Safety and Health at Work

Saf Health Work 2011;2:348-54 | http://dx.doi.org/10.5491/SHAW.2011.2.4.348

pISSN : 2093-7911
eISSN : 2093-7997

Original Article

Noise Exposure Assessment in a Dental School

Thitiworn CHOOSONG[1], Wandee KAIMOOK[2], Ratchada TANTISARASART[3], Puwanai SOOKSAMEAR[2], Satith CHAYAPHUM[2], Chanon KONGKAMOL[1], Wisarut SRISINTORN[1] and Pitchaya PHAKTHONGSUK[1]

[1]Occupational Health Unit, Department of Community Medicine, Faculty of Medicine
[2]Department of Otolaryngology Head and Neck Surgery, Faculty of Medicine
[3]Dental Hospital, Faculty of Dentistry, Prince of Songkla University, Hat Yai, Songkhla, Thailand

Objectives: This cross-sectional study was performed in the Dental School of Prince of Songkla University to ascertain noise exposure of dentists, dental assistants, and laboratory technicians. A noise spectral analysis was taken to illustrate the spectra of dental devices.

Methods: A noise evaluation was performed to measure the noise level at dental clinics and one dental laboratory from May to December 2010. Noise spectral data of dental devices were taken during dental practices at the dental services clinic and at the dental laboratory. A noise dosimeter was set following the Occupational Safety and Health Administration criteria and then attached to the subjects' collar to record personal noise dose exposure during working periods.

Results: The peaks of the noise spectrum of dental instruments were at 1,000, 4,000, and 8,000 Hz which depended on the type of instrument. The differences in working areas and job positions had an influence on the level of noise exposure ($p < 0.01$). Noise measurement in the personal hearing zone found that the laboratory technicians were exposed to the highest impulsive noise levels (137.1 dBC). The dentists and dental assistants who worked at a pedodontic clinic had the highest percent noise dose (4.60 ± 3.59%). In the working areas, the 8-hour time-weighted average of noise levels ranged between 49.7-58.1 dBA while the noisiest working area was the dental laboratory.

Conclusion: Dental personnel are exposed to noise intensities lower than occupational exposure limits. Therefore, these dental personnel may not experience a noise-induced hearing loss.

Key Words: Noise-induced hearing loss, Noise, Dental practice, Dental school, Dental instruments

Introduction

Exposure to high levels of noise has been a well-known cause of noise-induced hearing loss (NIHL) [1]. Such NIHL found in dentists and dental auxiliaries [2-7] has appeared as a drop in their audiogram frequencies at 4,000-6,000 Hz which might be due to exposure to a high level of noise from their instruments such as clinical handpieces, turbines, and laboratory machines. The noise level of the ultrasonic scaling handpiece, low speed rotary, curette hand instrument, and other dental instruments increase around 1-6 dBA depending on the instrument maintenance and their lifetime. Noise levels of high speed, free running handpieces differed around 1-13 dBA compared to the level when treating teeth, and the noise frequency of new instruments generated higher frequencies at more than 8,000 Hz to achieve increased cutting efficiency and reduced vibration

Received: March 14, 2011, **Revised:** August 8, 2011
Accepted: August 12, 2011, **Available online:** December 5, 2011
Correspondence to: Thitiworn CHOOSONG
Occupational Health Unit, Department of Community Medicine
Faculty of Medicine, Prince of Songkla University
Karnchanavanit Road, Hat Yai, Songkhla 90110, Thailand
Tel: +66-8-3532-2259 or +66-7445-1167, **Fax:** +66-7442-9928
E-mail: thicho@hotmail.com

[8,9].

The noise levels in a dental school were assessed by Ünlü et al. [10] and Sampaio Fernandes et al. [11] and were found to range between 60-99 dBA. The highest noise levels were found in the laboratories. The noise measurement techniques in many studies were taken in short working time periods using a sound level meter in a manner called the grab sampling technique [8-14]. However, dental practices seem to produce noise continuously within a short period which is usually followed by a quiet period such as when performing a check-up or reading X-ray films. Therefore, noise measurements in this study were performed to ascertain noise levels in terms of an 8-hour time-weighted average (TWA) during each working period at all dental clinics and at the dental laboratory using both the noise dosimeter and the sound level meter. The 8-hour TWA was calculated by the following equation [1].

$$TWA = 16.61 \, Log_{10} (D/100) + 90$$

Where, TWA = the eight hour time-weighted average in decibels (dBA)

D = the dosimeter readout in percent noise dose

Log_{10} = the logarithm to base 10

The percent noise dose was taken to describe noise exposure in the dentists' and dental auxiliaries' hearing zone. Noise frequency analysis was performed to illustrate the noise spectra of dental devices during dentistry practices.

