

Hearing impairment among workers occupationally exposed to excessive levels of noise

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Abstract: Pure tone audiometry screening and ear examinations were conducted among 138 males working as machine and equipment operators occupationally exposed to intermittent noise of 85 to 105 dBA. Hearing loss up to 30 dB (preserved socially adequate hearing) was found in 25 workers. The hearing impairment was confirmed by distortion products of otoacoustic emissions measurements. A sharp increase in the frequency of cases can be found among the workers with service length over 10 years. While the frequency of the cases among workers with service length below 10 years is 5.45%, it is 26.5% among the subjects with service length over 10 years, with a gradual increase as a result of the increase in exposure duration. A positive correlation ($p < 0.05$) was found between the frequency of hearing impairment among the workers and the years of exposure to excessive noise levels. Some measures for preventing occupational noise-induced hearing loss were suggested.

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1 Introduction

Occupational noise is a working environment factor with a negative effect on both health and working capacity. According to ISO 1999 - 1990 the equivalent (for 8 hours) noise level of 85 dBA or less will not damage the hearing in 95% of the exposed subjects for a period of over 30 years [10]. Despite the technological improvements and innovations aimed at decreasing occupational noise exposure, there still exist many working places with noise intensity exceeding 85 dBA. Approximately 35 million workers in different

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industries in Europe are exposed to levels of noise above the standard [8].

The prime effect of continuous exposure to excessively high occupational noise is the development of progressive sensoryneural hearing loss, manifested in different degrees. The first to be affected are the high frequencies (4000–6000 Hz) and to a minor degree the neighboring low frequencies. The advancement of the process also leads to a hearing loss in the human voice frequencies (between 500 and 4000 Hz), which limits the working capacity and social adequacy of the workers [1, 5, 10]. The manifestation, progress and degree of occupational hearing impairment depend on several factors: nature and intensity of the noise, duration of exposure, age, individual sensitivity, presence of auditory diseases, as well as concomitant harmful occupational factors such as vibrations, hyperbaric pressure, and ototoxic agents.

The current research is aimed at defining the frequency of hearing impairment among people working in conditions of excessive noise depending on the duration of exposure (service length) and age.

2 Statistical methods and Experimental Procedures

138 males working as machine and equipment operators who had been exposed to intermittent noise of intensity between 85 and 105 dBA were examined. The subjects were divided by duration of service length in excessive noise environments and by age. Five groups were set depending on the duration of exposure: less than 5 years (19 workers); 6 – 10 years (36 workers); 11 – 15 years (45 workers); 16 – 20 years (14 workers); more than 20 years (24 workers). The defined age groups are as follows: 20 – 29 years (9 workers); 30 – 39 years (36 workers); 40 – 49 years (60 workers); 50 – 59 years (33 workers). Examination by an otorhynolaryngologist and pure tone audiometry screening were conducted. In 84% of the subjects with audiometry registered hearing impairment, distortion products of otoacoustic emissions (DPOAE) were examined.

For the audiometries a screening audiometer by the company MAICO - ST 20 for air and bone conductance was used. The DPOAE examination was done using a screening MAICO ERO•SCANTM SCREENER with the following automated protocol: the cochlea was stimulated with two signals of intensity $P_1 = 65$ dB SPL and $P_2 = 55$ dB SPL in the frequency spectrum of 2000 – 4000 Hz. Consecutive scanning for 2000, 3000 and 4000 Hz was conducted, normal response (PASS) being the correlation between signal and noise more than 5dB for every examined frequency. Han *et al.* [2] analyzed the correspondence between DPOAE and conventional pure tone audiometry and defined the importance of DPOAE for early diagnosis of hearing impairment resulting from noise impact. DPOAE may be useful in the identification of physiopathological hearing alterations caused by exposure to occupational noise, even in individuals where tonal audiometric responses were within acceptable limits [4]. The use of this objective method for examination of progressive hearing impairment has been discussed by other authors [3].

