# Hearing function in workers engaged in industry: Georgian material

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## INTRODUCTION

By the prevalence rate noise-induced hearing loss keeps the second place in the list of cochlear pathologies, the first position being occupied by the age-related impairments (Cruickchanks et al. 2010; Helfer et al. 2010). Disturbing effects of high-intensity sounds on health, in general, on inner ear, in particular, have been investigated for a long time. The influence of noise on hearing function in industrial workers was in particular the topic of some special debates (Eleftherioou 2002; Meyer et al. 2002). Noise-induced hearing impairment seems to be the major avoidable auditory disorder (Dobie 1995). Systematic audiometrcal inspection appears thus essential for detection of incipient stages of the pathology. If revealing any dysfunction hints, protective technical procedures have to apply or to reinforce the existing items while specific medical manoeuvres have to accomplish aiming the rehabilitation of happened distortion and/or prevention of its further progressing. Background and regular dynamic audiometric testing should be carried out particularly on individuals being regularly engaged in noisy job affairs (McBride 2004).

The aim of the present study was the tracing of the consequences of systematic industrial noise exposures on hearing function in workers involved in construction of transcaucasian oil-pipe line in Georgia. The distinct purpose of performed investigations was the evaluation of hearing thresholds in industry workers within the wide range, including 10 kHz and 12 kHz frequencies, that being dissimilar from the routine audiometrical examinations where the high-frequency border is conventionally limited by 8 kHz. The referent control probes were in parallel fulfilled on co-workers of neighbor humanitarian organizations.

## METHODS

The test group covered 157 workers engaged in transcaucasian oil-pipe line manufacturing jobs. The control group was represented by 115 employees of non-industrial, mostly of educational local institutions. Either the test and control sample was divided into five consecutive decade age subgroups: 20-29, 30-39, 40-49, 50-59, and 60-69 years. The transcaucasian oil-pipe line is relatively a new development. The job noise influences in most test subjects was thus rather limited in time and generally covered months up to the pair of years. In separate individuals only, the service term approximated to 3, 4, 5 years.

Individuals of both test and control groups have been inspected at first otoscopically and tympanometrically and all were proved to own normal outer- and middle-ears. None of the subjects of the control group reported job-related or any other type of high-intensity sound-exposure incident in the past while all individuals of both groups rejected potentially confounding any other hearing disturbing affair: application of ototoxic drugs, hormonal disorders, bilirubinaemia, etc. Hearing acuity has been assessed via the tonal audiometer (ITERA, Madsen) in a sound-proof room. Air- and bone-

conduction thresholds were estimated in both ears consecutively within the extended frequency band, 0.125-12 kHz. The audiometric data in individuals of different age subgroups of test and control samples were compared statistically via the Student's *t* test.

## RESULTS

At lowest frequencies, 0.125-0.5 kHz, hearing thresholds in test and control groups were identical proving no low-frequency perception alterations under high-intensity noisy environment influences. The thresholds appeared rather similar at 1-3-kHz frequencies also although a slight while dubious trend to the higher hearing thresholds in the test vs. control group was likely traced with respect to. At higher frequencies, 4, 6, 8, 10, and 12 kHz, on the other hand, the hearing thresholds in the worker group noticeably and systematically exceeded those in the control group. The 4-12-kHz frequency band appeared thus particularly sensitive to high-intensity industrial noise effects. To focus the attention of readers just to the reliable group dissimilarities, in both offered illustrations (Figures 1 and 2) the results of 0.125-0.5-kHz frequencies are omitted totally while those of questionable 1-3-kHz and indisputable 4-12-kHz frequencies are represented only.

The hearing threshold differences between the test and control groups by the general pattern appeared rather similar in three initial age subgroups, 20-29, 30-39, and 40-49 years (Figures 1 and 2). In all of them the differences systematically accentuated from the lower to the higher frequencies. The greatest gaps between were correspondingly seen at utmost components of the applied frequency band, 12 and 10 kHz. At 12-kHz frequency, in particular, the test vs. control threshold differences in the age subgroups of 20-29, 30-39, and 40-49 years amounted on the mean to 17.9, 10.7, and 10.6 dB, respectively, while at 10-kHz frequency to 7.3, 9.1, 13.6 dB, respectively. At 12-kHz frequency the group differences were statistically significant in all three considered age subgroups ($p<0.01$, $<0.01$, and $<0.005$, respectively). At 10-kHz frequency, on the other hand, the group difference appeared significant ($p<0.01$) in the age subgroup of 40-49 years only. Those in the age subgroups of 20-29 and 30-39 years remained non-significant although also seemed reliable. Generally, taking into account the common audiogram patterns in the test and control individuals, within the band of 4-12-kHz frequencies the group dissociations looked rather systematic while the absence of statistically significant outputs could be attributed to the limited number of observations in separate age subgroups.

