

## Hearing Threshold and Noise Exposure of Dentists at Padjadjaran University Dental Hospital in Bandung

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### Abstract

Health and work safety at one's workplace is an important aspect for a dentist's practice sustainability. Often, factors such as the health of dentists' hearing condition are disregarded. Dentists operate high-intensity noise-emitting instruments ranging between 72-94 decibels daily and for long working hours averaging 3-8-hour time-weighted average (TWA). These long-term exposures may induce hearing impairment. This study was carried out to determine whether the high-intensity noises generated by dental instruments and its prolonged exposure could cause noise-induced hearing loss among dental practitioners at Padjadjaran University Dental Hospital in Bandung. A cross-sectional study was conducted on 91 general dental practitioners and specialists. Each individual was subjected to tests that comprised of subjective examinations – a questionnaire and anamnesis, and objective examinations which included distortion product otoacoustic emission (DPOAE) and pure-tone audiometry tests. From the respective examinations, results showed that 6% of working dentists developed hearing abnormalities and 23.2% reported tinnitus. The average of noise exposure received by dentists was 3.7 hours per day and 4.7 ≈ 5 days a week. Hearing abnormalities were more prone to be found in older aged group working dentists with longer working experience, meanwhile the percentage of dentists reporting tinnitus, was notably found within the younger aged group of dentists with varying duration of noise exposure. Dentists are prone to risks in developing noise-induced hearing loss especially dentists with longer hours and years of working experience.

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### Introduction

Noise-induced hearing loss, which ranks among the 10 most common occupational diseases, is defined as bilateral sensorineural hearing loss that develops progressively over a period of several years as a result of continuous or intermittent loud noise exposure of more than 85 decibels at the workplace<sup>1,2</sup>. Developing countries mainly in Southeast Asia haven't fully recognized the effects of excessive noise exposure. This is due to a multitude of factors, namely the lack of existing government regulations and a similar lack of personnel for

inspecting and controlling the level of noise emission in many occupation sectors. Indonesia is considered as one of the countries with highest level of workers reported to be suffering from noise-induced hearing loss<sup>3,4</sup>.

Dentists or dental practitioners are among many professions who are at risk of developing noise-induced hearing loss. Dental practitioners work with instruments such as high and low-speed turbine handpieces, ultrasonic scalers, and compressors, which continuously emit loud noises varying between 72 to 94 decibels<sup>5</sup>. The extent of hearing loss depends on the intensity of the noise and duration of noise exposure. The Occupational Safety and Health Administration (OSHA) limits loud noise exposure to 85 decibels and according to Indonesia's Ministry of Health Decision No. 1204/MENKES/SK/X/2004 on Requirements of Hospital Environmental Health ("SK Menkes 1204"), the maximum noise exposure allowed is 80 decibels in the course of 8 working hours<sup>6-8</sup>.

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For over 40 years, diverse research and experiments have been trying to correlate between prolonged noise exposure and its effects on hearing condition of dental practitioners<sup>9</sup>. A study in Saudi Arabia reported 15.8% of dental practitioners were suffering from hearing loss, while another study by Khaimook, et al. revealed the prevalence of hearing loss in dental practitioners to be 17.7%<sup>10,11</sup>.

This study is preliminary and to the best of the authors' knowledge, this is the first study of its kind in Indonesia. The aim of this study is to display the hearing thresholds and duration of noise exposure received by dental practitioners working at Padjadjaran University Dental Hospital in Bandung, as well as promoting a healthy and safe working environment for dental practitioners.

### Materials and methods

This descriptive, cross-sectional study retrospectively evaluated hearing thresholds from 125 to 8000 Hz in a group of dental practitioners working at Padjadjaran University Dental Hospital in Bandung, which took place in December 2018.

This study was approved by the ethical committee of Faculty of Medicine, Padjadjaran University (No.1235/UN6.KEP/EC/2018), and written informed consents were obtained from all the subjects participated in this study. This study involved 91 general dental practitioners and specialists from various departments such as oral surgery, orthodontics, periodontics, prosthodontics, pedodontics, restorative dentistry, oral medicine, and radiology. The subjects' ages ranged from 25 to 60 years to rule out possibilities of presbycusis<sup>12,13</sup>. Subjects completed a questionnaire regarding duration of working experience and specification on subject's inclusion and exclusion criteria comprising of noise exposure history, acute and chronic ear diseases and underlying diseases such as hypertension, hypercholesterolemia, diabetes mellitus and were selected on the basis of the lack of ear trauma or surgery, exposure to radiation and chemotherapy treatments.

