Are dental hygienists at risk for noise-induced hearing loss? A literature review

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PRACTICAL IMPLICATIONS OF THIS RESEARCH

- Dental hygienists may be at risk for noise-induced hearing loss because of their repeated daily use of high- and low-frequency noise-emitting devices.
- Preventive measures can be taken to mitigate this risk in clinical practice.
- Active (electronic) sound control devices offer effective hearing protection without compromising comfort or communication with clients.

ABSTRACT

Objective: The aim of this review is to explore dental hygienists' risk for noise-induced hearing loss (NIHL) and to describe the current hearing protection options. **Methods:** A literature search was undertaken using the following databases: PubMed, CINAHL, Cochrane Libraries, and Google Scholar. The returns were screened using inclusion and exclusion criteria and the remaining studies were critically appraised. **Results and Discussion:** Seventeen articles assessed noise levels and NIHL risk in dental settings; and 11 articles examined hearing protection devices. The literature revealed that oral health practitioners were exposed to excessive noise limits (85 dBA) in an 8-hour workday, therefore increasing the risk of NIHL. Oral health professionals need to be aware of this risk and the preventive measures they can take to reduce the potential for hearing loss. Effective preventive measures may include hearing protective devices (HPDs), educational programs, insulated noise-absorbing materials, and regular monitoring of noise exposure. **Conclusion**: Dental hygienists may be at risk for permanent or temporary hearing loss in their work environment. Permanent hearing loss from the use of ultrasonic scalers appears to be minimal. To prevent hearing loss, active (electronic) HPDs are recommended as they allow practitioners to protect their hearing and communicate with clients.

RÉSUMÉ

Objectif : Le présent examen visait à explorer le risque couru par les hygiénistes dentaires en matière de la déficience auditive due au bruit (DADB) et à décrire les options de protection de l'ouïe actuelles. **Méthodes :** Une recherche documentaire a été effectuée au moyen des bases de données suivantes : PubMed, le CINAHL, la bibliothèque Cochrane et Google Scholar. Les trouvailles ont été triées au moyen de critères d'inclusion et d'exclusion et les études restantes ont été évaluées de façon critique. **Résultats et discussion :** Un total de 28 articles ont répondu aux critères d'inclusion. Dix-sept (17) articles ont évalué les niveaux sonores et le risque de DADB en milieux dentaires : 11 articles ont examiné les dispositifs de protection de l'ouïe. La documentation a révélé que les praticiens de santé buccodentaire étaient exposés à des valeurs de limites sonores excessives (85 dBA) au cours d'une journée de travail de 8 heures, augmentant ainsi le risque de DADB. Les professionnels de la santé buccodentaire doivent être sensibilisés à ce risque et aux mesures préventives qu'ils peuvent prendre pour réduire le potentiel de perte d'ouïe. Des mesures préventives efficaces peuvent comprendre des dispositifs de protection de l'ouïe (DPO), des programmes éducatifs, des matériaux insonorisants et la surveillance régulière de l'exposition au bruit. **Conclusion :** Les hygiénistes dentaires peuvent être à risque de perte d'ouïe permanente ou temporaire dans leur environnement de travail. La perte d'ouïe permanente en raison de l'utilisation de détartreurs ultrasoniques semble être minime. Pour prévenir la perte de l'ouïe, des DPO actifs (électroniques) sont recommandés, puisqu'ils permettent aux praticiens de protéger leur ouïe et de communiquer avec leurs clients.

Keywords: dental hygiene; hearing impairment; hearing loss; hearing protective devices; noise-induced hearing loss; occupational noise; suction; ultrasonic scalers

CDHA Research Agenda category: risk assessment and management

BACKGROUND

According to Statistics Canada, "an estimated 19% of adults (4.6 million) have at least mild hearing loss in the speech frequency range."[1] Hearing is important for daily living and vital to maintaining personal safety. A hearing impairment can result in the inability to hear warning signals, such as car horns, fire alarms, and other lifesaving sounds, which increases the risk for incidents and puts lives at stake.[2] There are many types of hearing loss in adults; the most common is sensorineural hearing loss.[3]

