Evaluation of noise exposure and acoustic discomfort in a university dental hygiene clinic

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PRACTICAL IMPLICATIONS OF THIS RESEARCH

- Dental hygienists use a variety of manual and mechanical tools during routine appointments with clients. Mechanical tools, such as ultrasonic scalers, air/water syringes, and slow-speed handpieces, all produce noise.
- Exposure to noise during dental hygiene appointments can be a source of discomfort for clinicians, aggravating task exertion, interfering with communication, and reducing the ability to concentrate while performing dental hygiene procedures.
- More research is needed to evaluate acoustic discomfort perceived by patients and practitioners in clinical settings.

ABSTRACT

Background: The aim of this study was to evaluate the noise exposure of dental hygiene students in a university clinic and assess the degree of perceived acoustic discomfort. **Methods:** Personal and environmental phonometric measurements were carried out during dental hygiene sessions at the clinic. An anonymous, online questionnaire was also administered to the 57 students to establish the degree of perceived acoustic discomfort. **Results:** The noise exposure levels measured in the university clinic were below the lower regulatory action values (LAeq = 77.2 dB(A); LCpeak = 112 dB(C)). No differences in sound levels were observed between left and right ears. The questionnaire highlighted that noise exposure during task performance was related to perceived annoyance, with the majority of students believing that noise increased task exertion. **Conclusion:** Exposure to noise during dental hygiene appointments, although below regulatory values, can be a source of discomfort, aggravating task exertion, interfering with communication, and reducing the ability to concentrate while carrying out dental hygiene procedures.

RÉSUMÉ

Contexte : L'objectif de cette étude était d'évaluer l'exposition au bruit des étudiants en hygiène dentaire dans une clinique universitaire et le degré d'inconfort acoustique perçu. **Méthodes :** Des mesures phonométriques individuelles et environnementales ont été effectuées lors des séances d'hygiène dentaire à la clinique. Un questionnaire anonyme en ligne a également été administré aux 57 étudiants afin d'établir le degré d'inconfort acoustique perçu. **Résultats :** Les niveaux d'exposition au bruit mesurés dans la clinique universitaire étaient inférieurs aux valeurs d'action réglementaire inférieures (Leq = 77,2 dB(A); PEAK pondéré C = 112 dB (C)). Aucune différence dans les niveaux sonores n'a été observée entre les oreilles de gauche et de droite. Le questionnaire soulignait que l'exposition au bruit pendant l'exécution de la tâche était liée à l'agacement perçu, la majorité des étudiants croyant que le bruit augmentait l'effort de la tâche. **Conclusion :** L'exposition au bruit pendant les séances d'hygiène dentaire, bien qu'inférieure aux valeurs réglementaires, peut être une source d'inconfort, d'aggravation de l'effort à la tâche, d'entrave à la communication et de réduction de la capacité de concentration pendant les procédures.

Keywords: dental hygiene; hearing impairment; hearing loss; hearing protection devices; noise-induced hearing loss; occupational noise; suction; ultrasonic scalers

CDHA Research Agenda category: risk assessment and management

INTRODUCTION

A dental hygienist is a qualified and licensed health professional who deals with primary, secondary, and tertiary prevention in order to improve a person's oral health. In particular, dental hygienists develop and participate in personalized oral disease prevention programs, collect anamnestic data, and identify lesions and/or anomalies affecting hard and soft tissues in the oral cavity. They also collect radiographic and photographic documentation and compile periodontal files, recording dental–periodontal clinical indices and carrying out non-surgical maintenance or supportive periodontal therapy.

During a dental hygiene appointment, the dental hygienist uses various manual or mechanical tools to carry out procedures. Mechanical tools, such as ultrasonic scalers, air/water syringes, and slow-speed handpieces, are a source of noise, the acoustic level of which must be determined in order to prevent possible disturbances.

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In a recent systematic review[1] analyzing the risk of hearing loss among oral health professionals, it emerged that, in the majority of the studies included (82%), years of clinical experience was a significant risk factor for hearing loss among dentists and dental specialists. Dental assistants and dental hygienists were less frequently mentioned in the reviewed studies.[1] There was a difference between the left and right ears in 71% of the trials, with the left ear exhibiting more damage in dental assistants and dentists, due to the proximity to the noise-producing equipment.