Materials and Methods

This cross-sectional analytical study was performed in the Dental School of Prince of Songkla University from May to December 2010.

Dental clinics and subjects in this study

The Dental School of Prince of Songkla University is divided into 7 professional clinics including the pedodontic clinic, undergraduate student clinic, graduate student clinic, prosthodontic clinic, orthodontic clinic, oral surgery clinic, dental services clinic, and one dental laboratory. The dental service clinic is open on workdays and weekends, and during the workdays, the working period is divided into three periods while during the weekends only one period is provided.

The participants who voluntarily agreed to carry a personal noise dosimeter during working hours included 113 dentists and dental auxiliaries. These subjects were divided into three groups according to their job positions: 55 dentists, 49 dental assistants, and 9 laboratory technicians.

Noise measurements

Noise exposures of dentists and dental auxiliaries were assessed using two sampling techniques which included the noise level survey in the working areas and in the personal hearing zones. The spectral analysis of dental devices was taken at 12.5 though 20,000 Hz.

Noise level in working areas and spectral analysis of dental instruments

Sound level meters with octave band frequency analysis (Rion NL-31, Rion, Tokyo, Japan; SoundPro SE-DL, Quest, Oconomowoc, WI, USA) were used to measure noise levels in all clinics during working periods, while the octave band frequency analysis mode was performed to describe the noise frequency of each instrument during the treatment of teeth. The grab sampling technique was performed to describe the noise spectrum of dental instruments according to each treatment used and each dental instrument in a very short time. The noise frequency and amplitude were reported only at 16, 31.5, 63, 125, 500, 1,000 (1k), 2,000 (2k), 4,000 (4k), 8,000 (8k), 16,000 (16k), and 20,000 (20k) Hz. All dental instruments were measured during dental and laboratory operation. The noise intensities were read out as an equivalent continuous A-weighted sound level in decibels (dBA) for each minute during the period sampled.

Noise level in the hearing zones of dentists and dental auxiliaries

The noise dosimeters (Spark™ 706, Larson Davis, Provo, UT, USA) followed the Occupational Safety and Health Administration criteria including an exchange rate of 5 decibels; the frequency weighting was A; the response was slow; the criteria level was 90 dBA; and the threshold was 80 dBA. The 80 dBA threshold dosimeter was used to measure the noise that employees identified during a walk around and whose exposure may exceed 85 dBA on a TWA [1]. After that, it was attached to the subjects' collar in order to determine the personal noise dose during working periods. The noise dosimeter readout was in percent noise dose exposure (percent dose) and the equivalent continuous A-weighted sound level in decibels (dBA) for each minute during the period sampled. Noise level was presented in decibel A-scale (dBA) which referred to a human hearing threshold and was calculated for an 8-hour TWA for each period of work, while impulsive noise levels were presented in decibel C-scale (dBC).

Statistical analysis

All noise data were analyzed by using R program version 2.11.1.

The Mann-Whitney U test and Kruskal Wallis test were utilized to compare noise levels between two and more than two groups, respectively.

Results

Dentistry practices and the octave band analysis during dentistry practices

According to this dental school, the dental specialists are consultants or moderators for dental students for each special clin-

