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Noise exposure and hearing threshold levels in call center operators

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ABSTRACT

The overall objective of the study was to analyze the risk of noise-induced hearing loss (NIHL) in call center operators. Conventional pure-tone audiometry and high-frequency audiometry were performed in 78 subjects, aged 19-44 years (mean ± SD: 28.1±6.3 years), employed up to 12 years (2.7±2.9 years) at one call center. All subjects were also inquired about their headphones usage habits, hearing-related symptoms and risk factors for NIHL. Noise exposure from communication headsets was evaluated using MIRE technique as specified by the ISO 11904-1:2002 standard. The background noise prevailing in offices was also measured according to ISO 9612:2009. A personal daily noise exposure level calculated by combining headset and non-headset work activities ranged from 68-79 dB (74.7±2.5 dB). In majority (90%) of subjects, mean hearing threshold level in the frequency range of 1–8 kHz did not exceed 20 dB HL. Nevertheless, high frequency notches were found in 15% of audiograms. Moreover, some of call center operators reported hearing-related symptoms. Further studies are needed before firm conclusions concerning the risk of NIHL in this professional group can be drawn.

INTRODUCTION

In past decades, there has been an increase in the usage of wired and wireless headsets in various occupational industry. One of the most dynamic and fastest growing branches where communication headsets are necessary to carry out by workers their basis tasks are call centers.

According to statistics, about of 1.3–4.0% of working population in European countries are employed in call centers [1]. In Poland, the estimated number of call center operators is around 24 725 [2].

The most common occupational health consequences in call center operators can be categorized as visual problems due to working with a video display units, voice disorders due to continuous talking, and auditory problems due to intense headset use and acoustic shocks [1, 3].

However, relatively little research has been published on the risk of hearing damage from using communication headsets. Such a situation has probably been in part due to the difficulties in the measurement set-up and in the evaluation of the exposure itself.

Although several standards describe methods for general noise measurements in occupational settings (e.g. ISO 9612:2009) [4], these are not directly applicable to noise assessments under communication headsets. For measurements under occluded ears, specialized methods have been specified by the International Standards Organization (ISO 11904) such as the microphone in a real ear and manikin techniques [5, 6]. Simpler methods have also been proposed in some national standards such as the use of general purpose artificial ears and ear simulators in conjunction with single number corrections to convert measurements to the equivalent diffuse field (AS/NZS 1269.1:2005, CSA Z107.56-13) [7, 8, 9].

Nevertheless, nowadays in Poland noise exposure from communication headsets, especially in call center operators, are not routinely carried out. Thus, there is no data on the scale of noise exposure and risk of noise-induced hearing loss (NIHL) in this professional group.

Therefore, the overall purpose of this study was to evaluate hearing status of call center operators in relation to their noise exposure.

MATERIALS AND METHOD

A study was carried out in call center operators, including questionnaire surveys, measurements of background noise and noise from headphones, and hearing tests.

The study group comprised 78 workers employed in one call center. They were recruited by advertisement and received financial compensation for their participation in the study. The study design and methods were approved by the Bioethical Commission of the Nofer Institute of Occupational Medicine, Lodz, Poland.

Questionnaire surveys

All participants filled in a questionnaire developed to enable identification of occupational and non-occupational risk factors of NIHL and self-assessment of hearing status.

The questionnaire consisted of items on: a) age and gender, b) education and/or profession, c) work history, including time of employment/exposure to noise and/or usage of headsets at current and previous workplaces, d) data concerning current job (details of work pattern and equipment used, preferred volume control setting, type of call typically handled, etc.), e) medical history (past middle-ear diseases, and ear surgery, hereditary disorders, cholesterol levels, arterial hypertension, head trauma, etc.), f) physical features (body weight, height, skin pigmentation), g) lifestyle (smoking, noisy hobbies, using portable media players, attending disco/bars, rock concerts etc.), and h) hearing-related symptoms such as hearing impairment, difficulties in hearing or understanding whisper, normal speech and speech in noisy environment, as well as presence of tinnitus and hyperacusis.

