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NOISE CONTROL FOR A BETTER ENVIRONMENT

Self-assessment of Hearing Ability among Workers Using Communication Headsets

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ABSTRACT

The objective of the study was to analyse the self-assessment of hearing ability in employees using communication headsets. The study group comprised 104 workers (aged: 32.1±7.0 years), including military aviation personnel (n = 12), transcribers (n = 18) and call centre operators (n = 74).

All participants were asked to fill in a questionnaire developed to enable identification of occupational and non-occupational risk factors of noise-induced hearing loss (NIHL) and self-assessment of hearing status. In addition, their hearing ability was assessed using a (modified) Amsterdam Inventory for Auditory Disability and Handicap ((m)AIADH).

Almost all study subjects assessed their hearing as a good (97.1%). Nevertheless, some of them (21.0%) reported gradually progressing hearing deterioration and complained of problems with understanding speech in noisy environment (27.9%), hearing whisper (17.3%) and experienced post-work temporary hearing symptoms (16.2-25.7%) as well. Generally, hearing-related problem were most often reported by transcribers.

Study subjects examined using the (m)AIADH obtained the mean total score (72.7±9,0) at the level of 86.4±10.7% of the maximum value (84), which was close to normative value and suggested no hearing problems. Furthermore, mean scores obtained in subgroups of military aviation employees, transcribers and call centre operators did not differ significantly.

Keywords: Noise, hearing loss, communication headsets

1. INTRODUCTION

Noise in the workplace is responsible for 16-24% of adult-onset hearing loss worldwide[1]. In the European Union, 7.2% of workers report work-related hearing problems[2]. Among various factors, the increased use of wired and wireless

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communication headsets is raising concerns regarding exposure to potentially hazardous noise levels[3]. Communication headsets are commonly found in workplace settings such as call centers, retail stores, fast food outlets, airport ground and control tower operations, industrial and construction sites, and military sites [4,5].

In the last decades, there has been a significant increase in the use of headset communication sets by employees in various wire and wireless industries. Such devices are used, among other, in the centers of telemarketing services (call centers), ground handling of airports and air traffic control, in the service of transcribing (recording from hearing), media, transport, construction, in military services, and in industry and catering (quick service bars)[6]. In turn, long-term exposure through headphones to noise (sounds) of over 85 dB is associated with the risk of hearing loss[7].

The objective of the study was to analyse the self-assessment of hearing ability in employees using communication headsets.

2. METHODOLOGY

Questionnaire surveys, being a part of large study aimed at the assessment of risk of NIHL among communication headset users, were carried out in the military aviation base, call centre of one of the mobile telephony networks, 2 (district and county) courts and a private company employing transcribers, The study group comprised 104 people (58 women and 46 men), including 12 military aviation employees (5 pilots and crew members, 4 aircraft maintenance employees and 3 air traffic controllers), 18 transcribers and 74 call centre operators using headphones or communication headsets .

The study design and methods were approved by the Bioethical Commission of the Nofer Institute of Occupational Medicine, Lodz, Poland (Resolution No. 13/2016 of November 18, 2016 and Resolution No. 17/2018 of November 20, 2018).

2.1 Questionnaire Survey

The aim of the questionnaire research was self-evaluation of the employees' hearing status and identification of occupational and non-occupational risk factors for hearing loss. A questionnaire specially prepared for this purpose containing, inter alia, questions about: a) the course of work, education, current position, b) the specifics of work with headset communication sets, including their type, manner and time of use, scope and type of activities performed, c) self-assessment of the state of hearing, d) diseases and e) lifestyle (e.g. smoking, noisy hobbies, etc.).

In addition, all subjects completed a (modified) Amsterdam Inventory for Auditory Disability and Handicap ((m)AIADH). This questionnaire consists of 30 questions, including 2 control questions not included in the assessment. The questions are divided into five parts (subscales) assessing separately: a) the ability of discrimination (differentiation) 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 almost 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 subscales the total was 15). [8,9]

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2.2 Statistical Analysis

Answers to the questionnaire and frequency of some outcomes were presented as proportions in all study subjects as well as individual subgroups of employees. Differences between subgroups of employees in the frequency (percent) of responses or results achieved were assessed using the Fisher's exact test. In turn, the average age, work experience, daily noise exposure level (and other variables) in subgroups of employees were compared in pairs using T Tukey's test (HSD) for unequal group sizes.