In the age subgroup of 50-59 years, as in three preceding subgroups, hearing thresholds in the test sample at high boarder frequencies, 12 and 10 kHz, exceeded those in the control sample. The extents of differences were however statistically non-significant and qualitatively much smaller, amounting on the mean to 5.6 and 3.9 dB, respectively. At preceding components of the noise-sensitive frequency band, 8, 6, and 4 kHz, on the other hand, threshold deviations between the test and control individuals were preserved both in sign as well as in degrees. The most noticeable difference between appeared at 4-kHz frequency. It amounted on the mean to 11.5 dB and reached the statistically significant level ($p<0.05$). At two remainder components of the critical frequency band, 8 and 6 kHz, the group differences were somewhat smaller, 9.0 and 8.9 dB, respectively, and appeared reliable although failed to reach the statistically significant level.

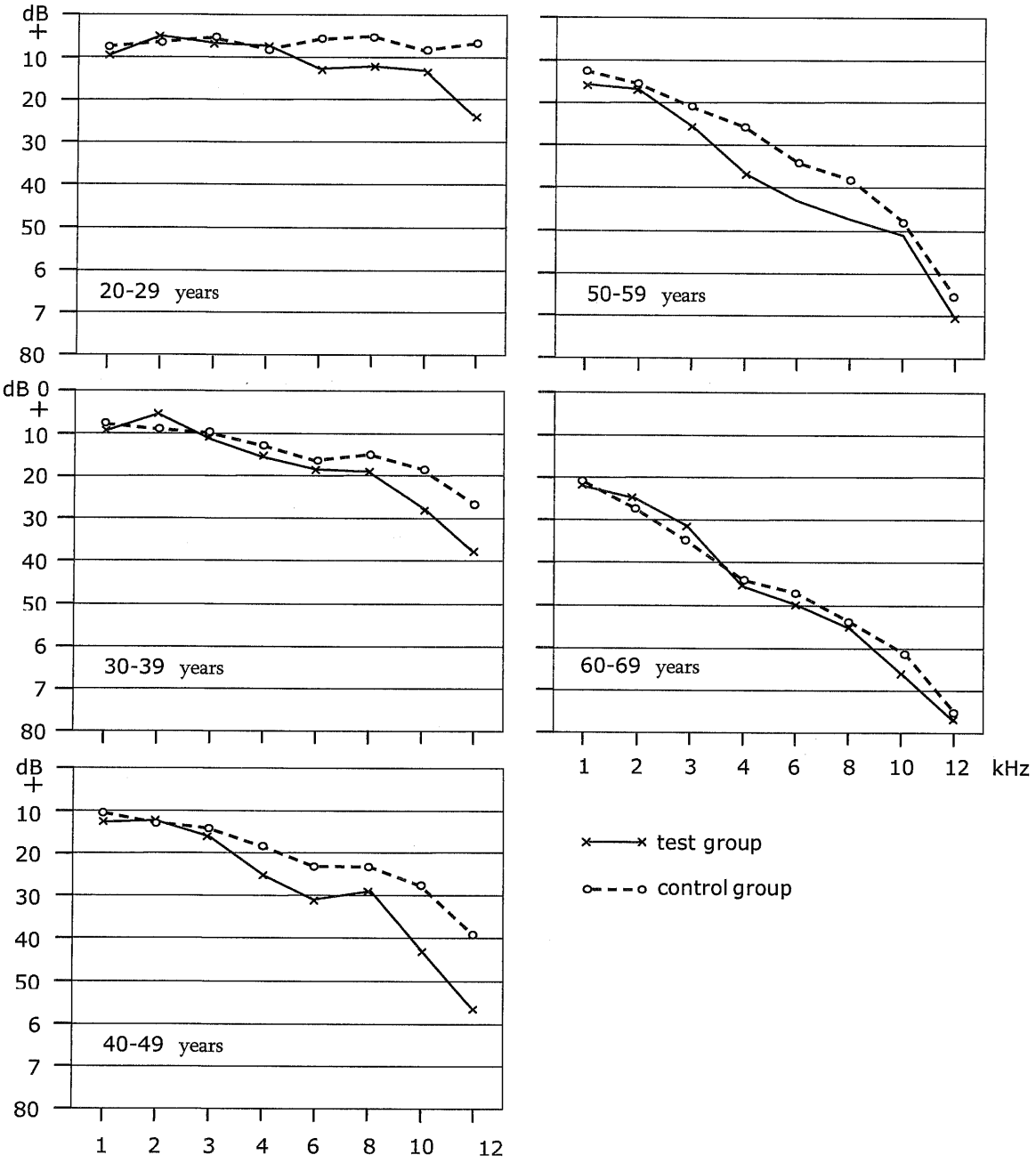


**Figure 1:** Mean hearing thresholds (dB) in individuals of test and control groups of different age subgroups (years) at 1-12 kHz frequencies

In the utmost age subgroup, 60-69 years, hearing threshold differences between the test and control samples were minute, irregular, and statistically non-significant for all inspected frequency components (Figures 1 and 2). At all constituents of the noise-sensitive frequency band, 12, 10, 8, 6, and 4 kHz, the trends towards greater hearing thresholds in the test vs. control individuals were nevertheless preserved. The mean differences between were though petty, only 2.2, 4.3, 1.4, 2.5, and 0.5 dB, respectively, and statistically far not significant.