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Sensorineural hearing loss is defined as damage to the parts of the inner ear causing hearing loss.[3] The most common type of sensorineural hearing loss is age related (presbycusis) followed by noise-induced hearing loss (NIHL).[4] NIHL is described as the loss of hearing due to damage to the sensitive parts of the inner ear from overexposure to loud sounds.[3,5,6] It is the result of cumulative, long-term exposure to moderate and loud noises, which may affect one ear or both. The damage can be permanent and irreversible. However, damage can be limited if diagnosed at the early stages when preventive interventions can occur.[7,8] Unlike presbycusis, NIHL is not age related, and thus can happen at any time depending on the circumstances.[6]

The noises that cause NIHL can be either very loud for a short period of time, such as an explosion, or moderate to loud over an extended period, such as industrial machines or music,[6,8] which result in damage to the inner ear and subsequently cause permanent hearing loss.[3,6] Common symptoms of NIHL are muffled hearing, difficulty understanding or following conversations, as well as tinnitus.[8,9] Tinnitus is the perception of buzzing, whistling, ringing, roaring or other phantom sounds in the ear.[10,11] The causes of tinnitus are hearing loss, earwax blocking the ear canal, age, ear injury, medications, and other health problems.[10,11]

Excessive noise has many implications for daily life, as well as the potential to contribute to certain health conditions, such as increased risk for cardiovascular disease (including hypertension and ischemic heart disease), stress, sleep disruption, fatigue, anxiety, depression, difficulty concentrating, and mood disorders.[8,12-16] When the resulting NIHL occurs, people have difficulty communicating in groups, public settings or by telephone, which lead to social withdrawal.[2]

NIHL is related to work noise. Using data from two Canadian Health Measures Survey (CHMS) cycles (2012 to 2013 and 2014 to 2015), researchers determined that approximately 11 million Canadians (43%) worked in noisy environments.[12] Of these, over 6 million (56%) were classified as vulnerable to workplace noise.[12] The Canadian Centre for Occupational Health and Safety notes that the daily allowable time-weighted occupational noise exposure limit in most Canadian jurisdictions is 85 dBA over an 8-hour workday for 5 days a week, over 40 years.[17] Yet many workers in noisy environments are not required to wear hearing protection devices, which places them at risk for occupational NIHL.[12]

The daily allowable occupational noise exposure limit is important for oral health professionals to know, as the noise levels from dental devices have been suggested as a potential contributor to NIHL based on multiple studies.[13,18-21] These studies noted that high- and low-frequency noise-emitting devices are frequently used by the oral health team daily.[18,19] Oral health care professionals need to be aware of potential hearing loss risk if these noise levels are deemed dangerous for an average workday. They should also be familiar with the options to prevent such damage from occurring.

Objective

The aim of this review is to explore the risks for NIHL among dental hygienists and to describe the current hearing protection options available.

METHODOLOGY

A literature search was conducted in the electronic databases PubMed, CINAHL, Cochrane Libraries, and Google Scholar using the following keywords: hearing loss, hearing impairment, suction, ultrasonic scalers, noise-induced hearing loss, hearing protective devices, occupational noise, and dental hygiene. The inclusion criteria were 1) published in peer-reviewed sources; 2) written in English; 3) published within the past 20 years; 4) adult population studies. The following items were excluded: 1) letters to the editor; 2) studies of noise in dental laboratory settings.

The titles and abstracts retrieved were read by 2 of the team members (KH and SH) to determine their suitability for this review based on the inclusion/exclusion criteria. In addition, the reference lists were scanned for additional resources. Research methodologies included were randomized controlled trials, systematic reviews, descriptive studies, surveys or questionnaires, reviews, and pilot studies. Studies primarily assessing noise or hearing impairment in the oral health setting or with oral health personnel using ultrasonic scalers were highlighted.

RESULTS

There were 28 studies that met the inclusion criteria. Twenty-seven of the studies were from peer-reviewed journals; the remaining study was a dissertation from the Program in Audiology and Communication Sciences, Washington University School of Medicine.[15] Two articles were excluded as their primary focus was either not on clinical dental noise or did not include ultrasonic scalers as part of the study. The designs of the 26 included studies were as follows: 1 quantitative systematic review,[22] 2 quantitative randomized controlled clinical trials,[23,24] 1 quantitative case–control study,[19] 3 quantitative descriptive studies,[21,25,26] 15 quantitative cross-sectional studies,[13-15,18,20,27-35,39] 2 qualitative cross-sectional studies,[36,37] and 2 narrative reviews[38,42] (Table 1). Seventeen studies evaluated noise levels and the risk of NIHL when oral health professionals were using an ultrasonic scaler.[13,19-21,26,27,30-35,37-40,42] Eleven studies evaluated hearing protection devices and their current use in the oral health setting.[13-15, 22-25,27,29,36,38]