Henneberry et al.[2] conducted a literature review in order to determine the risk of noise-induced hearing loss (NIHL) among dental hygienists. They concluded that the risk of permanent hearing damage appears minimal, since the scientific literature does not highlight exceeding 85 dB(A) in the use of ultrasonic scalers. The review identified potential temporary effects on hearing (tinnitus and threshold shift) due to the use of these devices.

From the analysis of the literature, further studies emerged that evaluated the existence of possible risk profiles for the development of occupational hearing loss in personnel working in the oral health care field.[3–6] These studies mainly involved dentists, dental technicians, and dental assistants but could also be a useful reference for the exposure assessment of dental hygienists.

In the study by Al-Omoush et al.,[7] following audiometric tests conducted on a group of 244 dental operators, it emerged that, at frequencies of 1000 Hz, 2000 Hz, 4000 Hz, and 8000 Hz, dental assistants had significantly lower hearing thresholds in the left ear compared to the right. In this group, the degree of hearing loss showed a significant correlation with the duration of daily occupational exposure to noise and age.

In the study by Wilson et al.[8] conducted on dental hygienists divided into 2 groups of frequent and non-frequent users of ultrasonic scalers, results revealed no significant statistical differences between the right and left ear. However, a difference between the 2 groups was noted at 3000 Hz.

Further studies[3,9-12] also highlighted the increase in exertion and annoyance resulting from exposure to noise in the oral health care field.

Concerning dental hygienists' exposure to occupational noise and its classification, the research by Ramsey et al.[13] showed an equivalent exposure level of 81.4 dB(A) and a peak level of 113.9 dB(C). As far as the instrumentation used by dental hygienists was concerned, the aspirator in particular showed an equivalent level of 75.9 dB(A) during the aspiration of a cup of water, while the value dropped to 71.1 dB(A) during dry vacuuming. These noise levels experienced during routine periodontal maintenance therapy were below the legislative thresholds.

Numerous investigations have also been conducted in university dental clinics[14–20] in which different noise values were often found to be close to the lower action limit of 80 dB(A). In most of the studies, the noise levels detected were particularly linked to the configuration of the spaces in the university clinics, with numerous workstations in close proximity without sound-absorbing systems.

The purpose of this study was:

- to determine the levels of noise exposure to which students in the Degree Course in Dental Hygiene are subjected while performing different dental hygiene procedures, and to verify if there are significant differences between the right and left ears.
- to determine the sound levels produced by the instruments used.
- to determine the level of environmental noise during dental hygiene activities, particularly by evaluating the impact of different working environments.
- to evaluate the degree of acoustic discomfort perceived by the students in the dental clinic.

METHODS AND MATERIALS

Ethics approval

This study received ethical approval from the Regional Ethical Committee of Friuli Venezia Giulia Region (CEUR - No: 092/2018). All participants signed an informed consent form before taking part in the study.

Sampling subjects and places

The study was carried out on 57 students in the Degree Course in Dental Hygiene at the University of Trieste, Italy, by taking personal and environmental phonometric measurements. These measurements were taken to evaluate noise exposure levels during the dental hygiene appointments carried out as part of their curricular internship.

Phonometric measurements

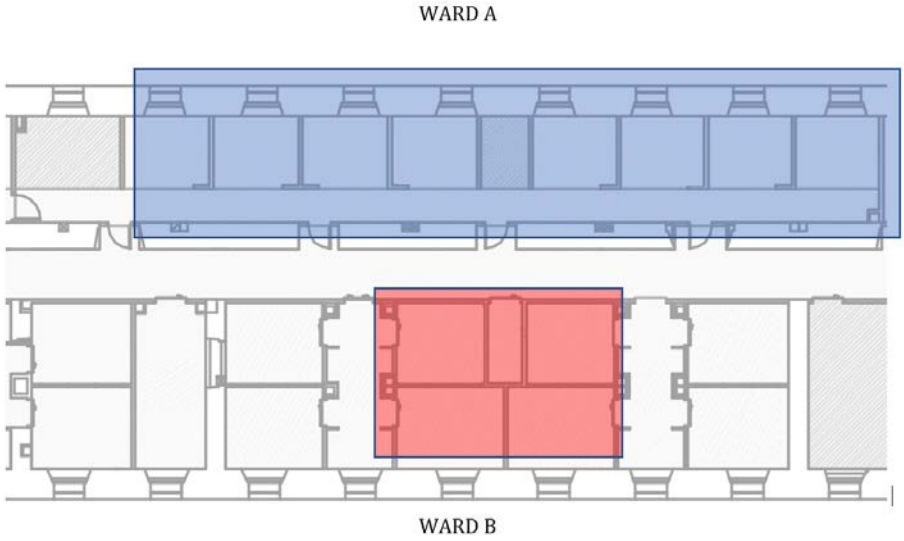
In this study, both personal dosimetric and ambient measurements were taken. All phonometric investigations were performed by an expert health and safety technician using a Larson Davis SoundExpert® LxT Sound Level Meter. Before each measurement session, phonometer calibration was performed by the same expert health and safety technician who carried out the measurements with a Larson Davis CAL200 class 1 calibrator S/N 9575, according to the UNI EN ISO standard 9612:11.[21]

