

Original Article

Noise levels of dental equipment used in dental college of Damascus University

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ABSTRACT

Background: In dental practical classes, the acoustic environment is characterized by high noise levels in relation to other teaching areas. The aims of this study were to measure noise levels produced during the different dental learning clinics, by equipments used in dental learning areas under different working conditions and by used and brand new handpieces under different working conditions.

Materials and Methods: The noise levels were measured by using a noise level meter with a microphone, which was placed at a distance of 15 cm from a main noise source in pre-clinical and clinical areas. In laboratories, the microphone was placed at a distance of 15 cm and another reading was taken 2 m away. Noise levels of dental learning clinics were measured by placing noise level meter at clinic center. The data were collected, tabulated and statistically analyzed using *t*-tests. Significance level was set at 5%.

Results: In dental clinics, the highest noise was produced by micro motor handpiece while cutting on acrylic (92.2 dB) and lowest noise (51.7 dB) was created by ultrasonic scaler without suction pump. The highest noise in laboratories was caused by sandblaster (96 dB at a distance of 15 cm) and lowest noise by stone trimmer when only turned on (61.8 dB at a distance of 2 m). There was significant differences in noise levels of the equipment's used in dental laboratories and dental learning clinics ($P = 0.007$). The highest noise level recorded in clinics was at pedodontic clinic (67.37 dB).

Conclusions: Noise levels detected in this study were considered to be close to the limit of risk of hearing loss 85 dB.

Key Words: Dental public health, occupational dentistry, stress

Received: November 2012

Accepted: October 2013

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INTRODUCTION

A sound, agreeable or disagreeable, is a stimulus discerned by the sense of hearing. Disagreeable or undesired sounds were described as noises, which may cause undesirable masking of sounds, may interfere with speech and communication, may produce pain, injury and brief or perpetual loss of hearing.^[1]

The acoustic environment of learning-teaching activities at a dental college is characterized by high noise levels in relation to other teaching areas, due to the exaggerated noise produced by the use of dental equipment's by many users at the same time. The sources of dental sounds that can be treated as potentially damaging to hearing are high-speed turbine handpieces, low-speed handpieces, high-velocity suction, ultrasonic instruments and cleaners, vibrators and other mixing devices, model trimmers and also worth mentioning are air conditioners.^[2,3] In dental learning areas, teachers and students will likely be exposed to continuous high levels of noise.

Exposure to noise constitutes a health risk and has both auditory and non-auditory effects. The non-auditory effects include hypertension, sleep

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disturbance, decreased learning performance, stress reactions, interference with communication and concentration, annoyance, mental fatigue and a reduction in efficiency.^[1,4-12]

While auditory effects may include permanent hearing loss, and short term exposure to loud noise can cause a temporary change in hearing or a tinnitus.

Hearing loss caused by noise is referred to as noise induced hearing loss. According to The National Institute for Occupational Safety and Health (NIOSH), noise-induced hearing loss is the most common occupational injury.^[13] Exposure to noise levels above 80 dB is associated with these consequences, which depends on the intensity of the noise, distance to the source, total duration of noise and the individual's age, physical condition and sensitivity.^[1,6,7,14-16] Furthermore, noise has an adverse impact on patients as a factor that may cause fear.^[17]

Exposure to noise is measured in units of sound pressure levels called decibels, named after Alexander Graham Bell, using A-weighted sound levels [dB(A)]. The A-weighted sound levels closely match the perception of loudness by the human ear.^[18]

NIOSH has recommended that all worker exposures to noise should be controlled below a level equivalent to 85 dB(A) for 8 h/day to minimize occupational noise induced hearing loss. NIOSH also recommends a 3 dB(A) exchange rate.^[19]

Noise pollution is one of the most important situations requiring a solution by the contemporary world.^[20] NIOSH has recognized noise as 1 of the 10 leading causes of work related diseases and injuries.^[14,21,22]

In dental learning areas, teachers and students are vulnerable to different noise levels while working and teaching in dental clinics and laboratories.

The aims of this study were to measure noise levels produced during the different dental learning clinics, by equipment's used in dental learning areas under different working conditions and by used and brand new handpieces under different working conditions.