The importance of the daily occupational noise limit to oral health professionals was discussed in 8 studies.[13,18-21,25,34,35] Two articles identified the age of the practitioner and length of time in practice as other contributing factors to NIHL.[21,28] Seven articles attributed

Table 1. Summary of included studies

Author	Methodology	Study purpose	Sample size	Relevant findings
Ahmed HO, 2017[33]	Quantitative cross-sectional	To examine and determine the noise level in a dental college (noise annoyance, subjective hearing loss, and hearing related problems among students).	n = 114	Noise level were between 58 dB(A) and 79 dB(A). Peak levels ranged from 89 dB(A) to 93 dB(A). Students with prolonged exposure had more hearing issues.
Alabdulwahhab BM, 2016[31]	Quantitative cross-sectional	To determine whether the persistent high-frequency sounds produced by the dental equipment could cause hearing decrement among Saudi dental practitioners.	n = 38	A majority of dental professionals in this study were right-handed and the position of instruments (i.e., high-volume suction being to the left of most dentists) could play a role in level of hearing impairment. Evaluated noise levels from ultrasonic scalers.
Al-Omoush SA 2019[29]	Quantitative cross-sectional	To examine the hearing threshold in oral health personnel. To evaluate sound levels of the equipment used by these personnel.	n = 244	Self-reported risk for hearing loss in oral health professionals who were exposed to dental noise >4 hrs a day. Left ear threshold was poorer than right ear. Relationship between hearing loss and daily duration of noise and age of subject.
Al-Rawi NH 2019[30]	Quantitative cross-sectional	To determine whether the persistent high-frequency noise produced by dental equipment could cause hearing impairment among the dental professionals.	n = 90	Evaluated noise levels from ultrasonic scalers. Suggests time in practice can be related to increased hearing loss.
Arabaci T, 2007[42]	Review	To review the safety, efficacy, role, and deleterious side effects of sonic and ultrasonic scalers in mechanical periodontal therapy.	N/A	Ultrasonic scalers may cause tinnitus, temporary shifts in hearing thresholds. No permanent damage due to airborne noise from ultrasonics, no conclusive information of transmission through the bones of the inner ear.
Bono SS, 2006[15]	Dissertation Quantitative cross-sectional	To survey dentists' opinions of noise caused by handpieces. To quantify the noise output of dental handpieces including sonic/ultrasonic scalers.	Survey (n = 12) Handpieces (n = 6)	Dentists would wear HPD if instruments were deemed harmful to their hearing. Hearing loss is multifactorial. Oral health care providers should be 12 inches (30.48 cm) away from the noise source. The noise output for the titan and the Piezo was 80 dB(A). Frequency of use should be considered.
Burk A, 2016[13]	Quantitative cross-sectional and survey	To assess potential noise exposure among dentists, dental hygienists, and dental students. To assess the differences in exposure between the 3 oral health professional groups.	n = 46	Evaluated noise levels from ultrasonic scalers. Results suggest that oral health professionals and students may have some risk of developing NIHL particularly in pediatric clinical settings. HPD
Chopra A 2016[27]	Quantitative cross-sectional	To evaluate the negative auditory and non-auditory effects immediately after using ultrasonic scalers and their potential role in the development of permanent hearing loss.	n = 60	Noise-emitting devices such as ultrasonic scalers produce significant immediate auditory and non-auditory changes. It is important that oral health care providers recognize the initial signs of hearing damage and adopt appropriate measures while working to prevent the development of permanent hearing impairment in future.
Choosong T 2011[39]	Quantitative cross-sectional	To determine noise exposure among oral health professionals.	n = 113	Noise levels in the dental school were approximately 60 dB. This level may cause annoyance, conversation interference, and concentration difficulty but not NIHL. Evaluated noise levels from ultrasonic scalers.