Statistical analysis was carried out with the assumed significance level of $\alpha = 0.05$, except for comparisons of response rates or mean pairs in different subgroups of employees simultaneously, when the value of α divided by the number of possible comparisons N ($\alpha = 0.05 / N$) was assumed as the statistical significance. STATISTICA 9.1 (manufactured by StatSoft Inc., USA) was used for the calculations.

3. RESULTS

3.1 The Study Group

The research covered 104 people (58 women and 46 men), aged 18-59, including 12 military aviation employees (5 pilots and crew members, 4 aircraft maintenance personnel and 3 air traffic controllers), 18 transcribers and 74 call centers operators that use headsets or headset communication sets every day for a period of 0.3 to 28 years (Table 1). Almost all of the respondents wore headphones (99.0%), of which more than half (61.5%) - unilateral. Among the operators of call centers operators, the only users of monaural headphones, were those who set them only for one preferred ear (83.8%).

Individual subgroups of work positions, i.e. military aviation employees, transcribers and call center operators, did not differ in terms of age, seniority and period of using headset communication sets. Only call center operators used longer (on a weekly basis) headset communication sets compared to other subgroups of employees. In turn, pilots and technicians used these devices at lower gain settings than transcribers and telelemarketers (Table 1).

Table 1. Characteristics of the study group - workers using communication headsets.

Characteristic	Workers						
	total	pilots and crew members	service of aircrafts	air traffic controllers	millitary aviation employees*	transcribers	call center operators
	(N=104)	(N=5)	(N=4)	(N=3)	(N=9)	(N=18)	(N=74)
Males [%]	55.8	100.0	100.0	100.0	100.0	61.1	47.3
Age [years] (M±SD)	32.1±7.0	37.3±8.7	40.8±2.3	31.3±2.8	38.6±6.9	32.4±6.4	31.3±7.0
Education							
higher [%]	53.8	80.0	50.0	66.7	66.7	77.8	43.2
high school [%]	44.2	20.0	50.0	33.3	33.3	16.7	55.4
other [%]	2.9	0.0	0.0	0.0	0.0	5.6	2.7
Tenure [years] (M±SD)	8,6±6.1	3.8±3.4	8±5.9	3.1±4.3	5.9±5.0	3.1±2.4	7.4±4.8
Type of employment							
full-time job [%]	90.0	100.0	100.0	100.0	100.0	55.6	92.7
part-time job [%]	2.0	0.0	0.0	0.0	0.0	0.0	2.8
other [%]	8.0	0.0	0.0	0.0	0.0	44.4	0.0
Type of CH							
earphones [%]	2.9	20.0	0.0	0.0	11.1	11.1	0.0
binaural headphones [%]	37.5	80.0	100.0	100.0	88.9[b]	77.8 [a]	18.9 [a b]
monaural headphones [%]	61.5	0.0	0.0	0.0	0.0	11.1 [a]	83.4 [a]
Usage of CH							
duration [years] (M±SD)	5.0±4.7	13.0±11.8	14.3±6.1	3.1±4.3	13.6±9.2	2.8±2.0	4.5±3.1
time per day [h] (M±SD)	6.2±2.3	3.0±1.0	2.1±0.9	1.3±0.4	2.5±1.0 **[b c]**	3.2±1.8 **[a c]**	7.4±0.9 **[a b]**
time per week [h] (M±SD)	29.9±12.7	8.0±5.4	12.0±3.5	9.2±9.4	9.5±5.0 **[b c]**	18.9±11.4 **[a c]**	36.4±6.6 **[a b]**
volume settings [%] (M±SD)	71.9±23.5	42.4±29.2	53.8±25.3	50.0±0.0	47.4±26.5**[b c]**	76.1±17.**4** **[c]**	75.2±22.8**[b]**

[*] Excluding air traffic controllers.

[a. b. c] differences between pairs of subgroups of workers ($p<0.05/3$).

CS – communication headset, M - mean, SD - standard deviation

About 50% of the surveyed people were exposed to noise in the previous workplace, of which 41% to loud or very loud noise. What a every fourth person declared frequent (at least a few times a month) spending free time in pubs, music clubs or music concerts. A much higher percentage (42%) of surveyed employees admitted that they often conducted telephone calls outside the workplace, and 59% from a dozen to several dozen minutes a day. Half of the people reported that they listened to music for at least an hour a day using mp3 players. However, only a few (7%) of the people declared having a noisy hobby.

Among other, additional risk factors for hearing loss such as smoking, hypertension, diabetes, Reynoud's syndrome, light skin complex, ototoxic antibiotics, smoking was the most common. Over 2/3 of employees surveyed smoked or smoked cigarettes in the past, while additional risks occurred in most individual people.