MATERIALS AND METHODS

In pre-clinical and clinical areas, the microphone was placed at ear level at a distance of 15 cm from a main noise source to simulate the auditory position of the operator. The noise levels of the equipment's were measured at the corner of the learning area, which

may consider the less noisy part of the learning area to eliminate as much as possible the interference with the external noise. The noise levels were measured over about 20 s interval and the maximum and minimum intensities in decibel was recorded. This was repeated three times sequentially in the same day, so we recorded 6 measurements for each equipment, one maximum and one minimum for each time interval. The mean of the values was determined and the overall value was recorded.

The noise levels of equipment's used in laboratories, pre-clinical and clinical areas at the dental college of Damascus University were measured under different working conditions. The laboratories, pre-clinical and clinical areas will be henceforth referred to as dental learning areas in this study.

The equipment's of which the noise levels were measured in clinical areas were: Ultrasonic scaler, turbine, contra angle handpiece, micro motor handpiece, low volume suction pump, high volume suction pump and amalgamator (capsule). The measurements were taken with the equipment only turned on (without cutting) and during cutting operations. Ultrasonic scalers with or without suction pump and suction pumps running free and when they touch mucosa were measured for noise levels. Noise levels of brand new and used handpieces were also measured. The noise level of micro motor handpiece was measured by setting it at 35.000 rpm.

The noise levels of different dental learning clinics was measured by placing the noise level meter at the center of the clinic during the middle-third of working time (between 11 a.m. and 1 p.m.), which nearly represents the highest noise hours. We recorded 6 measurements for each clinic. The number of equipments, which were used at the same time, was 20 equipments. Noise levels were measured in seven clinics: Operative, fixed prosthodontics, removable prosthodontics, endodontics, pedodontics, oral surgery and periodontics.

The sound levels were measured with a precision sound level meter (BEHA UNITEST 93517, Germany) with a microphone in dental learning areas. Sound levels were measured in A-weighted sound levels in decibels dB(A). The sound level is measured on the A scale, which was designed to mimic the response of the human ear.

At the dental laboratories, the noise levels of laboratory equipments were measured in a similar

way. The microphone was placed near the technician's ear at a distance of 15 cm from a main noise source to simulate the noise intensity reaching the eardrum and another reading was taken 2 m away. This was to simulate the person within a 2 m radius of the operator who is also exposed to the same noise. We recorded 6 measurements for each equipment in each situation.

The equipments of which the noise levels were measured in the dental laboratories were: Stone trimmer, automatic molding machine, manual molding machine and sandblaster.

The data were collected, tabulated and statistically analyzed using *t*-tests with significance level set at 5% using the statistical package for the social sciences program version 13 (SPSS Inc., Chicago, IL, USA).

RESULTS

The results of the noise levels of equipments measured in dental laboratories at two distances of 15 cm and 2 m are shown in Table 1.

The noisiest laboratory equipment recorded in this study was by the sandblaster with an $L_{A(eq)}$ of 93.32 ± 1.99 at 15 cm distance. The $L_{pk(max p)}$ (highest value) recorded was 96 dB(A).

The results of the noise levels of the equipments measured in pre-clinical and clinical areas are shown in Table 2.

The results indicated that the maximum sound levels of equipments in dental clinics and laboratories were 92.2 dB and 96 dB, respectively. In dental clinics, the highest noise was produced by the micro motor handpiece while cutting on acrylic (92.2 dB) and the lowest noise (51.7 dB) was created by the ultrasonic scaler without suction pump. The highest noise in

laboratories was caused by the sandblaster (96 dB at a distance of 15 cm) and the lowest noise by the stone trimmer while only turned on (61.8 dB at a distance of 2 m).

There was significant differences in noise levels of the equipments used in dental laboratories and dental learning clinics ($P = 0.007$). The mean noise levels of the equipments used in dental laboratories were much higher than those used in dental clinics. The mean noise level for dental laboratories engines at a distance of 15 cm from a main noise source was 81.62 dB, compared with the mean value of 73.75 dB for dental clinic equipments ($P = 0.009$).