Both personal and ambient measurements were taken in the following 2 locations at the university clinic (Figure 1):

- **Ward A:** 8 dental stations (width 270 cm, depth 247 cm, height 410 cm) parallel to each other, separated by a low wall (293 cm) and connected by an open corridor
- **Ward B:** 4 closed clinics (width 220 cm, depth 310 cm, height 340 cm) equipped with a sliding door to close off the room.

The equipment supplied to the dental stations consisted of an air/water syringe, aspirator, fast aspirator (Dental

Figure 1. Layout of the university dental clinic



Units Stern Weber S300, Cefla, Imola, Bo, Italy), slow-speed handpiece Bien Air® (maximum rotation speed [rpm]: 40,000, Bien Air Dental SA, Bienne, Switzerland) and ultrasonic scaler Newtron® handpiece (28 kHz to 36 kHz Newtron Satelec Acteon, Va, Italy).

For the evaluation of personal exposure to noise, 6 students were randomly selected, consistently with the requirements of the UNI EN ISO standard 9612:11 for the assessment of noise exposure in homogeneous noise exposure groups.[21] In total, 62 dosimetric measurements were carried out, each lasting 25 minutes; 31 of these were taken on the right ear and 31 on the left ear. The microphone was fixed with a special support on the operator's shoulder at a distance of approximately 4 cm above and approximately 10 cm from the opening of the auditory canal (Figure 2).

To measure ambient noise levels during the dental hygiene appointments, 57 measurements lasting 5 minutes each were carried out. For each measurement, the microphone was placed on a tripod in a vertical position, at the height of the operator's ear and connected to the sound level meter using an extension lead (Figure 2). Noise measurements were also taken in the common areas (corridors, tutor office, instrument laboratory).

In order to measure background levels, 16 environmental measurements lasting 5 minutes each were conducted while the dental hygiene clinic was inactive.

Figure 2. Microphone placement for dosimetric measurements

Questionnaire for evaluating acoustic discomfort

To evaluate the acoustic discomfort perceived by the dental hygiene students and compare perceived and actual noise exposure,[11,12,18,20,22] an anonymous questionnaire (Appendix) was developed to collect personal data and individual anamnestic information, as well as information regarding exposure to noise during the training activity. Indications relating to the degree of perceived discomfort were rated on a 5-point Likert scale.

The questionnaire was administered via Google Forms to 57 students in their second or third academic year. It was also administered to postgraduate trainee students in the Dental Hygiene Degree Course, as they had already undergone curricular traineeship activities. All participants had previously signed consent to be enrolled in the study.

Statistical analysis

Excel for Windows was used to gather the data, and STATA-17 (StataCorp College Station, Texas) was used to analyze it. The Mann-Whitney test was then used to compare the results. One Way ANOVA test and the Games-Howell Post Hoc test ($p < 0.05$) were used to determine the presence of any statistically significant differences between groups.

Table 1. Comparison of noise exposure levels

		Mean	SD	Median	25th percentile	75th percentile
Personal noise exposure levels	LAeq	77.2 dB(A)	+2.65	77.2 dB(A)	75.4 dB(A)	78.3 dB(A)
	LCpeak	112 dB(C)	+5.35	112 dB(C)	108 dB(C)	116 dB(C)
Levels of exposure to ambient noise during the dental hygiene session	LAeq	66.8 dB(A)	+3.46	67.5 dB(A)	65.0 dB(A)	69.5 dB(A)
	LCpeak	97.3 dB(C)	+7.15	95.9 dB(C)	92.8 dB(C)	101 dB(C)
Levels of exposure to ambient noise in non-active clinics	LAeq	50.4 dB(A)	+4.30	51.9 dB(A)	46.7 dB(A)	53.2 dB(A)
	LCpeak	87.7 dB(C)	+5.33	112 dB(C)	108 dB(C)	116 dB(C)
		Right ear		Left ear		*P* value
Left and right ear comparison	LAeq	77.1 ± 2.41 dB(A)		77.3 ± 2.90 dB(A)		0.817
	LCpeak	113 ± 5.09 dB(C)		111.4 ± 5.56 dB(C)		0.218
		Ward A		Ward B		*P* value
Environmental noise comparison: Wards A and B	LAeq	67.4 ± 2.71 dB(A)		67.2 ± 3.92 dB(A)		0.878
	LCpeak	99.9 ± 6.83 dB(C)		93.9 ± 6.04 dB(C)		0.002