Table 1. *continued*

Author	Methodology	Study purpose	Sample size	Relevant findings
Daud MK, 2011[32]	Quantitative comparative cross-sectional	To determine intensity and frequency of oral health instruments. Determine prevalence of NIHL in dental staff nurses.	n = 65	Dental staff nurses might be at risk for NIHL. Evaluated noise levels from ultrasonic scalers.
Kadanakuppe S 2011[25]	Quantitative descriptive	To measure, analyse, and compare noise levels of equipment under different working conditions and to measure and compare noise levels between used and brand-new handpieces under different working conditions.	N/A	Evaluated noise levels from ultrasonic scalers. The noise levels detected in this study were considered close to the limit of risk of hearing loss. HPD
Khaimook W 2014[21]	Quantitative descriptive	To determine the prevalence of hearing loss among dental personnel exposed to instrument noise during the workday. To identify noise levels in work areas. To identify risk factors of hearing loss.	n = 76	Risk factors are age and career length. No significant difference was found between dental personnel and control group.
Khan A 2006[37]	Qualitative cross-sectional	To determine if noise producing dental tools are a predetermining factor for NIHL.	n = 333	Hazardous auditory output is affected by intensity, duration, and frequency. Noises emitted from dental tools, including the ultrasonic scaler, are lower than the permissible limits, yet it is advisable that dentists using high-speed drills should have periodic hearing tests.
Lazar A 2015[34]	Quantitative cross-sectional	To assess prevalence of self-reported hearing difficulties among experienced dental hygienists who have been practising for a minimum of 20 years and explore the relationship between hearing difficulties and occupational noise exposure from ultrasonic scalers.	n = 372	Long-term noise exposure from dental equipment, such as ultrasonic scalers, may contribute to hearing difficulties among experienced dental hygienists.
Ma KW 2017[14]	Quantitative cross-sectional	To conduct noise exposure assessments on oral health professionals' daily working environment and to relate this as a health risk assessment.	n = 60	Noise in the oral health environment was within the recommended occupational limit. However, the increase in noise was related to dissatisfaction in the health risk assessment. HPD
Manchir M 2016[36]	Qualitative cross-sectional	To survey dentists regarding the type of HPD they prefer.	n = 15	Studied 4 different HPDs. The active noise devices (electronic) are preferred.
Messano GA 2012[20]	Quantitative cross-sectional	To investigate prevalence and factors associated with perceived hearing impairment among dentists.	n = 215	Self-reported incidence of hearing related problems due to dental equipment, including ultrasonic scalers.
Myers J 2016[18]	Quantitative cross-sectional	To evaluate noise levels in dental offices and to estimate the risk and prevalence of tinnitus and NIHL in practising dentists.	n = 144	Results from sound level measurements and questionnaire responses indicate that dentists are a population that could be placing their hearing health at risk in a typical daily work environment. Evaluated noise levels from ultrasonic scalers.
Paramashivaiah R 2013[38]	Review	Review of the literature on the various hazards associated with ultrasonic and sonic instrumentation.	N/A	Listed the factors associated with hearing loss among dentists. Conclusion was that using ultrasonic scalers was not associated with NIHL.
Salmani Nodoushan M 2014[23]	Quantitative RCT	To compare the effect of face-to-face training in effective use of earplugs with appropriate noise reduction rating (NRR) to overprotection of workers by using earplugs with higher than necessary NRR.	n = 150	Training in appropriate use of earplugs significantly affects the efficacy of earplugs—even more than using an earplug with higher NRR.