The analyzed subgroups of aviation employees, transcribers and call centers operators did not differ in terms of frequency of additional risk factors for hearing loss.

3.2 Self-assessment of the hearing status

Almost all surveyed employees rated their hearing as good (97.1%). Nevertheless, 21.0% of the respondents complained of hearing deterioration, which in most cases increased gradually (80.0%) and affected both ears (60.0%). Moreover, some of them complained of problems with understanding speech in noisy environments (27.9%) and with hearing a whisper (17.3%) (Table 2).

Most likely, hearing problems occurred among transcribers. There were no statistically significant differences in the self-assessment of hearing after work in the subgroups of aviation workers, transcribers and telephone center operators ($p > 0.05 / 3$) (Table 2).

Some of the surveyed employees observed the occurrence of temporary deterioration of hearing (18.6%), tinnitus (16.5%) and fullness (plugging) of ears (31.0%) after working with headphones. Symptoms of this type usually occurred sporadically.

Table 2. Prevalence of self-reported hearing-related symptoms in the study group using communication headsets.

Self-assessment	Workers [%]						
	total	pilots and crew members	technical service of aircrafts	air traffic controllers	millitary aviation employees*	transcribers	call center operators
Good hearing	97.1	100.0	100.0	100.0	100.0	83.3	98.6
Hearing impairment	21,0	20.0	25.0	0.0	22.2	38.9	17.1
right ear	20.0	0.0	0.0	-	0.0	0.0	36.4
left ear	20.0	0.0	100.0	-	50.0	0.0	27.3
both ears	20.0	100.0	0.0	-	50.0	100.0	36.4
sudden	15.0	0.0	0.0	-	0.0	14.3	18.2
increasing gradually	80.0	100.0	100.0	-	100.0	71.4	81.8
increasing in different manner	10.0	0.0	0.0	-	0.0	14.3	9.1
Difficulties with understanding							
whisper	17.3	0.0	25.0	0.0	11.1	44.4	12.2
normal speech	1.9	0.0	0.0	0.0	0.0	5.6	1.4
speech in noisy environment	27.9	0.0	25.0	33.3	11.1	44.4	25.7
trebles	1.0	0.0	0.0	0.0	0.0	0.0	1.4
Need for higher radio and TV volume settings	9.9	20.0	25.0	0.0	22.2	27.8	4.2
tinnitus	11.8	0.0	25.0	0.0	11.1	11.1	12.5
Post-work temporary hearing impairment	18.6	0.0	0.0	0.0	0.0	16.7	19.4
Post-work tinnitus	16.5	20.0	0.0	0.0	11.1	22.2	19.2
Post-work sensation of blocking the ear / ears	31.0	0.0	25.0	0.0	11.1	22.2	36.6

* Excluding air traffic controllers, a,b,c Significant differences between transcribers and call center operators ($p < 0.05/3$)
no statistically significant differences between pairs of subgroups of workers ($p < 0.05/3$).

Employees examined using (m)AIADH obtained an average total score (72.6 ± 9.0) at 86.4 ± 10.7% of the maximum value, thus close to normative value (Table 3). Good (close to the maximum value) results were obtained also for almost all parts of the questionnaire (scales I, II, IV and V). The lowest result (mean ± SD: 78.9 ± 12.6% of the maximum value) was recorded in the case of the III scale, assessing speech understanding in noise. There were no statistically significant differences between the mean scores obtained in subgroups of aviation employees, transcribers and call centers operators ($p > 0.05 / 3$) (Table 3).

The total score below 70% of the maximum value was obtained only by 9% of call center operators. The highest percentage of relatively low scores (below 70%) was recorded in 12.5% of transcribers and 8.5% of aviation employees, respectively in the case of the parts assessing sound detection (V scale) and understanding speech in noise (scale III).

Table 3. Self-assessment of hearing ability in study group of workers in term of the AIAHD scores.