RESULTS

Phonometric measurements

Analysis of the individual dosimetric measurements showed that the average equivalent level of noise exposure did not exceed the lower action limit set at 80 dB(A), settling at values close to 77.2 dB(A) (Table 1). In the same way the peak level C did not exceed the lower action limit set at 135 dB, corresponding to 112 dB(A).

Furthermore, no statistically significant differences emerged in the levels of exposure to noise between the operators' right and left ears, neither regarding the equivalent A level nor the peak C level (Table 1).

Environmental measurements under operating conditions revealed equivalent sound levels below 70 dB(A). No statistically significant differences were found between Wards A and B of the dental clinic regarding the mean equivalent level of exposure to noise. Instead, a statistically significant difference was found in the peak levels measured in the 2 areas of the clinic ($p < 0.001$) (Table 1).

With regard to the background environmental measurements carried out during the period of inactivity in the clinic, an equivalent sound level of 50.4 dB(A) was found.

Spectral analysis of dosimetric measurements revealed that there was an increase in sound levels in the frequency range between 500 Hz and 800 Hz. An increase in noise levels was also observed in the frequency range above 16,000 Hz (Figure 3).

The analysis of the noise levels during the different instrumental operations showed that the highest sound levels were recorded during procedures involving the aspirator in combination with the air/water syringe and the slow-speed handpiece (Table 2). Regarding use of the ultrasonic scaler, sound levels close to 72 dB(A) were detected, while use of the aspirator revealed values close to 70 dB(A). The air/water syringe used individually demonstrated sound levels of 68.5 dB(A) while the use of the slow-speed handpiece was characterized by an acoustic emission close to 66 dB(A).

Questionnaire for evaluating acoustic discomfort

The questionnaire for the assessment of acoustic discomfort had a participation rate of 78.95% (45 of the 57 students). Twenty (20) of these students were enrolled in their second year and 24 in their third year, while 1 carried out postgraduate internship activities. Most of the respondents were female (84.4%); the average age of the respondents was 24.8 years (Table 3).

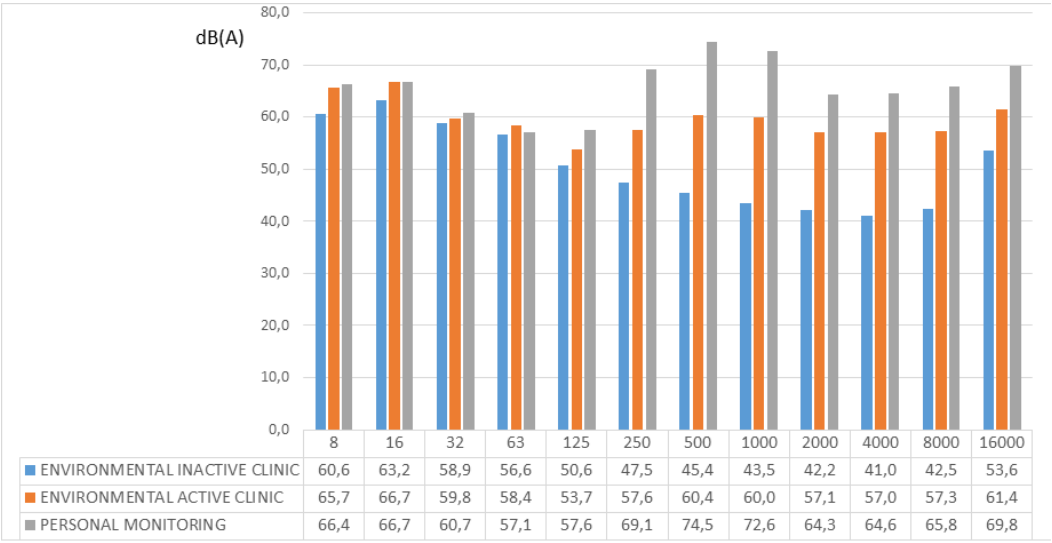
Second-year students reported spending on average 2 days per week in dental hygiene appointments, while those in their third year spent on average 2.3 days per week in dental hygiene appointments. The postgraduate intern performed dental hygiene procedures 5 days per week.

