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Assessment of Ambient Noise Exposure among Medical Staff in Dental Clinics Center of Dammam Medical Complex, Saudi Arabia

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Abstract

Introduction: Exposure to loud noise is a major problem for medical staff, especially in dental clinics and laboratories. **Aim**: This research aims to assess the ambient noise in dental clinics and the impact of noise on medical staff in dental clinics at Dammam Medical Complex, Saudi Arabia. **Materials and Methods**: A Cross sectional study was performed. Ambient noise was measured using the sound level meter in various laboratories and clinics. **Results**: The data showed that the maximum noise levels were between 116 and 56 dB(A) with peak levels ranging from 116 to 106 dB(A) in the laboratory and clinic environment. There is a significant correlation with the number of medical personnel, the area of the laboratory or clinic and the number and nature of the equipment used with the sources and ambient noise in their workplace and with daily exposure might cause severe impact on hearing loss in such clinics. **Conclusion:** The study strongly recommends the implementation of preventive measures and should be for periodic medical examinations and educational programs of the highest priority for medical staff in clinics and dental laboratories.

Keywords: Ambient Noise, Dental Clinics, Dental Staff, Hearing Loss, Personal Protective Equipment, Saudi Arabia

1. Introduction

Noise has negative impacts including hearing loss, cardiovascular stimulation, pituitary, and adrenal gland stimulation, increased gastric secretion, suppression of the immune response to infection, and sleep disturbance (Passchier-Vermeer & Passchier, 2000)[18]. Even though noises with lower intensities do not cause serious hearing problems, they can lead to several harmful effects such as negative physiological consequences, deficient speaking awareness and recognition, and limited personal privacy (Passchier-Vermeer & Passchier, 2000)[18].

Hearing loss is an increasingly common problem worldwide, and noise-induced hearing loss is the second most common acquired cause. The mechanism of damage is thought to involve many diverse pathways, which include oxidative damage, mechanical shearing forces, and glutamate excitotoxicity (Kang, 2006; Khademi, *et al.*, 2011)[11,12].

Excessive noise is becoming a significant problem for Intensive Care Units (ICUs), Emergency Room (ER), dentist clinic, Coronary Cardiac Unit (CCU) and other hospital departments as a result of advanced technology which lead to having more equipment in these units such as monitoring devices with sound alarms, infusion pumps and telephones (Rabiyan & Gharib, 2004; Darbyshire, 2016; Imam & Hannan, 2017)[7,10,19].

Compared to patients, patients are exposed to noise from dental instruments only occasionally and it has minimal risk of developing noise-induced hearing loss

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or tinnitus from dental sound sources such as high-speed hand pieces that the dentists are using constantly every day (Alabdulwahhab, *et al.*, 2016)[3].

In Saudi Arabia, 2016, Alabdulwahhab examined whether the persistent high-frequency sounds produced by the dental equipment could cause hearing defect among dental practitioners. About 15.8% of the dentists and 2.6% of the control group had some hearing loss (Alabdulwahhab, *et al.*, 2016).

A study in Saudi Arabia, 2005, revealed the prevalence of hearing problem among dentists in Saudi Arabia, the symptoms ranged from tinnitus, headache, or speech discrimination difficulties. 16.6% had tinnitus, 14.7% had speech discrimination difficulties and 63% had problems with speech discrimination in the presence of background noise (Al Wazzan, *et al.*, 2005)[2].

A study had been conducted in the United Arab Emirates aimed at examining the noise exposure, hearing related problems, and awareness of students of Dentistry College towards the noise. The measurement of noise revealed that maximum noise levels were 65 – 79 dBA with peak levels between 89 and 93 dbA. A minority of the students (10%) reported that they think they will develop hearing loss. The study recommended that students should materials to minimize noise levels especially during the lab work (Ahmed & Ali, 2017)[1].

