

Hearing Difficulties Among Experienced Dental Hygienists: A Survey

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Abstract

Purpose: Assess prevalence of self-reported hearing difficulties among experienced dental hygienists who have been practicing for a minimum of 20 years and explore the relationship between hearing difficulties and occupational noise exposure from ultrasonic scalers.

Methods: A 19-item survey was mailed to a random sample of 1,067 dental hygienists who had obtained their California licenses between 1972 and 1992. To estimate the prevalence of hearing difficulty, binomial proportion and associated 95% confidence interval are presented. Logistic regression model of hearing difficulty was used to assess an association with ultrasonic scaler use.

Results: Response rate was 35% (n=372/1,067). The prevalence of self-reported hearing difficulty was 40% (95% confidence interval, 35 to 44%). Of the 17% (95% confidence interval, 14 to 21%) of respondents that reported hearing difficulty due to ultrasonic scalers, most (91%) reported that their hearing difficulty was confirmed by an audiologist. Respondents with hearing difficulty due to scalers were 2-times (odds ratio: 2.0, 95% confidence interval, 1.1 to 3.6, p=0.03) more likely to report significantly higher scaler use than those who did not have hearing difficulty after adjusting for age and other potential causes of hearing difficulties.

Conclusion: The prevalence of hearing difficulty at 40% among dental hygienists with an average age of 56 years was considerably higher than the reported national average at 17% for adults 70 years or older. Long-term noise exposure to dental equipment, such as ultrasonic scalers, may contribute to hearing difficulties among experienced dental hygienists. Ear protection is suggested as a preventive measure while using noisy dental equipment.

Keywords: dental hygienist, ultrasonic scalers, hearing loss, noise-induced, occupational hazards

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INTRODUCTION

Dental personnel are in an occupational field that exposes them to hazardous noises on a daily basis.¹ The decibel, which is measured on a logarithmic scale using an A-weighted sound levels (dBA), is used to express the sound level associated with noise measurements. A small change in the number of decibels results in a large change in the amount of noise and the potential damage to a person's hearing. Both Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH) recommend all worker exposures to noise should be controlled below a level equivalent to 85 dBA for 8 hours to minimize occupational noise induced hearing loss, and 15 minutes for 100 dBA to avoid hearing loss. The ultra-high speed drill, for example, was introduced in the 1970s, and it produced noise levels of 100 dBA or more.² At that time, a committee of the American Dental Association (ADA) reported that extended exposure to this new type of equipment could cause auditory damage.²

A historical overview of the literature from 1950 to 2001 concluded that further studies were needed to assess occupational noise-induced hearing loss associated with the use of the dental instruments, as the air turbine, due to inconclusive study results.² A Finnish study (1981 to 1982), for example, looked at hearing of dentists and dental nurses over age 25 with a high frequency audiometer and found no statistically significant difference between the hearing of controls without any known history of ear-related problems or noise exposure.³ A longitudinal study of dentists who had practiced for a minimum of 10 years (1973 and 1988) found that the prevalence of hearing impairment was greater in the follow-up period, but the authors attributed this to presbycusis (age-related hearing loss) and not noises in the dental office.⁴ Since the 1970s, technological improvements were made to dental equipment, which reduced the amount of noise to a level thought to be safe (i.e., <85 dBA).

Instruments, such as ultrasonic scalers, have been reported to produce 68 to 75 dBA, and sometimes up to 90 dBA.¹ Even though this noise level is usually below the sound limits of OSHA⁵ and NIOSH,⁶ recurring use of dental instruments producing these decibel levels may cause hearing impairment.^{1,5} Aged instruments produce higher noise levels, often above 85 dBA. Turbines, for example, become louder after 1 year of sterilization cycles if they are not properly maintained.⁷⁻¹²

Evidence suggests that hearing impairment remains a problem among dental professionals.¹³⁻¹⁹ A pilot study of 40 dental hygienists from the U.S. (Virginia) with high exposure to noise from ultrasonic scalers had poorer hearing, as measured by pure tone audiometry, than those with low exposure.¹³ Four separate questionnaire-based surveys from Italy,¹⁶ Belgium,¹⁴ Thailand¹⁷ and United Arab Emirates¹⁸ reported hearing problems: 30%, 19%, 11% and 5%, respectively. A study from Malaysia reported 5% prevalence of hearing loss based on audiometry.¹⁹ To date, a limited number of studies have investigated prevalence of hearing impairment in dental hygienists, especially studies of U.S. dental hygienists. To our knowledge, there are no previous studies that assess prevalence of hearing difficulty among dental hygienists licensed in California. The primary purpose of this study was to address this gap by assessing the prevalence of self-reported hearing difficulties among dental hygienists who obtained their license from California between 1972 and 1992. The secondary aim was to evaluate occupational noise-induced hearing difficulties associated with the use of ultrasonic scalers.

