletal disorders among dental hygienists. Int J Dent Hygiene. 2012 Nov;10:265-69.
4. Vidal, HF, Soriano EP, Caldas AF, et al. Cumulative trauma disorders among dentists. J Musculoskelet Pain. 2014 Jun;22(2):193-98.

5. Morse T, Bruneau H, Michalak-Turcotte C, et al. Musculoskeletal disorders of the neck and shoulder in dental hygienists and dental hygiene students. J Dent Hyg. 2007 Jan;81(1):1-16.

6. Carvalho MVD, Soriano EP, Caldas A, et al. Work-related musculoskeletal disorders among Brazilian dental students. J Dent Educ. 2009 May;73(5):624-30.

7. Hayes M, Smith D, Taylor J. Musculoskeletal disorders in a 3 year longitudinal cohort of dental hygiene students. J Dent Hyg. 2014 Feb;88(1):36-41.

8. Anton D, Rosecrance J, Merlino L, Cook T. Prevalence of musculoskeletal symptoms and carpal tunnel syndrome among dental hygienists. Am J Ind Med. 2002 Sep;42(3):248-57.

9. Simmer-Beck M, Branson B. An evidence-based review of ergonomic features of dental hygiene instruments. Work. 2010 Jan;35(4):477-85.

10. Hayes MJ, Smith DR, Cockrell D. An international review of musculoskeletal disorders in the dental hygiene profession. Int Dent J. 2010 Oct;60(5):343-52.

11. Morse T, Bruneau H, Dussetschleger J. Musculoskeletal disorders of the neck and shoulder in the dental professions. Work. 2010 Jan;35:419-29.

12. Kierklo A, Kobus A, Jaworska M, et al. Work-related musculoskeletal disorders among dentists-a questionnaire survey. Ann Agric Environ Med. 2011 (no month);18:79-84.

13. Cosaboom-Fitzsimons, ME, Tolle, SL, Darby, M, Walker, ML. Effects of five different finger rests positions on arm muscle activity during scaling by dental hygiene students. J Dent Hyg. 2008 Oct;82(4):98-107.

14. Dong H, Loomer P, Barr A, et al. The effect of tool handle shape on hand muscle load and pinch force in a simulated dental scaling task. Appl Ergon. 2006 Sep;38(5):525-31.

15. Dong H, Barr A, Loomer P, et al. The effects of periodontal instrument handle design on hand muscle load and pinch force. J Am Dent Assoc. 2006 Aug;137:1123-30.

16. Rempel D, Lee D, Dawson K, et al. The effects of periodontal curette handle weight and diameter on arm pain. J Am Dent Assoc. 2012 Oct;143(10):1105-13.

17. Liskiewicz ST, Kerschbaum WE. Cumulative trauma disorders: an ergonomic approach for prevention. J Dent Hyg. 1997 Oct;71:162-7.

18. Bramson JB, Smith S, Romagnoli G. Evaluating dental office ergonomic risk factors and hazards. J Am Dent Assoc. 1998 Feb;129:174-83.

19. Leigh JP, Miller TR. Occupational illnesses within two national data sets. Int J Occup Environ Health. 1998 Apr;4(2):99-113.

20. Ozawa T, Nakano M, Sugimura H, et al. Effects of endodontic instrument handle diameter on electromyographic activity of forearm and hand muscles. Int Endod J. 2001 Mar;34(2):100-6.

21. Suedbeck J, Tolle, SL, McCombs, G, et al. Effects of Instrument Handle Design on Dental Hygienists' Forearm Muscle Activity During Scaling. J Dent Hyg. 2017 Jun, 91(3); 47-54.

22. Eapen, C, Kumar, B, Bhat, A K. Prevalence of cumulative trauma disorders in cell phone users. J Musculoskelet Res. 2010 Sep; 13(03), 137-45.

23. Bendero, JM., Doon, ME., Quiogue, KC, et al. Ergonomics study on mobile phones for thumb physiology discomfort. In AIP Conference Proceedings. 2017 Sep; 1885(1):020275.

24. Ashurst, JV, Turco, DA, Lieb, BE. Tenosynovitis caused by texting: an emerging disease. J Am Osteopath Assoc. 2010 May; 110(5): 294-6.

25. Johnson, JD, Gaspar, MP, Shin, EK. Stenosing tenosynovitis due to excessive texting in an adolescent girl: a case report. J Hand Microsurg. 2016 Apr; 8(1):45.

26. Ali, M, Asim, M, Danish, SH, et al. Frequency of De Quervain's tenosynovitis and its association with SMS texting. Muscles Ligaments Tendons J. 2014 Jan; 4(1):74.

27. Eapen, C, Kumar, B, Bhat, AK, Venugopal, A. (2014). Extensor pollicis longus injury in addition to De Quervain's with text messaging on mobile phones. J Clin DiagnRes. 2014 Nov; 8(11): LC01-4.

28. Damasceno, GM, Ferreira, AS, Nogueira, LAC, et al. (2018). Text neck and neck pain in 18–21-year-old young adults. Eur Spine J 2018 Jun;27(6): 1249-54.

29. Akkaya, N, Dogu, B, Ünlü, Z, et al. (2015). Ultrasonographic evaluation of the flexor pollicis longus tendon in frequent mobile phone texters. Am J Phys Med Rehabil.2015 Jun;94(6):444-8.