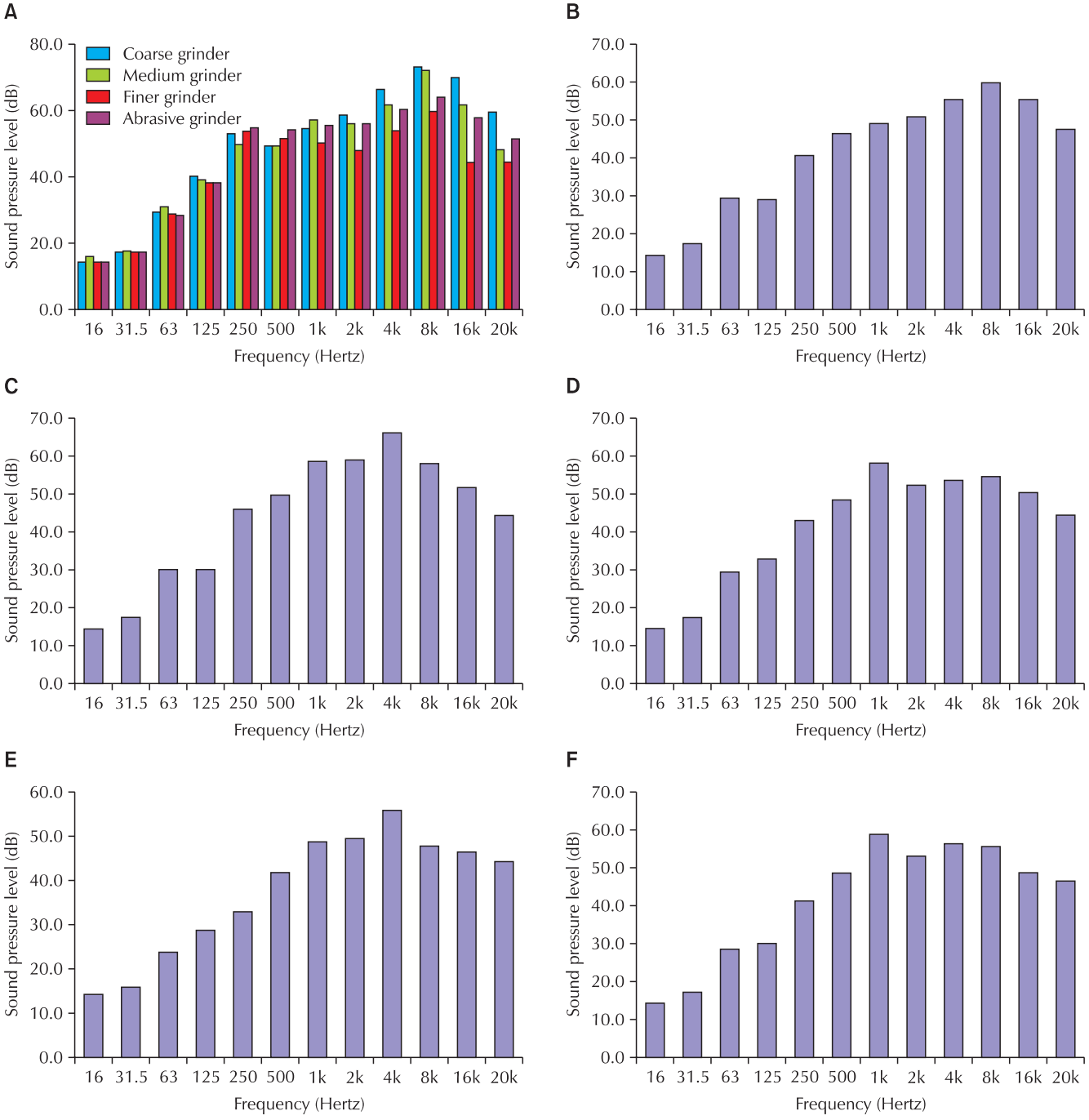

Fig. 1. Octave band analysis of each instrument during dental practices. (A) Noise frequency of heads of the grinder. (B) Noise frequency of micro motor. (C) Noise frequency of air-rotor handpiece. (D) Noise frequency of ultrasonic scaler. (E) Noise frequency of triple syringe or dental syringe. (F) Noise frequency of saliva suction.

ic, such as the pedodontic clinic, undergraduate student clinic, graduate student clinic, prosthodontic clinic, orthodontic clinic, and oral surgery clinic, which is open 9:00 a.m.-12:00 noon. There were three periods of working hours at the dental services clinic (09:00 a.m.-12:00 noon, 1:00-4:00 p.m., and 5:00-8:00 p.m.) on weekdays while only one period (9:00 a.m.-4:00 p.m.; lunch time was noon) on weekends. The dental specialists were on duty at the dental services clinic for at least one period per day during a workweek, but were working for a full work period on the weekends which included no micro-teachings for the dental students.