Dentists are one of the health care providers that highly prone to develop occupational hearing loss. In a study comparing the prevalence of hearing loss among the general population to workers in dentistry exposed to noise at their work environment. It surveyed 76 workers in dentistry and compared them to 76 participants as a control group. The study concluded that loss of hearing was more likely in workers working in their occupation for more than 15 years. Also, workers above 40 years old are more prone to hearing loss according to the study population. (Khaimook, *et al.*, 2014)[13].

A study revealed that dental practitioners are in very high risk of developing hearing loss due to continuous exposure to noise as the results showed that the first and second hours of clinical care has very high intensity of noise at work. The mean noise was for the first three hours of work 82.38 ± 3.85, 80.99 ± 4.78, and 70.06 ± 6.95 dB respectively (Da Cunha, Dos Santos & Júnior, 2017)[6].

The study by Theodoroff measured also the intensity of sound generated by high-speed handpieces while being used to patients. Among the study population, dental clinicians' hearing was more negatively affected compared to other groups as dental professionals do not use high-speed handpieces (Theodoroff & Folmer, 2015).

Prince Philip Dental Hospital of Hong Kong carried out noise exposure assessment, health risk assessment done afterward at the pediatric dentistry clinic and dental lab. The results of the study revealed the scope of the psychoacoustics parameters in the quantification of sound quality of the noise and the estimation of its negative impacts on the dental professionals' health condition (Ma, Wong & Mak, 2017)[16].

Assessment of hearing in dental practitioners compared to other academic professionals was done in German study in 2014. A sample of 115 participants was recruited to assess their hearing. The results revealed that hearing impairment in dentists was higher than in other professions. This attributed to the daily exposure to noisy devices. The study extended its scope and concluded that environment and urban area has also a role in the effect on hearing difficulty among the study population (Willershausen, *et al.*, 2014)[21]. The main aim of the present study is to assess and determine the impact of ambient noise on medical staff in dental clinics center of Dammam medical Complex.

2. Material and Methods

2.1. Study Setting

The study was carried out at Dental Clinic Center of Dammam medical Complex in Dammam City, which is a large city located in the Eastern Province of the Kingdom of Saudi Arabia on the coast of the Arabic Gulf. It is one of the largest cities in the Gulf Cooperation Council, with a population of 941,358 as of 2012.

Study Type. The study is Observational cross-sectional survey. All medical staff (physicians, nurses, lab technician, hygienist and assistants) working in Dental Clinic Center of Dammam medical Complex in Dammam, Saudi Arabia.

2.2. Sampling Study Population

All health care workers (physicians, nurses and assistants) working in Dental clinic center of Dammam medical Complex in Dammam which are 52 Clinics will be included in the study. Measurements of noise level was recorded using calibrated Sound Level Meter Monitor RA 233 Casella Cel-63 1A (SLM) where, recording of data was done at morning and afternoon intervals in the following dental clinics: Hygiene area, Advance

Restorative, Prosthodontic, Endodontic, Orthodontic, Maxillofacial surgery, Periodontics, Pediatrics, Laboratories (working area, ceramic, plaster and casting) and Sterilization. Before the start of the survey, the instrument was calibrated to monitor continuous sounds, alarms, and conversation in the workplace. We opted for a sound range between 50 dBA - 130 dBA.

The points assessed in each sector were chosen based on the length of stay of nurse and the dentist and aisle were the places of longer permanence where the professional stayed.

Sound levels in working shifts morning and afternoon were the dependent variables of the current study part, while the independent variables were the number of staffs, area of workplace, and number of equipment in each area.

3. Data Analysis

Data analysis was started after data abstraction, screening, and key-in the data in Statistical Package for the Social Sciences Processor (SPSS, version 25.0, copyright IBM Corporation, 1989, 2017).

4. Ethical Considerations

Permission to conduct the study was obtained from Ministry of Health to Dammam Medical Complex. Confidentiality of the information from the participants was maintained.

5. Results

5.1. Sociodemographic of Participants

This study included a total of 98 respondents. Their distributions were by age, gender, marital status, family history, occupation, and education as shown in (Table 1), where, 34.4% of the participants are male. Most of the participants were of young age (below 30). The mean age of the participants was 32.7 (±6.2) years old with a range from 22 to 50 and above years of age.