30. Gustafsson, E, Johnson, PW, Hagberg, M. Thumb postures and physical loads during mobile phone use–a comparison of young adults with and without

musculoskeletal symptoms. J Electromyogr Kinesiol. 2010 Feb; 20(1):127-35.

31. Bandinelli S, Benvenuti E, Lungo ID, et al. Measuring muscular strength of the lower limbs by hand-held dynamometer: a standard protocol. Aging (Milano) 1999 Oct;11(5):287-93.

32. Merlo, LJ, Stone, AM, Bibbey, A. Measuring problematic mobile phone use: development and preliminary psychometric properties of the PUMP scale. J Addict. 2013; 2013:912807. Epub 2013 Sep 4.

33. Horak, FB. Postural orientation and equilibrium: what do we need to know about neural control of balance to prevent falls? Age Ageing. 2006 Sep;35 (Suppl. 2), ii7–ii11.

34. Lord, SR, Rogers, MW, Howland, A, Fitzpatrick, R. Lateral stability, sensorimotor function and falls in older people. J Am Geriatr Soc. 1999 Sep;47 (9):1077–81.

Research

State Licensing Board Requirements for Entry into the Dental Hygiene Profession

Kristen Johnson, RDH, MS; JoAnn Gurenlian, RDH, MS, PhD, AFAAOM; Kandis Garland, RDH, MS; Jacqueline Freudenthal, RDH, MHE

Abstract

Purpose: The purpose of this study was to identify current requirements for initial licensure and entry into the dental hygiene profession across state dental and dental hygiene licensing boards in the United States.

Methods: A non-experimental study design was used to study dental and dental hygiene board licensing requirements in the United States, Puerto Rico and the Virgin Islands. Each regulatory board website was searched for requirements for entry-level dental hygiene licensure. Requirements were recorded on an Excel spreadsheet. State dental practice acts were reviewed to gather further information and 20 regulatory bodies were contacted to verify accuracy. Descriptive statistics were used to analyze data.

Results: Information from a total of 52 dental boards (n=52) was examined for this study. Nearly all boards (n=51, 98.1%), with the exception of Alabama, required completion of entry-level education from a CODA accredited dental hygiene program and successful completion of the National Board Dental Hygiene Examination. Most states (n=51, 98.1%), except Delaware, also required a live-patient, a clinical board examination. Application fees ranged from $47.70 to $600. States varied considerably in terms of requirements for background checks, age, military status, and infection control training.

Conclusion: Although the majority of regulatory bodies require completion of entry-level dental hygiene education from a CODA accredited program and successful completion of national board and a live-patient, clinical examination, there is considerable variation in other additional requirements for initial dental hygiene licensure.

Keywords: dental hygiene workforce models, dental hygiene education, licensure, accreditation standards, scope of practice

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Introduction

Licensure and regulation have been important aspects for public health in the dental hygiene profession since its inception. The purpose of licensing is to protect the health and safety of consumers and to ensure a high quality of care is provided. Typically, practitioners are required to undergo specific education from an accredited institution and examination as a means of demonstrating that the public is protected from fraudulent or incompetent service providers.[1,2] In 1917, Connecticut became the first state to require dental hygienists to become licensed to practice.[3] Since that time, dental hygiene licensure has been regulated by individual state dental boards.[4] State boards of dentistry, also known as boards of dental examiners or state dental licensing boards, are created by the state legislature. Their authority typically includes the "establishment of qualifications for licensure; issuance of licenses to qualified individuals; establishment of standards of practice and conduct; taking disciplinary action against those who engage in misconduct; and promulgation of rules to enable the board to perform its duties."[5]

There are currently 52 state dental boards, including the District of Columbia and the Virgin Islands. Nineteen state boards also include dental hygiene committees or councils, which are responsible for governing actions associated with the practice of dental hygiene. In 2018, California became the first state to have a self-regulating, dental hygiene licensing body, that is not a subcommittee of a dental board, when the Dental Hygiene Committee of California was renamed the Dental Hygiene Board of California (DHBC). The DHBC

is recognized as an independent board operating within the Department of Consumer Affairs, with full authority to license and regulate dental hygienists in addition to reviewing and disciplining dental hygiene educational programs in the state of California.[6]

In order to be licensed as a registered dental hygienist, one must first graduate from an accredited dental hygiene program within a college or university. The candidate for dental hygiene licensure is also required to pass the National Board Dental Hygiene Examination, as well as a state or regional clinical examination.[7] In addition, each state has its own requirements for licensure, including a jurisprudence examination, official school transcripts, basic life support certification, local anesthesia, and age requirements. Licensure can be denied to applicants who are not in compliance with the state's dental practice act or those with criminal convictions. Most states include background checks as part of their licensing procedures.[8] In 2018, the American Dental Hygienists' Association (ADHA) proposed that the Commission on Dental Accreditation (CODA) implement changes in regards to the entry-level degree for dental hygiene education, replacing the associate degree with the baccalaureate degree (Standard 2-1). Standard 2-1 currently specifies that the educational requirements for entry-level into the profession of dental hygiene "must include at least two academic years of full-time instruction or its equivalent at the postsecondary college-level."[9] CODA requested justification for this change and five areas to be addressed. One of these areas included the need for information from state dental and dental hygiene boards regarding current requirements for licensure and entry into the profession.[10] The purpose of this study was to identify current requirements for initial licensure and entry into the dental hygiene profession, from state dental and dental hygiene licensing boards in the United States (US).