METHODS AND MATERIALS

This study was approved by the University of California, San Francisco's Institutional Review Board. The study population consisted of dental hygienists who received their licenses from California between 1972 and 1992. An older population was selected to provide the licensee with the opportunity to have practiced 20 years and, thus, be exposed to ultrasonic scalers during this time. The selection of subjects with 20 or more years of experience decreases the external validity of the study since the results cannot be generalized to all dental hygienists, but increases the internal validity because these individuals could be exposed for a longer duration to occupational noise that may have contributed to hearing difficulty. Therefore, licensees that were practicing less than 20 years either part-time or full-time as a clinical dental hygienist were not eligible for this study. Full-time is defined as working 4 or more days per week.

A 3-page 19-item survey with at least 5 questions per page was developed by the authors, incorporat-

ing questions from the Dental Hygiene Work History Questionnaire that included information about use of ultrasonic scalers in clinical practice, hearing difficulties and exposure to loud noises.¹³ The survey also requested additional self-report information, such as earplug use and barriers to using earplugs while providing direct patient care and demographic information (e.g., sex and year the dental hygienist was first licensed). The survey was pre-tested by 3 California-licensed dental hygienists, who had practiced more than 20 years, and it was revised accordingly.

To assess the primary aim of this study, prevalence of self-reported hearing difficulties, a sample of 1,067 subjects were randomly selected by computer generation performed by the R & D Data Corporation from a population of 5,725 dental hygienists licensed by the state of California between 1972 and 1992. This sample size of 1,067 subjects was based on an expected response rate of 30% or 320 respondents. It was assumed that 30% of the respondents would report hearing difficulty with a margin of error of 10% based on a 95% confidence level. This estimate was based on a previous study that reported 30% prevalence of Italian dentists with hearing impairment with a 10% margin of error.¹⁶ Mailing addresses of the subjects were obtained from the R & D Data Corporation. Identification numbers were used to ensure subject confidentiality, while permitting follow-up of non-respondents. A second mailing was sent 4 weeks later to those not responding to the first mailing. No monetary incentives were provided to the dental hygienists randomly selected to participate in this study.

Descriptive statistics of the survey questions were calculated and are presented as the frequency (percentage) for categorical variables and mean and standard deviation for variables measured on a continuous scale. To estimate the prevalence of hearing difficulty, binomial proportion and associated 95% confidence interval are presented.

The secondary aim of this study was to explore the relationship of hearing difficulties with ultrasonic scaler usage. Separate univariate logistic regression analysis of each outcome: self-reported hearing difficulty status (presence or absence) and hearing difficulty status due to ultrasonic scalers was used to explore an association with scaler usage (independent variable) and these associations are reported as odds ratios with corresponding 95% confidence interval. Ultrasonic scaler usage was calculated for each respondent based on 4 self-reported questions:

1. Average number of years of ultrasonic scaler use
2. Average days per week of ultrasonic scaler use
3. Average minutes of ultrasonic scaler use per patient
4. Average number of patients treated per day

If a respondent did not complete a question, median scaler usage based on all respondents for that question was imputed before total scaler usage for each respondent was calculated. Total ultrasonic scaler usage (reported in days) was dichotomized as high usage (>103 days) and low usage (≤103 days). The cut-off is the median of the distribution of the ultrasonic scaler usage among all respondents.

Multivariable logistic regression analysis was performed if the univariate logistic regression analysis presented a statistically significant effect. This multivariable analysis was used to evaluate potential confounders, age and other possible causes of hearing difficulties due to family history, congenital defect, infectious disease, loud noise exposure, occupational exposure and other causes that may contribute to hearing difficulties. Statistical analyses used SAS version 9.3 (SAS Institute, Cary, NC). All statistical tests provided 2-sided p-values, and p-values (p<0.05) were considered statistically significant. The results presented are consistent with the guidelines for reporting surveys.²⁰

RESULTS

Of the randomized sample of 1,067 California dental hygienists licensed from 1972 to 1992, 20 surveys did not reach the dental hygienists and were returned. Fifteen (4%) reported that they had been licensed between 1964 and 1971, and 1 (<1%) in 1993. After 2 mailings conducted in 2013, 395 surveys (37%) were returned. Of the 395 respondents, 23 surveys were excluded because the respondents had not practiced 20 years or more as a clinical dental hygienist. Thus, the response rate for those that met the study eligibility criteria was 35% (372/1,067).