The questionnaire revealed that second-year students had an average of 2.1 dental hygiene appointments during the internship day, while third-year students had an average of 4.1 appointments per day. The postgraduate intern declared that they had an average of 4 dental hygiene appointments per day of internship. Each dental hygiene appointment lasted approximately 1 hour.

Fifteen percent (15.6%) of respondents stated they suffered from hearing problems, specifically muffled ear (71.4%), tinnitus (14.3%), and hypoacusia (14.3%).

The students were asked to answer questions on their perception of noise using a scale of 1 to 5, in which 1 represented low irritation or minimal stress and 5 represented high irritation or stress. In general, the working environment was perceived as a cause of

Figure 3. Spectrum analysis of personal and workplace noise levels



	8	16	32	63	125	250	500	1000	2000	4000	8000	16000
ENVIRONMENTAL INACTIVE CLINIC	60,6	63,2	58,9	56,6	50,6	47,5	45,4	43,5	42,2	41,0	42,5	53,6
ENVIRONMENTAL ACTIVE CLINIC	65,7	66,7	59,8	58,4	53,7	57,6	60,4	60,0	57,1	57,0	57,3	61,4
PERSONAL MONITORING	66,4	66,7	60,7	57,1	57,6	69,1	74,5	72,6	64,3	64,6	65,8	69,8

acoustic discomfort (average score 3.4, SD 0.96) and auditory stress (average score 3.2, SD 1.0). Overall, environmental noise could represent a potential source of interference during work performance (average score 2.6, SD 1.1), causing a potential decline in concentration (average score 2.9, SD 1.2). Most dental hygiene students (75.6%) declared that noise during dental hygiene appointments increased job exertion.

Students were also asked to rate their level of annoyance in Ward A and Ward B, to assess whether there were any variations relating to the different configuration of the workstations. Questionnaires showed higher perceived annoyance in Ward A (Table 4).

Participants were also asked to rate their level of annoyance with noise caused by different instruments used during dental hygiene procedures. Results showed that the aspirator and the ultrasonic scaler were perceived as noisier while the slow-speed handpiece and the air/water syringe were perceived as less disturbing (Table 4).

The survey showed that over 53% of respondents believed that noise was variable during dental hygiene appointments. Thirty-seven percent (37.8%) of students stated the need to raise their voice almost half the time during oral hygiene procedures, 22.2% more than half the time, and 17.8% almost always.

Regarding communication during dental hygiene appointments, 40% of respondents found themselves having to ask other operators to repeat what they said almost half the time, 26.7% more than half the time, and 6.7% always.

With regard to perceived disturbance after dental hygiene appointments, the most frequently reported

Table 2. Noise levels related to the instruments used

Instruments	Mean of LAeq	SD	Max of LCpeak	8 Hz	16 Hz	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	16000 Hz
Air/water syringe; slow-speed handpiece; fast aspirator	78.92	1.74	90.9	63,6	63.85	65	54.31	51.08	61.24	64.53	63.82	67.97	70.96	77.17	77.9
Air/water syringe; fast aspirator	76.27	4.42	97.36	61.3	62.35	61.34	55.29	51.94	58.2	63.01	62.38	65.06	69.77	70.53	71.06
Ultrasonic scaler; fast aspirator	74.89	5.45	110.28	61.54	62.52	61.71	55.58	51.5	57.84	62.42	62.68	62.92	66.07	66.22	71.92
Slow-speed handpiece; fast aspirator	73.78	3.52	102.79	61.54	62.79	61.6	55.55	52.03	56.08	60.31	61.32	63.08	67.14	68.83	70.04
Ultrasonic scaler	71.92	8.16	115.62	60.95	60.9	61.44	55.58	53.35	59.51	65.95	64.94	57.95	60.86	61.22	60.03
Fast aspirator	69.68	5.89	128.57	61.15	62.95	59.99	55.66	53.22	59.36	63.72	63.29	58.12	58.86	58.99	59.78
Air/water syringe	68.46	7.43	106.85	62.19	63.65	59.65	55.8	52.6	60,7	64.72	61.8	56.3	54.77	52.87	52.71
Slow-speed handpiece	66.11	6.54	115.78	60.81	62.98	60.46	55.56	53.47	58.05	62.2	58.97	54.03	54.07	53.85	56.34