In addition, subjects' hearing ability was assessed using a (modified) Amsterdam Inventory for Auditory Disability and Handicap ((m)AIADH) [10]. This questionnaire consists of 30 questions and comprises 2 control questions not included in the assessment. The questions are divided into five parts (sub-scales) assessing separately: a) the ability of discrimination of sounds (subscale I), b) auditory localization (subscale II), c) understanding speech in noise (subscale III), d) intelligibility in quiet (subscale IV), and e) detection of sounds (subscale V).

The respondents reported how often they were able to hear effectively in the situations specified above. The four answer categories were as follows: almost never, occasionally, frequently, and al-most always. Responses to each question were coded on a scale from 0 to 3; the higher the score, the smaller the perceived hearing difficulties. The total score per subject was obtained by adding the scores for 28 questions. Maximum total score of the questionnaire was 84. Additionally, the answers for each subscale were summed up (maximum score for subscale I was 24, while for the other scales the total was 15 each) [10].

Noise exposure evaluations

To assess the noise exposure of call center operators noise levels generated by the headsets and background noise levels were measured and information on typical working pattern were also collected.

The background noise levels were measured using integrating-averaging sound level meter and personal sound exposure meters, i.e. the SVANTEK (Poland) sound analyzer type SVAN 958 and the Brüel & Kjær (Denmark) personal dosimeters type 4443. The measuring instruments were placed consecutively at different locations in the call center to give a representative sample of typical background noise levels. The following noise parameters were determined according to PN-N-01307:1994 [11] and ISO 9612:2009 (PN-EN ISO 9612:2011) [4, 12]: a) A-weighted equivalent-continuous sound pressure level (SPL), b) maximum A-weighted SPL with S (slow) time constant, and c) peak C-weighted SPL.

Noise exposure from communication headsets (during phone calls as well as during awaiting them) was evaluated using a microphone in the real ear (MIRE) technique, as specified in ISO 11904-1:2002 (PN-EN ISO 11904-1:2008) [5, 13]. According to this standard, a miniature probe microphone, the SVANTEK type SV25S (connected to the one of two available inputs of the dual-channel acoustic dosimeter type SV102) was placed at the entrance of the ear canal of call center operators, and the aforesaid noise parameters together with sound pressure levels in 1/3-octave bands (from 20 to 10000 Hz) were determined. Simultaneously, the second channel of dosimeter (equipped with standard ½" microphone type SV25D) was used for assessment of noise exposure outside the other ear.

According to ISO 11904-1:2002 [5] results of the frequency analysis under headphone were then converted into corresponding diffused-field levels to obtain the diffuse-field related A-weighted sound pressure levels. A job-based measurement strategy according to ISO 9612:2009 was applied for exposure evaluation from both the headsets and background noise [4]. In general, 204 random samples of SPLs (lasting in total approx. 91 hours) were collected. Each single noise sample measured using MIRE technique usually lasted approx. 30 minutes.

Since subjects used single-ear headsets, noise exposure was separately assessed for ear without and with headphone. In the latter case, for each study subject, daily noise exposure level ($L_{EX,8h}$) was calculated by combining headset and non-headset work activities and taking into account declared time of the headset usage (per working day), using the following equation:

$$L_{\mathrm{EX,\,8h}} = 10 \times \log\left[\frac{1}{T_{\mathrm{o}}}\left(T_{\mathrm{H}} \times 10^{0.1 \times L_{\mathrm{H\text{-}C,\,Aeq,T}}} + T_{\mathrm{B\text{-}N}} \times 10^{0.1 \times L_{\mathrm{B\text{-}N,\,Aeq,T}}}\right)\right] \quad (1)$$

where: $L_{H\text{-}C,\,Aeq,T}$ is the energy mean of corrected (diffuse-field related) A-weighted equivalent-continuous SPLs under headset, in dB; $L_{B\text{-}N,\,Aeq,T}$ is the energy mean of A-weighted equivalent-continuous SPLs of background noise, in dB; T_H is the declared time of the headset usage per working day, in hours; $T_{B\text{-}N}$ is the effective duration of non-headset work activities, in hours; T_o is the reference duration, T_o=8 hours.

