Nonoccupational noise exposures and their hazards: a literature review

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Abstract

Noise pollution has been extensively studied during the last 30 years. Although most of the government regulations protect the vast majority of the workforce in the in the United States, they fail to consider the workers' exposure to noise during nonworking hours as well as the rest of the population exposure to nonoccupational noise. A review of published research on the noise and potential effect of various nonoccupational sources of noise is presented in this paper.

Riesgos de la exposición al ruido no ocupacional

Sinopsis

La contaminación causada por el ruido se ha estudiado extensamente durante los pasados 30 años. Aunque la mayoría de las reglamentaciones promulgadas por el gobierno van dirigidas a proteger a la fuerza trabajadora en los Estados Unidos, éstas no consideran la exposición de los trabajadores ni del resto de la población al ruido no ocupacional. Este escrito repasa los resultados de varios estudios científicos sobre los efectos del ruido no ocupacional.

Introduction

During the 1960s noise began to be viewed as a type of pollution. In 1971 the Environmental Protection Agency founded the Office of Noise Abatement and Control (ONAC). The ONAC conducted research to determine how noise affects the hearing and to establish noise emission ethics. Eleven years after its establishment, and with the noise pollution problem increasing, the ONAC was closed due to budget cuts. By January 1990, the National Institute of Health indicated in a consensus statement that 10,000,000 Americans were incurring in irreversible and untreatable hearing damage because of excessive exposure to noise at home, on the job and during recreational activities (NIH, 1990). Almost parallel to the sequence of events previously described, the U. S. government promulgated regulations (the Walsh-Healy Public Contract Act of 1969, the Occupational Safety and Health Act of 1971, and the OSHA Hearing Conservation Amendment of 1983) that limited occupational exposure to noise and provided for the protection of hearing in employees. Although these regulations protect the vast majority of the workforce in the United States, they fail to consider the workers' exposure to noise during nonworking hours as well as the nonworking population's exposure to nonoccupational noise.

This paper reviews published research on the noise levels and potential effect of various nonoccupational sources of noise. The discussion on nonoccupational noise will be divided into five categories as described by Clark and Bohne (1984):

1. Recreational
2. Hobbies/workshop
3. Household
4. Music
5. Transportation

Figure 1 shows a range of maximum sound pressure lev
for various noise sources within each category (Clark and Bohne, 1984). Although there are no regulations for nonoccupational noise, it is evident that most of the items listed can generate SPLs (dBA) that exceed the OSHA permissible exposure level (PEL) of 90 dBA time-weighted average (TWA) per 8-hour day