In the dental laboratory, only a micro motor handpiece drill with different grinder heads was used. The heads of the grinder included coarse, medium, fine and abrasive grinders which were run at speeds of 300,000 to 400,000 rpm. However, the highest peak noise frequency of all heads of a grinder was at 8,000 Hz (Fig. 1A). Dentistry practices are different depending upon a patient's oral health problems; however, the use of the main dental instruments is the same. The noise frequencies during the use of an air turbine micro motor handpiece drills with speeds of 100,000 to 300,000 rpm (micro motor, Fig. 1B), air-rotor handpieces (air-rotor, Fig. 1C), ultrasonic scalers (Fig. 1D), triple syringes or dental syringes (Fig. 1E), and saliva suction (Fig. 1F) were analyzed by a sound level meter with octave

Table 1. Percentages of noise dose exposure and noise level (8-hour time-weighted average [TWA], dBA) in hearing zones and working area at specialist clinics

Clinic	Hearing zone *		Working area† (8-hour TWA, dBA) (n = 1)
	Dose (%)	8-hour TWA (dBA)	
Pedodontic (total)	4.60 ± 3.59	64.3 ± 9.39	55.2
- Dentist (n = 6)	5.33 ± 4.29	65.8 ± 8.66	
- Dental assistant (n = 8)	4.05 ± 3.15	63.2 ± 10.3	
Undergraduate student (total)	0.78 ± 0.72	50.3 ± 11.3	54.9
- Dentist (n = 16)	0.67 ± 0.74	48.1 ± 12.4	
- Dental assistant (n = 6)	1.07 ± 0.61	56.0 ± 4.85	
Graduate student (total)	0.52 ± 0.57	46.3 ± 11.4	50.1
- Dentist (n = 6)	0.37 ± 0.75	39.2 ± 13.1	
- Dental assistant (n = 7)	0.64 ± 0.37	52.4 ± 4.75	
Prosthodontic (total)	0.48 ± 0.59	45.7 ± 12.7	54.7
- Dentist (n = 3)	0.67 ± 0.72	51.0 ± 7.69	
- Dental assistant (n = 2)	0.20 ± 0.28	37.7 ± 17.7	
Oral surgery (total)	1.35 ± 1.26	56.0 ± 6.78	53.4
- Dentist (n = 5)	1.10 ± 1.47	53.4 ± 8.08	
- Dental assistant (n = 10)	1.47 ± 1.20	57.3 ± 6.05	
Orthodontic (total)	0.29 ± 0.23	45.4 ± 7.05	49.7
- Dentist (n = 4)	0.35 ± 0.30	46.6 ± 7.47	
- Dental assistant (n = 7)	0.24 ± 0.19	44.2 ± 7.31	
Dental service (weekend, total)	1.88 ± 1.39	59.1 ± 6.21	57.3
- Dentist (n = 14)	2.15 ± 1.43	60.5 ± 5.78	
- Dental assistant (n = 10)	1.50 ± 1.31	57.1 ± 6.57	
Laboratory			
- Laboratory technician (n = 9)	4.22 ± 1.62	66.4 ± 3.98	58.1

*, †$p < 0.01$, Kruskal Wallis Test.

Table 2. Percentages of noise dose exposure and noise level (8-hour time-weighted average [TWA], dBA) in hearing zones at outpatient clinic (3 work periods)

Clinic	Hearing zones					
	First period		Second period		Third period	
	Dose	8-hour TWA	Dose	8-hour TWA	Dose	8-hour TWA
Dental service*	0.53±0.31	51.1 ± 4.58	0.53 ± 0.65	49.2 ± 6.28	0.84 ± 0.60	53.1 ± 6.82
(weekday and afterwork)	(n=6)		(n=8)		(n=17)	
- Dentist	0.80 ± 0.17	55.1 ± 1.49	0.87 ± 1.07	51.8 ± 9.07	0.76 ± 0.66	52.1 ± 6.99
	(n=3)		(n=3)		(n=9)	
- Dental assistant	0.27 ± 0.06	47.1 ± 1.69	0.32 ± 0.15	47.7 ± 4.47	0.93 ± 0.56	54.2 ± 6.92
	(n=3)		(n=5)		(n=8)	

*$p < 0.01$, Kruskal Wallis Test (among 3 work periods).

Table 3. Noise intensity classified by job position

Job position*	Percent dose	8-hour TWA (dBA)	Impulsive noise (dBC)
Dentist† (n = 51)	1.39 ± 2.01	52.8 ± 11.2	121 ± 7.80
Dental assistant† (n = 48)	1.29 ± 1.70	53.9 ± 8.92	123 ± 8.17
Laboratory technician (n = 9)	4.22 ± 1.62	66.4 ± 3.98	137 ± 14.2

TWA: time-weighted average.
*$p < 0.01$, Kruskal Wallis Test (dentist vs. lab man and assistant vs. lab man).
†$p > 0.05$, Mann-Whitney U test (dentist vs. assistant).

band analysis.