The average age of the respondents was 56 years (SD=8) and the median year of the California dental hygiene license was 1981 (range=1964 to 1993). Nearly all respondents were females (n=371/372, 99%). The majority (77%) reported at least 21 years of direct patient care using ultrasonic scalers and working at least 3 days per week (70%), which was considered part-time since they worked less than 4 days per week.

Most respondents (79%) reported using the ultrasonic scalers for 5 to 20 minutes per patient, and a few respondents (1%) reported using the scalers for greater than 50 minutes per patient. The median usage of ultrasonic scalers was 103 days (25th percentile=38 days, 75th percentile=254 days, range=0.007 days to 1,367 days). Nearly all respondents (94%) answered all 4 questions about ultrasonic scaler usage. Of the 24 respondents (7%) that did not, most (n=23/24, 96%) responded to the majority of questions (3 of 4 questions, 12/24,

Table I: Percentage of Respondents Reporting Other Possible Causes of Self-Reported Hearing Difficulty, Exposure to Loud Noises and Earplug Use

Variable	Percentage of Respondents (%)
Possible Causes of Hearing Difficulties*	
Family History	9
Congenital Defect	1
Infectious Disease	3
Loud Noise Exposure	15
Occupational Exposure (other than Dental Hygiene)	6
Other	20
Exposure to Loud Noises*	
Listening to loud music through headphones	33
Attending rock concerts	66
Playing a musical instrument in a group	12
Earplug Use	
Currently use earplugs while using ultrasonic scalers**	5
Plan to use earplugs in the future#	57
Identified barriers to using earplugs##	52

*Numbers do not equal 100 because respondents could select more than one response.

**372 respondents

#359 respondents

##347 respondents

50%; answered 2 of 4 questions, 11/24, 46%) except for a respondent (4%) that answered a question.

Table I provides a list of possible causes of self-reported hearing difficulty. The most frequent response was other (20%) and then loud noise exposure (15%). The most common loud noise was attending rock concerts (66%). Few (5%) reported wearing earplugs while using ultrasonic scalers, and over half (52%) also reported difficulty hearing due to scalers. While the majority (57%) reported that they plan to use earplugs in the future, 23% also reported barriers to earplug use. Of the respondents that indicated barriers to wearing earplugs while using ultrasonic scalers (52%), many (49%, 95/193) responded to an open-ended question about the barriers of wearing them. The most common barrier was communicating and interacting with patients (74%, 70/95). Other various reasons (26%) were also reported.

Prevalence of Self-Reported Hearing Difficulties Among Dental Hygienists

Over one-third (40%, 95% confidence interval, 35 to 44%) reported that they had been told or had experienced hearing difficulties and 17% (95% confidence interval, 14 to 21%) reported hearing difficulty due to scaler use. Thirteen percent indicated that their hearing difficulty was diagnosed by an audiologist. Of the 17% that reported hearing difficulty due to scalers, 91% had confirmed this hearing difficulty with an audiologist. The average age of those with self-reported hearing difficulties due to ultrasonic scalers was 56 years (SD=8) and those without hearing difficulties average age was 57 (SD=6).

Relationship Between Hearing Difficulty and Use of Ultrasonic Scalers

Hearing difficulty due to any cause, including the use of ultrasonic scalers, was 1.5 times (95% confidence interval, 1.0 to 2.3) more likely to be associated with higher usage of ultrasonic scalers than those with no hearing difficulty, but this finding was not statistically significant ($p=0.05$). Those with hearing difficulty due to use of ultrasonic scalers were 2.3 times (95% confidence interval, 1.3 to 4.1) more likely to have higher ultrasonic scaler usage than those without hearing difficulty ($p=0.003$). The multivariable logistic regression results (odds ratios=2.0, 95% confidence interval, 1.1 to 3.6) remained statistically significant after adjusting for potential confounders, age and other potential causes of hearing difficulties ($p=0.03$).

DISCUSSION

The results from this study indicated that 40% of respondents (average or median age of 56 years, range 42 to 81 years) that were licensed in California reported hearing difficulties. This prevalence was much higher than the 17% prevalence of hearing impairment among Americans aged 70 years and over, but similar to the 45% prevalence of hearing impairment among Americans 80 years and over that was reported between 1999 and 2006 from the National Health and Nutrition Examination Survey.²¹ Even if we assume that all of the non-respondents of the survey did not have hearing difficulty ($n=672$), then the prevalence of hearing difficulty still remains higher at 17% than the national average at 6.1% for women 50 to 59 years old.²²