5.2. Correlation between Noise and Dental Work

Statistical analyses have been done to test the hypotheses of noise impacting the work of dental personnel because of noise. Using bivariate analysis, it was found that the impact of noise and the source of noise subscales were positively correlated. $r(97) = .682$, $p < 0.01$ (Table 2).

Table 1. Demographic of participants

Characteristics	(n=98)	Percentage Respondents
Sex:		
Male	63	65.6%
Female	33	34.4%
Age:		
21 -25	42	40.8
26-30	40	38.8
31 and above	21	20.4
Educational Level		
Diploma	38	39.2%
High Diploma	1	1%
Bachelor	33	34%
Resident	5	5.2%
Specialist	12	5.2%
Consultant	5	4.1%
Other (please specify)	3	3.1%
Subspecialty		
Endodontics Clinic	11	11.8%
Orthodontics Clinic	11	11.8%
Periodontics Clinic	5	5.4%
Oral and Maxillofacial Clinic	5	5.4%
Pediatric Dentistry Clinic	7	7.5%
Prosthodontics Clinic	9	9.7%
Diagnostic Clinic	1	1.1%
Dental Hygienist Clinic 1	2	2.2%
Dental Hygienist Clinic 2	2	2.2%
Advanced Restorative Dentistry Unit	6	6.5%
Special Need & compromised clinic	1	1.1%
Dental Emergency Clinic	1	1.1%
Saudi Board Training	3	3.2%
Sterilization	2	2.2%
Radiology	0	0.0%
Lab	17	18.3%
Other (please specify):	10	10.8%
Dental Work		
Assistant	27	28.7%
Consultant Dr.	4	4.3%
Dental Hygienist	9	9.6%
Lab Technician	16	17%
Nursing Staff	5	5.3%
Resident Dr. (Physician)	20	21.3%
Specialist Dr.	13	13.8%

Table 2. Correlation testing between noise sources and the impact of noise on dental personnel

		Noise Source
Impact of noise	Pearson Correlation	.682**
	Sig. (2-tailed)	< .01

** Correlation is significant at the 0.01 level (2-tailed).

It was found that the impact of noise on dental workers of the current study is negatively correlated with their work experience r (91) = -.267, p = 0.01. On the other hand, it was found that the impact of noise is not correlated with the job they are doing now r (93) = .124, p = .233. It was found that the impact of noise in the dental workplace was not significantly correlated with the working experience of the dental personnel (Table 3).

Upon analyzing the correlation between working shift and dental workers whether they experience noise inside the clinic. Pearson chi-square test revealed that there is no correlation between their duty shifts and experiencing noise inside the workstations (p<0.05) (Table 4).

5.3. Analysis of Noise Measurement at Dental Clinics

In terms of noise sound level in a different clinic and the relation with the area, number of equipment, number of staffs, gender, mean of sound noise level am & pm, the (Table 5) shows the noise sound levels in each clinic.

To find a relation between the noise level measurements at morning shift and afternoon shift in different dental clinic specialty, mean of the sound noise level of morning and evening are shown in the (Table 6).

Kolmogorov-Smirnov and Shapiro-Wilk tests of normality were applied. As shown in the (Table 7), significant variations were found in morning and afternoon ambient noise levels (p<0.001).

Correlation between noise levels and dental working area were revealed that the sound levels in workplace areas of the clinic found to be correlated with the number of staffs, several equipment (r=0.255), or area of the workplace but the relation not significant. Table 8, shows the significance levels accordingly.

The independent variable on the noise sound level - these variables represent in (number of staffs, age, work experience, gender, working area, number of equipment, and clinics specialty Table 9.

Table 3. Correlation between work status and the impact of noise

	Work Experience		Job	Impact of noise
Work experience	Pearson Correlation		-.039	-.267*
	Sig. (2-tailed)		.714	.010
Job	Pearson Correlation	-.039		.124
	Sig. (2-tailed)	.714		.233
Impact of noise	Pearson Correlation	-.267*	.124	
	Sig. (2-tailed)	**.010**	.233	

* Correlation is significant at the 0.05 level (2-tailed).

