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Evaluation of Individual Noise Exposure in a Faculty Prosthodontic Clinic and Laboratory During the Post Covid-19 Pandemic

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Abstract

Objective: Noise is one of the issues brought on by modern technologies. Because of the technology they employ, some occupational groups are more affected by noise. The COVID-19 pandemic has caused significant changes in healthcare around the world, such as dental clinics and prosthodontic laboratories were also affected by this change. The working circumstances in prosthodontic dental clinic and prosthodontic laboratories underwent numerous adjustments included reducing the number of patients, tightening hygiene protocols and obediencing distance rules during the pandemic process. However, some factors, such as individual noise exposure, are still overlooked or not sufficiently taken into account. This study was conducted during post COVID-19 pandemic in a faculty prosthodontic clinic and laboratory to assess the individual noise sensitivity of academician dentists, dentistry interns, and laboratory technicians to see if the levels of noise were significant enough to pose a health danger.

Materials and Methods: In February-March 2023, a noise assessment was conducted to evaluate the noise levels in a faculty prosthodontic clinic and a single dental laboratory. During 8-hour work periods, five specific sound level meters (Cesva DC 112, Spain) were put on the collars of academician dentists, dentistry interns, and laboratory technicians to assess individual noise sensitivity.

Results: This study involves 74 persons, including 4 academician dentists, 60 dentistry interns, and 10 laboratory technicians. In terms of Leq and Lex-8 hour noise sensitivity, there was a statistically significant difference between the groups ($p<0.05$). The average maximum (Leq) sound level among academician dentists was 73.50±0.67 decibels, 75.14±3.41 decibels for dentistry interns, and 84.64±9.12 decibels for laboratory technicians.

Conclusion: Working in areas divided by screens with clinical regulations after the COVID-19 pandemic has relatively reduced individual noise exposure that were slightly below the occupational exposure limits (85dBA) for academician dentists, dentistry interns, excluding dental technicians who were exposed to noise levels, suggesting that they are at risk for hearing impairment. Additional measures are recommended for these groups working in the prosthodontic clinic.

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Introduction

Noise is defined as an uncomfortable and unwanted sound, and it is the product of sound waves consisting of rapid vibrations in the air. Dentists and dental laboratory technicians are exposed to the noise in the working environment throughout the day. The resulting noise affects dentists, dental laboratory technicians and the efficiency of the work when conducting noise-generating operations such as tooth preparations, model trimming, operating with a micromotor. As the exposure level increases and the duration is extended, noise can cause temporary or permanent loss of hearing (1,2).

Although the exposure to workplace noise was below the limit, the detrimental effects of working performance, physiological and psychological conditions and a self-reported state of health on people in the area would be caused by poor noise quality. It was also found that the negative symptoms of sleep disorders, exhaustion, headache, frustration, discontent with life, hypertensive heart disease, and tinnitus were correlated with exposure to noise (3–5).

The unit of measure for noise or sound intensity is decibels (dB). The lowest sound that the human ear can hear is called the "hearing threshold". The hearing threshold sound intensity is 0 (zero) dB. "Pain threshold" indicates the value that the ear can not withstand greater sound intensity, which is 140 dB (4,6).

The exposure action and exposure limit values for workers are seen in the Noise Legislation*, which came into force when it was published in Official Gazette No. 28721 and 28 July 2013, respectively (7) (Table 1).

Table 1. Exposure limit values and exposure action values defined in the noise legislation

Current levels of limits	dBA/Leq	dBC/Lpeak
Lower exposure action values	80 daily/weekly	135 daily/weekly
Upper exposure action values	85 daily/weekly	137 daily/weekly
Legal limit	87 daily/weekly	140 daily/weekly

"Three physical parameters used as risk predictors are added by noise legislation*:

a) Peak sound intensity (L peak): refers to the peak value of the instantaneous noise pressure weighted by c-frequency.
b) Daily noise exposure level (Lex, 8h) (dBA re. 20 µPa): time-weighted average of noise exposure levels as specified by ISO 1999:1990 (International Organization for Standardization) for a nominal eight-hour working day. It includes all sounds, including impulsive noise, present at work.
c) Weekly exposure level to noise (Lex, W): time-weighted average daily exposure level to noise for a nominal week of five days of eight-hour working as specified by the ISO 1999:1990.