The laboratory engines had the highest noise levels (at a distance of 15 cm from a main noise source-81.62 dB), whereas the noise levels in high-speed turbine handpieces (75.44 dB) ($P = 0.003$) and the low-speed contra angle handpieces (68.31 dB) ($P < 0.01$) were decreased.

The noise level of a contra angle handpiece at the clinical areas was significantly lower than at the pre-clinical areas ($P = 0.019$).

Noise levels of turbine in cutting activities compared to non-cutting showed that the noise levels measured during the cutting activities were significantly higher to those found when only turned on ($P < 0.01$). The average value of the difference was equal to 5.38 dB(A) and 19.45 dB(A) for brand new and used respectively.

There was no significant difference in noise levels of contra angle handpiece in cutting activities compared to non-cutting activities in both pre-clinical and clinical areas for brand new and used ones.

The average value of difference for turbine and contra angle handpieces (only turned on) was equal to 6.09 dB(A).

Table 1: Noise levels [dB(A)] of dental laboratory engines

Noise levels [dB(A)], laboratory engines							
Studied distance	Studied equipment and process	N	Mean	Standard. deviation	Standard. error	Minimum	Maximum
15 cm	Stone trimmer (only turned ON)	6	70.30	1.89	0.77	68.5	72.8
	Stone trimmer (cutting on stone)	6	80.07	6.22	2.54	70.1	86.6
	Automatic molding machine	6	74.90	1.66	0.68	72.9	76.9
	Manual molding machine	6	89.52	3.06	1.25	84.5	93
	Sandblaster	6	93.32	1.99	0.81	90.5	96
2 m	Stone trimmer (only turned ON)	6	65.42	2.65	1.08	61.8	68.7
	Stone trimmer (cutting on stone)	6	70.10	5.01	2.05	65.4	76.5
	Automatic molding machine	6	70.70	2.26	0.92	68.1	73.5
	Manual molding machine	6	81.23	2.39	0.98	77.3	83.6
	Sandblaster	6	82.40	1.93	0.79	81.2	86.2

Table 2: Noise levels [dB(A)] of the equipments measured in pre-clinical and clinical areas

Studied equipment	Studied process	N	Mean	Standard. deviation	Standard. error	Minimum	Maximum
Noise levels [dB(A)], contra angle handpiece in pre-clinical area							
Contra angle handpiece (brand new)	Only turned ON	6	70.97	1.80	0.73	68.9	73.5
	Cutting on typodont	6	72.15	5.02	2.05	67.1	77.8
Contra angle handpiece (brand used)	Only turned ON	6	71.58	1.90	0.78	69.5	74
	Cutting on typodont	6	74.82	4.32	1.76	69.5	81
Noise levels [dB(A)], clinical equipments							
Ultrasonic scaler	Without suction pump	6	64.48	12.20	4.98	51.7	77.4
	With suction pump	6	76.70	6.35	2.59	69.1	83
Turbine (brand new)	Only turned ON	6	68.20	1.20	0.49	66.9	69.6
	Cutting on tooth	6	73.58	3.64	1.49	69.7	78.8
Turbine (brand used)	Only turned ON	6	70.27	2.12	0.86	68.1	72.7
	Cutting on tooth	6	89.72	1.55	0.63	87.4	91.9
Contra angle handpiece (brand new)	Only turned ON	6	69.72	1.73	0.71	67.6	71.7
	Cutting on tooth	6	68.22	2.97	1.21	65.6	72.4
Contra angle handpiece (brand used)	Only turned ON	6	67.13	1.74	0.71	64.9	69.2
	Cutting on tooth	6	68.17	2.01	0.82	66.1	70.9
Micro motor handpiece	Only turned ON	6	77.70	1.97	0.80	74.9	80.7
	Cutting on acrylic	6	82.87	8.32	3.40	74.4	92.2
Suction pump (low volume)	Running free	6	77.85	7.19	2.94	70.3	87.2
	Touch mocusa	6	72.40	4.29	1.75	66.3	78.1
Suction pump (high volume)	Running free	6	75.12	6.37	2.60	68.9	81.7
	Touch mocusa	6	76.47	6.76	2.76	69.3	84.4

Furthermore, there was no significant difference in noise levels of micro motor handpiece in cutting activities compared to non-cutting activities.

