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## Journals

[Present Issue](#)

[Past Issues](#)

## THE SMANEWS

[Present Issue](#)

[Past Issues](#)

## [SMJ Editorial Board](#)

## Letters to the Editor

[Instructions to  
Authors](#)

## Noise is a Public Health and Social Problem in Singapore

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We live in an increasingly noisy environment. Noise from cars, road surfaces, underground trains, air travel and neighbourhood construction constantly bombard us from all directions. Leisure pursuits like discotheques, cinemas, arcade games, and personal audio sets constantly expose us to high levels of noise. Excessive noise exposure has a significant impact on the quality of life, and must be recognised as a major threat to human well-being<sup>(1)</sup>. Rapid population growth and urbanisation has resulted in increased levels of noise polluting our environment. Community noise levels are directly related to population density. An apartment in an urban precinct can be up to a thousand times (30 dBA) more noisy than in the suburban and rural areas. Furthermore some toys have been found to emit noise with an intensity that may damage hearing in children. Rapid industrialisation and economic growth of the highly populated East Asian nations have turned these countries into noise polluted communities.

## Occupational and Non-occupational Noise Induced Hearing Loss (NIHL)

In Singapore, over 50,000 workers in 1000 noisy factories are exposed to excessive noise at work<sup>(2)</sup>. NIHL is the most common industrial disease that is notifiable under The Factories Act 1975. Severe cases of NIHL with more than 50 dB hearing loss across the speech frequencies are compensable under the Workmen's Compensation Act 1975. As a result of the active management of noise exposure and early identification of workers with NIHL, advanced cases that qualify for compensation make up only 1.7% of all cases of NIHL. Furthermore there is a sharp decline in the number of newly diagnosed cases of NIHL.

The Factories (Noise) Regulations 1996 specify that a noise hazard exists if workers are exposed to an equivalent sound

pressure level of more than 85 dB(A) over an 8-hour workday. The Department of Industrial Health uses a 3 dB(A) trade-off between sound intensity and duration of exposure. For every 3 dB(A) above 85 dB(A), the duration of noise exposure has to be reduced by half. Hence a worker is permitted only 4 hours of exposure to 88 dB(A) noise, and only 2 hours of exposure to 91 dB(A) noise. All workers exposed to a noise hazard are required to undergo yearly Statutory Medical Examination and audiometry under the Factories (Medical Examination) (Amendment) Regulations 1997.

Unfortunately, the law does not protect nor compensate the large numbers of workers who are at risk of occupational NIHL in the entertainment industry, military and construction. Impulse noise from gun-fire, heavy piling in a construction site, live musical performances and recorded music are important threats to human hearing. Music club employees, performers and patrons are exposed to high levels of noise. But many choose to ignore the dangers they are exposing themselves to. As a result of the lack of awareness or fashion-consciousness, few of those at risk bother to use hearing protection(3).

There are also recreational, community and environmental causes of noise. Music aficionados who own expensive home and car hi-fi sets, motorcyclists who rev up their engines incessantly and fitness fans who work out to the thumping beat of an aerobics class are all at risk. The invention of the personal audio system is a major risk factor especially in teenagers who indulge for hours to music that has been turned up to high volumes.

Evidence suggests that children are more vulnerable to noise. Noisy high tech squeeze toys, battery operated toy machine guns and cars pervade the marketplace. Baby toys may produce intense noise in the frequency range that corresponded to the resonance frequency of the external ear canal(4). A child's head, pinna and external ear canal is shaped to allow greater amplification of high frequency sounds, which are relatively more harmful to hearing than low frequency sounds.

Drugs and chemicals can enhance the hazards of noise exposure. Agents like aminoglycoside antibiotics, nicotine from tobacco, and cisplatin can act in synergism with noise to damage hearing.

### **Impact on hearing, communication and health**

Sufferers of NIHL have difficulty with speech and communication. They strain to make out words in a conversation. Listening becomes an unpleasant and tiring chore. They may respond inappropriately in a conversation, causing a great deal of

embarrassment. Over time, patients begin to avoid difficult hearing conditions in social situations like a restaurant, during meetings or in church. This can affect the intimacy with one's spouse, family and friends. Because of their slow and inappropriate responses, patients with NIHL may be mistaken for being tardy and feeble-minded with a poor attention span. Elderly persons who suffer a double whammy of NIHL and presbycusis may suffer emotional problems and depression from social isolation and an inability to communicate effectively.

The ability to respond promptly to customer needs or absorb complex information rapidly is a prerequisite for success in our modern knowledge economy. Salesmen or business people with NIHL will find themselves at a disadvantage. Musicians depend heavily on an acute sense of hearing to determine pitch and loudness during performances. Those with impaired hearing will experience major obstacles in their career.

Noise can have other effects apart from NIHL. It can interfere with the learning process by disrupting effective communication between teachers and pupils, hence affecting scholarly performance. Teachers who have to persistently raise their voice above the clamour of ambient noise will develop hoarseness, vocal strain and fatigue. Research has shown that children in quiet schools have better academic performance compared to children in noisy schools. Elementary school children on the side of a school facing the train tracks performed worse on a reading achievement test than children facing the quiet side of the school. Scholastic achievement improved when a noise abatement program was instituted.

Noise acts as a biological stressor that can induce adverse effects on general health, behaviour, work performance, sleep, stress levels and hormonal changes. Noise induced stimulation of the autonomic nervous system can produce hypertension and other cardiovascular effects(5). Insomnia brought about by excessive noise in an urban district can cause repeated subconscious microarousals from sleep, reduction in REM sleep, increase in body movements during the night, daytime sleepiness and cardiovascular responses. Repeated sleep deprivation over the long term can lead to serious side effects.

Although high ambient noise levels may improve performance in monotonous tasks by producing arousal, complicated tasks that require cognitive ability will be affected. Information processing, decision making and creativity will be impaired by noise. Non-cognitive emotional skills such as motivation, drive to persist in solving difficult problems, and helping behaviour will also show decrements. In an interesting study, managers were found to recommend lower salaries for fictitious employees when exposed

to noise(6). Other studies point to a reduced tolerance for frustration and an increased tendency towards hostile and antisocial behaviour. The implication is that noise may have an important sociological impact that stretches far beyond the immediate medical and emotional problem. Could this be an important factor in the dehumanisation of today's urban environment?

### **The challenges that lie ahead**

Strict enforcement of hearing conservation programs in the factories has caused a sharp decline in the number of new cases of NIHL. But more needs to be done for non-occupational and occupational NIHL that is not covered by the Factories Act 1975. NIHL is a preventable disease. The public should be equipped with the necessary knowledge and skills to protect themselves. Public awareness programs should be targeted at high-risk groups like teenagers who frequent music clubs or use personal audio systems.

Innovations in drug treatment and drug delivery methods holds promise for the prevention and treatment of patients with NIHL. Research has uncovered new insights into how NIHL occurs. Several explanations attribute inner ear damage to the toxic effects of free oxygen radicals, glutamate, lack of the protective effects of glutathione (an anti-oxidant)(7), and angiotensin induced microcirculatory changes that cause local ischemia. Promising therapeutic candidates that have an otoneuroprotective action on NIHL include caroverine (anti-glutaminergic agent)(8), sarthran (angiotensin receptor antagonist)(9), allopurinol and superoxide dismutase(10).

In summary, overexposure to noise results in a wide array of effects on human health, including NIHL, social, behavioural and educational problems. Preventive and educational measures should be directed at at-risk groups who are most likely to suffer the consequences of noise over-exposure.

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