After questionnaire data compilation, 69 out of 91 participants – 44 women and 25 men – were deemed eligible as subjects of this study according to the inclusion and exclusion criteria. Any confounding effects had been ruled out to validate the liability of the hearing tests results. Thus, any discovered hearing abnormalities,

would solely be due to noise exposure. Examinations were followed by pure tone audiometry and distortion product otoacoustic emission (DPOAE) testings.

Pure tone hearing thresholds were tested by pure tone audiometer (frequencies from 125 to 8000 Hz using Madsen xeta), while DPOAEs were recorded on both subjects' ears using Madsen accuscreen.

### Results

Table 1 shows the descriptive analysis of the subjects' characteristics according to age groups, gender, working experience in years, duration of noise exposure daily and weekly. Out of 69 eligible participants, 53.6% of the subjects are within the 25 - 34 age group. The ratio of male to female participants is 1:2. Most of the subjects participating in this study had less than 10 years of working experience. The hourly and daily durations of noise exposure varied quite vastly among the participants, with 42.0% of participants exposed to dental instruments-related noise 1-3 hours daily and 30.4% of participants exposed for up to 5 days per week.

|                                  | Total             | %     |
|----------------------------------|-------------------|-------|
| Age                              |                   |       |
| 25-34                            | 37                | 53,6% |
| 35-44                            | 18                | 26,1% |
| 45-54                            | 9                 | 13,0% |
| ≥55                              | 5                 | 7,2%  |
| Median                           | 33 (25-60)        |       |
| Mean                             | 36                |       |
| Gender                           |                   |       |
| Male                             | 25                | 36,2% |
| Female                           | 44                | 63,8% |
| Working experience (years)       |                   |       |
| ≤ 10                             | 50                | 72,5% |
| 10 < x ≤ 20                      | 8                 | 11,6% |
| 20 < x ≤ 30                      | 7                 | 10,1% |
| ≥ 30                             | 4                 | 5,8%  |
| Duration of exposure (hours/day) |                   |       |
| ≤ 1                              | 10                | 14,5% |
| 1 < x ≤ 3                        | 29                | 42,0% |
| 3 < x ≤ 5                        | 19                | 27,5% |
| 5 < x ≤ 7                        | 7                 | 10,1% |
| ≥ 7                              | 4                 | 5,8%  |
| Mean                             | 3.7 hours/day     |       |
| Duration of exposure (days/week) |                   |       |
| 1                                | 2                 | 2,9%  |
| 2                                | 4                 | 5,8%  |
| 3                                | 11                | 15,9% |
| 4                                | 9                 | 13,0% |
| 5                                | 21                | 30,4% |
| 6                                | 19                | 27,5% |
| 7                                | 3                 | 4,3%  |
| Mean                             | 4.7 ≈ 5 days/week |       |

**Table 1.** Subject Characteristics.

Table 2 shows the subjects reporting tinnitus divided by the age groups with information retrieved from the self-filled questionnaires. Out of 16 subjects reporting tinnitus, 50% of them are within 25 - 34 age group.

| Age   | Total | %     |
|-------|-------|-------|
| 25-34 | 8     | 50,0% |
| 35-44 | 3     | 18,8% |
| 45-54 | 4     | 25,0% |
| ≥55   | 1     | 6,3%  |

**Table 2.** Subjects Reporting Tinnitus according to Age Groups.

Table 3 shows the conclusive data recapitulation of the DPOAE and pure tone audiometry examination results according to the subject's characteristic groupings. According to the OAE results, 2 subjects did not pass the examination, and both subjects were above 45 years old and had more than 30 years of working experience. Meanwhile according to the audiometry results, subjects with hearing impairment were found scattered within all age groups and duration of working experiences.