Methods

A non-experimental, descriptive study design was used to answer the following questions: 1) What are the state licensing board requirements for licensure and entry into the dental hygiene profession? 2) Are there differences in licensing board requirements for entry into the dental hygiene profession between state dental licensing boards and dental hygiene licensing boards? This design was deemed to be the most appropriate as no variables were manipulated.[11,12] Data, as identified on dental and dental hygiene licensing board websites, were documented and described.

The sample for this IRB exempt study included all state dental and dental hygiene licensing boards throughout the US, including the District of Columbia and the Virgin Islands. Puerto Rico was considered for inclusion; however, their website did not include any information about dental hygiene licensure by examination, nor did it include information regarding application for dental hygiene licensure. Personal contact with the licensing board of Puerto Rico was also unsuccessful.

An Excel spreadsheet was created to record information specific to each state board's licensure by examination for a new dental hygiene graduate. Licensure renewal, licensure for educators, and temporary licenses were excluded from this study. The data collection instrument was pilot tested using information from five states to verify the information for completeness and accuracy. Two co-investigators independently reviewed and verified information collected by the principal investigator (PI) as a way of establishing validity of the data collection process. In addition, the PI contacted a representative of the state board of dentistry of the first five state licensing boards to verify that the information posted on the website was current and accurate. This process was used to establish reliability as well as contribute to the validity of the study.

To obtain specific information, the PI searched each state dental board website for information about licensure for dental hygienists. The next step was to search for licensure by examination to ensure that the information collected was specific to licensing requirements for entry-level candidates. The PI evaluated the applications for specific requirements and noted them in the data spreadsheet by state. In many cases, the PI searched the dental practice act to gather complete information missing from the licensure application. In addition, the PI and a co-investigator contacted 20 state boards to verify where to locate the specific information and to verify the data collected. Furthermore, the PI contacted state licensing specialists to verify that the information provided on the website was current.

Descriptive statistics were used to analyze data. Similarities and differences among states has been summarized using frequencies and percentages.

Results

A total of 52 licensing boards were examined for this non-experimental study. All states and territories have a dental regulatory board. California also has a dental hygiene board and 19 other states have a dental hygiene committee or council, as shown in Table I. These dental hygiene committees' and board responsibilities vary by state. Responsibilities may include advising the dental board on rules and proposed statue changes about the dental hygiene profession, evaluating continuing education classes, monitoring dental hygienists' compliance with continuing education requirements, disciplinary decisions, and reviewing applications for licensure.

Individual state licensing application requirements are shown in Table II. Almost all (n=51, 98.1%) dental regulatory boards, with the exception of Alabama (n=1, 1.9%), require completion of a dental hygiene entry-level education from a CODA-accredited program and successful completion of the National Board Dental Hygiene Examination. Proof of education could consist of a letter from the dental hygiene program, official dental hygiene transcripts, or a notarized copy of a dental hygiene diploma. Most states (n=51, 98.1%), with the exception of Delaware (n=1, 1.9%), require a regional clinical board examination. All regulatory boards required an application fee. This fee ranged from $47.70 to $600.00, with an average fee of $164.44.

Most regulatory boards require a jurisprudence examination (n=40, 76.9%) and basic life support or cardiopulmonary resuscitation (CPR) certification (n=45, 86.5%) as a requirement for licensure (Table II). In addition, New York, Alabama, Delaware, Hawaii, Louisiana, Mississippi, North Carolina, Oklahoma, and Oregon (n=9, 17.3%) have language requiring applicants to verify completion of infection control training. Sixteen governing boards (30.8%) specify an age requirement ranging from 17 to 21 years of age. States vary considerably in terms of requirements for background checks, fingerprints, statements of good moral character, citizenship and immigration status. New Mexico, North Carolina, Rhode Island, South Dakota, Texas, West Virginia, and Wyoming (n=7, 13.5%) include a section on military status.

Some dental regulatory boards have additional specific requirements for entry-level licensure applicants. A radiation safety course is required for California licensure. HIV/AIDS training is required in Washington, while HIV, HBV and HCV status disclosure is necessary in Louisiana. Professional liability insurance is mandated in Colorado. Tennessee requires a letter of recommendation from a dental professional. Massachusetts, North Dakota, Ohio, and West Virginia (n=3, 7.7%) require signed statements from a physician, physician assistant, or nurse practitioner that the applicant is medically cleared to practice dental hygiene. Oklahoma may require a personal interview by the state board upon request. Four boards North Dakota, Oklahoma, South Dakota, and Wyoming (n=4, 7.7%) require personal references. Failure to pay taxes must be reported on applications in California, Missouri, New Jersey, and Tennessee (n=4, 7.7%) and student loan default reporting is mandated in New Jersey.

Discussion

This study was designed to address CODA's request for information regarding state licensure requirements for entry-level dental hygiene applicants. Results identified many similarities across the regulatory licensing bodies. Most regulatory boards require applicants to have graduated from a CODA-accredited dental hygiene program, have proof of passing a national written and a regional clinical examination, and successfully complete some form of background check. Most boards also require a jurisprudence exam and current CPR certification. No differences were found in these requirements between dental licensing boards and/or dental hygiene boards or committees. There is considerable variation beyond these primary elements in terms of additional requirements including age, armed forces status, application fees, professional liability insurance number and type of references, debt, health status, and additional training.