The linearly correlated dependence between frequency of cases with hearing impairment and length of exposure in noisy environments was determined, as well as the depen-

dence between the frequency of cases and age of the workers. The statistical programme used was Statistica 6.0 for Windows by StatSoft Inc.

3 Results

The results of clinical examination of the auditory system and the audiometric investigations conducted among 138 people working in conditions of excessive noise showed hearing impairment in 25 persons (18.12%). 21 of them underwent a DPOAE examination according to the protocol described above. Sensory hearing impairment was confirmed in all of the examined subjects. There were also two cases found with disease of the external ear and three cases with middle ear inflammation, in one of which hearing impairment was registered. Age-dependent hearing impairment (presbicusis) was diagnosed in two workers. The cause of the hearing impairment among the remaining 23 workers is most likely the long-term exposure to excessive noise levels in the working environment. In two of the cases there was monoauricular damage.

Figure 1 shows the relative portion of the workers with hearing impairment, divided into five groups depending on the length of exposure. A sharp increase in the frequency of cases can be found among the workers with service length over 10 years. While the frequency of the cases among workers with service length below 10 years is 5.45%, it is 26.5% among the subjects with service length over 10 years, with a gradual increase as a result of the increase in exposure duration. The highest portion of the cases with hearing impairment occurs among the workers with service length over 20 years - 45.83%. These results concur with those reported by other authors [6, 8, 9].

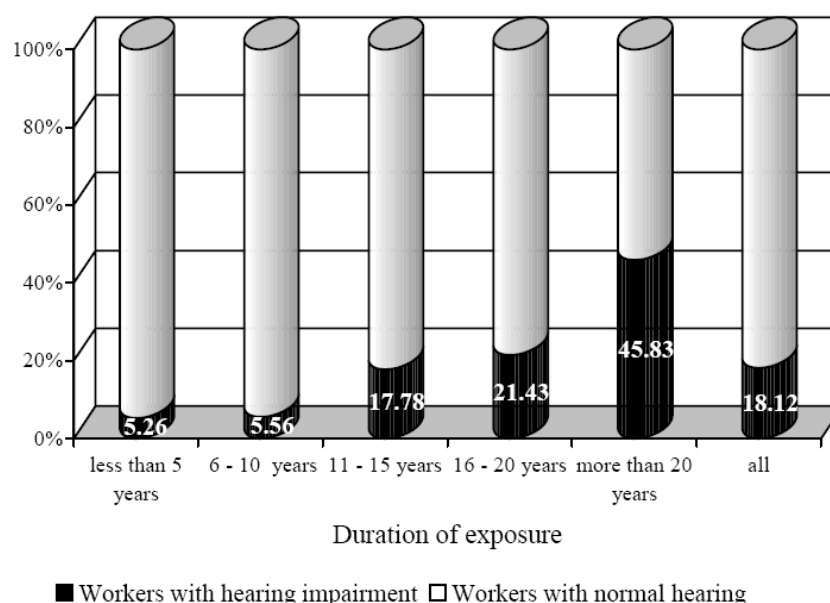


Fig. 1 Rates of cases of hearing impairment in workers exposed to excessive noise depending on the duration of exposure.

A very high positive linear correlation ($r = 0.93$, $p < 0.05$) is found between the service length in excessive noise environments and the frequency of cases with hearing impairment.

With the increasing age of the workers, there is a proportional rise of the portion of subjects with hearing impairment ($r = 0.97$, $p < 0.05$) - Figure 2. Among workers aged below 30 years, no hearing damage was found. In the 50 – 60 age group more than one third of the subjects had hearing impairment - 36.36%.

