Noise: An Ubiquitous Pollutant

The 'Developed' World and the 'Developing' World

In the developed world, excessive occupational sound exposure is diminishing. New manufacturing techniques such as welding or glueing are replacing riveting in shipyards and aircraft factories, making the workplace quieter. Greater efficiencies and automation are also reducing the total number of workers exposed and the sound levels which they experience. The developed world workforce expects a safe work site and has accepted occupational safety is a required priority. This is not the situation in much of the developing world where, in spite of some excellent programmes, equipment may not be silenced, hours of exposure are less monitored and hearing protection is rarely used. In addition, occupational sound levels are lower in the post industrial occupations than in manufacturing. Farm mechanisation is a global problem, machinery is loud, varied and work hours are not controlled.

The urban 'soundscape' is ever louder, in Toronto as well as in Karachi, in Sao Paulo as well as in Rome. Many cities have noise bye laws, however, few are implemented. Traffic noise is difficult to control and is a greater problem in developing world cities than in most of the developed world. More traffic, older and poorly silenced vehicles, amplified music in outdoor bazaars, all producing a cacophony of sound, making speech communication difficult. This is largely due to diesel trucks and motorcycles. The hearing of the 'Baby Boomers'** is worse by about 10 years than that of the preceding generation at the same age; i.e., 50 year olds today have hearing like 60X year olds of the last generation.

***Baby Boomers – The baby boom generation is a term which portrays a generation born during the middle part of the 20th Century*

Hearing Conservation Programmes

However, there is also cause for cautious optimism. Hearing conservation programmes have multiplied in industry and are effective. Their demonstrable (provable) benefits to occupational safety and the work environment encourage their adoption. Maximum sound level specifications are also more and more frequently required when machinery is ordered. Issues with classroom acoustics have become fairly widely recognised in the USA, Canada and several European countries, with helpful developments occurring. City noise is being addressed by an innovative programme in India (see Chadha, Djelantik and Agarwal in the next Issue of CEHH) and is being studied with interest in South East Asia. The World Health Organization has had workshops and has published recommendations regarding urban noise. Machinery of all types is becoming quieter. The more fuel efficient, modern jet engines are also less noisy. It is being recognised by manufacturers that noise is an unwanted by-product, not a needed indicator of power. Sadly, so much of this is offset by the increasing exposure to and intensity of recreational sound. The greater efficiency of the now ubiquitous MP3 players makes them more hazardous than the personal radios and CD players that preceded them.

Cellular Basis of Hearing Loss

The cellular basis of hearing loss from intense sound exposure is becoming clearer. Work is advancing rapidly on medication to prevent the damage produced by extreme noise exposure, such as in military noise. It seems to work in animal models; hopefully, it will translate to man.

When I started working in this area almost 50 years ago, I thought that by the year 2000 there would be no more industrial hearing loss in the industrialised nations. Well, I was wrong, but the amount is reducing. There is still much to be done. The focus has shifted from industrial to community noise and this requires continuing effort. ❑

THE RISK OF HEARING LOSS IN YOUNG ADULTS

Thais C Morata
PhD F-AAA CCC-A
Hearing Loss Prevention Team
Division of Applied Research and Technology
National Institute for Occupational Safety and Health
Cincinnati, OH 45226
USA

Email: tmorata@cdc.gov

In the past few years, the number of publications on the risk of acquired hearing loss among children and young adults has increased substantially both in the scientific literature as well as in the popular press.

The headlines tend to be fear-provoking:

- 'TURN IT DOWN! MP3 fans told'
- 'Sounding a warning on earbuds!'
- 'People risk hearing losses at younger ages, experts warn.'

Although sensationalised by the media, scientific evidence of increased risks to hearing faced by youth is not yet available.

Music Exposure amongst Children and Young Adults

The increased media attention may be a consequence of the introduction of MP3 players and a 2006 lawsuit which alleged that such devices pose a risk to users' hearing. This issue has brought widespread scrutiny to the question of potential risks to young people's hearing. Teenagers, more than any other age group, expose themselves to loud sound levels during their leisure time. Recreational exposure sources include toys, arcade games, and music (from concerts, discos, car stereos, and Walkman*-style and other personal media players). Modern audio equipment can produce peak sound pressure levels of 130-140 dB which are harmful to human ears. Recent studies have examined teenagers' noise exposures, their attitudes and behaviours towards noise and music, and the consequences of those exposures to their hearing.[1, 2, 3, 4, 5, 6] However, researchers have reported mixed results. Some studies found no effects of recreational music exposure and hearing loss. A study conducted in Brazil assessed the hearing thresholds of 957 young adults between the ages of 14 and 26 years and their exposure to amplified electronic music.[7] The main source of exposure was through personal media players, which was reported by 65% of the participants. However, no significant differences in audiometric thresholds were found between the exposed and the non-exposed. A study of 10,000 people conducted in Germany