|                                  | OAE |    |        | Audiometry |   |    |   |      |   |    |    |     |    |   |   |   |
|----------------------------------|-----|----|--------|------------|---|----|---|------|---|----|----|-----|----|---|---|---|
|                                  | P   | Rf | Normal | CHL        |   |    |   | SNHL |   |    |    | MHL |    |   |   |   |
|                                  |     |    |        | Sg         | M | Sv | M | Sg   | M | Sv | Sg | M   | Sv |   |   |   |
| Age                              |     |    |        |            |   |    |   |      |   |    |    |     |    |   |   |   |
| 25-34                            | 3   | 7  | 0      | 36         | 1 | 0  | 0 | 0    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| 35-44                            | 1   | 8  | 0      | 17         | 1 | 0  | 0 | 0    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| 45-54                            | 8   | 1  | 7      | 7          | 0 | 0  | 0 | 1    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| ≥55                              | 4   | 1  | 4      | 4          | 1 | 0  | 0 | 0    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| Gender                           |     |    |        |            |   |    |   |      |   |    |    |     |    |   |   |   |
| Male                             | 2   | 5  | 0      | 24         | 1 | 0  | 0 | 0    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| Female                           | 4   | 2  | 2      | 41         | 2 | 0  | 0 | 1    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| Working experience (years)       |     |    |        |            |   |    |   |      |   |    |    |     |    |   |   |   |
| ≤ 10                             | 5   | 0  | 0      | 49         | 1 | 0  | 0 | 0    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| 10 < x ≤ 20                      | 8   | 0  | 7      | 7          | 1 | 0  | 0 | 0    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| 20 < x ≤ 30                      | 7   | 0  | 6      | 6          | 0 | 0  | 0 | 1    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| ≥ 30                             | 2   | 2  | 3      | 3          | 1 | 0  | 0 | 0    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| Duration of exposure (hours/day) |     |    |        |            |   |    |   |      |   |    |    |     |    |   |   |   |
| ≤ 1                              | 1   | 0  | 0      | 10         | 0 | 0  | 0 | 0    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| 1 < x ≤ 3                        | 2   | 7  | 2      | 26         | 2 | 0  | 0 | 1    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| 3 < x ≤ 5                        | 1   | 9  | 0      | 19         | 0 | 0  | 0 | 0    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| 5 < x ≤ 7                        | 7   | 0  | 6      | 6          | 1 | 0  | 0 | 0    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| ≥ 7                              | 4   | 0  | 4      | 4          | 0 | 0  | 0 | 0    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| Duration of exposure (days/week) |     |    |        |            |   |    |   |      |   |    |    |     |    |   |   |   |
| 1                                | 2   | 0  | 2      | 2          | 0 | 0  | 0 | 0    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| 2                                | 4   | 0  | 4      | 4          | 0 | 0  | 0 | 0    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| 3                                | 1   | 0  | 1      | 10         | 1 | 0  | 0 | 0    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| 4                                | 8   | 1  | 8      | 8          | 0 | 0  | 0 | 1    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| 5                                | 2   | 1  | 0      | 20         | 1 | 0  | 0 | 0    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| 6                                | 1   | 9  | 0      | 18         | 1 | 0  | 0 | 0    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |
| 7                                | 3   | 0  | 3      | 3          | 0 | 0  | 0 | 0    | 0 | 0  | 0  | 0   | 0  | 0 | 0 | 0 |

**Table 3 .** DPOAE and Audiogram Results.

Table 4 shows the percentage results of the DPOAE and pure tone audiometry examination of the subjects. 5.8% of subjects were suffering from hearing impairment, either conductively or sensorineurally or both.

|                            | Total | %     |
|----------------------------|-------|-------|
| DPOAE                      |       |       |
| Pass                       | 67    | 97.1% |
| Refer                      | 2     | 2.9%  |
| Audiogram                  |       |       |
| Normal                     | 65    | 94.2% |
| Conductive hearing loss    | 3     | 4.3%  |
| Sensorineural hearing loss | 1     | 1.5%  |
| Mixed hearing loss         | 0     | 0.0%  |
| Tinnitus                   | 16    | 23.2% |

**Table 4.** Conclusive Table DPOAE and Audiometry Examinations.

### Discussion

Occupational noise-induced hearing loss is defined as bilateral sensorineural hearing loss that develops gradually over a period of several years because of exposure to continuous or intermittent loud noise in the work place<sup>10,11</sup>. Unlike presbycusis, which is not preventable, noise-induced hearing loss can be prevented by the use of protective equipment in noisy environments, including earplugs or earmuffs<sup>10,14,15</sup>, and also by other preventive measures such as controlling noise source, controlling noise transmission and other measures to protect the exposed person<sup>14</sup>.