Table 1. *continued*

Author	Methodology	Study purpose	Sample size	Relevant findings
Sharma M 2019[28]	Quantitative cross-sectional	To determine the impact of hearing education on the attitudes towards and beliefs about noise and hearing protection among dental students.	n = 24	Hearing education was effective in changing the attitudes and beliefs of dental students on hearing protection and occupational noise exposure.
Sorainen E 2002[26]	Quantitative descriptive	To evaluate the noise levels of current dentistry equipment under very controlled conditions.	N/A	The average ultrasound level of the hand pieces was below 90 dB. The average ultrasound level of the ultrasonic scaler at the one-third octave band of 25,000 Hz was 107 dB.
Spomer J 2017[24]	Quantitative RCT	To evaluate hearing devices in dental clinics to better understand barriers and facilitate the use of these devices.	n = 15	Two suggested HPDs: The DI-15 High-Fidelity Electronic Earplugs HPD (ranked highest) and Music PRO Electronic Earplugs (second).
Verbeek JH 2014[22]	Quantitative systematic review	To assess the effectiveness of interventions in preventing occupational noise exposure or hearing loss compared to no intervention or alternative interventions.	n = 19 studies n= 82,794 participants	Low-quality evidence supports the use of hearing protection. Low-quality evidence that hearing loss programs reduce the risk of hearing loss.
Willershausen B 2014[35]	Quantitative cross-sectional	To assess the hearing abilities of dentists compared to other academic professionals to determine possibly significant differences in their hearing.	n = 115	Dentists and dental personnel are exposed to a noise level of different frequency ranges due to the use of high-speed handpieces, various instruments, and ultrasound devices. Maximum sound levels of 85.8 dB and 92.0 dB were found.
Wilson JD 2002[19]	Quantitative case–control study	To determine whether long-term ultrasonic noise exposure in the dental office environment is related to dental hygienists' hearing status.	n = 698	Right and left ears were not statistically different in the hearing threshold levels. Ultrasonic noise may in fact be affecting dental hygienists' hearing at 3000 Hz.

the risk of NIHL to the high- and low-frequency noise-emitting devices frequently used daily by the oral health team over an extended period.[18-20,25,35,37,39] These devices can reach hazardous outputs depending on the duration of use and intensity. Another study expressed concern over whether oral health students are at risk for NIHL given the accumulation of noise from such a high number of operatories.[13] In addition to studying the causes of NIHL in the oral health setting and hearing protection devices (HPDs), 1 article described the different methods used to reduce noise levels in dental clinics, such as using sound-absorbing materials in the walls.[33]

Many themes emerged from these studies, including that oral health professionals and students may be at risk for NIHL[18]; age and length in practice may have an effect on NIHL[21,30]; and long-term exposure to the noises emitted from dental equipment[24,31] may contribute to hearing loss depending on the intensity, duration, and frequency of use of the devices[20,37]. Other themes focused on the importance of recognizing signs of NIHL[13,36] and adopting appropriate prevention methods. Methods such as sound-absorbing materials,[33] HPDs,[18] and proper training on use of HPDs [23,28] may be effective methods for preventing NIHL.

DISCUSSION

Eight specific topics identified from this literature review will be discussed under separate headings: 1) general oral health settings noise levels; 2) hearing damage due to ultrasonic scaler noise; 3) hearing impairment among oral health professionals; 4) HPDs; 5) benefits of wearing HPDs; 6) HPD education; 7) other hearing protection options; and 8) current use of HPDs in oral care offices.

General oral health settings noise levels

In order to understand the effects of sound on hearing, a brief description is required. Each sound produced has a frequency, Hertz (Hz), a rate at which the sound waves complete a cycle.[11] A healthy, young human can hear frequencies that range from 20 Hz to 20,000 Hz.[40] Although a person is able to hear sound waves in this range, the human ear is more sensitive to certain frequencies over others, meaning certain frequencies will be interpreted as louder even if they are not.[40] The A-weighted decibel scale was created to accommodate this so that lower frequencies are de-emphasized; the A-weighted filter assesses decibel levels at the noise level experienced by the listener.[11,40] It is also important to clarify that the decibel scale is a

logarithmic scale, therefore decibel levels do not cumulate by addition.[11] For example, when using the ultrasonic scaler and a low- or high-volume suction, the devices produce different frequencies and will be interpreted differently by the ear.[40]

Oral health professionals are exposed to many different types of noise—high- and low-speed handpieces, high- and low-volume suction, ultrasonic scalers and baths, and even noise related to loud client interactions throughout a workday—that contribute to increased noise levels. The noise levels from dental devices can accumulate very easily. This was evident in a simulated work environment where unobstructed suction noise levels, including both low and high volume, fell between 75 and 79 A-weighted dB (dBA)[19,26,32,35,38,39]; this range is within the recommended maximum 85 dBA exposure limit for an 8-hour workday.[8,12] Having an obstructed suction can increase the noise level to 96 dBA, which is similar to the noise levels reached when combining an unobstructed suction with a dental handpiece of 94 dBA,[18] both of which have a recommended 1-hour maximum exposure time according to the Canadian Centre for Occupational Health and Safety.[17] The presence of electric generators, aspirators, autoclaves, and compressors can also contribute to background noise. It is not known if this noise is damaging to hearing or just irritating to the clinician.[37]