**Walkman: Walkman is Sony's audio cassette player brand, now used to market its portable audio and video players. The original Walkman introduced a change in music listening habits (Wikepedia)*

reported that in the 18-to-25-year-old group unexposed to occupational noise, only a minimal difference in thresholds (not statistically significant) was seen between people who regularly go to discotheques (discos) and those who have never been there.[8] Similar findings were reported for Walkman users.[9] On the other hand, tinnitus and temporary threshold shifts have been reported by teenagers after attending music concerts or disco clubs, as well as by those who were/are heavy users of personal audio devices.[3] An interdisciplinary longitudinal investigation of the hearing status and noise exposure of teenagers conducted in Argentina found that the participants' hearing thresholds worsened during the four-year period of the study.[5] Authors also indicated that attending discos seemed more harmful than the use of media players; and that while the habit of attending music concerts had increased during the study, it did not increase as much as visits to disco clubs.

Other Potential Sources of Noise Exposure

Although music exposure seems to be the most studied source of excessive sound exposure to children and youth in several countries, there are also other potential sources of hazardous noise exposure. Dangerous sound pressure levels produced by some toys have been documented, and several countries have adopted sound level labels to alert consumers of the risk. Data from Sweden have shown the presence of the audiometric high frequency 'noise notch' in groups as young as ten years old.[10, 11]

Noise Exposure and Work Situations

Noise exposures at work are also an issue, and may even be the most significant source of hearing risk among youth. Although urbanisation has reduced the number of children working on farms worldwide, young people continue to be employed in this economic sector, as well as in other industries with noise risks. The proportion of young adults or children working, as well as their work conditions and legal protections, varies from country to country.

The Noise-damaged Ear and Later Hearing Loss

Recent basic science investigations on the long-term effects of noise exposure highlight another reason for concern regarding noise exposure among youth. Historically, hearing loss prevention researchers have assumed that noise damage ceases after the termination of noise exposure, with further deterioration in hearing threshold levels resulting only through the ageing process. This assumption, however, may be incorrect. Animal experiments have described noise-induced degeneration in the brain as a result of cochlear damage.[12, 13] Human and animal studies suggest that the noise-damaged ear does not age at the same rate as the non-damaged ear. Evidence indicates that while hearing impairment at the most noise-affected frequencies of 3000-6000 Hz tends to slow, hearing loss at the neighboring frequencies of 8000 Hz and 2000 Hz appears to accelerate.[14, 15, 16] Therefore, early noise exposure, even if resulting in negligible hearing loss, can potentially increase susceptibility to further hearing loss in later years.

Discotheque

Hearing in Young Adults in the USA

The hearing status of young US adults was examined over the past 20 years by comparing yearly prevalence of hearing loss in the baseline audiograms of 2526 individuals, ages 17 to 25, beginning employment between 1985 and 2004.[17] The prevalence of high frequency hearing loss decreased over the twenty-year period, while the prevalence of audiometric 'notches' remained constant. Their results suggest that, despite concern about widespread recreational noise exposures, the prevalence of hearing loss among a group of young US adults has not significantly increased over the past two decades. However, in view of the basic science research described above, it is possible that the effects of youth exposures will only be detected after a longer period of time. Further research is necessary to reveal and clarify any effects.

Hearing Protection

In the meanwhile, efforts to prevent noise exposure and hearing loss among youth are needed. In 2006, the Cochrane Review published a review of interventions to promote the wearing of hearing protection.[18] Only two studies met their rigorous criteria for inclusion in the report; and, of these, the one successful intervention was a four-year school-based hearing loss prevention programme for students working on their parents' farms (N=753). The intervention group was twice as likely as the control group (which received only minimal intervention) to wear some kind of hearing protection. This evidence suggests that long term school-based programmes can effectively increase the use of hearing protection among students and sheds some light on approaches that ought to be considered for increasing awareness of the value of hearing and means of preventing disorders.

New products and organisations have been created with the goal of reducing hearing risks (hearing loss and tinnitus) due to music exposure. For example, output limiting headphones are now available for some personal media players. Another approach towards reducing the risk of hearing loss is to establish regulations. Some are in place in countries like Switzerland, Italy, Austria, Finland and Sweden, with specific recommendations for exposure limits when it comes to musical activities or noise in the entertainment industry. But enacting new regulations can take a while. In the meantime, professional organisations in the USA and elsewhere have been taking steps to examine and share information on best practices in hearing loss prevention in schools.

Surveillance and Research

Surveillance of children and young adults' hearing seems necessary for a clearer understanding of the hearing risks facing them, as well as controlling their exposures to excessive sound pressure levels. Further research and public health interventions, such as exposure assessment and control, education, and audiometric testing targeted to children and youth are recommended by most of the investigators in this field.

