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Noise-induced hearing loss in workers exposed to urban stressors

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HIGHLIGHTS

- We studied traffic noise exposure and the affected frequencies of the hearing loss.
- We examined 714 outdoor and indoor workers.
- Noise exposure in 60 significant outdoor and indoor workstations was estimated.
- The level of individual daily noise exposure (LEX) was lower than 80dB(A).
- The results revealed a hearing loss at mid–low frequencies in all age groups.

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ABSTRACT

The technological and industrial progress together with the intensification of vehicular traffic and the adoption of new social habits are the cause of an increasing noise pollution with possible negative effects on the auditory system. This study aims to assess the noise exposure levels and the effects on the hearing threshold in outdoor and indoor male workers of a big Italian city. The study was carried out on 357 outdoor male workers, exposed to urban noise and on a control group of 357 unexposed indoor workers. Noise levels were measured in 30 outdoor and indoor areas. The subjects underwent tonal liminal audiometry in order to determine the value of their hearing threshold. During their working activity, outdoor and indoor workers are exposed to different noise levels LEX < 80 dB(A). At mid–low frequencies (250–2000 Hz), the results show significant differences in the average values of hearing threshold between the two groups in both ears and for all age classes; there are no significant differences between the two groups at higher frequencies. The outdoor noise levels measured are not usually ototoxic and the hearing loss at mid–low frequencies is not characteristic of the exposure to industrial noise. For these reasons the Authors hypothesize that the results may be due to the combined effect of the exposure to noise and to ototoxic air pollutants. The impairment of speech frequencies is disabling and involves the risk of missed forensic recognition.

1. Introduction

Noise pollution is now considered one of the main problems in urban areas: actually noise is one of the major pollutants in both workplaces and living space (Tomei et al., 2000a).

This is due to the increasing number of noise sources, such as the technological and industrial progress, the intensification of vehicular traffic and the adoption of new social customs (Azizi, 2010; Tomei et al., 2000a, 2000b). Nowadays people are used to living in a noisy environment and do not realize when the threshold limits are exceeded, which can occur at any time and any place, with both auditory and extrauditory negative health effects (Chiovenda et al., 2007; Cosa, 1980; De Sio et al., 2012; Milković-Kraus, 1990; Mosskov and Ettema, 1977; Sancini et al., 2012, 2013; Tomei F. et al., 1991, 1992, 1994, 1995, 2000a, 2003a, 2003b, 2004a, 2004b, 2005; Tomei G. et al., 2010). Until a few years ago the noise-induced hearing loss was a tecnopathic disease at the highest incidence and it still is one of the main reported diseases in Italy, being only second to musculoskeletal disorders (Ossicini et al., 2011). It's known that prolonged and continuous exposure to noise at high intensity causes hearing loss with damage of the hair cells of the inner ear together with a hearing threshold shift and an impairment of communication (Amjad-Sardrudi et al., 2012; Azizi, 2010; Sliwinska-Kowalska and Davis, 2012). This issue is clearly relevant in those workplaces where it may cause a lack of understanding of the warning messages with major risks of injuries (Amjad-Sardrudi et al., 2012).

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Outdoor workers are exposed to many stressors, also of psychosocial type. The noise-induced harmful effects on the auditory system are related to some characteristics of noise itself, intensity and duration of exposure and the frequency spectrum for example, to which other concurrent factors may be added, age and chemical and psychosocial stressors for instance. Actually the effects of urban stressors on the acoustic system in outdoor workers have been not sufficiently studied (Azizi, 2010; Dorner et al., 2010; Spinazzola et al., 1993; Tomei et al., 2000a, 2000b).

This study aims to assess the noise exposure levels and the effects on the auditory threshold in outdoor and indoor male workers of a big Italian city.

2. Materials and methods

From an initial population of 3170 workers, all female subjects, all subjects who were not traffic policemen and who had less than 4 years seniority were excluded from the study.

1112 male subjects were selected and underwent the following protocol:

- personal and work anamnesis;
- otoscopic and upper airway examination in order to assess the patency of the external auditory canal and the tympanic membrane;
- assessment of the hearing threshold by tonal liminal audiometry.

The audiometric tests were conducted with clinical audiometers (Amplifon Amplaid 309 Class I type B). After at least 16 h of no exposure to noise, each subject underwent a liminal tonal audiometric examination in a silent cabin, with assessment of the auditory threshold by air and by bone, in a range of frequencies from 250 to 8000 Hz.

