Florence, Italy 12-16 July 2015
ICSV22
The 22nd International Congress on Sound and Vibration

COMBINED EFFECT OF ENVIRONMENTAL FACTORS ON HEARING LOSS OF YOUNG PEOPLE

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Living in big cities exposes the population to upper noise levels than just a few years ago. The acoustic environment of daily life and social activities may not be considered as significantly ototoxic, according to phonometric investigations carried out in Italian urban centers. Little information is available about chronic effects on hearing of others factors as Whole body vibration (WBV), ototoxic substances (solvents, carbon monoxide, hydrogen cyanide), smoke habit. Occupational deafness may be caused or aggravated by the additive effects of several environmental factors, especially vibration. It is hypothesized that WBV impairs cochlear function. Researchers discuss on the ability of some chemicals present in both occupational settings and ambient environments to potentiate noise induced hearing loss. Some data indicate that toxic solvents in car paints act in synergism with moderate noise exposure, damaging the cochlear hair cells. Other studies underline an additive interaction at high frequencies (mostly at 8000 Hz) between smoking and noise. Regarding the occupational exposure to noise, we underline that TLVs couldn't protect all workers from the harmful effects of noise because of individual susceptibility; so TLVs cannot be considered as an absolute cut-off between safety and danger levels. This issue is even more complex in apprentices and youngest workers; in addition, there are no reference values for these kinds of population in Italy. The aims of our research are: identification of reference levels for auditory function in the youth ages, evaluation in a large population of young apprentices the incidence of early changes in the auditory function considering the additive effects of several environmental factors (vibration, chemical exposure, smoke habit) In this study were included more than 300 subjects. In detail, we observed a significant influence of age, level of education, smoke habit, moped use.

1. Introduction

Living in big cities exposes the population to upper noise levels than just a few years ago. Acoustical noise coming from road traffic is considered one of the most important noise source in an urban environment. Many studies have investigated the modelling of traffic noise, starting from experimental basis or from theoretical schemes.

The acoustic environment of daily life and social activities may not be considered as significantly ototoxic, according to phonometric investigations carried out in Italian urban centres, but

some data may underline a possible generic adverse effects of *annoyance* as discomfort, irritation and, in the opinion of some researchers, also emotional crises and a persistent neurotic symptomatology.

Even young people are exposed to noise levels in urban areas and some researchers speculate on a possible adverse effect of noise on learning and cognition. Data are at the moment inconsistent.

In general, the findings relative to the learning and cognitive effects of noise are not easily interpreted. These discrepancies may be due to the specific noise levels and tasks involved, especially if an arousal effect takes place. Further research is needed to clarify the exact relationships between the arousing and distracting effects of noise.

In addition there are sex, age and socioeconomic differences in performance under noise environments. For example, older subjects performed more poorly in both noise and no noise environments and middle class elementary students perform at lower levels in a white noise or home noise environment compared to lower class children.

On the other hand, socially relevant behaviours can be affected by noise. In general, no major disruption of sleep patterns are reported for subjects experiencing sonic booms, but some changes in EEG sleep patterns in response to white noise are reported. REM compensation seems to occur on quiet nights following noisy nights. There are contradictory data with respect to the effects of sonic booms. An other aspect to consider is the potential role of noise in influencing a wide range of socially relevant behaviours, as a decrease of tolerance in a noise environment or the induction of anxiety in social situations.

With respect to noise as an independent variable, a casual review of the literature indicates, with few exceptions, that noise is treated as a unitary influence and little attention is focused on the potential interactive effects of noise with other stressors.

Little information is available about chronic effects on hearing of others factors as Whole body vibration (WBV), ototoxic substances (solvents, carbon monoxide, hydrogen cyanide), smoke habit. It is hypothesized that WBV impairs cochlear function. (1). Researchers discuss on the ability of some chemicals present in both occupational settings and ambient environments to potentiate noise induced hearing loss (2). Some data indicate that toxic solvents in car paints act in synergism with moderate noise exposure, damaging the cochlear hair cells (3). Other studies underline an additive interaction at high frequencies (mostly at 8000 Hz) between smoking and noise.