Other countries have looked at hearing problems among dental personnel. Four separate questionnaire-based surveys from Italy,¹⁶ Belgium,¹⁴ Thailand¹⁷ and United Arab Emirates¹⁸ reported hearing problems: 30%, 19%, 11% and 5%, respectively. The lowest prevalence of hearing difficulty was reported in Unit-

ed Arab Emirates and Malaysia at 5%.^{18,19} The lower prevalence observed in this Malaysian study, of whom 94% used ultrasonic scalers, may also have been due to a younger population (i.e., average age 39 years vs. 56 years in this study) with less occupational exposure (i.e., 68% worked for 10 years vs. all worked at least 20 years in this study) and pure tone audiometry being used as the assessment of hearing impairment, rather than self-report. A recent study conducted in Italy demonstrated a 30% self-reported prevalence of hearing impairment among general dental practitioners, as compared to a prevalence of 15% for general medical practitioners.¹⁶ Both sets of practitioners had been practicing for at least 10 years, a period generally considered sufficient to generate hearing difficulty.

One reason for the higher prevalence of hearing difficulty in this study may be due to longer occupational exposure. As part of the eligibility criteria, dental hygienists had been practicing for a minimum of 20 years and obtained their licenses between 1972 and 1992. However, 15 respondents (4%) indicated that they had received their license between 1964 and 1971, and 1 (<1%) from 1993. It is unclear whether this discrepancy was due to survey recall bias of these 16 respondents or an issue with the records from the R & D Data Corporation. Since these participants had practiced for more than 20 years, they were included in the final analyses. Furthermore, a sensitivity analysis was performed that excluded these 16 respondents from the analyses, and the results were nearly identical.

Hearing status was not measured with audiometry, so data in this study were the respondents' perceptions of their hearing difficulties, and the respondents' use of the ultrasonic scalers may have been over or under reported. Most dental hygienists (91%) that reported hearing difficulty due to scalers also reported that their hearing difficulties were confirmed by an audiologist. Medical records were not obtained from the audiologist to confirm the cause of hearing difficulty, and therefore, hearing difficulty due to ultrasonic scaler usage may have been over-reported.

This study showed that respondents with hearing difficulties due to ultrasonic scalers were 2-times more likely to have higher scaler use than those without hearing difficulties, even after potential confounders were included in the model ($p=0.03$). These findings are comparable to a previous report in which dental hygienists with high ultrasonic usage had poorer hearing, as measured by pure tone audiometry, than those with low ultrasonic usage.¹³ They are also consistent with a study of Italian dentists concluding that frequent use of ultrasonic scalers was significantly associated with self-reported hearing impairment (odds ratios=3.6, 95% confidence interval, 1.1 to 12.2, $p=0.03$).¹⁶

Assessment of other possible causes of hearing difficulties was included in the present study, whereas some previous studies have excluded respondents with history of hearing loss due to infection or congenital defects.¹³ Another risk factor of hearing impairment is increasing age, which has been associated with higher prevalence of self-reported hearing impairment.²³ Age-related hearing loss is typically gradual and progressive. We were interested in the influence of these risk factors as potential contributors to hearing difficulty. The effect of ultrasonic usage on hearing difficulty remained statistically significant after adjustment for other possible causes of hearing difficulties and age ($p=0.03$). Age did not seem to be a confounder in the relationship, but other causes of hearing difficulties did appear to contribute to hearing difficulties. This finding suggests that ultrasonic-related hearing difficulty is not simply the result of the respondents' increased age since age was controlled for in the model, but appears to contribute from more frequent use of the ultrasonic scalers.

In the present study, only a few respondents (5%) indicated that they were currently using earplugs to prevent hearing impairment and reduce exposure to occupational noise pollution, but approximately half the respondents indicated that they would consider using them in the future. This preventive attitude is encouraging since many people are unaware of their hearing loss until it is too late.²⁴ Longitudinal studies are needed to assess whether wearing ear protection while using noisy dental equipment reduces the risk of hearing loss. Once hearing has been damaged, hearing problems are permanent and irreversible. Kilpatrick stated that if hearing loss is suspected from dental sources, some type of ear plug or ear muff should be used.²⁵

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CONCLUSION

The prevalence of hearing difficulty at 40% among dental hygienists with an average age of 56 years in this study population was considerably higher than the national average reported by the National Health and Nutrition Examination Survey at 17% for adults 70 years or older. This higher prevalence of hearing difficulties among survey respondents who are considerably younger may be caused by occupational exposures, such as long-term use of ultrasonic scalers, but additional studies are needed to confirm the causes of hearing difficulty in this population. To prevent potential hearing impairment, wearing ear protection, such as earplugs, is suggested while using noisy dental equipment. Longitudinal studies are needed to assess whether wearing ear protection while using noisy dental equipment reduces the risk of hearing loss.

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