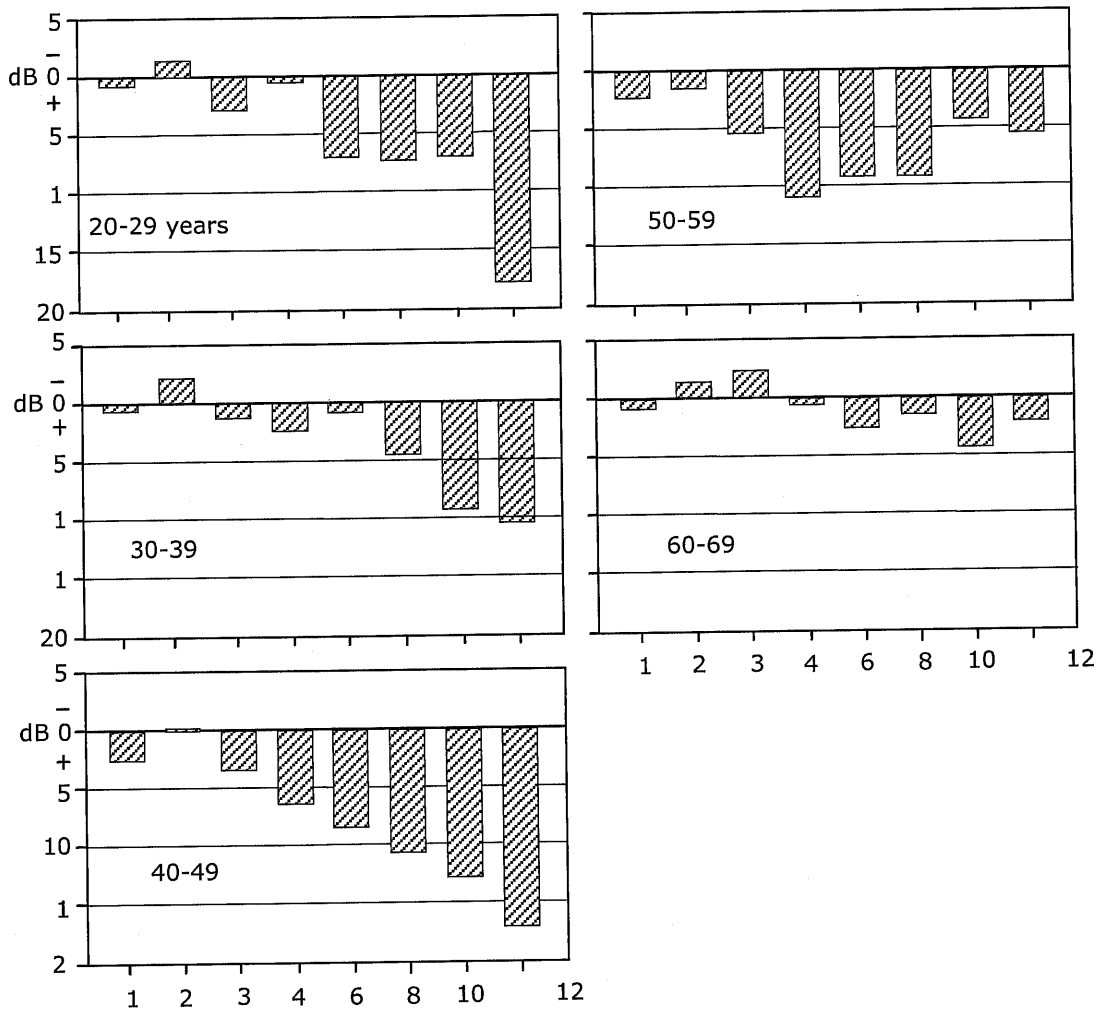


**Figure 2:** Differences between mean hearing thresholds (dB) in individuals of test (columns) and control (0 dB) groups of different age subgroups (years) at 1-12 kHz frequencies

The data of accomplished investigations have demonstrated that in individuals of young and elderly ages, 20-29, 30-39, and 40-49 years, high-intensity job-related noises preferentially affect the perception of sounds of 12- and 10-kHz frequencies. The sensations of other constituents of the high-frequency band, 8, 6, and 4 kHz, are also underwent impaired influences although consecutively of lesser and lesser degrees. The perception qualities of still lower frequencies, 3 kHz and less, are hardly subjected to any regular industrial noise effects. The sensitivity of the 12-4-kHz frequency band to the high-intensity industrial noise expositions appears rather similar in subjects up to 50 years of age.

In subjects of the next age decade, 50-59 years, age-related changes are significantly advanced in cochlea resulting in noticeable increments in sensation thresholds, particularly at utmost audiometrical frequencies, 12 and 10 kHz (Sharashenidze et al. 2007). Due to hearing losses over the certain critical level, the environmental noise fails to exert additional disturbing influences on perception of sounds just of 12- and 10-kHz frequencies. With regard to the preceding constituents of the noise-sensitive frequency band, 8, 6, and 4 kHz, on the contrary, the extents of age-related threshold

alterations still remain under the critical level. Due to the noise influences therefore the hearing thresholds at 8-4-kHz frequencies continuo to increase regularly. Generally, thus, in individuals of 50-59 years of age the noise-sensitive frequency field is narrowed while is restricted to the inferior part of the intrinsic band: 8-4 kHz instead of 12-4 kHz.