The air turbine micro motor handpiece drill (both in the laboratory and dental clinics) showed the highest peak at 8,000 Hz, and an air-rotor handpiece and triple syringe or dental syringe showed the highest peak at 4,000 Hz. The ultrasonic scaler and saliva suction showed the highest peak at 1,000 Hz.

Noise levels in the hearing zones and working areas

The total sampling hours at the special clinics and the dental services clinic (including overtime) were 3 hours/day while at the dental service clinic (weekend) and at the laboratory they were 6 hours/day. However, all of the noise level data were calculated and presented in 8-hour TWAs.

The highest noise level in a working area and hearing zone was in the laboratory (58.1 and 66.43 ± 3.98 dBA, respectively) (Table 1). The percentage of noise dose and noise level in the dental personal hearing zones and in the working areas showed significant differences among all clinics and the laboratory (Table 1). Among all dental clinics, the highest percentage of noise dose exposure was in the pedodontic clinic (4.60 ± 3.59%) while the lowest percentage of noise dose exposure was in the orthodontic clinic (0.29 ± 0.23%). The dental service during the weekends showed a higher noise level than during the week (Table 2).

Different job positions had a significant influence on the level of noise exposure. The noise level measured in percentage of noise dose, TWA and the level of impulsive noise (4.22 ± 1.62%, 66.43 ± 3.98 dBA and 137.1 dBC, respectively) was found to be the highest for laboratory technicians while the dentists were exposed to higher noise levels than dental assistants. However, there were no significant differences in noise levels between the dentists and dental assistants in all noise measurement techniques (Table 3).

Discussion

Dental instruments are normally used simultaneously with saliva suction. Therefore, noise frequency analysis of dental instruments could not be measured for each dental instrument separately at the dental clinics except for at the dental laboratory. Accordingly, saliva suction was used simultaneously with the ultrasonic scaler, and all noise spectrums of both of these

dental instruments were quite the same with the highest noise frequency at the same peak of 1,000 Hz. This may have been due to the ultrasonic scalers' noise frequencies interfering with the saliva suction's noise frequencies. The highest noise spectrum of an air-rotor handpiece and triple syringe was the same at 4,000 Hz; however, the micro motor handpiece at both the dental clinics and the dental laboratory showed the same highest noise frequency at 8,000 Hz. The peak differences in noise frequency in this study might vary due to the types of dental instruments. This finding agreed with a study by Bahannan et al. [8], Mueller et al. [15] and Barek et al. [16]. However, the noise level of a micro motor handpiece at the dental clinic was lower than at the dental laboratory which may have been because dentists rarely used the maximum speed of the air turbine micro motor handpiece (drill) during dental treatment, while in the dental laboratory it was always used at the higher speeds. This result was consistent with studies by Szymañska [7], Nimmanon et al. [13], Mojarad et al. [14], and Mueller et al. [15]. Barek et al. [16] and Sorainen and Rytkönen [17,18] reported the main frequency of dental devices has a peak at 40-46.5 kHz; however, in this study the noise spectrum of all dental devices could not be measured above 20 kHz because of the limitation of the sound level meter and human hearing cannot detect noise frequencies above 20 kHz. Therefore, these frequencies were not mentioned in this study.

In the current study, noise levels in the personal hearing zones were 45.4-66.4 dBA while those in the working areas of the Dental School of Prince of Songkla University were 49.7-58.1 dBA. These noise levels in the working areas were consistent with the noise levels in the Dental School at the University of Porto, Portugal [11]. The highest noise level recorded for all dental clinics was at the pedodontic clinic (64.3 ± 9.39 dBA). This clinic normally has children crying during oral health treatment but when no children are crying, the noise level was quite low and was in line with other clinics (-45.4 dBA).