Table 3. Demographic composition of survey participants

Year of study	Sex	Number of participants	Age	SD
2	F	17	23.1	+2.8
	M	3	24.0	+4.0
	Total	20	23.3	+2.9
3	F	20	25.7	+8.2
	M	4	28.8	+6.9
	Total	24	26.2	+8.0
Postgraduate	F	1	24.0	

Table 4. Annoyance assessment of noise levels in relation to the clinic space and the equipment used

Annoyance level on a scale of 1 to 5	Mean ± SD	*P* value
Ward A	3.60 ± 1.12	<0.001
Ward B	1.56 ± 0.73	
Fast aspirator	3.13 ± 1.24	
Aspirator	3.02 ± 1.18	
Ultrasonic scaler	2.73 ± 0.96	<0.001
Slow-speed handpiece	1.58 ± 0.69	
Air/water syringe	1.20 ± 046	

problem was headache. In fact, 26.7% reported suffering from headaches more than half the time after work; 17.8% always or almost always. Just over thirteen percent (13.3%) said they felt ear buzzing almost half the time or more, and 17.7% reported muffled ears at least half the time or more after dental hygiene appointments.

Finally, the students were asked to share their personal observations. From this open-ended question, it emerged that acoustic discomfort from clinical noise was experienced not only by operators, but also by the patients exposed for the duration of the appointment. Above all, students indicated that noise was a problem when treating patients with dental anxiety or those living with mental health conditions.

DISCUSSION

This study revealed that the lower action limits[23] exceeded neither the equivalent level (77.2 dB(A)) nor the peak value (112 dB(C)) of noise measured in the dental clinic.

Considering that the duration of dental hygiene practice was limited during the week (ranging from a minimum of 4.2 hours/week for second-year students to 20 hours/week for postgraduate students), standardized 8-hour time weighted average (TWA)[21] measurements were inferior to 70 dB(A), even when considering the most exposed student (67.2 dB(A) for the postgraduate student). These results are consistent with the findings of Burk and Neitzel,[18] which indicated 66.4 dB(A) of noise exposure among dental hygienists, but were lower than levels detected by Ramsey et al.,[13] which revealed 81.4 dB(A) readings during dental hygiene appointments.

Research conducted at dentistry colleges has yielded different findings. In particular, Choosong et al.[16] detected 8-hour TWA noise levels ranging between 49.7 dB(A) and 58.1 dB(A). Kadanakuppe et al.[24] measured noise levels ranging between 64 dB(A) and 97 dB(A), observing that lower noise levels were related to brand new dental instruments. Ahmed and Ali[9] found a noise level between 58 dB(A) and 79 dB(A), with peak levels ranging from 89 dB(A) to 93 dB(A), noting that students with prolonged exposure had more hearing issues. Antoniadou et al.[20] found that personal noise measurements ranged from 74.5 dB(A) to 78.5 dB(A), consistent with the findings of the present study.

Regarding the comparison between measurements relating to the right ear and the left ear, no statistically significant differences emerged. These outcomes are consistent with the findings of Wilson et al.[8] who, after subjecting a sample of dental hygienists to audiometric examination, noted that both ears were similarly affected by noise exposure.

When comparing data taken in Wards A and B, no statistically significant variations were found in the levels of personal and ambient noise exposure. Higher peak levels, however, were found in Ward A, which is characterized by an open configuration in which the numerous workstations are not entirely separated from one another.

Regarding the characteristics of the sound levels emitted by dental hygiene instruments, it has been observed that the instruments responsible for the greatest acoustic contribution are the ultrasonic scaler (LAeq = 71.9 dB(A), SD 8.2) and the aspirator (LAeq = 69.7 dB(A), SD 8.2), especially when used in conjunction with other instruments such as the air/water syringe (LAeq = 68.5 dB(A), SD 7.4) and slow-speed handpiece (LAeq = 66.1 dB(A), SD 6.5). Sound levels related to the ultrasonic scaler were comparable to those detected by Baseer et al.[25] (68.5 dB(A)) and by Qsaibati et al.,[26] who observed levels ranging from 64.5 dB(A) to 76.7 dB(A). Otoum et al.[27] recorded ultrasonic scaler noise levels ranging from 58 dB(A) to 81.6 dB(A), slow-speed handpiece sound levels between 60.1 dB(A) and 78.9 dB(A), and aspirator noise levels reaching 83.5 dB(A). As far as the results of the spectral analysis are concerned, particularly with regard to the characteristics of the acoustic emissions correlated with the use of the ultrasonic scaler, the present study found the presence of an important contribution of frequencies above 16,000 Hz, which is consistent with recent literature.[16,28,29]