The clinical examination is an aspect of the licensure process that has been debated within dentistry and dental hygiene. Live patients are required for the regional organizations administering clinical licensure examinations and includes the Council of Interstate Agencies (CITA), Central Regional Dental Testing Service (CRDTS), Commission on Dental Competency Assessments (CDCA), (formerly Northeast Regional Board of Dental Examiners or NERB), Southern Regional Testing Agency (SRTA), and Western Regional Examining Board (WREB). The live patient requirement brings up a range of ethical considerations including patient welfare, free and informed consent, and adequate follow-up care.[13-15]

Alternative assessments of clinical competency as qualifications for entry to the profession was studied in a cross-sectional survey of all CODA-approved entry-level dental hygiene program directors by Fleckner and Rowe.[16] Findings revealed that most dental hygiene program directors agreed that a single state and regional exam had "low validity in reflecting the complex responsibilities of the dental hygienist in practice" and that graduating from a CODA-approved dental hygiene program and passing a national board exam certifies that a graduate is capable of functioning as a licensed dental hygienist.[16]

While an alternative to the regional clinical exam for dental hygiene has not been created, others have championed a call for this change in dentistry.[17] In 2014, the American Dental Education Association (ADEA) House of Delegates passed Resolution 5-H 2014, recommending the elimination of the human subject/patient-based components of the clinical licensure examination process and called for a task force to create a plan to transition to an alternative licensure process.[18] Since that time, dental graduates in California, Colorado, New York, and several other states can obtain licensure through the successful completion of

Table I. Dental hygiene regulatory bodies: responsibilities by state

State	Regulation	Composition	Responsibilities
AZ	Committee	5 DHs (1 from dental board) 1 dentist (from dental board) 1 public member	Advise board on rules and regulations concerning dental hygiene education, regulation and practice Evaluates CE classes for expanded function Monitors compliance with CE requirements
CA	Board	4 DHs 1 dentist 4 public members	Issuing, reviewing, and revoking licenses Developing and administering examinations Adopting regulations, determining fees and continuing education requirements
CT	Ad hoc committee as needed	Not specified	Address rules or disciplinary actions
DE	Committee	3 DHs	Writes the examination for licensure in conjunction with dental board Votes on issues of licensure by credentials, disciplinary decisions, continuing education requirements, and issues involving the policy and practice of dental hygiene but not the scope of practice
FL	Council	4 DHs (1 from board) 1 dentists (from board)	Develops all dental hygiene rules to submit to the board for approval
GA	Committee	1 DH 1 dentist	Not defined
IA	Committee	2 DHs (board members 2 dentists (board members)	Make all rules pertaining to dental hygiene; the dental board is required to adopt and enforce these rules
ME	Subcommittee	3 DHs (1 board member) 2 dentists (board members)	Perform an initial review of all applicants for licensure as a dental hygienist Review submissions relating to continuing education and all submissions related to public health supervision status of dental hygienists
MD	Committee	3 DHs (all board members 1 dentist (board member) 1 public member (board member)`	All matters pertaining to dental hygiene must first be brought to the committee for its review and recommendation

an advanced education, post-graduate residency program. In Minnesota, dental students can complete the objective structured clinical exam (OSCE), a modified version of the National Dental Examining Board of Canada's licensure exam, rather than take the traditional exam involving live patients. In California, dental students can obtain licensure by successfully completing a hybrid portfolio. Other dental schools have adopted a curriculum integrated format that was piloted at the University of Buffalo.[17,20] With regards to dental hygiene, in 2018, the ADHA also adopted policy promoting the elimination of the patient procedure-based single encounter clinical examination.[19] However, at this point in time, there are no alternatives to a live-patient examination for candidates for dental hygiene licensure.

More recently, a Task Force on Assessment of Readiness for Practice (TARP) was created consisting of members of the American Dental Association (ADA), the American Student Dental Association (ASDA) and ADEA to address the issues of the use of single encounter, procedure-based examinations on patients, as part of the dental licensure process along with licensure portability challenges that are burdensome and unnecessary for validating patient safety.[21] The TARP has proposed a modernized process for initial

Table I. Dental hygiene regulatory bodies: responsibilities by state (continued)

State	Regualtion	Composition	Responsibilities
MI	Committee	2 DHs 2 dentists 1 dental assistant 1 public member	Considers matters related to the dental hygiene profession and make recommendations to the Board
MO	Commission	5 DHs (1 board member)	Makes recommendations to the board concerning dental hygiene practice, licensure, examinations, discipline and educational requirements
MT	Committee	2 DHs (board members) 1 dentist (board member)	Formulates specific recommendations to bring to the entire board for action
NV	Committee	3 DHs (board member) 1 dentist (board member)	Formulates recommendations on dental hygiene rules for the board
NH	Committee	4 DHs (1 board member) 1 dentist (board member)	Proposes rules concerning the practice, discipline, education, examination and licensure of dental hygienists
NM	Committee	5 DHs (2 board members) 2 dentists 2 public members	Adopts all rules pertaining to dental hygiene Also responsible for the discipline of dental hygienists The board enforces the dental hygiene committee's rules
OK	Committee	5 DHs (1 board member)	Not defined
OR	Standing committee as needed	Not specified	Not defined
RI	Committee	1 DH 1 dentist 1 public member	Serves as an examining committee for applicants applying for licensure as dental hygienists
TX	Advisory Committee	3 DHs 1 dentist 2 public member	Not defined
WA	Committee	3 DHs 1 public member	Develops rules and definitions to implement in the dental hygiene practice act with the dental hygiene examining committee