Similar calculation was made for the non-equipped ear. However, in this case instead of diffuse-field related A-weighted equivalent-continuous sound pressure level under headset, the noise level measured outside of the aforesaid ear was taken into consideration.

Hearing examinations

The standard pure-tone audiometry (PTA) and high-frequency audiometry (HFA) was performed in subjects under study. Hearing threshold levels (HTLs) for air conduction were determined using an ascending-descending technique in 5-dB steps at the frequencies from 0.25 to 16 kHz. The auditory rest before the audiological evaluations was 14 hours. In addition, transient-evoked otoacoustic emissions (TEOAE) and distortion-product otoacoustic emissions (DPOAE) were determined. However, results of the latter tests will be described elsewhere.

The audiological evaluations were performed with the VIDEOMED clinical audiometer, model AUDIO 4002 with the HOLMCO headphones for the PTA, and the HDA 200 (Sennheiser) headphones for HFA. The standard pure-tone audiometry assessed air-conduction hearing threshold levels at frequencies from 0.25 to 8 kHz, while high-frequency tone audiometry was used at frequencies 9, 10, 11.2, 12.5, 14 and 16 kHz.

Before the hearing examinations, otoscopy was performed. Hearing tests were carried out in a quiet room located in the call center where the A-weighted equivalent-continuous sound pressure level of background noise did not exceed 35 dB.

Data analysis

Audiometric hearing threshold levels in call center operators were compared to age-related reference data from highly screened non-noise-exposed populations according to ISO 7029:2017 [14].

Percentages of ears with hearing threshold levels exceeding 20 dB at any of high frequencies (3–8 kHz) and with mean hearing threshold levels exceeding 20 dB at speech frequencies (0.5, 1, 2 and 4 kHz) were also calculated. Furthermore, to identify early signs of NIHL, the prevalence of high frequency notched audiograms was analyzed. According to Cole's recommendation, a high-frequency notch was defined as a hearing threshold level at 3 and/or 4 and/or 6 kHz at least 10 dB HL greater than at 1 or 2 kHz and at 6 or 8 kHz [15].

Answers to the questionnaire and frequency of some outcomes (e.g. prevalence of hearing-related symptoms) were presented as proportions with 95% confidence intervals (95% CI). Differences in averages of noise levels obtained from MIRE technique for various volume settings were analyzed using t-test for independent data or Mann-Whitney U-test, were applicable. Likewise, t-test for dependent data or Wilcoxon singed-rank test was applied for comparison of hearing threshold levels in call center operators with reference data from non-noise-exposed populations. The STATISTICA (version 9.1. StatSoft, Inc.) software package was used for statistical analysis.

RESULTS AND DISCUSSION

Study group characteristics and questionnaire data

The study group comprised 37 females and 41 males aged 19–44 years (mean±SD: 28.1±6.3 years), employed up to 12 years in call center (mean±SD: 2.7±2.9 years), including over half (56.0%) less than 2 years. Almost all participants (98.7%) used the Plantronics single-ear headsets with microphone. Every fifth worker put the headphone alternately on both ears, while the others put it always on the same right (42.3%) or left ear (36.6%).

Nearly two-thirds of current call center operators (61.5%, 95% CI: 50.4–71.5%) were exposed to noise at the previous workplace, of which 70.6% (95% CI: 56.9–81.3%) to loud noise. Furthermore, nearly half of them declared the frequent (at least a few times per month) attending music clubs, pubs or loud music concerts (48.7%; 95% CI: 37.8–59.7%).

A somewhat lower percentage (37.5%; 95% CI: 27.2–49.1%) used personal audio players every day (or a few times a week) for at least one hour a day. Only a few of subjects (4.0%, 95% CI: 1.0–11.7%) had noisy hobby (e.g. shooting or motor sport).

Among other risk factors for NIHL (such as smoking, elevated blood pressure, diabetes, white-finger syndrome, light skin pigmentation, ototoxic antibiotic treatments and overweight) [16] the most frequent was smoking and overweight. Of study subjects, 59.0% (95% CI: 47.9–69.2%) were smokers at present or in the past, while 39.7% (95% CI:28.9–51.6%) had BMI exceeding 25.