Hearing damage due to ultrasonic scaler noise

Ultrasonic noise refers to sound with a frequency above the 20 kHz that the human ear can hear.[11,42] If the ultrasound is too strong it can create audible subharmonies within the ear which are interpreted as squeaking sounds[25] and could be harmful over the long term.[38] Ultrasonic scalers used in oral health settings produce high-intensity ultrasonic sound between 20 kHz and 50 kHz.[41]

Ultrasonic scalers on average have noise levels of 69 dBA to 84 dBA,[15,26] which is within the safe 8-hour occupational noise limit. Other studies found the average noise level for ultrasonic scalers to be 87.1 dBA[32,35,38] or even up to "107 dB at the one-third octave band of 25,000 Hz."[26] It should be noted that the majority of the frequencies in this octave band are completely inaudible to humans regardless of intensity.[43] While the measurement of 107 dB is above the recommended 87 dB, human ears are insensitive to this ultra-high frequency, so a person would not hear it.[43] The studies did not examine the cumulative noise level of the ultrasonic scaler and either the low- or high-volume suction, which are traditionally used together in practice. However, as previously mentioned, the different frequencies would be interpreted differently by the ear.[40]

A reduction in hearing, called a threshold shift, occurs when the ear decreases its sensitivity level in response to noise exposure, thereby raising the threshold required to hear sound; once a threshold shift occurs only noise louder than a certain threshold will be heard.[11,42] A temporary shift can occur after an exposure to loud or intense noise and will usually resolve within a day, or could take up to a week.[11,42] A permanent threshold shift will occur when the inner ear is damaged and the ability to hear is reduced permanently.[11,42]

A temporary threshold shift has been reported following the use of an ultrasonic scaler, causing an individual to require a louder stimulus than usual to hear the same frequency.[27,42] This temporary condition was found to last between 16 hours and 48 hours, but the researchers cautioned that a certain degree of permanent damage could take place.[27]

Dental hygienists have expressed concern over the risk of hearing loss as a result of using ultrasonic scalers. Lazar et al.[34] surveyed 273 dental hygienists who self-reported that ultrasonic scalers may contribute to hearing loss. Seventeen percent of the participants reported having hearing difficulties, such as tinnitus, specifically due to ultrasonic scaler use.[34] Arabaci et al.[42] reported in their review that, following the use of ultrasonics, a temporary shift in the hearing threshold and tinnitus may occur. However, when compared with the general population there were minimal differences in these symptoms. Wilson et al.[19], in a pilot study using pure-tone audiometry testing, revealed a statistically significant difference between a group of dental hygienists who frequently used ultrasonic scalers compared to a group that did not use these devices.[19] Upon further analysis, this same study found hearing was specifically affected at 3000 Hz and there was no significant difference between the groups at other frequencies.[19] Interestingly, no significant differences were found between right and left ears using pure-tone audiometry testing,[19] but when tested with otoacoustic emission, which determines the function of the inner ear cells, the left ear had a greater reduction than the right.[27,31] However, there was no indication of whether the participants were right or left handed, which would affect the positioning of the instruments.[27,31] Chopra et al.[27] additionally found through pure-tone audiometry testing that ultrasonic scalers have an immediate effect reduction on hearing.[27]

Hearing impairment among oral health professionals

There is evidence of hearing impairment to a certain degree among oral health professionals through pure-tone audiometry testing.[30,31] A cross-sectional study surveyed 100 general dental practitioners with at least 10 years of work experience. These practitioners self-reported a higher presumptive hearing impairment compared to a similar control group made up of 115 general medical practitioners.[20] The perceived hearing loss was not confirmed with any formal audiometric testing, which reduces validity and generalizability of the results of this study. Al-Omoush and colleagues[29] conducted a quantitative case–control study that included 244 dental professionals. The participants were divided into 4 test groups, with 1 control group consisting of 62 dental students. Otoscopy, tympanometry,

and pure-tone audiometry assessments were conducted and values were compared with those of the control group. Study findings revealed dental professionals had a higher prevalence of hearing loss than non-dental professionals.[29] In contrast, a different case–control study in which dental personnel received otoscopic exams and pure-tone audiometry testing showed no significant difference in hearing impairment between oral health professionals and the control group.[21] Similarly, Alabdulwahhab et al.[31], in a cross-sectional study, found no significant differences between dentists and those in the control group.