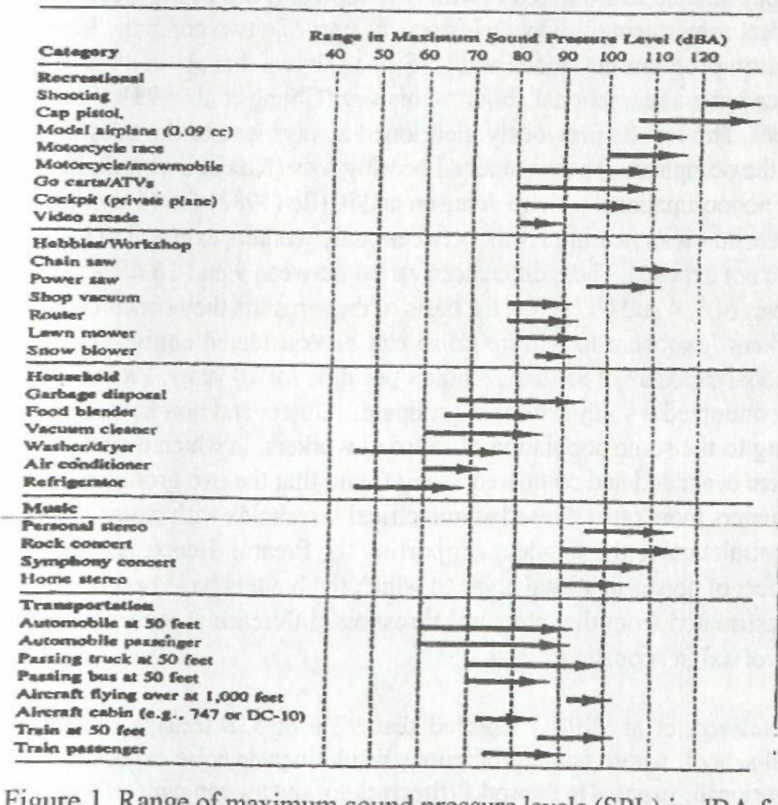

Figure 1. Range of maximum sound pressure levels (SPL) in dBA for various noise sources

Recreational

Firearms and fireworks

By the early 1990s, 60,000,000 persons were using firearms in the U.S. for target practice and hunting (Griffing, 1994). Reported peak sound levels (PSPL) from sport rifles and shotguns have ranged from 143.5 to 172.5 dB PSPL (Odess, 1972; Axelsson et al., 1981). The fact that individuals exposed to gunfire may sustain hearing loss is widely accepted. It has been reported that independent assessment of shooting history, as part of a two-company hearing conservation program in Canada and U. S., has shown that about 49% of the workforce have a recreational shooting history (Chung et al., 1981; Clark et al., 1987). The results previously mentioned always lead to the question of whether the occupational noise-induced hearing loss (NIHL) is contributed to by some nonoccupational activity. Johnson and Riffle (1982) found significant differences in mean hearing levels between male workers exposed to gunfire and those not exposed. These differences varied between 9 and 16 dBA for the frequencies of 3, 4 and 6 kHz. On the basis of these results they concluded that the workers' exposure to gunfire noise can be considered equivalent to an occupational exposure of 89 dBA, 8 hours per day, for 20 years. Prosser et al. (1988) conducted a study with two groups of hunters and non hunters, both belonging to the same population of railroad workers, in which their hearing levels were evaluated and compared. They found that the two groups differed in that hunters more often showed asymmetrical thresholds with worse hearing levels contralateral to the shoulder supporting the firearm. Hence, an estimate of the effect of nonoccupational noise to which the hunters have been exposed can be estimated from the interaural threshold difference at the frequencies most involved in acoustic trauma.

Axelsson et al. (1981) reported that 92% of 538 teenage boys from technical school, whose future professions would include noise exposure, have been occasionally exposed to fireworks (firecrackers and toy cap guns). Fireworks can emit from 140 to 160 dB PSPL (Axelsson, 1996). There is no doubt that a single explosion close to the ear can result in a permanent sensorineural hearing loss. These recreational activities create reasonable questions about the conditions of these youngsters' auditory system by the time they begin working in industry.

Motor sports and indoor sports arenas

In a study of 41 motorcyclists, the average noise level reported was 95 dBA at 50 mph and 107 dBA at 80 mph (McCombe, 1994). After one hour of high-speed riding (80 mph), the subjects suffered a mean maximal temporary threshold shift of 11 dB at 1 kHz. According to the researcher, the incorporation of a pair of earmuffs under the helmet shell reduced the previous noise levels to 84 dBA at 50 mph and 93 dBA at 80 mph. Axelsson et al. (1981) indicated that 24 % of the teenage boys in his study reported regular use and turning-up (removal of the muffler in part or whole) of mopeds. This practice increased the sound level from 70 to 80 dBA for a normal moped to a noise level of 90 to 100 dBA.

The noise level at certain sports events, specially at coliseums and domes, may often exceed ototraumatic levels. At a monster-truck event the average noise level for two hours was 97 dBA, with continuous noise level frequently at 122 dBA, and noise peaks of up to 139 dBA (Casali, 1990). Sometimes the noise comes from the fans, as in game six of the 1987 World Series at the Metrodome (Axelsson, 1996). The continuous noise level for the 3-hour, 22-minute game was 96.9 dBA.