Noise exposure evaluation

Table 1 summarizes measurement results of the background noise and noise from headsets. In particular, it presents both, uncorrected (at real-ear) and corrected (diffuse-field related) A-weighted sound pressure levels measured using MIRE technique.

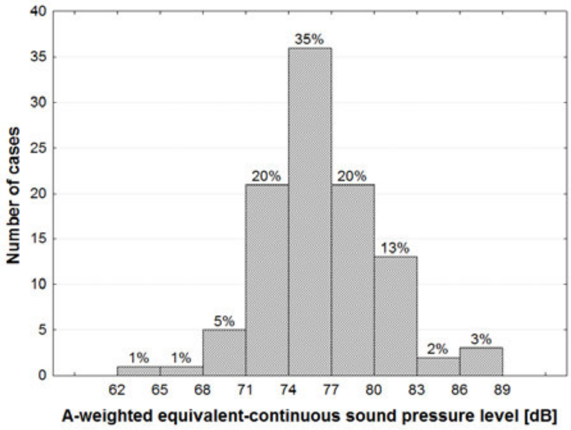
Table 1: Summary results of noise measurements at workplaces in call center

Mean ± SD [L_{eq}] **10th/ 50th /90th percentiles**	**Total**	**Headset volume setting, V**		
		V≤50%	**50%<V<100%**	**V=100%**
SPLs in the real ear with headphone (MIRE)				
Corrected (diffuse-field related) A-weighted equivalent-continuous SPL [dB]	76.1±4.1 [78.3] 72/ 76/ 81	72.7±3.7 [74.0][a,b] 69/ 73/ 77	76.0±3.0 [77.1][a] 72/ 76/ 79	77.2±3.7 [79.1][b] 73/ 76/ 82
Uncorrected A-weighted equivalent-continuous SPL [dB]	80.0±4.2 [82.2] 76/ 80/ 86	76.4±3.6 [77.6][a,b] 72/ 77/ 80	79.5±2.8 [80.5][a] 76/ 79/ 83	81.3±3.7 [83.1][b] 77/ 81/ 87
Uncorrected maximum A-weighted SPL [dB]	96.2±5.7 91/ 95/ 105	93.4±5.7 88/ 92/ 98	94.7±3.6 90/ 95/ 100	97.6±5.7 92/ 96/ 105
Uncorrected peak C-weighted SPL [dB]	112.9±5.4 108/ 111/ 120	111.4±3.1 107/ 111/ 114	112.5±5.7 108/ 110/ 122	113.8±5.9 108/ 112/ 124
SPLs outside the ear without headphone				
A-weighted equivalent-continuous SPL [dB]	67.9±3.6 [69.4] 63/ 68/ 73	66.8±3.4 [68.1] 63/ 66/ 71	67.1±2.8 [67.9] 64/ 67/ 70	68.7±3.7 [70.2] 64/ 68/ 74
Maximum A-weighted SPL [dB]	83.6±8.4 76/ 81/ 99	82.4±7.6 75/ 81/ 92	82.3±7.5 75/ 81/ 91	84.8±9.0 76/ 83/ 100
Peak C-weighted SPL [dB]	108.6±8.5 98/ 108/ 121	106.3±7.7 99/ 104/ 119	110.0±8.7 100/ 109/ 122	108.9±8.7 97/ 109/ 120
SPLs of the background noise				
A-weighted equivalent-continuous SPL [dB]	58.1±5.7 [61.5] 51/ 58/ 62			
Maximum A-weighted SPL [dB]	79.7±6.7 72/ 79/ 88			
Peak C-weighted SPL [dB]	98.1±8.0 91/ 97/ 110			

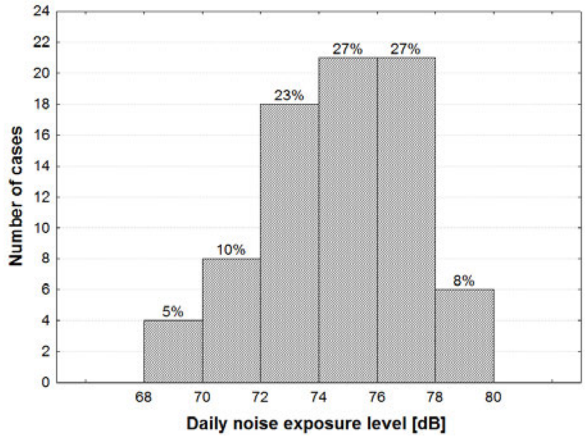
L_{eq} – energy average of N samples of measured A-weighted equivalent-continuous SPLs,

[a, b] Significant differences between SPLs with various volume settings of communication headsets ($p<0.05/3$).