licensure of dentists that includes completion of a university-based, CODA accredited dental education program including documentation of clinical competence and assessment of psychomotor skills; passage of the National Board Dental Examination; and successful passage of a valid and reliable clinical assessment that does not utilize the single encounter clinical examination performed on a live patient. TARP has proposed substituting the live patient examination with the following options: use of an OSCE, graduation from a CODA accredited PGY-1 program, or the use of other assessments such as the Portfolio or Compendium of [Clinical] Competency Assessment. Furthermore, TARP has recommended that state boards enact changes to allow for increased licensure portability as well as the examination of a common core of credentials that can serve as a basis for licensure compacts between states.[21] These dental assessment models could also be adapted for dental hygiene, allowing for reciprocity between states and increased licensure portability. These recommended changes have begun in Oregon through Senate Bill 824 that allows that State Board of Dentistry to accept results of national and regional testing agencies or clinical board examinations by other states for applicants who wish to practice dentistry or dental hygiene. Alternative assessments that do not require live patients are acceptable.

Table II. Dental hygiene entry-level, initial licensure requirements

State	Clinical Exam	Proof of Education	Application Fee	Jurisprudence	CPR	Background Check	Other Requirements
AL	CITA CRDTS WREB SRTA	DH Transcripts	$225	Yes	Yes	Criminal fraud questions Good moral character with testimonials Notarized affidavit Passport photo Citizen/immigration status	HEP B series
AK	CITA WREB	DH Transcripts Certification of Completion	$300	Yes	Yes	Professional fitness National Practitioners Data Bank Self Query Notarized affidavit Release of records	Abuse identification and reporting
AR	CITA CDCA CRDTS WREB SRTA	DH Transcript	$100	Yes	Yes	Passport photo	
AZ	CITA CDCA WREB	Certificate of Completion	$300	Yes	Yes	Good moral character Fingerprints Notarized affidavit Passport photo	
CA	CITA CRDTS WREB	Certificate of Completion	$200	Yes	Yes	Fingerprints Criminal fraud questions Passport photo	Expanded function education if out of state Radiation safety course Failure to pay taxes results in denial of license
CO	CITA WREB SRTA	DH Transcripts	$160	No	Yes	Personal data questions Citizen/immigration status	Professional liability insurance
CT	CDCA CITA SRTA	DH Transcripts	$150	No	Yes	Yes, but parameters not specified	
DE		DH Transcripts	$189	Yes (must be notarized)	Yes	Fingerprints Notarized affidavit	Proof of high school transcripts or GED
DC	CDCA CITA WREB	DH Transcripts	$245	Yes	Yes	Criminal fraud questions Good moral character Personal affidavit Passport photo	
FL	CDCA CITA	Certification of Completion	$135	Yes	Yes	Criminal fraud questions Release of records	
GA	CRDTS	DH Transcripts	$75	Yes	Yes	National Practitioners Data Bank Criminal fraud questions Notarized affidavit Citizen/ immigration status	
HI	CDCA CITA CRDTS WREB SRTA	Certificate of Completion	$246	No	Yes	Citizen/immigration status Release of records	
ID	CITA WREB	DH Transcripts	$150	Yes	Yes	Notarized affidavit Release of records	

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Table II. Dental hygiene entry-level, initial licensure requirements (continued)

State	Clinical Exam	Proof of Education	Application Fee	Jurisprudence	CPR	Background Check	Other Requirements
IL	CDCA CITA CRDTS WREB SRTA	Certificate of Completion	$100	No	Yes		
IN	CDCA CITA WREB SRTA	Certificate of Completion DH Transcripts	$100	Yes	Yes	Fingerprints Criminal fraud questions Personal data questions Passport photo	
IA	CITA WREB	Certificate of Completion	$100	Yes	Yes	Release of records	
KS	CITA CRDTS WREB CRTA	DH Transcripts	$100	Yes	Yes	National Practitioner Data Bank Notarized affidavit Passport photo	
KY	CDCA CITA WREB SRTA	DH Transcripts Proof of Completion of Requirements	$125	Yes	Yes	Fingerprints FBI background check National Practitioner Data Bank Notarized affidavit Personal data questions	
LA	CITA	Certification of Education	$280	Yes	Yes	Fingerprints Personal data questions Notarized affidavit Passport photo Proof of citizenship or immigration with birth certificate	HIV status disclosure
ME	CDCA CITA WREB SRTA	Certification of Education DH Transcripts	$241	Yes	Yes	National Practitioner Data Bank Personal affidavit	Abuse identification and reporting
MD	CDCA CITA	DH Transcripts; certified	$275	Yes	Yes	Good moral character National Practitioner Data Bank Personal data questions Notarized affidavit Passport photo Release of records	
MA	CDCA CITA WREB SRTA	DH Transcripts Letter from Dean	$126	Yes	Yes	Good moral character National Practitioner Data Bank Notarized affidavit Passport photo	Physician statement
MI	CDCA CITA WREB	Certificate of Completion DH Transcript	$47.70	No	Yes	Good moral character Fingerprints Personal affidavit	
MN	CDCA CITA CRDTS WREB Results notarized	DH Transcript notarized	$148.25	Yes, and notarized	Yes	Complete background check Personal data questions Personal affidavit and notarized affidavit Passport photo	