Minimum and maximum equivalent sound pressure level (Leq): defined as a steady constant noise level with total acoustic energy comparable to that of fluctuating concrete noise over a similar period of time" (8).

The Leq and L peak are measured simultaneously by most modern sound level meters and dosimeters. Noise measurements have been conducted in dental clinics and laboratories in various studies when dealing with different brand handpieces and different users in the same setting, and the noise level has been reported to be in the range of 60-99 decibels. The noise threshold value is stated to be similar to the risk of hearing loss (5,8–12).

The World Health Organization stated in the statement on hearing loss published in 2004 that noise below 25 dB will not cause any hearing impairment, noise between 26-40 dB may cause slight hearing impairment, 41-60 dB noise will cause moderate hearing impairment, 61-80 dB noise will cause severe hearing impairment, and 81 dB and above will cause profound hearing impairment including deafness (13).

Coronavirus disease (COVID-19), first identified in China in 2019, spread rapidly around the world and was accepted as a pandemic. Coronavirus 2 (SARS-CoV-2), which causes severe acute respiratory syndrome and causes Coronavirus disease (COVID-19), has spread to 216 countries. The COVID-19 pandemic has posed a significant challenge to healthcare systems as it spread rapidly, exceeding hospital capacity, and putting healthcare workers at high risk of exposure. As part of the new infection control policies, to reduce the risk of exposure and transmission to COVID-19, prosthetic procedures were performed within a specific area, with the distance between patients divided by 2 m in all clinical settings.

When the literature is reviewed, it has been reported that there are a limited number of studies evaluating individual noise exposure in an 8-hour working day in the post-COVID-19 pandemic period. The purpose of this research is to measure the amount of individual noise produced in a prosthodontic dental clinic and laboratory during the post-pandemic period.

The null hypothesis was that there would be no differences in key parameters of Leq, Lex-8 hour and L peak values that affect the individual noise exposure

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among academician dentists, dentistry interns and dental laboratory technicians.

Material and Methods

The ethical comitte of the Harran University granted the study the necessary ethical permission (HRU/23.02.26/23.01.2023). The respondents had to fulfill the following inclusion requirements in order to be qualified for participation. The following qualifications were working in a prosthodontic dental clinic throughout the study's defined time frame of February 2023 to 17 March 2023, using prosthodontic dental services at the aforementioned clinics during the study, and giving informed consent to participate in the study by answering "Yes" were all inclusion criteria.

In a prosthodontic dental clinic and a laboratory, noise level tests were conducted. The level of noise was measured by a sound level meter with a microphone (Cesva DC 112, Spain). The sound level meter responds to sounds close to the human ear and provides an objective measurement of sound levels that can be replicated. The sound level is measured in decibels (dB) on the A-scale, which has been developed to simulate the reaction of the human ear to the harmful impact of noise and is therefore required to assess the risk of hearing loss worldwide. 4 academician dentists, 60 dentistry interns and 10 laboratory technicians were among the participants who voluntarily agreed to carry a sound level meter during working hours. Individual noise measurements were taken over 3 weeks with 5 noise level meters and individual exposure values were determined.

At the prosthodontic dental clinic, the sound level meter's microphone was put on the academician dentist's and dentistry intern's collar at a distance of 15 cm from the ear. The noise level was similarly measured in the dental laboratory.

Before and after the noise exposure measurements, the sound level meters were calibrated. Over a 5-second interval, the noise was measured and the noise intensity in decibels was reported.

On the same day, 3 different values were obtained in noise measurements made according to task-based measurement strategy (Leq). At the same time intervals, L peak values were measured. As a result, Lex 8-hour personal exposure measurements were recorded.

The mean value of Leq (equivalent to the constant sound level at a particular time interval) and L (peak) (highest value) has been calculated and the total value has been registered.