Table 4. Pearson Chi-Square Tests between noise and work

		Job	Work shift
Do you experience noise inside the clinic?	Chi-square	7.661	2.855
	P value	.363	.582
Have you experienced any difficulties hearing what people say?	Chi-square	3.876	2.983
	P value	.794[a]	.561

Table 5. Noise levels in different dental clinics

Clinic	Area (Length * Width)	No of Equipment	No of Staff
Hygiene	5*5	3	2-1
Advance Restorative	5*5	9	5-2
Prosthodontic	5*5	10	5-2
Endodontic	5*5	13	5-2
Orthodontic	5*5	6	5-2
Maxillofacial surgery	5*5	8	5-2
Periodontics	5*5	9	5-2
Pediatrics	5*5	9	5-2
Lab			
Working Area	400 m	13-40	16-8
Ceramic	4*14	14	7
Plaster	5*3	6	7-1
Casting	5*3	8	7-1
Sterilization	8*6	13	11-7

Table 6. Noise level measurements at the morning shift and afternoon shift in different dental clinic specialty

Area	Morning (min)	morning (max)	afternoon (min)	afternoon (max)	Mean of the sound morning and afternoon
Hygiene	63	79	75	80	74.25
Advance restorative	63	91	56	80	72.5
Prosthodontics	72	83	65	88	77
Endodontics	66	91	71	72	75
Orthodontics	58	76	68	84	71.5
Maxillofacial Surgery	64	68	55	65	63
Periodontics	71	73	68	86	74.5
Paediatrics	12	81	66	68	56.75
Lab					
Working area	6	88	81	81	64
Ceramic	81	98	79	79	84.25
Plaster	4	90	82	82	64.5
Casting	10	16	88	88	50.5
Sterilization	68	80	66	78	73
Out clinic	58	63	56	61	59.5
Empty clinic before patient & staff coming	48	56	48	56	52

Table 7. Kolmogorov-Smirnov and Shapiro-Wilk tests of noise level measurements at the morning shift and afternoon shift

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Morning (min)	.289	15	.001	.799	15	.004
Morning (max)	.183	15	.189	.816	15	.006
Afternoon (min)	.126	15	.200	.969	15	**.844**
Afternoon (max)	.225	15	.039	.904	15	.008

Table 8. Pearson Correlation (r) of noise level measurements at the morning shift and afternoon shift with other factors

		Equipment	No of Staff	Area/m²
Morning (max)	Pearson Correlation (r)	.255	.069	.222
	P value	.401	.823	.466
Afternoon (max)	Pearson Correlation	-.022	.102	-.085
	P value	.943	.739	.782
Morning (min)	Pearson Correlation	-.230	-.414	-.090
	P value	.449	.159	.771
Afternoon (min)	Pearson Correlation	.230	.348	-.111
	P value	.450	.244	.717

Table 9. Multivariate regression analysis

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	60.489	11.358		5.326	.000
Daily_working_hours	.646	1.354	.024	.477	.635
Age	-.008-	.074	-.006-	-.104-	.917
Gender	-.105-	.716	-.008-	-.146-	.884
Work_experience	-.190-	.574	-.019-	-.331-	.741
Equipment_N	.236	.164	.134	1.438	.155
No_Staff	1.778	.350	.713	5.082	.000
Area_m2	.379	.080	.276	4.750	.000
Clinic_Type	-3.272-	.213	-1.479-	-15.337-	.000

a. Dependent Variable: Sound_Noise_level

The Coefficients table refers to the contribution of the independent variable in interpreting the variance in the Sound Noise level. It's clearly obvious that No Staff, Area m^2, and Clinic Type had a significant impact on the Sound Noise level, where the significant level was (0.000).