There was no significant difference in noise levels between low and high volume suction pump. Furthermore, there was no significant difference in noise levels of ultrasonic scaler without suction pump and with suction pump.

Noise levels of used equipments compared with brand new equipments in the clinics showed that the noise levels produced by used turbine were significantly higher than those produced by the brand new turbine ($P = 0.045$) [Figure 1]. There was no significant difference in noise levels between brand new and used contra angle handpieces in both pre-clinical and clinical areas.

In this study, the high-speed turbine was significantly noisier than low-speed contra angle ($P = 0.001$). The average value of difference for the high-speed turbine against low-speed contra angle handpiece was equal to 7.14 dB(A) [Figure 2].

The results of the noise levels at the center of the dental learning clinics are shown in Table 3. The highest noise level for all dental clinics was at the Pedodontic Clinic (67.37 ± 5.56 dB(A)) ($P = 0.019$).

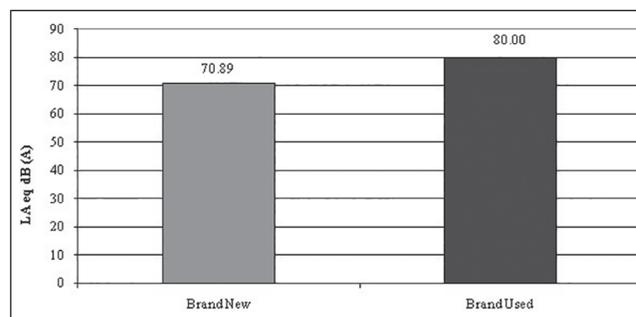


Figure 1: Average noise levels of used and brand new dental turbine compared

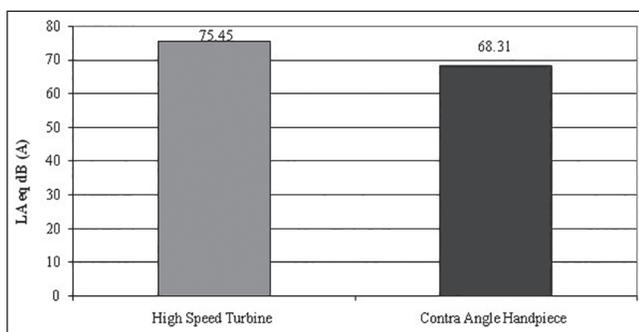
DISCUSSION

In this study, noise levels of the equipments used in dental learning areas under different working conditions were measured.

The noise levels measured in this study were similar to that measured in other international studies of noise in dentistry. Noise levels for suction pump were 69.41-81.51 dB(A) in this study, whereas in the United Kingdom^[1] they were 68-70 dB(A), in Portugal they were 70-74 dB(A)^[6] and in India they were 79-81 dB(A).^[23] Noise levels for the turbine were 66.72-84.16 dB(A) in this study, whereas in the United Kingdom,

Table 3: Noise levels [dB(A)] of different dental learning clinics

Noise levels [dB(A)], dental learning clinics						
Clinic type	N	Mean	Standard. deviation	Standard. error	Minimum	Maximum
Operative	6	63.92	3.70	1.51	60.2	67.7
Fixed prosthodontics	6	66.10	5.73	2.34	60.6	73.5
Removable prosthodontics	6	60.27	7.42	3.03	48.7	67.7
Endodontics	6	66.13	4.02	1.64	61.1	72.5
Pedodontics	6	67.37	5.56	2.27	61	74.3
Oral surgery	6	66.98	4.02	1.64	62.1	72.7
Periodontics	6	60.70	4.54	1.85	56.5	65.6

**Figure 2:** Mean noise levels of high-speed turbine and contra angle handpieces

Portugal, India and Saudi Arabia were 70-75 dB(A), 68-76 dB(A), 75-81 dB(A) and 69-76 dB(A), respectively; for contra angle handpiece they were 66.12-70.5 dB(A) in this study, whereas in United Kingdom, Portugal, India and Saudi Arabia were 72-75 dB(A), 69-75 dB(A), 70-76 dB(A) and 65-71 dB(A), respectively.^[1,6,14,23]

The noise levels of turbine measured during the cutting activities were significantly higher to those found when only turned on. This may be attributed to the friction between the cutting material and cutting tools.