Statistical Analysis

Using SPSS 20.0 (IBM Inc, Chicago, USA) with a significance level of 5 percent, the data were collected, tabulated and statistically analyzed. For numerical variables, descriptive statistics were described as mean ±standard deviation and for categorical variables as frequency (percentage).

Compliance of numerical variables to normal distribution was checked by the Kolmogorov-Smirnov test. However, due to the insufficient number of observation in the academician and laboratory group, non-parametric comparison methods were used. Kruskal-Wallis analysis and post hoc test were preferred for comparison of the groups. Significant comparison results are shown with the different letters.

Results

A total of 74 participants, including 4 academician dentists, 60 dentistry interns and 10 dental technicians participated in this study. Of the 74 participants, 42 (56.8%) were women and 32 (43.2%) were men (Table 2).

Table 2. The number and percentage of distribution of participants

Comparison Groups	Number of Tested Subjects	Percentage
Academician Dentists	Female(4)	5.41
	Male(0)	0
Dentistry Interns	Female(35)	47.30
	Male(25)	33.78
Dental Laboratory Technicians	Female(3)	4.05
	Male(7)	9.46
Total	74	100.0

In terms of Leq and Lex 8 hour noise measurement data, a statistically significant difference was found between academician dentists and dental laboratory technicians ($p<0,001$). Similarly, in terms of Leq and Lex

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8 hour noise measurement data, a statistically significant difference was found between dentistry interns and laboratory technicians (p<0,001).

Table 3. The mean, standard deviation (SD) values and results of one way ANOVA test for comparison of noise level among dentists, dentistry interns and dental laboratory technicians

	Academician Dentists (n:4) Mean±SD (median; min-max)	**Dentistry interns (n:60) Mean±SD (median; min-max)**	**Dental Laboratory Technicians (n:10) Mean±SD (median; min-max)**	**P**
Leq dBA	73.50±0.67 **a** (73.40;72.93-74.18)	75.14±3.41 **a** (74.50; 72.43-78.25)	84.64±9.12 **b** (84.00; 75.83-93.73)	<0.001 *
Lex 8 hour	73.68±1.09 **a** (73.45; 72.78-74.80)	75.26±3.40 **a** (74.75; 72.20-78.55)	84.84±9.27 **b** (84.00; 75.83-93.85)	<0.001 *
L Peak	120.10±2.80 **a** (120.60; 117.18-122.45)	126.01±8.10 **a** (124.40; 119.70-132.18)	131.00±14.66 **a** (129.60; 119.68-140.70)	<0.106

***:** Significant at P ≤ 0.05, Different superscripts are statistically significantly different
Significant at 0,05 level according to Kruskal-Wallis pairwise test

The results displayed in Table 3 demonstrate that the average equivalent sound pressure level (Leq) recorded during measurement ranged between 73.50±0.67 dBA among academician dentists, 75.14±3.41 dBA among dentistry interns and 84.64±9.12 dBA among dental technicians, and the median of the Leq was ranged between 73.40-84.00 dBA.

During the 8-hour working period, the highest noise level was found to be 74.80 dBA among dentists, 78.55 dBA among dentistry interns and 93.85 dBA among dental technicians.

Among the participants, academician dentists and dentistry interns measured values close to a noise exposure level of 85 dB, which is the allowable noise exposure limit during the 8-hour working period determined by the National Institute of Occupational Safety and Health, while values above the limit value were measured in the dental laboratory technicians group.

Discussion

This research was designed to determine personal sensitivity to dental device-generated noise and to take action if noise is detected above thresholds. Noise has been listed by the National Institute for Occupational Safety and Health as one of the leading causes of temporary or permanent hearing loss. The highest value for sensitivity to noise over an 8-hour working day has been recorded to be 85 dB. In dental clinics such as dental high-speed generators, Kilpatrick (3) suggested a range of sounds that could be dangerous to the hearing of dentists. The noise level in 89 dental clinics was calculated by Mojarad (10) et al. in a report. They found that in dental clinics, the highest sound level was 85.8 dB. They concluded that the maximum level of noise in dental clinics is very close to the limit of hearing loss, often below the noise level that harms the human ear (85dB).