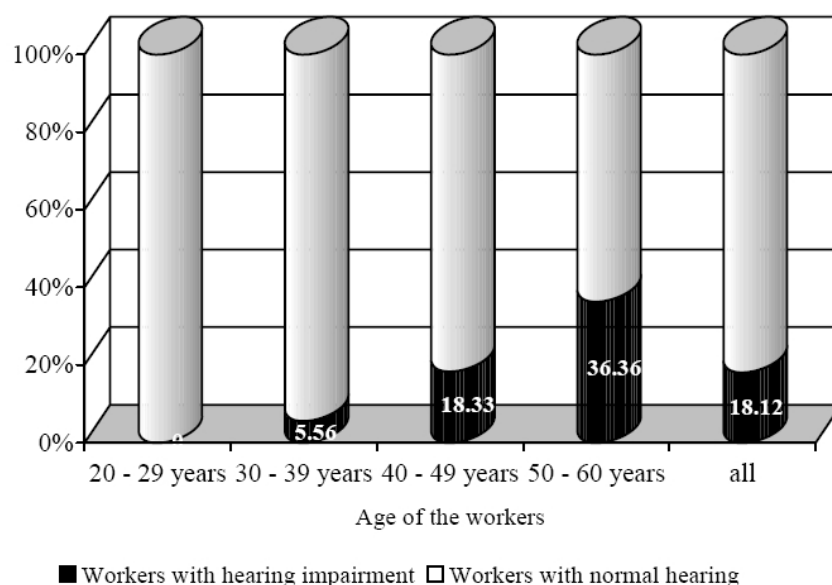


Fig. 2 Rates of cases of hearing impairment in workers exposed to excessive noise depending on their age.

4 Discussion

In a general study of workers in different industries with registered hearing impairment for the period from 1992 to 2002 in Poland, Sulkowski *et al.* [8] report that the most affected group are the people aged 50 to 59 and exposed to excessive noise for more than 20 years. These results are completely identical to ours.

According to the D. Dimov scale, four degrees of hearing impairment are defined, based on the arithmetic mean of the registered hearing impairment (in dB) at the four main frequencies from the field of social hearing - 500, 1000, 2000 and 4000 Hz [10]. The hearing impairment found in all 25 subjects is defined as First degree (less than 30 dB) - socially adequate hearing. All the workers have unaffected working capacity and are subject to regular clinical examinations, hearing tests, appropriate medical treatment and prophylaxis. Using personal protective devices against noise impact at work is obligatory.

There is a special WHO programme known as the Prevention of Deafness and Hearing Impairment (PDHI). A meeting of the participants in the PDHI programme dedicated to hearing damage caused by excessive noise took place in Geneva in October 1997.

The conclusion of the participants was that exposure to excessive noise is a main cause of hearing damage worldwide and it can be successfully averted. Occupational hearing loss is the most common occupational disease worldwide. It is recommended that each country should introduce a national programme for prevention of hearing damage caused by excessive noise as part of the public health preservation programmes. It is necessary that appropriate legal acts and measures for reducing the sources of noise and effective prophylaxis are adopted [7]. Currently the foundations of modern-day legislation in this area are being laid in Bulgaria.

In conclusion the excessive noise levels are an occupational risk factor that can still be found at many working places in different industries. The increased time of exposure also increases the risk of hearing damage. The current study shows the positive correlation between the frequency of hearing damage and the length of service in conditions of excessive noise.

As prevention against hearing damage, the following are necessary:

- Strict observation of the existing standards for protection of workers against occupational noise exposure.
- Technological, architectural and arrangement improvements for reducing the noise levels at workplaces and for decreasing the number of workers exposed to them.
- Systematic monitoring and control of the noise levels in the working environment.
- Use of effective personal protective devices (suitable antiphons).
- Education of the workers about the risks of occupational exposure to excessive noise.
- Preliminary and recurring examinations of the workers by an otorhynolaryngologist (audiometry included) aimed against admission of subjects with higher vulnerability to noisy working environment, early detection of hearing impairment, and timely prophylaxis and treatment to decrease the risk of occupational hearing damage.

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