Table II. Dental hygiene entry-level, initial licensure requirements (continued)

State	Clinical Exam	Proof of Education	Application Fee	Jurisprudence	CPR	Background Check	Other Requirements
MS	CDCA CITA WREB SRTA		$150	Yes	Yes	Good moral character	
MO	CDCA CITA CRDTA WREB SRTA	DH Transcripts	$155	Yes	Yes	Good moral character Personal data questions Notarized affidavit Passport photo	Child support obligation Failure to pay taxes results in denial of license
MT	CITA WREB SRTA	Certificate of Completion	$185	Yes	Yes	National Practitioner Data Bank	
NE	CITA CRDTS WREB SRTA	DH Transcripts	$110	Yes	No/Yes if licensed for Nitrous	Personal data questions Citizenship/immigration status with documentation	
NV	CDCA CITA WREB	DH Transcripts	$600	Yes	Yes	Good moral character Fingerprints National Practitioner Data Bank Criminal fraud questions Personal data questions Passport photo Citizenship/immigration status	
NH	CDCA CITA SRTA	DH Transcripts	$100	Yes	Yes	Notarized criminal background check two character references Criminal fraud questions Personal data questions Citizen/immigration status with birth certificate	
NM	CDCA CITA CRDTS WREB SRTA	Certificate of Completion	$350	Yes	Yes	Complete background check Criminal fraud questions Notarized affidavit Passport photo	
NY	CDCA	Certification of Completion DH Transcripts	$128	Yes	Yes	Good moral character Criminal fraud questions Citizenship/immigration status	Child support obligation Abuse identification and reporting
NC	CITA		$275	Yes	Yes	Fingerprints Complete background check	
ND	CITA WREB SRTA	DH Transcripts	$200	Yes	Yes	Fingerprints National Practitioner Data Bank	Notarized copy of DH Diploma Three personal references Physician statement
OH	CDCA CRDTS WREB SRTA	Certification of Education; Certified DH Transcripts	$184	Yes	No/Yes if licensed for local anesthesia	Good moral character Complete background check Notarized affidavit Passport photo	HEP B series Physician statement

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Table II. Dental hygiene entry-level, initial licensure requirements (continued)

State	Clinical Exam	Proof of Education	Application Fee	Jurisprudence	CPR	Background Check	Other Requirements
OK	CRDTS WREB	DH Transcripts	$100	Yes	Yes	National Practitioner Data Bank Criminal fraud questions Passport photo Citizenship/immigration status with birth certificate	Copy of DH Diploma Personal interview if requested by Board Three personal references
OR	CDCA CITA WREB	Certification of Education DH Transcripts	$180	Yes	Yes	Fingerprints Personal data questions Notarized affidavit Passport photo	
PA	CDCA CITA WREB		$75	No	Yes	Good moral character	
RI	CDCA CITA WREB	DH Transcripts	$65	No	No/Yes if licensed for L.A. or N2O2	Criminal fraud questions Notarized affidavit Passport photo Citizenship/immigration status	
SC	CITA CRDTS	DH Transcripts	$150	No	Yes	Personal data questions Notarized affidavit Passport photo Citizenship/immigration status notarized	
SD	CITA CRDTS WREB	DH Transcripts	$215	Yes	Yes	Good moral character National Practitioner Data Bank Criminal fraud questions Personal data questions Passport photo Citizenship/immigration status with birth certificate Release of records	Three personal references
TN	CDCA CITA CRDTS WREB SRTA	DH Transcripts	$125	Yes	Yes	Complete background check Criminal fraud questions Passport photo Citizenship/immigration status notarized	Two letters of recommendation by a dental professional Failure to pay taxes results in denial of license
TX	CITA CRDTS WREB	DH Transcripts	$126	Yes	Yes	Fingerprints National Practitioner Data Bank Notarized affidavit Passport photo Citizenship/immigration status	American Association of Dental Board self-query Official High School transcripts
UT	CDCA CITA WREB	DH Transcripts	$60	No	Yes	Good moral character Criminal fraud questions Personal data questions Personal affidavit Citizen/immigration status	
VT	CDCA CITA WREB	Certificate of Completion	$150	Yes	Yes		Emergency office procedure course

Table II. Dental hygiene entry-level, initial licensure requirements (continued)

State	Clinical Exam	Proof of Education	Application Fee	Jurisprudence	CPR	Background Check	Other Requirements
VA	CITA WREB CRDTS SRTA CDCA	Certification of Education DH Transcripts	$175	No	No	National Practitioner Data Bank Notarized affidavit	
VI	CITA WREB	Certification of Education DH Transcripts	$100	Yes	No	Good moral character with two letters of references National Practitioner Data Bank Complete background check Notarized affidavit Passport photo Citizen/immigration status Release of records	
WA	CDCA CITA CRDTS WREB	Certification of Completion DH Transcripts	$100	Yes	Yes	Fingerprints Complete background check Personal data questions	Expanded function education 7 hours of HIV/AIDS training
WV	CDCA CITA CRDTS WREB SRTA	Certificate of Completion	$75	Yes	No	Good moral character with a certified letter stating in good standing National Practitioner Data Bank Criminal fraud questions Personal data questions Notarized affidavit Passport photo Citizenship/immigration status	Physician statement
WI	CDCA CITA CRDTS WREB	DH Transcripts	$150	Yes	Yes	Criminal fraud questions Personal data questions Personal affidavit Passport photo Citizenship/immigration status	Education requirements for expanded function
WY	CDCA CITA CRDTS WREB	DH Transcripts	$150	Yes	Yes	Good moral character National Practitioner Data Bank Criminal fraud questions Personal data questions Personal affidavit Passport photo Citizenship/immigration status	Education requirements for expanded functions Three personal references Three professional references