Score	Workers						
	total	pilots and crew members	technical service of aircrafts	air traffic controllers	millitary aviation employees*	transcribers	call center operators
	M ± SD percentyl 10. / 50. / 90. 10th / 50th/ 90th percentile						
Total	72.6±9.0 59 / 75/ 81	74.8±7.7 65 / 80/ 82	76.0±6.7 66 / 80/ 81	73.3±9.5 65 / 73/ 82	69.8±8.8 54 / 70.5/ 81	74.8±7.7 65 / 80/ 82	73.6±9.3 58 / 77/ 81
Scale I (distinction of sounds)	21.9±2.2 24 / 22/ 24	23.4±0.7 22 / 24/ 24	23.4±0.9 22 / 24/ 24	23.5±0.6 23 / 23.5/ 24	21.4±2.3 19 / 21.5/ 24	23.4±0.7 22 / 24/ 24	21.8±2.3 19 / 22/ 24
Scale II (auditory localization)	12.70±2.3 15 / 13/ 15	13.2±1.9 10 / 14/ 15	13.4±2.1 10 / 14/ 15	13.0±1.8 11 / 13/ 15	12.1±2.1 9 / 12/ 15	13.2±1.9 10 / 14/ 15	13.0±2.5 9 / 14/ 15
Scale III (intelligibility in noise)	17.8±1.9 13 / 12/ 14	11.1±2.4 6 / 12/ 13	11.8±1.3 10 / 12/ 13	10.3±3.4 6 / 11/ 13	11.4±2.0 9 / 11/ 15	11.1±2.4 6 / 12/ 13	12.2±1.6 10 / 12/ 15
Scale IV (intelligibility in quiet)	13.2±1.9 15 / 14/ 15	13.3±1.7 11 / 14/ 15	13.4±1.5 11 / 14/ 15	13.3±2.1 11 / 13.5/ 15	13.1±1.8 10 / 13.5/ 15	13.3±1.7 11 / 14/ 15	13.2±2.1 10 / 14/ 15
Scale V (detection of sounds)	12.9±2.4 15 / 14/ 15	13.7±1.9 10 / 15/ 15	14.0±1.7 11 / 15/ 15	13.3±2.4 10 / 14/ 15	11.8±2.4 8 / 12/ 15	13.7±1.9 10 / 15/ 15	13.3±2.4 10 / 14/ 15

[*] Excluding air traffic controllers.
no statistically differences between pairs of subgroups of workers ($p<0.05/3$)

4. DISCUSSION

The aim of the work was self-assessment of the state of hearing among employees of various industries using communication headsets. These tests were limited to pilots and members of military aircraft crews, aircraft maintenance personnel and controllers of military air traffic as well as transcribers and call centers operators.

The surveyed employees used communication headsets on average from 2 to 8 hours a day (range: 10th-90th percentile). In addition, the results of questionnaire surveys indicate that some employees have additional risk factors for hearing loss. About 42% of the respondents smoked in the past or currently smoke cigarettes, and approx. 27% of the respondents declared frequent listening through headphones. It is obvious that in the case of the abovementioned factors, the risk of hearing damage is higher than that resulting only from exposure to noise generated by communication headsets.

In the study of the Amsterdam questionnaire, users of headset communication sets obtained an average total result close to the norm (87.8 ± 10.9% of the maximum value) (Table 3). A similar situation took place in the case of particular parts of the questionnaire, although the lowest average result was recorded in the case of the III scale, assessing speech understanding in noise (78.9 ± 12.6% of the maximum value). It is not surprising that for this scale the highest percentage of relatively low scores (<70% of the maximum value) was observed in 8.5% of the military personnel exposed to the highest noise levels.

It is noteworthy that in the study, the AIADH questionnaire totaled less than 70% of the maximum value obtained only by 7% of call center operators. No wonder that almost all surveyed employees rated their hearing as good. Some of them, however, noticed a hearing impairment (16.2%) and reported problems with speech understanding in a noisy environment (28.4%) and hearing a whisper (16.2%), and also observed the occurrence of temporary deterioration after working in headphones: (dulling) hearing (17.6%), tinnitus (16.2%) and feelings of fullness (blockage) of the ears (25.7%).

Summing up, the results of the conducted self-assessment of the state of hearing among military aviation employees, transcribers and call center operators indicate the need to include headsets with the hearing protection program adapted to the specifics of their work.

It is also reasonable to continue research with particular emphasis on employees in other industries before conclusions regarding the risk of hearing damage are formulated in connection with the use of communication headsets.

5. CONCLUSIONS

- The results of conducted self-assessment of the state of hearing among users of communication headsets indicate the necessity to continue research extended to measure the sound level during occupational exposure to noise in order to assess the risk of hearing impairment and carry out hearing tests.
- The results of the conducted self-assessment of the state of hearing among military aviation employees, transcribers and call center operators indicate the necessity of supporting the users of headset communication sets with the hearing protection program, adapted to the specifics of their work.

- It is also reasonable to continue research with particular emphasis on employees in other industries before conclusions regarding the risk of hearing damage are formulated in connection with the use of communication headsets.
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