Generally, headphones generated noise at A-weighted equivalent-continuous SPLs ranging from 63 to 88 dB, while background noise remained within the range of 54–74 dB. It is obvious that higher volume settings of communication headsets were associated with higher levels of produced sounds, but without significant impact on A-weighted equivalent continuous SPLs measured outside the non-occupied ear (ear without headphone) (Table 1).



a)



b)

Figure 1: Distributions of diffused-field related A-weighted equivalent-continuous SPLs produced by communication headsets (a) and daily noise exposure levels in call center operators (b)

According to responses to the questionnaire, workers spent on phone calls from 2.0 to 10.0 hours per day (5.2±2.0 hours). Furthermore, majority of them (77.6%) usually set volume of communication headset at over 50% of maximum value, including 14.9% at 100% of maximum volume. Subsequently, the personal daily noise exposure level determined on the basis of data from the MIRE technique remained within the range of 68–79 dB (mean±SD: 74.7±2.5 dB), while obtained for ear without headphone varied from 63 to 70 dB (mean±SD: 66.6±1.7 dB).

Generally, these values did not exceed neither the Polish maximum admissible intensity (MAI) values for occupational noise ($L_{EX,8h}$=85 dB) nor the lower exposure action value ($L_{EX,8h}$=80 dB) specified by the 2003/10/EC Directive [17, 18]. In addition, it worth noting that both A-weighted maximum SPLs and C-weighted peak SPLs (measured during both headset and non-headset activities) were also lower than Polish admissible levels which equal 115 and 135 dB, respectively [17].

It is worth stressing that noise levels occurring during phone calls were higher than recommended levels ($L_{Aeq,T}$=65 dB) to ensure proper working conditions (at workplaces. observational dispatcher cabins, telephone remote control rooms used in management procedures, on premises for precise works, etc.) [11]. Not unsurprisingly, therefore, that noise prevailing in call centers was assessed as annoying by part of workers. (The latter results will be described in details elsewhere).

Generally, outcomes of this study are in agreement with results of some earlier investigations [19, 20, 21, 22]. For example, recently, Gerges et al. [20] analyzed results of 166 noise level measurements in various call centers in Brazil. These measurements were also carried out according to methodology described in ISO 11904-1:2002 [5]. However contrary to us, each single measurement lasted much longer and included the whole working shift. Therefore, the measuring equipment (with mini-microphone) was installed at the beginning of the subject's working day and it was removed at the end. Diffuse-field related A-weighted sound pressure levels determined on the basis of these measurements remained within the range from 71 to 85 dB, however, with only 14.4% of cases exceeding 80 dB [20].

On the other hand, much earlier, Patel and Brougthon [22] visited 15 call centers in order to evaluate if there was a risk to hearing from working in call center. They measured noise exposure in the 150 operators and revealed that corrected noise levels generated by headsets fitted on the KEMAR manikin varied from 65 to 88 dBA, while background noise levels were between 57 and 66 dBA. Subsequently, taking into account time spending by workers on phone calls, the estimated daily noise exposure level ranged from 67 to 84 or 87 dBA in case of using for estimation mean or maximum corrected noise levels, respectively. On that basis, Patel and Broughton concluded that daily noise exposure level of call center operators is unlikely to exceed 85 dB and therefore the risk of hearing impairment is extremely low [22].