The Risk of Hearing Loss in Young Adults

Disclaimer

The findings and conclusions in this article are those of the author and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

References

1. Noise exposure from leisure activities: a review. Clark WW. *J Acoust Soc Am.* 1991; **90**: 175-181.
2. Noise exposure and hearing loss among student employees working in university entertainment venues. Sadhra S, Jackson CA, Ryder T, Brown MJ. *Ann Occup Hyg.* 2002; **46**: 455-463.
3. The influence of socio-economic status on adolescent attitude to social noise and hearing protection. Widén SE, Erlandsson SI. *Noise Health.* 2004; **7**: 59-70.
4. Self-reported tinnitus and noise sensitivity among adolescents in Sweden. Widén S E, Erlandsson SI. *Noise Health.* 2004; **7**: 29-40.
5. Recreational noise exposure and its effects on the hearing of adolescents. Part I: An interdisciplinary long-term study. Serra MR, Biassoni EC, Richter U, Minoldo G, Franco G, Abraham S, Carignani JA, Joekes S, Yacci MR. *Int J Audiol.* 2005; **44**: 65-73.
6. Recreational noise exposure and its effects on the hearing of adolescents. Part II: Development of hearing disorders. Biassoni EC, Serra MR, Richter U, Joekes S, Yacci MR, Carignani JA, Abraham S, Minoldo G, Franco G. *Int J Audiol.* 2005; **44**: 74-85.
7. Avaliação dos Limiares Auditivos de jovens e sua relação com hábitos de exposição à música eletronicamente amplificada. Jorge Júnior JJ. *Doctoral Dissertation*. Department of Otolaryngology, University of São Paulo, São Paulo. 1993. 102 pp.
8. On the relation between exposure to sound and auditory performance. Fleischer G, Muller R. *Proceedings of the SAE 2005 Noise and Vibration Conference and Exhibition.* May 2005, Grand Traverse, MI, USA, 2005.
9. Noise-induced hearing loss in young adults: the role of personal listening devices and other sources of leisure noise. Mostafapour SP, Lahargoue K, Gates GA. *Laryngoscope.*1998; **108**: 1832-1839.
10. Early noise-induced hearing loss in teenage boys. Axelsson A, Jerson T, Lindberg U, Lindgren F. *Scand Audiol.* 1981; **10**: 91-96.
11. Hearing loss at age 7, 10 and 13 - an audiometric follow-up study. Costa OA, Axelsson A, Aniansson G. *Scand Audiol Suppl.* 1988; **30**: 25-32.
12. Holes in the reticular lamina after noise exposure: implication for continuing damage in the organ of Corti. Bohne BA, Rabbitt KD. *Hear Res.* 1983; **11**: 41-53.
13. Noise-induced degeneration in the brain and representation of inner and outer hair cells. Morest DK, Bohne BA. *Hear Res.* 1983; **9**: 145-151.
14. Longitudinal threshold changes in older men with audiometric notches. Gates GA, Schmid P, Kujawa SG, Nam B, D'Agostino R. *Hear Res.* 2000; **141**: 220-228.
15. The influence of ageing on noise-induced hearing loss. Rosenhall U. *Noise Health*. 2003; **5**: 47-53.
16. Acceleration of age-related hearing loss by early noise exposure: evidence of a misspent youth. Kujawa SG, Liberman MC. *J Neurosci.* 2006; **26**: 2115-2123.
17. Trends in the prevalence of hearing loss among young adults entering an industrial workforce 1985 to 2004. Rabinowitz PM, Slade MD, Galusha D, Dixon-Ernst C, Cullen, MR. *Ear Hear*. 2006; **27**: 369-375.
18. Interventions to promote the wearing of hearing protection. El Dib RP, Verbeek J, Atallah AN, Andriolo RB, Soares BG. *Cochrane Database Syst Rev.* 2006; **19**: CD005234.

❑

PREVENTING NOISE INDUCED HEARING LOSS IN FUTURE GENERATIONS

Gael Hannan

Manager of Programs / Hearing Health Advocate
The Hearing Foundation of Canada
80 Richmond Street West, Ste. 1401
Toronto, Ontario M5H 2A4
Canada

Email: ghannan@hearingfoundation.ca
Website: www.hearingfoundation.ca

Take a moment to consider the listening behaviour of those around you every day. You can often hear a thumping car stereo before you see the car coming down the street. Riding public transport, you hear the music coming from the headphones of your fellow riders. If you attend concerts and clubs, your ears may ring for days afterwards. If you have children, the noise from their video game battles can be heard in every corner of the house.

These types of listening behaviour have become increasingly common in recent years. Yet have we really thought about the impact it may have on our hearing? At the Hearing Foundation of Canada, we have become concerned that this amounts to a huge, unregulated, although unintentional experiment that exposes the general population – especially young people – to the risk of noise-induced hearing loss.

Sound Sense

Several years ago, reacting to alarm bells set off by Canadian and international researchers, the Hearing Foundation became increasingly concerned about this issue and its impact on the future of our young people. As a result, the Hearing Foundation designed, with the help of the Ontario Trillium Foundation – an award winning and unique preventative education programme called *Sound Sense/Oui à l'ouïe.*

Students learn just how loudly they listen to their MP3 players