Video arcade

A noise level ranging from 88 to 90 dBA was measured in three different arcade game centers (Mirbod, Inaba, Yoshida, Nagata, Komura and Iwata, 1992). Using the computed noise pollution levels (L_{NP}) and L_{90} the researchers estimated that these levels of noise might cause 4 to 8 dB temporary threshold shift (TTS) at 4 kHz in an individual with less than one hour of exposure to such noise level.

Hobbies/workshop

Do-it-yourself power tools

McClymont and Simpson (1989) issued a questionnaire to 100 males who used do-it-yourself power tools. The seven tools considered were:

1. circular saw
2. hammer drill
3. electric lawn mower
4. orbital sander
5. jigsaw
6. hedge cutter
7. electric drill.

The questionnaire consisted of three questions for each of the power tools about the frequency of use, the occurrence of tinnitus after using the tool and the usage of hearing protector. In order to make inferences on the likely risk to hearing from power tools, the noise levels of the tools were measured in real life applications. All the power tools tested produced sound levels greater than 90 dBA. It was found that most of the devices were used for less than one hour per week. The most commonly used device was the standard electric drill and the least used was the circular saw. Tinnitus was experienced by 34 individuals after using the power tools. The mean duration of the tinnitus was 10 minutes. Only six individuals used ear plugs as hearing protection.

Household

Kitchen appliances

The idea of a peaceful and quiet house or apartment has been threatened by noisy modern kitchen appliances. Verbunt (1992) conducted an experiment to analyze the different noise sources of a 400 watt food processor. The aerodynamic noise of the axial cooling fan, the toothed belt, and the electric motor were identified as the main sources of noise. Together these parts generate a sound-power level of 84 dBA. By redesigning the axial cooling fan the researcher was able to reduce the sound power level to 80 dBA.

Cordless telephones

Clark (1991) indicated that the cordless telephone has been clearly linked to NIHL. Thirteen cases of acoustic trauma conducive to permanent hearing loss were caused by cordless telephones (Singleton et al., 1984). In 12 of the cases the trauma resulted from the individual picking up the telephone when it was ringing and placing it to the ear without switching to the talk mode. The other case of trauma resulted from a loud extraneous crack sound the patient compared to a pistol shot which occurred while the telephone was in use in the talk mode. Singleton et al. (1984) indicated that the ring intensity ranged from 137.1 to 141.4 dBA with a peak impulse sound level of 145.5 dBA. The duration of the ringing is approximately 5 seconds. A study of 24 additional cases of cordless telephone injury seems to validate Singleton et al. (1984) findings about the hazard of acoustic trauma represented by the sound levels produced by the ringing of some cordless telephones (Orchik et al., 1987). The affected ear showed evidence of reduced sensitivity with greatest deficit at 0.5 and 1 kHz. For these frequencies the mean threshold for the injured ear was poorer by 20 and 29 dB respectively. The researchers concluded that the insult can affect the frequency region within the speech spectrum

Music

Live concerts

There have been many studies conducted on the effects of live concerts particularly pop and rock music. Although most of the studies reported similar SPL, above 90 dBA, there seem to be different opinions on the effect to the human hearing. According to Clark (1991) it is reasonable to believe that attendees at rock concerts are routinely exposed to sound levels above 100 dBA. On the other hand, he stated that it is unlikely that attending classical music concerts poses any risk of NIHL for anyone. Also, he reported that the average level (Le4) for a 2-hour jazz big-band concert was 96.1 dBA and concluded that although the noise from jazz concerts exceeds that from symphony concerts, is unlikely that the typical audience will develop significant NIHL from that exposure alone. Studies on people attending pop and rock concerts generally show that most listeners sustain moderate TTSs of up to 30 dB at 4 kHz, that recover within few hours to a few days after the exposure (Clark and Bohne, 1986; Patel, 1996). A completely different point of view on the subject was presented by Dibble (1995) in a paper where he concluded that:

1. A sound which is pleasing, and therefore less stressful, may also be less damaging medically.

2. Music as a cause of NIHL is nowhere near as damaging as what might be described as conventional industrial noise.

Although his own measurements of sound levels at live pop and rock concerts (Leq) ranged between 104 to 105 dBA he mentioned that what causes damage, if any, is the dislike of the music content and not the fact that the sound is too loud. He supports his point of view with the result of various studies conducted in the U.S. and the U.K. In one of these studies the subjects were exposed to 60 minutes of music and 60 minutes of noise at similar levels (Barry and Thomas, 1974). It was found that the noise-induced TTS exceeded the music-induced TTS by about 9 dB over the midrange. Another cornerstone of Dibble's (1995) conclusions is the observation reported by Fletcher (1972) in which no clearly observable losses were found when the pure tone thresholds of 100 rock musicians and 100 rock music spectators were compared with those of 400 normal hearing control subjects.

<u>Discotheques</u>

Recent measurements made in discotheques show an SPL at the dance floor between 85 and 110 dBA and 90 to 95 dBA in the surrounding areas (Patel, 1995; Axelsson, 1996). Since most of the people frequent the discotheques only for a few hours weekly or monthly, the risk of hearing damage is very small (Clark, 1991). A possible reason for this is that discotheques tend to turn up the bass to give music more beat, while sound systems in a rock concert crank up the higher frequencies, at which people are more vulnerable to damage (Patel, 1995).

Personal cassette players

There is a general concern about potentially hearing damage caused by personal cassette players (PCP). Four out of ten subjects reported tinnitus after listening to pop music of their own choice from a PCP for exactly 1 hour at their most comfortable level (Helstrom and Axelsson, 1987). In another study 6 out of 16 subjects had TTS of 10 dB at one or more frequencies after listening to rock or fusion music of their own choice from a PCP for exactly three hours at their most comfortable level (Lee et al., 1985). The maximum SPL of the PCP used in the studies previously mentioned ranged from 104 to 126 dBA. This type of noise exposure becomes more alarming with the results of various surveys and questionnaires that show school children between 11 and 18 years old among the typical users of PCP (Clark, 1991; Axelsson, 1996).

Playing music

Based on a thorough audiological examination of the Danish orchestral musicians it was concluded that they do have increased hearing threshold levels compared to a reference group (Ostri et al., 1989). In the youngest age group of musicians (20 to 29 years old) 50% experienced regularly recurring TTS after a performance of high SPL music. The hearing damage found in the musicians was attributed to the symphonic music. Although the case previously described is considered to be part of occupational noise exposure rather than leisure noise exposure, it is important to understand that for each professional musician there are many amateur musicians practicing many hours per day just to eventually become a professional.

Transportation

Urban transportation

A two-year study of the traffic noise and the perception and attitudes toward the noise of exposed individuals was conducted in the urban areas of the capital city of Riyadh, in Saudi Arabia (Koushki et al., 1988). The noise pollution level (LNP) for 42 different locations monitored ranged from 79 to 105 dB. It was found that more than one in four individuals reported that traffic noise caused headaches and nearly one in four stated nervousness as a result of exposure to noise. However, only one in 10 indicated awareness concerning the loss of hearing from long-term exposure to traffic noise.

Conclusions

On the basis of the literature reviewed in this paper, what seems to be the most important issue to address is the lack of knowledge by the general populations, including those exposed to occupational noise, about the devastating effects of noise exposure on their hearing system and the quality of life. An education program across all academic and social levels may produce better results than imposing more government regulations. Since both government and industry will benefit from a population aware of the potential damages of noise exposure, they should join efforts to create and maintain the educational campaign. Unlike the regulations in industry that place the burden on the employer, an effective education program will place the knowledge and responsibility on the individuals. A recommended complement to the education program might be a product-labeling system containing a warning notice in addition to the basic information about the sound level generated by the product.

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