Oral health professionals could be exposed to different levels of noise depending on whether they are students or professors in a student clinic or depending on their specialty.[13,33] Pediatric clinics had the highest average and variability in noise levels, suggesting their personnel are at greatest risk for NIHL.[13] Meanwhile, students experience a large variability in noise exposure in preclinical and clinical settings depending on the skill exercises and client care that day, as well as class size and floor plan.[13] About 80% of dental students report noise annoyance in clinic, with some students reporting difficulty hearing phone conversations and symptoms of tinnitus.[33] Over half of students were not aware that noise levels could be dangerous and were unaware of measures they could take to protect themselves.[33] While the evidence supporting NIHL in oral health professionals is inconclusive, as there are so many variables involved, it is important to educate oral health professionals on the hearing risks that may be associated with their work environment.

Hearing protection devices

Hearing protection is recommended more frequently in dental offices now than in the past, but it is still uncommon for dental hygienists to use HPDs.[24] As more studies on this topic are conducted, there may be a rise in dental hygienists wearing HPDs. There are 2 main forms of HPDs: 1) passive noise control and 2) active sound control.[44]

Passive noise control devices work as physical barriers to sound.[44] There are several types of passive sound control devices, such as earmuffs, disposable foam earplugs, and ear canal plugs.[36,44] Earmuffs consist of sound attenuating material and soft ear cushions. These fit over the ear, have hard outer cups and a head band. The inability to communicate with clients and disinfect such devices eliminate them as a viable option for dental hygienists.[36] Another passive device is disposable foam earplugs. These HPDs are designed to be rolled into a thin cylinder and inserted in the ear canal where they expand to fit the user's ear canal.[36] These HPDs are disposable, which makes cleaning unnecessary, although the discarding of the devices does result in environment waste. The foam plugs are the least expensive form of HPDs. However, the cost of replacements may become a deterrent for use.[24,38] The ear plugs will decrease the amount of noise exposure but not as much as earmuffs. However, both earmuffs and earplugs may not be the best choices for dental practitioners as these devices muffle the sound of their own voice but more importantly inhibit the ability of the practitioner to communicate with their clients.[24] Since communication is an essential part of dental hygiene practice, the limiting nature of these HPDs does not make them viable noise prevention options.

Ear canal plugs are another type of passive HPD that is recommended. These devices come in 2 forms. The first are premolded, reusable plugs typically made of silicone, rubber or plastic. The second are canal caps, which consist of earplugs on a plastic or metal band. These devices are either inserted into the ear canal or sit at the opening of the ear canal.[24,36] The advantages of these HPDs are that they are reusable, they last 2 to 3 months, they are available in different sizes, they are generally inexpensive, and they can be cleaned.[24,36] In addition, the ear canal plugs provide the wearers with the ability to place them around the neck when not in use, which many practitioners find convenient.[36] The disadvantages of this type of HPD are that it is often difficult to find the correct size, some people may require a different size plug for each ear or require training for proper fit and insertion, and communication with clients and colleagues once again may be difficult.[24,36]

The active sound control devices electronically modify sound transmission, reducing unwanted noise instead of blocking noise.[36,38] These devices use hearing aid batteries, and they offer hearing protection from high-level sounds while allowing other sounds to be heard.[24,36] Therefore, the major benefit for the dental hygienist is that they enable 2-way communication with clients. In addition, the electronic HPD can be disinfected and tends to fit better than the previously discussed options. However, the electronic models are the most expensive of the HPDs, costing at least $100 for over-the-counter models and more for custom-made models. The higher initial price and the cost of replacement batteries may make these devices less attractive options for some practitioners.[24]

The consensus from clinicians is that the electronic models are the preferred HPD.[25,36] This is due to ease of use, comfort, feeling of openness, general pleasant appearance, and the ability to communicate with the client.[25,36] Two-way communication between client and practitioner is crucial as it is a major component in ensuring the success of care and maintaining client comfort and safety.[24,36]