In the present research, the equipment (Cesva DC 112, Spain) used to measure sound levels calculates the sound pressure level (in dB) by reflecting the ear's frequency response. This equipment calculates the measurement of A-weighted sound [dB(A)], the architecture of which mimics the human ear's reaction. Since human hearing responds to all frequencies differently, sound measured in frequency bands may be A-weighted or changed to account for the estimated frequency dependence of human hearing. The microphone of the sound level meter has been positioned 15 cm away from the participant's ear in this research that responds to sound in the same way as the human ear and offers objective, reproducible measurement of sound levels (2,10).

Noise levels were measured at 76.6 dB in the dental clinic and 87.2 in the prosthodontic laboratory, according to results from a study conducted by Singh et al.(12). In comparison, Choosong et al. (13) obtained noise levels of 58-66 dBA in one of the dental school in Thailand and concluded that this dental personnel were exposed to noise intensities lower than that causes hearing loss, but it can cause discomfort, conversation interruption and focus difficulty. Similar to these studies, in our study, noise levels were found to vary between 73.50 and 84.00 dBA.

In the Burk & Neitzel noise research (5), using partial or full-shift Time-Weighted Average (TWA) dosimetry measurements on 46 individuals, Leq interval levels of 3.75 min were found to range from 63.6 to 103.5 dBA. In the present research, 5-second interval Leq levels were ranged from 73.50±0.67 to 84.64±9.12 dBA. In the post-COVID-19-pandemic period, the difference in

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the measurement distance and the procedures performed, the difference in the number of people participating in our sample, and the difference in the measurement time of exposure to noise may be the explanation for our results being different from this research.

Sampaio Fernandes and his colleagues (5), measured the noise levels of dental equipment only turned on and during cutting operations in the range of 60-99 dB for dental student clinic and laboratory. The sound levels detected 73.68±1.09 dB for academician dentists and 84.84±9.27 dB for dental laboratory technicians in our study were similar to this study.

In this research, the personal noise exposure resulting in different clinical and laboratory work has been measured. The disparity in noise levels can be due to the use of different instruments for different periods of time in prosthodontic applications.

The level of noise exposure among academician dentists was slightly lower than among dentistry interns and significantly lower than laboratory technicians ($p<0.01$) because academician dentists used brand new turbines and rarely used the maximum speed of their handpieces during dental treatments.

The noise regulation published in 2003 in our country and the European legislation restricted exposure to everyday noise to 85 dB (4). During the Covid-19 pandemic, working in areas divided by screens has relatively reduced the individual noise exposure of academician dentists and dentistry interns. According to the results of this research, the noise exposure of academician dentists, dentistry interns and dental laboratory technicians is below 85 dBA, but according to the article issued by the World Health Organization in 2004, the academician dentists and dentistry intern groups are close to serious hearing risk values. The laboratory technician group is in danger of serious hearing loss and even deafness.

Conclusion

This research revealed that during post COVID-19 pandemic, academician dentists, dentistry interns and dental laboratory technicians were exposed to noise values close to the noise values measured in previous studies during their dental practice, even when working in areas divided by screens. The null hypothesis was partially rejected because there was no statistically significant difference between the groups in L peak values ($p<0.106$). The average noise levels (standard deviation) (Leq) for academician dentists, dentistry interns and laboratory technicians were 73.50±0.67 dBA, 75.14±3.41 dBA, 84.64±9.12 dBA respectively and Lex 8 hour noise measurement values were evaluated for academician dentists, dentistry interns and laboratory technicians were 73.68±1.09 dBA, 75.26±3.40 dBA, 84.84±9.27 dBA respectively ($p<0.01$). No significant differences were observed between academician dentists and dentistry interns across occupational groups, and noise levels were below the occupational exposure limits (85 dBA), but dental technicians were significantly close to the exposure threshold and therefore at risk for hearing loss. Laboratory workers were informed and warned about the use of hearing protection equipment.

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