6. Discussion

In this study, almost none of the participants use any hearing protection device during work shifts however the study did not investigate why they do not use them. Similarly, a study by Theodoroff and Folmer (2015)[20] found that the dental workers included in the study were not using any type of ear protection, possibly because of embarrassment or the tool may affect the communication with patients or other colleagues.

The study by Altinöz, Gökbudak, Bayraktar and Belli (2001)[4] stated that as a worker being in a noisy workplace, you should not participate in activities directly after work. In the same study, it was reported that hearing will recover and heal after a certain period of rest, relax, and inactivity.

Exposure to noise in general, and in a dental clinic, negatively affects the function and efficiency of the personnel. Besides, it makes them prone to noise-induced hearing loss and hearing impairment. In medical literature, many studies confirmed the harmful consequences of prolonged exposure to noise levels more than 85 dBA if not using any protective measures, namely, hearing loss and hearing problems. Hence, the levels of noise need to be taken into consideration in workplaces. Many sources could lead to noise in dental clinics, such as handpieces, suction devices, scalers, and other devices (Kumar, Sharma, Kalavathy & Kashinath, 2011; Berger, 1983; Dobie, 1985)[5,8,14].

The measurement has been done at morning and at evening working hours to compare. Pediatric clinics had the highest noise level in morning (81 – 112 dBA) compared to (66 – 68 dBA) in the evening. This was followed by a lab working area in having the highest noise levels (88 – 106 dBA) in morning and around 81 dBA in the evening. Clinics like orthodontics, periodontics, and prosthodontics had almost similar noise level, all of which were less than 85 dBA in the morning and evening. While endodontics clinic high noise levels in the morning (63 – 91 dBA). The empty clinics had low levels of noise, obviously, as they are not occupied and not being used, levels were ranged from 48 dBA to 56 dBA. The results are comparable to a study been done in 2013 about noise levels in the endodontic clinic and another similar study (Dutta, Mala & Acharya, 2013; Mojarad, Massum & Samavat, 2009)[9,17].

These results suggest that concerns about noise-induced hearing loss among workers in dental clinics are there and needs to be taken into consideration. The current study is a potential for educating the workers related to the noise. Especially, with the reports of the survey that the workers are underestimating the consequences of this noise. Moreover, they are not even taking measures to protect themselves.

The results of the current study were different than a study in the clinical school of dentistry in Songkla University. The mean in the noise levels was from 58.1 to

66.43 dB, while in the current study was ranged from 116 to 48 dBA. The difference could be due to the methodology of the study compared to the study at university also conducting a study in a university clinic is different than conducting it in a public clinic. On the other hand, the present study results were more consistent with a study in Brazil in terms of methodology while the noise level in their study is lower than in the current study (Da Cunha, Dos Santos & Júnior, 2017)[6].

The sound levels in workplace areas of the clinic found to be not correlated with the number of staffs, the number of equipment, or area of the workplace. Such results are not conclusive, because logically and from most studies, the noise levels in areas are related to the people inside and the equipment and even the size of the place. More deep investigations need to be implemented to verify such results.

7. Conclusion

The current study suggests that dental personnel are at risk of developing noise-induced hearing loss, based on the workplace and duration of exposure to noise. Noise reduction means need to be implemented to minimize the harmful consequences of noise and to improve the perceptions of noise among dental personnel such as dentists, nurses, and technicians. Education programs related to hearing protection and maneuvers to be done in order to protect their hearing. This suggests the high needs to take actions in this regard and do root-cause problem analysis to solve this and minimize that noise. Further studies are recommended in the future to disclose risk factors related to working hours, workplace, years of experience, and non-occupational hearing impairment.

8. Declarations

Ethics approval and consent to participate.

The study was approved by ethical committee of ministry of health. Consent to participate was provided.

9. Competing Interests

There is no competing interest financial and non-financial between the authors.

10. Funding

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11. Authors Contributions

KS the correspondence author conceived the concept and design, data collection, data interpretation. He drafted the manuscript and revised the article. AM the co-author that collected and analyzed the data. HA the co-author that revised and proof reading.

12. Acknowledgment

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13. Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

14. Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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