Benefits of wearing hearing protection devices

Decreasing the risk of NIHL is the main purpose of an HPD. However, HPDs may also decrease the risk of both short- and long-term side effects from exposure to increased noise,[22] such as fatigue, nausea, headaches, irritation, tinnitus, and even hypertension.[14] Long-term benefits of wearing an HPD may include increased work performance and work satisfaction.[14-15]

Hearing protection device education

Special training on the use of HPDs is available to help practitioners effectively use these devices.[22,23] There is a moderate level of quality evidence demonstrating that the effectiveness of hearing protection is close to 8 dB better following instruction on the proper use of HPDs as compared to no instruction.[22,23] In addition, there is increased effectiveness in noise reduction rating with proper instruction on how to use the HPD, even when compared to an HPD with a higher level of protection used by someone who is not properly instructed.[23] It is also shown that having the HPD correctly sized to a person's ear canal results in higher usage of the device.[23]

One study of dental students implemented an educational program to increase their knowledge of hearing and how it may be affected in oral health care settings.[28] The researchers asked questions before and after the education program was provided. The pre-questionnaire noted a lack of knowledge of the risks of NIHL.[28] After the participants were educated on the risks of NIHL, the post-questionnaire revealed students were more likely to wear HPDs.[28]

While education on why a practitioner should wear HPDs is important, so is training prior to using HPDs. Learning the proper insertion techniques and application will improve the protection provided from these devices.[36] There is literature available online, credible YouTube videos, and websites on the proper use and insertion of HPDs. However, seeing the appropriate hearing specialist may ensure optimal selection and application of an HPD.[36]

Other hearing protection options

In all oral health settings, there is a risk of noise exposure among practitioners, but also potentially among the clients and other staff.[13,18-21,28] Given the possible exposure to damaging levels of noise in this setting, Ahmed et al.[33] recommended placing sound-absorbing materials in the walls when building dental offices.[33] Materials such as foam padding and fiberglass insulation will absorb sound more than wood, gypsum board, concrete, brick, and tile, which reflect sound.[45,46] Other recommendations have been based on the dental equipment itself.[24,25,33] Due to the excessive noise emitted by older models of dental equipment, it is recommended that such equipment be replaced with new, less noisy models.[24,25,33,39] Factors influencing the noise generation of dental equipment could be handpiece design, misuse or wear, and poor maintenance of the equipment.[24,25]

It is recommended that regular monitoring of noise levels in the office be conducted to ensure proper reduction protocols are incorporated, when necessary, to reduce the risk of NIHL.[14] The implementation of a hearing loss prevention program would be ideal in the oral health setting. Such a program would incorporate testing on noise exposure, audiometric testing, and training for all oral health care providers.[13] Incorporating a prevention program will ensure that dangerous noise levels are discovered in the early stages before causing any negative long-term hearing complications.

Current use of hearing protection devices in oral care offices

Avoiding excessive noise exposure is the best option for preventing NIHL.[8,24] Unfortunately, the total avoidance of noise is impossible in the oral health care setting. The options for reducing noise include modifying the equipment and/or the acoustic environment to produce less noise and/or wearing HPDs.[24,36] While the use of HPDs is presently uncommon among oral health care practitioners, education should be provided to help reduce exposure risk. Such education and awareness should increase the use of devices that do not interfere with communication.[23,24] Additionally, the inclusion of education on the prevention of NIHL within both dental hygiene and dental curricula is highly recommended. Awareness of this subject could encourage early action to protect the hearing of all oral health professionals.[28] Recognizing the risks of NIHL is essential to oral health professionals, and the use of preventive measures is highly recommended.[27]

CONCLUSION

This article indicates that dental hygienists along with other oral health professionals could be at risk for NIHL in their work environment. However, more research is necessary on the dental hygienists' exposure to high-frequency noise as a result of the use of ultrasonic scalers, and the long-term effects such exposure could have on hearing. Permanent hearing loss risk appears to be minimal for dental hygienists using ultrasonic scalers because they do not exceed the daily allowable occupational noise limit of 85 dBA. Temporary effects on hearing as a result of using these devices include tinnitus and threshold shifts. It is recommended that dental hygienists have regular hearing exams performed by audiologists. If the dental hygienist decides to wear HPDs, the active (electronic) HPDs are preferred as they are comfortable and allow communication with clients.

CONFLICTS OF INTEREST

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