In the oldest age subgroup inspected, 60-69 years, due to further age-related alterations in cochlea, hearing sensation capacities are additionally reduced within the total noise-sensitive frequency band, 12-4 kHz. Just due to the significant hearing threshold increments, job-related noises stop to exert further harmful influences on cochlear receptors. Hearing threshold differences between workers and non-workers are minimized therefore and become unreliable.

Because of high-frequency hearing perception qualities, individuals of younger ages, up to 50 years, are more subjected thus to the job-related noise influences. In individuals of older ages, more than 50 years, due to critical age-related increments in auditory thresholds, job-related noises gradually stop to affect additionally the hearing sensitivity. Correspondingly, the noise influences become more restricted in width and limited in degree. Moreover, in individuals over 60 years of age the job-noise effects are actually eliminated totally.

## CONCLUSIONS

Hearing impairment consequences of regular noise exposures in workers engaged in industrial jobs concern selectively high sound frequencies, 12-4 kHz. Noise-induced hearing deterioration particularly invades 12- and 10-kHz frequencies.

Systematic audiometrical inspection of industrial workers within the extended band, covering 10- and 12-kHz frequencies, serves to detect the starting hearing disorder hints even. The negative trends should be followed by organization of complex of reliable technical and/or medical services aiming to neutralize harmful noise influences and to block or rehabilitate already happened sensorineural dysfunctions.

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