Self-assessment of hearing capability

Generally, majority of participants (87.2%, 95% CI:77.7–93.0%) assessed their hearing as good. However, some of them reported gradually progressing hearing impairment (24.4%, 95% CI: 16.2–35.1%) and complained of difficulty in hearing whisper (15.4%, 95% CI: 8.9–25.2%), problems with understanding speech in noisy environment (28.2%, 95% CI: 19.4–39.1%), hyperacusis (15.4%, 95% CI: 8.9–25.2%) and having tinnitus after work (6.4%, 95% CI: 2.5–14.6%).

Call center operators examined using the (m)AIADH obtained the mean total score 85.7±10.1% of the maximum value (84), which suggested no substantial hearing problems (Table 2). Only a small percentage of subjects (7.8%, 95% CI: 3.4–16.4%) obtained the total score under 70% of the maximum value. Relatively low scores were more frequent in subscales evaluating auditory localization (subscales II) and intelligibility in noise (subscale III), because 24.4% (95% CI: 16.2–35.1%) and 16.9% (95% CI: 10.1–27.0%) of call center scored below 70% of maximum value.

Table 2: Call center operators' self-assessment of hearing ability in the (m)AIADH scores

Score in the (m)AIADH	Mean ± SD	10^{th}/ 50^{th}/ 90^{th} percentile
Total	71.9±8.5	61/ 73/ 81
Subscale I – Distinction of sounds	21.8±2.2	19/ 22/ 24
Subscale II – Auditory localization	12.3±2.5	9/ 13/ 15
Subscale III – Intelligibility in noise	12.0±1.5	10/ 12/ 14
Subscale IV – Intelligibility in quiet	13.0±1.8	10/ 13/ 15
Subscale V – Detection of sounds	12.9±2.1	10/ 14/ 15

Results of audiometric tests

Audiometric hearing threshold levels (HTLs) determined in the 78 call center operators (156 ears) together with age-related reference data from the otologically normal population ("highly screened") in accordance with ISO 7029:2017 [14] are shown in Figure 2. As can be seen, operators' HTLs in the frequency range of 0.5–8 kHz were higher than expected for highly screened non-noise-exposed population, while in the higher frequency was close (9–11.2 kHz) or better (at 12.5 kHz) than expected.

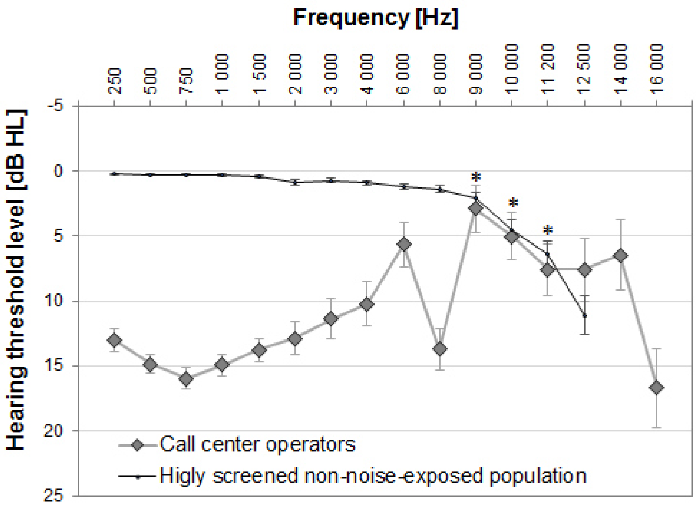


Figure 2: Hearing threshold levels determined in the 78 call center operators (156 ears) in relation to expected median values for reference (age- and gender-related) non-noise-exposed otologically normal population according to ISO 7029:2017 [14]. For majority frequencies, excluding those marked (*) significant differences were noted ($p<0.05$). Data are given as mean values with 95%CI

However, a half (50.0%, 95% CI: 39.2–60.8%) of study subjects had normal hearing, i.e. in both ears their HTLs in the frequency range 1000–8000 Hz did not exceed 20 dB HL. Furthermore, both speech-frequency hearing loss (mean threshold at 500, 1000, 2000 and 4000 Hz > 20 dB HL) and high-frequency hearing loss (mean threshold at 3000, 4000 and 6000 Hz > 20 dB HL) were observed only in a few percent (<10%) of analyzed audiograms (Table 3).