However, Fernandes *et al.* presented average values of +6 dB(A) and Bahannan *et al.* presented average values of +10 dB(A), in similar conditions of measurement in Portugal and Saudi Arabia, respectively.^[6,14]

The significant level of difference in noise levels of used turbines compared to brand new turbines could be an indication of bearing failure.^[24] The bearing resistance is affected by wear, not only of the metal surfaces, but also of the ball-cages, when roughness contributes to friction.

In general, the used turbine was noisier at an average of about 9.11 dB(A) difference more than the brand new one [Figure 1]; therefore, the hearing damage risk may be lesser among dentists who use brand new turbine.

In this study, the high-speed turbine was the noisiest equipment compared to low-speed contra angle. This agrees with the findings of Bahannan *et al.*^[14] Altinöz *et al.*^[25] and Fernandes *et al.*^[6] This is concordant with antecedent studies mentioning that the high-speed turbine handpiece generates a higher noise level than the low-speed handpiece.^[3,14,16] Maximum sound pressure levels of the noise created by the dental drill was 91.9 dB by the brand used dental turbine while cutting on a tooth, which has a risk of damage to the dentists' hearing.

The noise level of a contra angle handpiece at the clinical areas was lower than at the pre-clinical areas, which may have been because students rarely used the maximum speed of the air contra angle handpiece during dental treatment, while in the pre-clinical area it was always used at the higher speeds. This result was consistent with studies by Szymanska,^[26] Nimmanon *et al.*,^[27] Mojarad *et al.*^[28] and Mueller *et al.*^[16]

Dental laboratories in dental teaching institutions were the areas of highest noise levels when compared to other dental learning areas.

The effect of noise on learner comfort affecting the work performance and mental efficiency has been researched.^[4,5,9-11] Noise can induce learned helplessness, increase arousal, alter the choice of task strategy and decrease attention to the task.

Fernandes *et al.* suggest the classification given by Cavanaugh to set a limit value in places of learning in dental teaching institutions. Accordingly, 56 dB(A) could be adequate as the upper limit value for a relaxed communication at a normal tone at 3 m.^[6] All the evaluated areas presented a value higher than this maximum.

The highest noise level recorded for all dental clinics was at the Pedodontic clinic. This may be due to the children who are normally crying during the oral health treatment.

Comparison of noise levels in this study with some European limits indicated that they did not comply with these laws. Some international legal limits for equipment noise levels in $L_{A(eq)}$ (dB[A]) are: Italy ≤ 40 , France ≤ 38 , Sweden ≤ 35 , Portugal ≤ 46 and India ≤ 50 .

In this study, there were some high recorded measurements of noise levels, which have a risk of damage to the dentists' hearing (exceeding the limit of risk of hearing loss of 85 dB[A]) such as stone trimmer, manual molding machine, sandblaster (at distance 15 cm and 2 m), low volume suction pump, turbine (brand used) and micro motor handpiece. Therefore, a necessary reduction of exposure in sound levels is required for acoustic comfort.

CONCLUSION

Based on the above study it can be concluded that the noise levels detected in this study were considered to be close to the limit of risk of hearing loss (85 dB(A)); a necessary reduction of exposure in sound levels is required for acoustic comfort.

ACKNOWLEDGMENTS

This work was supported by a grant from Dental Collage of Syrian Private University. I would like to sincerely thank all those whose help was imperative to the completion of this research.

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How to cite this article: Qsaibati M, Ibrahim O. Noise levels of dental equipment used in dental college of Damascus University. Dent Res J 2014;11:624-30.

Source of Support: This work was supported by a grant from Dental Collage of Syrian Private University. **Conflict of Interest:** None declared.