The daily noise exposure of dentists and dental auxiliaries as estimated in this study were found to be lower than expected as indicated in a study by Sampaio Fernandes et al. [11] Further, dentists and dental assistants were less prone to NIHL than the laboratory technicians [9,14,19]. The maximum level of impulsive noise at the dental laboratory (137.1 dBC) was high, though not beyond the occupational standard of 140 dB (peak) [1]. The impact noise standard takes both noise level and its frequency into consideration, with the allowable impact noise standards being set at 140 dB with a frequency of 100 times/day; 130 dB with a frequency of 1,000 times/day; and 120 dB with a frequency of 10,000 times/day [20]. The frequency of impact noise, however, was not reported in this study due to limitations of the instruments. Our study revealed that the noise levels in the dental school were around 60 dB and might cause annoyance, conversation interference, and concentration difficulty but not NIHL [20].

The noise levels in dental school represented a nuisance noise. The dental instruments had various peaks of noise frequency at 1,000, 4,000, and 8,000 Hz. The dentists and dental assistants were exposed to noise levels lower than the occupational exposure limits and thus, were not at risk of NIHL.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Acknowledgments

This research was supported by a grant from the Faculty of Medicine, Prince of Songkla University, Thailand (No.53-151-09-2-3).

References

1. Occupational Safety and Health Administration, US Department of Labor. Hearing Conservation (OSHA 3074-2002). Washington, DC: Occupational Safety and Health Administration; 2002. 25 p.
2. Di Francesco RC, Sperandio FA, Ganzsanchez T, Bottino MA. Noise-induced hearing loss in dentists. Otolaryngol Head Neck Surg 1997;117:210-1.
3. Zubick HH, Tolentino AT, Boffa J. Hearing loss and the high speed dental handpiece. Am J Public Health 1980;70:633-5.
4. Chowanadisai S, Kukiattrakoon B, Yapong B, Kedjarune U, Leggat PA. Occupational health problems of dentists in southern Thailand. Int Dent J 2000;50:36-40.
5. Wilson CE, Vaidyanathan TK, Cinotti WR, Cohen SM, Wang SJ. Hearing-damage risk and communication interference in dental practice. J Dent Res 1990;69:489-93.
6. Al Wazzan KA, Al Qahtani MQ, Al Shethri SE, Al Muhaimeed HS, Khan N. Hearing problems among the dental personnel. JPDA 2005;14:210-4.
7. Szymanska J. Work-related noise hazards in the dental surgery. Ann Agric Environ Med 2000;7:67-70.
8. Bahannan S, el-Hamid AA, Bahnassy A. Noise level of dental handpieces and laboratory engines. J Prosthet Dent 1993;70:356-60.
9. Hyson JM Jr. The air turbine and hearing loss: are dentists at risk? J Am Dent Assoc 2002;133:1639-42.
10. Ünlü A, Böke B, Belgin E, Sarmadi H. Effects of equipment used in laboratory environment on dental technicians' hearing

threshold. J Islamic Acad Sci 1994;7:237-40.
11. Sampaio Fernandes JC, Carvalho AP, Gallas M, Vaz P, Matos PA. Noise levels in dental schools. Eur J Dent Educ 2006;10:32-7.
12. Chen Y, Wang S, Chiang S, Wu C, Peng Y, Hung H, Yu J. The noise of dental instruments evaluated at sound pressure level. 2009 Annual Meeting and 22nd Symposium of Acoustical Society of the Republic of China. 2009. p. C54-9.
13. Nimmanon V, Rodanant P, Klannukarn CR, Ponpai N, Leeyawattananupong W, Sringamprom S. Noise level in a dental laboratory. J Dent Assoc Thai 2009;59:173-82.
14. Mojarad F, Massum T, Samavat H. Noise levels in dental offices and laboratories in Hamedan, Iran. JDT 2009;6:181-6.
15. Mueller HJ, Sabri ZI, Suchak AJ, McGill S, Stanford JW. Noise level evaluation of dental handpieces. J Oral Rehabil 1986;13:279-92.
16. Barek S, Adam O, Motsch JF. Large band spectral analysis and harmful risks of dental turbines. Clin Oral Investig 1999;3:49-54.
17. Sorainen E, Rytkönen E. Noise level and ultrasound spectra during burring. Clin Oral Investig 2002;6:133-6.
18. Sorainen E, Rytkönen E. High-frequency noise in dentistry. AIHA J (Fairfax, Va) 2002;63:231-3.
19. Setcos JC, Mahyuddin A. Noise levels encountered in dental clinical and laboratory practice. Int J Prosthodont 1998;11:150-7.
20. Plog BA, Niland J, Quinlan PJ. Fundamentals of Industrial Hygiene, 4th ed. Itasca (IL): National Safety Council; 1996. 1011 p.