Noise-induced hearing loss is usually diagnosed by pure-tone audiometry, which examines the ear's ability to transmit sound impulses by air and bone conduction. Audiometry tests are considered subjective, time-consuming, and not quite sensitive to small changes in pure tone thresholds<sup>16</sup>. Thus, otoacoustic emission is often brought in to confirm a possible diagnosis. This method is considered accurate, objective, fast, and non-invasive to assess the function of outer hair cells in clinical practice<sup>16</sup>. This theory was applied in this study as the subjects' hearing impairment discovered through audiometry results were confirmed by the DPOAE results.

During distribution of questionnaire, all subjects were to report any experience of tinnitus throughout the course of their years of practice. Tinnitus is the perception of noise in the absence of an acoustic stimulus<sup>17</sup>. It is not a disease, merely a symptom and a predisposition factor to an underlying condition. During or leading to

noise-induced hearing loss, tinnitus occurs due to the decrease of gamma amino butyric acid (GABA) regulation of peripheral auditory nerves and causes the decrease of inhibitory function of efferent nerves. These spontaneous changes cause a decrease in afferent impulses and compensation inhibition of proximal auditory pathways, which causes tinnitus<sup>18</sup>.

The prevalence of noise-induced hearing loss in dental practitioners according to previous studies ranges from 7 to 16%<sup>1,10,11,19,20</sup>. A comparative study conducted in Brazil in 2011 reported 15% of dentists suffered from sensorineural hearing impairment<sup>21</sup>. Another study in Sao Paulo, Brazil examined hearing thresholds of dental professionals and discovered subjects were more irritated by higher frequencies noise produced by the instruments and hearing impairment found in subjects were to be originating from higher frequency levels<sup>22</sup>. A study by Szymanska et al reported that suction, salivary ejectors, turbines, amalgamators, turbines and compressors, and ultrasonic scalers caused impaired hearing<sup>23,24</sup>. Meanwhile, a study conducted in Saudi Arabia reported 21% of dental practitioners experienced hearing loss, with 37% of whom reported experience of tinnitus<sup>25,26</sup>. Another study conducted by Clive in 2004 reported 31.8% of dental practitioners had experienced tinnitus throughout their practice<sup>25,27</sup>.

In this present study, according to the DPOAE and audiogram examination results, the prevalence of hearing loss in dental practitioners was 5.8%, which shows a lower percentage compared to studies performed previously. Respectively, there are 23.2% of dental practitioners reported experiencing tinnitus in the course of their practices. Dental practitioners who were suffering from hearing loss are found in the older age group, meanwhile dental practitioners reporting tinnitus came from varying age groups. A dental practitioner's hearing condition is largely influenced by the intensity of the noise and the duration of exposure, as well as the dental practitioner's working hours and years of experience<sup>11</sup>.

Consequently, there is a risk for dental practitioners to develop noise-induced hearing loss. Therefore, to create a healthy and safe working environment, dental practitioners are encouraged to follow recommendations by existing legislations. This may be done, for example, by obeying the maximum noise level

allowed by The Occupational Safety and Health Administration of United States Department of Labor, Ministry of Health Decision No. 1405/MENKES/SK/XI/2002 on the Requirements of Office and Industry Environmental Health ("SK Menkes 1405") and Ministry of Health Decision No. 1204/MENKES/SK/X/2004 on Requirements of Hospital Environmental Health ("SK Menkes 1204") of not exceeding 80 to 85 decibels per 8 hours time-weighted average (TWA)<sup>6,7,28</sup>.

In addition to existing legislations, preventive measures should be carried out, such as performing regular assessment of noise level using noise-meter in dental practitioner's work places, maintenance of rotary equipment, and personal protection through the use of earplugs. Dental practitioners are encouraged to participate in audiometry examinations periodically for early detection and prevention of significant auditory impairments<sup>10,14</sup>.

## Conclusions

Dentists are prone to developing noise-induced hearing loss, especially dentists with longer years of working experience.

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## Declaration of Interest

The authors report no conflict of interest.

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