Considering students' subjective perceptions, the present study found that students perceived a feeling of annoyance caused by noise while carrying out their tasks. Acoustic discomfort (average score 3.4) and auditory stress (3.2) were attributed to the working environment on a 1–5

Likert scale of increasing perceived annoyance levels. These results are consistent with the findings of Dierickx et al.,[10] who observed average values of 2.9 (SD 0.9) relating to perceived noise annoyance among young dentists during dental practice.

In particular, most of the students (75.6%) thought that noise increased job exertion, as they experienced fatigue related to self-repetition and speaking with a raised voice in order to be heard by patients and colleagues.

As observed by Chen et al.[30] and Ahmed and Ali[9] the main cause of noise annoyance was the use of dental instruments. In general, the phonometric outputs in the current study were consistent with students' perceived instrument disturbance. In fact, higher levels of annoyance were related to the noise emitted by the ultrasonic scaler and the aspirator. In contrast, the least annoying tool was the air/water syringe followed by the slow-speed handpiece (Table 4). These findings support those observed by Neitzel et al.,[22] who showed that subjective evaluation has the potential to be used as a screening method to identify noise sources.

Data from the questionnaire indicate that a greater level of annoyance was perceived by students in Ward A: overall, noise levels in that ward were closer to the lower action limit of 80 dB(A). This finding explains the acoustic discomfort expressed by the students, which was greater in Ward A. The configuration of the ward, which does not allow for separation between the various dental stations, is realistically the cause of the highest peak and the consequent acoustic discomfort of the operators. As highlighted by Dierickx et al.,[10] Al-Omoush,[7] and Khotbesara et al.,[31] exposure to noise also constitutes a significant source of discomfort for dental hygienists. It aggravates job exertion, interferes with communication, and reduces the ability to concentrate during procedures.

In light of the findings of the current study, modification to the layout of Ward A, with a "closed module" solution, and the selection of ultrasonic scalers and aspirators with lower acoustic emissions would likely reduce the degree of discomfort experienced by clinic operators.

Strengths and limitations

This study has several strengths. First, the instruments used in the clinic were recently acquired and are well maintained. It cannot, therefore, be ignored that if the instruments were older and more worn, they might emit higher noise levels and consequently pose a greater risk for work-related hearing loss. Similarly, the instrumentation used for the noise investigation was recently acquired, classified as a class 1 of accuracy for noise monitoring, and was calibrated at every use. Second, all instrumental investigations were performed by an expert health and safety technician. Third, measuring real ambient noise directly, rather than estimating it from literature data, has several key advantages: it provides real-time, location-specific data that accurately reflect the current environmental conditions; it accounts for the unique characteristics of the environment; and it provides precise noise measurements that are crucial when the purpose is to assess the health impacts of noise on workers or population in general terms. Finally, the questionnaire for the evaluation of acoustic discomfort had a high response rate, at close to 79%. In academic research, a good survey response rate is often considered to be between 60% and 80%.[32]

Conversely, this study has some limitations. The instrumental noise measures were taken in a non-controlled environment. The reproducibility of these measurements is inherently limited by the lack of control over external influences such as room shape and size, surface materials, sound reflection, and reverberation. Another limitation was the use of a non-validated questionnaire to assess the acoustic comfort among dental hygiene students. Using non-validated surveys can lead to inaccurate estimates if there are systematic differences between respondents and the target population. Finally, the study relied on a survey to assess noise comfort and discomfort. Noise discomfort is subjective; individuals perceive noise differently, depending on factors such as personal tolerance, health, and stress levels. External factors such as the type of task, concentration needs, and individual sensitivity also play a role in how noise is perceived. However, in this study the combination of a survey with instrumental noise measurements provided a fuller understanding of workplace noise and its impact on dental hygienists' comfort.

CONCLUSION

Data from this study indicate that the noise present in this university dental hygiene clinic is unlikely to be related to acoustic damage. However, the exposure to noise during dental hygiene appointments can be a source of discomfort, aggravating task exertion, interfering with communication, and reducing the ability to concentrate while performing dental hygiene procedures. Further studies should be carried out to evaluate acoustic discomfort perceived by patients, especially by odontophobic individuals living with mental health conditions or more broadly by particularly sensitive individuals.