Another consideration associated with licensure and regulation has been noted in a comparison of nurse practitioners and dental hygienists by Taylor.[22] Dental hygiene has been largely regulated by dentists, who in turn are also employers, whereas nursing has been self-regulated since the early 1900s.[22] Taylor notes that the structure of dental hygiene licensure allows state legislators and dental boards to "suppress dental hygienists from practicing to the fullest extent of their training."[22] Reducing restrictions on the dental hygiene scope of practice would allow increased opportunities to expand access to care. With new workforce models and direct access available in some form in most states, Taylor recommends conducting and publishing research documenting the safety and quality protection practices, along with cost analyses as a means to encourage regulatory changes.[22] Previous research has not demonstrated that licensure improves the overall quality of care or the health and safety of the public. While consumer complaints may be registered with state boards, only a small percentage of these

complaints result in disciplinary action, while increased dental hygiene licensing requirements have been shown to increase the average cost of the dental visit to consumers by seven to eleven percent.[2]

Dower et al. also supported the need to restructure scope of practice regulations for health professions, indicating that regulatory flexibility is needed to support changes in education, competence, and practice.[23] National organizations such as the Institute of Medicine and National Governors Association have called for reforms including easing scope of practice restrictions and improving reimbursement policies for health care providers. However, the legal aspects of practice can impose artificial barriers preventing providers, such as dental hygienists and nurse practitioners, from practicing to the fullest extent of their education.[23] Current health practices do not fit into this outdated regulatory scheme.[23] A realignment of the scope of practice with professional competence, adopting regulatory flexibility to accommodate new roles, recognizing and accommodating overlapping scopes of practice, and establishing a national clearinghouse, is needed.[23] Dower et al. also encourage the development of "model" practice acts that are either exemplary current state practice acts or ideal practice acts based on professional competence, similar to those created by physical therapy, occupational therapy, pharmacy, and social work.[23] Dental hygiene could consider testing these model practice acts within regulatory boards and committees and then determine whether or not the authority of the dental hygiene committee is sufficient to regulate the profession.

Another option is to consider the development of interstate compacts, a reciprocity agreement structure in which states construct multi-state licensing agreements using a common set of qualifications for all compact members. In this structure, states bridge the existing gaps in licensing requirements which in turn, facilitates portability. Nursing and physical therapy are examples of healthcare professions utilizing this arrangement.[2] Recent legislation in the state of Arizona (House Bill 2569) recognizes licensed professionals from any state and grants licensure to practice in Arizona provided the applicant is establishing residency in Arizona and has practiced their profession in another state in good standing for a minimum of one year. This legislation reflects recommendations from a recent US Health and Human Services report, "Reforming America's Healthcare System Through Choice and Competition" designed to establish new ways to provide quality care to the public at affordable costs.[24]

This study has limitations. Every effort was made to ensure that all data gathered from the dental regulatory board websites were current for 2019. However, some websites displayed outdated information on their official site. In such cases, either the PI or a co-investigator contacted a licensing specialist of the governing board to verify the data represented on the official site. Also, either the PI or a co-investigator reviewed the published rules and regulations to verify consistency and accuracy of licensure information. At least 20 boards were contacted personally to review and verify information. Further research into licensure and regulatory practice could examine the need for dental regulatory bodies to govern dental hygiene scope of practice. If dental hygiene committees can make decisions regarding the licensure, practice, and discipline of dental hygiene, oversight by a dental (dentist) board may not be necessary. Additionally, if entry-level dental hygiene education programs teach to competence, further investigation should be conducted to identify the relevance of various forms of a national clinical examination to support the portability of licensure across state lines.

Conclusion

Data regarding current requirements for entry-level licensure to practice dental hygiene was collected from dental and dental hygiene licensing boards in the US and the Virgin Islands. While the majority of regulatory bodies require completion of entry level dental hygiene education from a CODA-accredited program along with successful completion of national board and regional clinical examinations, additional requirements for initial licensure vary. No differences in entry-level licensure requirements were identified between the dental boards and the self-regulating dental hygiene board. Further research is recommended to examine the need for dental regulatory boards to govern dental hygiene scope of practice and to explore the relevance of a national clinical examination to support portability of dental hygiene licensure across states.

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Kristen Johnson, RDH, MS is a graduate of the Idaho State University Master of Science in dental hygiene program; ***JoAnn Gurenlian, RDH, MS***, ***PhD, AFAAOM*** is a professor and graduate program director in the Department of Dental Hygiene; ***Kandis Garland, RDH, MS*** is an associate professor in the Department of Dental Hygiene; ***Jacqueline Freudenthal, RDH, MHE*** is a professor and Dental Hygiene Department Chair; all at Idaho State University, Pocatello, ID.