We recorded the demographic data of each subject, his medical history and the values of the hearing threshold at the different frequencies and for both ears separately.

Traffic policemen were selected from the 30 different areas of the city which were considered representative for the traffic. 253 traffic policemen were excluded because we needed for each area the same number of subjects.

All subjects who were healthy at the time of the visit, with no signs or symptoms of otologic diseases and no earwax in their auditory canal, were selected; all subjects (no. 462) showing at least one of the excluding factors (Table 1) were excluded.

The remaining 397 traffic policemen were divided by age forming the following groups: 20–24 years, 25–34 years, 35–44 years, 45–54 years, and 55–64 years. Only the groups 25–34/35–44/45–54 were taken into account because there were too few members in the other groups.

The final sample was composed of 357 traffic policemen of the Municipal Police of mean age 38.1 ± 7.5 years.

The traffic policemen were assigned to the control of the flow of vehicles on roads and areas with high and medium traffic intensities and to monitor and regulate the traffic at road junctions, parking areas and traffic limited-areas. They carried out outdoor activities for at least 80% of their working time (7 h a day for at least 5 days a week) and were not provided with personal equipment for the protection against dust and fumes in the urban workplace.

This group was compared with a control group of 357 male subjects of mean age 38.9 ± 6.7 years. Controls were employees of the Municipal Police who carried out administrative and bureaucratic tasks, matched by age and working age, with the same working time and no occupational exposure to noise. The controls were selected through the same exclusion/inclusion criteria used for the traffic policemen. The two groups were matched as shown in Table 2.

In order to assess the noise exposure of traffic policemen, sound level measurements were carried out in the workplaces; these measurements were conducted under the worst conditions of noise exposure in 30 points as already described. The noise level was detected at the ear of the operator. Measurement times were long enough and recorded during the most critical periods for what concerns the traffic: each measurement lasted 20 min and was carried out at rush-hour. The noise produced by vehicular traffic was continuous and repetitive allowing to collect noise sampling periods that provided reliable data related to the eight-hour working day; the time of breaks was also known. In accordance with the Italian legislation, sound level measurements were carried out by photometric instrumentation of Class 1 according to the IEC (International Electrotechnical Commission) standard n. 651 of 1979 and n. 804 of 1984 and subsequent regulations. In particular, the measurements were made with integrating sound level meter of Class I of the company QUEST MOD 1900 CLASS 1. The sound level meter was calibrated by QUEST signal calibrator which emitted a constant signal at 1000 Hz with an amplitude of 110 dB, by a 1/2 inch microphone. The calibrations were performed before and after each measuring cycle. The measurements were considered valid when the difference between the two calibrations, performed before and after the measuring cycle, was equal to or less than 0.5 dB.

The equivalent continuous noise level (L_{eq}), that is the average intensity of a floating noise integrated over time during the different work activities, expressed in dB(A), was assessed; the equivalent noise level in weighting C scale (L_{Ceq}) and in terms of level of acoustic peak ($L_{peak,C}$) were also evaluated. The level of daily personal noise exposure L_{EX} dB(A) that is the equivalent noise level of each worker for a working shift of 8 h, was calculated.

For outdoor workers, the level of daily personal noise exposure L_{EX} was estimated per single worker or per similar groups, taking into account the position occupied during the working hours and the corresponding residence times.

The same procedure was used to assess the noise exposure indoor workers were exposed to; the sound level measurements were carried out under the worst noise conditions and in the 30 points considered significant on the basis of the inspections. For each of the 30 points, more sound level measurements were made, at call centers, internal administrative offices, radio rooms and office desks. Even for indoor workers, the noise was continuous and repetitive allowing to collect noise sampling periods that provided reliable data related to the eight-hour working day; the time of breaks was also known.

All subjects consented to their personal details being available, declaring that they had been made aware that these data were ranked as “sensitive information”, and consented that the data arising from the research protocol should be treated in an anonymous and

Table 1
Excluding factors.

Excluding factors	No. of subjects
Leisure noise exposure	153
Family history	29
Past or ongoing otologic disease	107
Conductive hearing loss	55
Use of ototoxic drugs and/or leisure exposure to chemical substances	33
Diseases of the upper airways	85

Table 2
Layering by age of the two studied groups.

Age groups	25–34	35–44	45–54	Total
Traffic policemen	125	137	95	357
Controls	125	137	95	357