Nevertheless, high-frequency notches (at 3, 4 or 6 kHz) were observed in 15.4% of audiograms. Most of them occurred at 4 kHz. The portion of bilateral notching at any frequency was 3.8%.

Table 3: Summary results of standard pure-tone audiometry in call center operators

Pure tone audiometry	**Proportion of ears (95% CI) [%]**
Mean hearing threshold level	
at frequencies of 0.5, 1, 2 and 4 kHz > 20 dB HL	6.4 (3.4–11.6)
in frequency range 1-8 kHz > 20 dB HL	7.7 (4.4–13.1)
in frequency range 3-8 kHz > 20 dB HL	9.0 (5.4–14.6)
Hearing threshold level:	
at frequencies of 0.5, 1, 2 or 4 kHz > 20 dB HL	20.5 (14.9–27.6)
in frequency range 1-8 kHz > 20 dB HL	34.0 (27.0–41.7)
in frequency range 3-8 kHz > 20 dB HL	26.3 (20.0–33.7)
High-frequency notching	
total at 3, 4 or 6 kHz	15.4 (10.5–22.0)
right ear at 3, 4 or 6 kHz	12.8 (7.0–22.3)
left ear at 3, 4 or 6 kHz	17.9 (10.9–28.1)
bilateral notching at 3, 4 or 6 kHz	3.8 (0.9–11.3)

Such hearing test results are not surprising since, according to the ISO 1999:2013 model, a permanent shift of hearing threshold greater or equal to 25 dB HL in speech frequencies should not take place in males with healthy ears, provided the exposure to noise does not exceed 15 years for 85 dBA level and 6 years for 90 dBA level [23].

In general, the findings presented here confirm some earlier results. For example, Mazlan et al. [24] examined call center operators in Malaysia, among others, in order to analyze the prevalence of hearing loss in relation to the duration of service. Their study group comprised 136 workers, aged 18–35 years, wearing headphones and receiving calls continuously for 7 hours. Likewise in our study, the majority (47%) of Malaysian subjects have been working between 2–3 years and the longest duration of service was 8 years in 3 subjects. The average noise level from headphones was found to be 58 dB.

Hearing test results revealed that 78.8% of examined call center operators had normal hearing in both ears and only 21.2% of them were found to have hearing impairment in either one or both ears. That prevalence was comparable to prevalence of hearing loss in normal subjects used as controls in other Malaysian studies. Furthermore, there was no association between hearing loss and duration of employment. Thus, it was concluded that there was no evidence of noise induced hearing loss among call center operators with prolonged exposure to noise from headphones and the duration of service [24].

On the other hand, other conclusions were formulated by EL-Bahir et al. [25], who analyzed the prevalence of sensory-neural hearing loss (SNHL) among older 58 telephone operators, including those using headphone (age: 46.3±8.1 years, time of employment: 20.6±9.1 years) in comparison with 30 administration staff workers (age: 47.2±8.1 years, time of employment: 21.7±8.2 years). They found that telephone operators had significantly higher prevalence of acoustic shock symptoms and decreased hearing sensitivity compared to the controls. In particular, they noted 44.8% cases of SNHL among the telephone operators versus no cases among the controls; all of them were bilateral in distribution and concluded that among other studied factors, only headset use (OR= 5.2, 95%CI = 1.7–16.1) and age (OR= 1.1, 95%CI = 1.0–1.2) were significant risk factors for developing SNHL among telephone operators [25].

CONCLUSIONS

Noise measurements showed that the mean daily personal noise exposure level of call center operators is unlikely to exceed the lower exposure action value ($L_{EX,8h}$=80 dB) as specified in the 2013/10/EC noise directive [17].

Majority of call center operators had normal hearing. But despite the young age and short time of usage of communication headsets, a part of them complained of some hearing-related symptoms and had high-frequency notched audiograms typical for noise-induced hearing loss.

Further studies are needed, comprising a greater number of subjects, as well as longer time of employment, before firm conclusions concerning the risk of NIHL in the call center operators can be drawn. Especially as, alarming information coming from recently published paper presenting a case report of noise-induced hearing loss in 30-years old call center operator [26].

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