CONFLICTS OF INTEREST

The authors have declared no conflicts of interest.

APPENDIX: Acoustic Comfort Assessment Questionnaire

1. Date_____

2. Sex
□ Male □ Female

3. Age_____

4. Year of study □ 1 □ 2 □ 3 □ Postgraduate

5. How many hygiene sessions do you have on average during the internship day? _____
6. How many days a week do you have hygiene sessions as part of the internship? _____
7. How long does an average hygiene session last? (indicate the minutes) _____

8. Do you suffer from one of the following hearing problems?
□ Tinnitus □ Muffled ear □ Hypoacusis

9. Generally, would you say that the noise in your workplace bothers you? (1 = not at all; 5 = totally)
□ 1 □ 2 □ 3 □ 4 □ 5

10. Generally, would you say that the noise in your work environment reduces your ability to concentrate during work performance? (1 = not at all; 5 = totally)
□ 1 □ 2 □ 3 □ 4 □ 5

11. Generally, would you say that noise in your work environment interferes with work performance? (1 = not at all; 5 = totally)
□ 1 □ 2 □ 3 □ 4 5

12. Do you think that the noise around you increases job exertion?
□ Yes □ No

13. How would you rate your hearing stress on a scale of 1 (minimum stress) to 5 (high stress) during dental hygiene sessions?
□ 1 □ 2 □ 3 □ 4 □ 5

14. How annoying do you consider the background noise you hear when you have sessions in one of the 8 units on a scale of 1 to 5? (1 = minimal annoyance; 5 = high annoyance)
□ 1 □ 2 □ 3 □ 4 □ 5

15. How annoying do you consider the background ambient noise you hear when you perform conservative/pedodontic sessions on a scale from 1 to 5? (1 = minimal annoyance; 5 = high annoyance)
□ 1 □ 2 □ 3 □ 4 □ 5

16. How annoying do you consider the noise produced by the vacuum cleaner on a scale of 1 to 5 where 1 = minimal annoyance and 5 = high annoyance?
□ 1 □ 2 □ 3 □ 4 □ 5

17. How annoying do you consider the noise produced by the fast extractor fan on a scale of 1 to 5 where 1 = minimal annoyance and 5 = high annoyance?
□ 1 □ 2 □ 3 □ 4 □ 5

18. How annoying do you find the noise made by the air/water syringe on a scale of 1 to 5 where 1 = minimal annoyance and 5 = high annoyance?
□ 1 □ 2 □ 3 □ 4 □ 5

19. How annoying do you find the noise produced by the slow-speed handpiece on a scale of 1 to 5 where 1 = minimal annoyance and 5 = high annoyance?
□ 1 □ 2 □ 3 □ 4 □ 5

Continued...

20. How annoying do you find the noise produced by the ultrasonic scaler on a scale of 1 to 5 where 1 = minimal annoyance and 5 = high annoyance?
    ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

21. How do you judge the variability of the noise level during the dental hygiene session?
    ☐ Stable, never variable
    ☐ Usually constant
    ☐ Usually variable
    ☐ Always variable, never constant

22. During the dental hygiene session, how many times did you have to raise your voice to be heard by someone not far from you due to the noise present?
    ☐ Never or hardly ever
    ☐ Less than half the time
    ☐ Almost half the time
    ☐ More than half the time
    ☐ Always or almost always

23. During your dental hygiene session, how many times do you find yourself having to ask others to repeat what they said?
    ☐ Never or hardly ever
    ☐ Less than half the time
    ☐ Almost half the time
    ☐ More than half the time
    ☐ Always or almost always

24. How many times have you heard your ear ringing or buzzing after your work shift?
    ☐ Never or almost never
    ☐ Less than half the time
    ☐ Almost half the time
    ☐ More than half the time
    ☐ Always or almost always

25. How many times have you perceived the sound around you muffled after the work shift?
    ☐ Never or almost never
    ☐ Less than half the time
    ☐ Almost half the time
    ☐ More than half the time
    ☐ Always or almost always

26. Have you ever had a headache after your work shift?
    ☐ Never or almost never
    ☐ Less than half the time
    ☐ Almost half the time
    ☐ More than half the time
    ☐ Always or almost always

27. Personal considerations regarding noise during the work shift (open ended)

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