Corresponding author: Kristen Johnson, RDH, MS; kjohnsonrdhap@gmail.com

References

1. Kleiner, MM. The Hamilton project; reforming occupational licensing policies [Internet]. Washington, DC: Brookings Institution; 2015 Jan 27 [cited 2018 Sept 10]. Available from: https://www.hamiltonproject.org/papers/reforming_occupational_licensing_policies.
2. U.S. Department of Labor. Occupational licensing: a framework for policymakers [Internet]. Washington, DC: U.S. Department of Treasury; 2015 [cited 2018 Oct 7]. Available from: https://obamawhitehouse.archives.gov/sites/default/files/docs/licensing_report_final_nonembargo.pdf
3. Sindecuse Museum of Dentistry. Dental hygiene: a century of progress [Internet]. Ann Arbor (MI); University of Michigan; 2019 [cited 2018 Oct 19]. Available from: https://www.sindecusemuseum.org/dental-hygiene-a-century-of-progress
4. Boyleston ES, Collins MA. Advancing our profession: are higher educational standards the answer? J Dent Hyg Summer 2012, ; 86(3), 168-78.
5. American Association of Dental Boards. State dental boards [Internet]. Chicago: American Association of Dental Boards; 2019 [cited 2019 Jan 17]. Available from: https://dentalboards.org/links/
6. Dental Hygiene Board of California. How to become licensed in California [Internet]. Sacramento (CA): Department of Consumer Affairs; 2019 [cited 2019 Feb 3]. Available from: https://www.dhcc.ca.gov
7. American Dental Hygienists' Association. Dental hygiene education: curricula, program enrollment and graduate information [Internet]. Chicago: American Dental Hygienists' Association; c2012-2019 [cited 2018 Sept 10]. 29 p. Available from: https://www.adha.org/resources-docs/72611_Dental_Hygiene_Education_Fact_Sheet.pdf
8. American Dental Hygienists' Association. Advocacy: regulatory boards [Internet]. Chicago: American Dental Hygienists' Association; c2012-2019 [cited 2018 Oct 9]. Available from: https://www.adha.org/regulatory-boards
9. Commission on Dental Accreditation. Accreditation standards for dental hygiene education programs [Internet]. Chicago (IL): American Dental Association; c2018 [cited 2019 Feb 24]. Available from: https://www.ada.org/~/media/CODA/Files/dental_hygiene_standards.pdf?la=en
10. Livingston, Harold, M. (Chair, Commission on Dental Accreditation, Chicago, IL). CODA to ADHA DH proposed standards revisions [Internet]. Letter to: Ann Battrell (American Dental Hygienists' Association, Chicago, IL). 2017 Aug 23. 6 paragraphs.
11. Lo-Biondo-Wood G, Haber J. Nursing research: methods and critical appraisal for evidence-based practice. 9th ed. St. Louis, MO: Elsevier; 2018. 552 p
12. Polit DF, Beck CT. Nursing research: generating and assessing evidence for nursing practice, 9th ed. Philadelphia, PA: Wolters Kluwer Health, Lippincott Williams & Wilkins; 2012. 773 p
13. Jenson and Lantzy et al. Is it ethical to involve patients in state board examinations? J Am Coll Dent 2002 Spring;69(2):39-42.
14. Lantzy MJ, Muzzin KB, DeWald J, et al. The ethics of live patient use in dental hygiene clinical licensure examinations: a national survey. J Dent Educ 2012 Jun:76(6):667-81.
15. Donaldson ME, Gadbury-Amyot CC, Khajotia SS, et al. Dental education in a flat world: advocating for increased global collaboration and standardization. J Dent Educ 2008 Apr;72(4): 408-21.
16. Fleckner LM, Rowe DJ. Assuring dental hygiene clinical competence for licensure: a national survey of dental hygiene program directors. J Dent Hyg 2015 Jun;89(1):26-33.
17. Friedrichsen SW. Moving toward 21st-century clinical licensure examinations in dentistry. J Dent Educ Jun 2016;80(6):639-40.
18. American Dental Education Association. Proceedings of the 2014 ADEA House of Delegates: Resolution 5H-2014. J Dent Educ 2014 Jul;78(7):974-5.
19. American Dental Hygienists Association. ADHA Policy Manual [Internet]. Chicago (IL): American Dental Hygienists Association; 2019 Jun [cited 2019 Sept 14]. Available from: https://www.adha.org/resources-docs/7614_Policy_Manual.pdf
20. Gambacrota JE, Glick M, Anker AE, et al. The Buffalo model: shifting the focus of clinical licensure exams in dentistry to address ethical concerns regarding patient care. J Dent Educ 2016 Jun;80(6):641-7.
21. American Dental Education Association. Report of the task force on assessment of readiness for practice [Internet]. Washington (DC): American Dental Education Association; 2018 Sept.[cited 2019 May 15]. Available from: https://www.adea.org/TARPreport/
22. Taylor H. Parallels between the development of the nurse practitioner and the advancement of the dental hygienist. J Dent Hyg 2016 Feb;90(1):6-11.
23. Dower C, Moore J, Langelier M. It is time to restructure health professions scope-of-practice regulations to remove barriers to care. Health Affairs 2013 Nov;32(11):1971-6
24. U.S. Department of Health and Human Services. Reforming America's healthcare system through choice and competition [Internet]. Washington (DC): U.S. Department of Health and Human Services; 2018 Oct [cited 2019 May 15]. Available from: https://www.hhs.gov/sites/default/files/Reforming-Americas-Healthcare-System-Through-Choice-and-Competition.pdf