The combined effects of different agents are under study, in particular interaction between noise, WBV and heat. To obtain a better understanding of such combined-stress effects a major experiment was conducted using heat, noise and vibration , both singly and in combination. Measurements were made of tracking ability, choice reaction time, voice communication, mental arithmetic, visual acuity, body temperature, heart rate, weight loss, and subjective ratings of the stress. The conclusions are at the moment contradictory.

Another central aspect is the massive increase of exposure to noise for extra-occupational reasons – *social noise* – in particular in young population.

According to a document published by the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHRs) of the European Commission: "Exposure to excessive noise is a major cause of hearing disorders worldwide. It is attributed to occupational noise. Besides noise at the workplace, which may contribute to 16% of the disabling hearing loss in adults, loud sounds at leisure times may reach excessive levels, for instance in discos and when using personal music players (PMPs)". And the SCENIHR adds: "It is estimated that over two decades, the number of young people with social noise exposure has tripled (to around 19%) since the early 1980s, while occupational noise has decreased" (4).

With the growing popularity of portable music devices, there has been increasing concern in the scientific community regarding noise-induced threshold shifts (NITSs) among young population. Historically, acoustic trauma was considered a disease of adulthood caused by exposure to hazard-

ous noise on the battlefield or in occupational settings. There was however, a threefold increase in the reports of tinnitus in those subjects with significant social noise exposure.

A study using data from National Health and Nutrition Examination Survey (NHANES) III estimate the prevalence of NITSs among children in the United States and indicated that 12% to 15% of school-aged children had hearing deficits attributable to noise exposure. Many studies from other countries, including Sweden, the United Kingdom, France, and China, found evidence of noise-related hearing loss.

Reviews of the literature concluded that excessive noise is a major cause of hearing loss among school-aged children and that hearing impairment is increasing because of voluntary exposure to loud noise (5-7).

With the recent massive increase in the popularity of portable digital music players such as MP3 players, exposure to high sound levels has risen dramatically, and millions of adolescents and young adults are potentially at risk of permanent hearing loss as a result. In addition to exposure via MP3 players, many young people are exposed to high-volume music in discotheques – where mean sound levels range from 104 to 112 decibels dBA – and at pop concerts, where sound levels are even higher (8). Combined exposures to high-volume music can have cumulative effects on hearing impairment, thus exacerbating the risk of hearing loss. Nor have any studies reported on cumulative exposure to high-volume music from a combination of sources such as MP3 players, stereo headphones, discotheques, and pop concerts. In the absence of such data, information about adolescents' self-reported music-listening behaviours may be used in combination with information about average sound levels of MP3 players, discotheques, and pop concerts to estimate whether and to what extent today's adolescents are at risk of developing permanent hearing loss from voluntary exposure to high-volume music.

Adolescents often exceeded current occupational safety standards for noise exposure, highlighting the need for specific safety standards for leisure-time noise exposure.

As concerns the potential ototoxicity of ordinary life and social activities (except of particular places as discos, motor sports, hunting, shooting, etc.), a clear agreement in considering the obtained values as significantly ototoxic doesn't exist. With regard to occupational exposure to noise, all defined TLVs are referred to sound pressure levels and to exposure times that represent conditions under which it can be assumed that nearly all workers may be continuously exposed without adverse effects on their hearing function and may understand a normal conversation. Nevertheless, the application of the TLVs themselves couldn't protect all workers from the harmful effects of noise because of individual susceptibility; so TLVs cannot be considered as an absolute cut-off between safety and danger levels (9). The evaluation of hearing function and of the impact of noise in apprentices and youngest workers is even more complex. In fact, this issue presents many peculiarities regarding the special care needed for the younger workforces. To date, in the Italian legislation, there aren't any reference values regarding noise for the youngest working population.

There is also the need to find methods capable both to predict the earlier noise damage and to allow a sort of detection of most susceptible people.

2. Objectives

The aims of our research were the identification of reference levels for hearing function in the youth ages and the underlining of the importance of social noise exposure in young working population and the role of extra-occupational noise exposures (as vibrations or environmental chemical exposure) in hearing loss in young populations. To pursue these objectives, we have investigated the hearing function, through an audiometric examination, in a large population of young apprentices.

3. Methods

We enrolled 308 young apprentices – 192 males and 116 females – engaged in work activities involving exposure to noise. We excluded from the study, a priori, subjects older than 24 years and those with the finding of an occlusive plug of earwax at the otoscopic examination. We also excluded, *a posteriori* (during data analysis), subjects with a history of significant occupational exposures to noise and people with otological diseases or with major abnormalities found at the audiometric examination. All subjects underwent the same study protocol, including audiometric examination and a medical history questionnaire, administered by expert interviewers.

The questionnaire is particularly focused on extra-occupational noise exposure as social noise causes. A group of items is related to use of portable digital music players such as MP3 players. Other questions are about vibrations risks, also including moped use, and possible exposure to some chemicals.

4. Results

In this study were included 308 young apprentices, of which 192 males and 116 females, with a mean age of 19.2 years ± 2.4 years, a mode of 20 years and a median of 19 years. Seven subjects (0.022% of the study population) hadn't completed the Italian compulsory school. More than 50% of young people referred the use of a scooter to get to the workplace; this may be considered as one of the main non-occupational risk factors – perhaps the most important – for hearing loss in young people. As regards the frequentation of discos, 1/3 of the subjects reported that they had never go to discos, 1/3 only occasionally, the remaining 1/3 reported the habit to go to discos with a frequency of at least once per week. Fifty-six percent of the subjects reported that they regularly used headphones for listening to music. Nine percent of the subjects reported that they played musical instruments (7 guitar, 5 piano, 4 battery and 9 other instruments). So, the music – both listening in the discos and in the headphones – represents a major non-occupational risk factor for hearing loss in young people. Only a young man reported to was an hunter; this fact confirms that hunting was almost abandoned in young people and, consequently, it is no longer a risk factor for hearing loss.

Nineteen percent of the subjects reported childhood ear disease (such as otitis media) and 3% reported acute ear traumas (in 70% of cases by bursting of firecrackers). No subject reported a previous malaria or anti-tubercular drugs assumption. Four percent of subjects said they had at least a relative with a congenital deafness and 8% with an acquired deafness. The 98% of the subjects reported a subjective feeling of a good hearing function, 4 a reduced hearing function on the right, 2 a reduced hearing function on the left, and one bilaterally; six percent reported tinnitus. None reported a clear exposure, occupational or not, to chemicals.

The audiometric examinations of the 308 subjects enrolled in this study were analyzed, as well as a total population, according to the influences of the following variables: gender, age, education.

The average value of hearing thresholds appears bilaterally lower in females. This is particularly evident for the 2000-4000 Hz frequencies and for the left ear. A certain explanation of this phenomenon cannot be found, but we could propose some assumptions. Usually young girls were more focused in performing the test and, therefore, carried out it more carefully; in addiction some males had a low occupational exposure, though often not reported. Finally, among the males there was a greater prevalence in moving on a scooter and in frequenting discos.

Regarding the age, we observed that the average value of the audiometric threshold was bilaterally lowest in the group of less young subjects. We observed this phenomenon for all tested frequencies and it was particularly evident for the left ear. Once again, the explanation of this phenomenon is difficult. We could assume that the older (and more psychologically mature) subjects have better carried out the test. Regarding the education, the average value of the audiometric threshold appears bilaterally lowest in the group of subjects who had a higher education. In particu-

lar, the difference is clear for subjects with an education less than 9 years. We could assume that this low level of education is related to cognitive difficulties, with a significant influence on both comprehensive and collaborative skills of the young people.

5. Conclusions

The analysis of data from the young apprentices group, almost equally divided between the two sexes, studied by specific questionnaire and with audiometric examinations, allows us to highlight the influence of some factors (gender, age, education, social condition) on the hearing function. In detail, we observed a higher threshold among males, younger and less educated; this result may seem, at least, paradoxical but we cannot forget some factors (concerning cognition and attention) which may justify it. We believe that will be necessary to carefully consider these aspects in future audiometric investigations performed (mainly with epidemiological purposes) on groups of young subjects.

More researches needed to better focus the possible role of moped use, with additional risk of noise and vibration and the possible interaction between the two factors, on the hearing loss risk.

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