SOUND RESEARCH
Quality of Life Focus: Noise-Induced Hearing Loss Risk Awareness

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Reference Terms

OSHA – Occupational Safety and Health Administration
NHANES – National Health and Nutrition Examination Survey
dB – decibels
CHD – Chronic Heart Disease
CVD – Cardiovascular Disease
LAeq – Equivalent continuous noise level
dBA LDN – Calculation of day and night noise levels

INTRODUCTION AND PUBLIC HEALTH IMPORTANCE

NIHL was formally acknowledged as a medical condition in the United States (US) during the Industrial Revolution, first named 'boilermaker's disease' as a reference to the hearing loss suffered by workers building engines that powered transportation and production [2].

Noise is defined as unwanted sound. Environmental noise consists of all the unwanted sounds in our communities except that which originates in the workplace. **The potential health effects of noise pollution are numerous, pervasive, persistent and medically and socially significant.** Noise produces direct and cumulative adverse effects that impair health and that degrade residential, social, working and learning environments with corresponding real (economic) and intangible (well-being) losses.[1]

Noise is the most common modifiable environmental cause of hearing loss among young and middle-aged adults, and the most common self-reported cause of hearing loss among men.[2]

Noise exposure is the second most common cause of acquired hearing loss (after aging).[3]

An estimated 24% of hearing loss in the United States has been attributed to workplace exposures.[4]

As the population grows and as sources of noise become more numerous and more powerful, **there is increasing exposure to noise pollution, which has profound public health implications.**

Chronic environmental noise causes a wide variety of adverse health effects, including sleep disturbance, annoyance, noise-induced hearing loss (NIHL), cardiovascular disease, endocrine effects and increased incidence of diabetes.[6]

Hearing loss is present in approximately 60% of people with tinnitus [132, 133], suggestive of similar pathological processes after harmful noise exposure.

It is difficult to overstate the social cost of NIHL and its impact on quality of life. The additional effort required to process sound leads to fatigue, headaches, nervousness, depression and anger.[7]

A previous United States Census found that 30% of Americans complained of noise, and 11% found it to be bothersome. Among those who complained, noise was sufficiently bothersome to make nearly 40% want to change their place of residence.[5]

Children with NIHL suffer from decreased educational achievement and impaired social-emotional development, score significantly lower on basic skills and exhibit behavioral problems and lower self-esteem.[8]

As a society, our history is filled with failures to recognize the agents that cause disease; once the causes have been recognized, we have responded reluctantly, slowly, and often inadequately. The case with tobacco is an instructive one. It took many years of lobbying by dedicated individuals before legislators and the general public recognized the links between the hazards of tobacco smoke and disease; as a result, laws were finally enacted and behaviors changed accordingly.

A National Institutes of Health (NIH) panel concluded that high-visibility media campaigns are needed to **develop public awareness of the effects of noise on hearing** and the means of self-protection. In addition to informing the public, these programs should target primary healthcare physicians and educators who deal with young people.[1]

Adding the benefits of reduced cardiovascular disease to cost-benefit analyses of proposed noise mitigation policies and investments (such as low noise pavement, noise barriers, active noise control) could appropriately enhance the economic valuation of these strategies, as the scale of the impacts estimated here make modest mitigation seem economically promising.[9]

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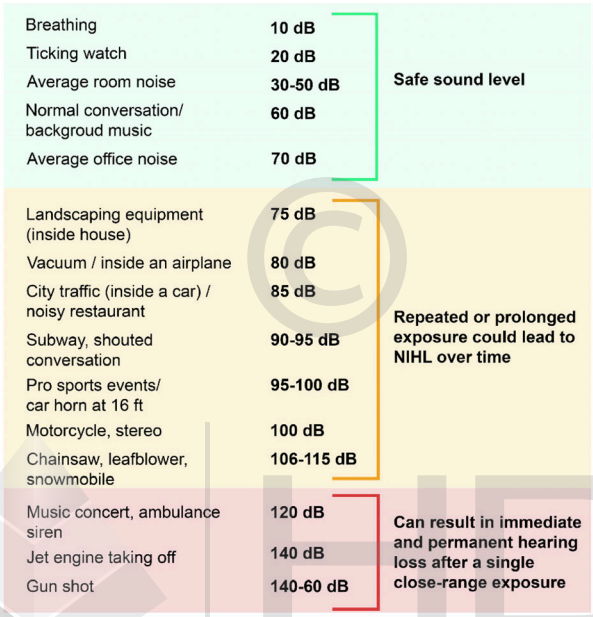
KEY RESEARCH STATISTICS

Both the loudness of sound (called the intensity) and the amount of time you hear the noise are important. Sound is measured in decibels. Eight hours of hearing noise at 85 decibels could hurt your hearing. At higher sound levels, you could lose hearing in even less time.[3]

As many as 30 million Americans are exposed to potentially harmful sound levels in their workplaces.

Approximately 16% of disabling hearing loss in adults globally is attributed to occupational noise, ranging from 7 to 21% across various geographic regions [16].

Outside of work, many persons pursue recreational activities that can produce harmful noise. Sixty million Americans own firearms, and many use them without adequate hearing protection.[3]



Examples of noise exposure levels in occupational and non-occupational settings. Data from the United States National Institute for Occupational Safety and Health [30] and the Hearing Health Foundation [31].

The most recent Global Burden of Disease report (2019) estimated that 1.57 billion people, or **20.3% of the world population, are affected by any kind of hearing loss,** with 62% over the age of 50 years [8].

As **NIHL is the second most common cause of hearing loss** after presbycusis (age-related hearing loss) [9,10], it imposes an enormous burden on individuals and health systems.

Recent estimates indicate that >100 million Americans are exposed to levels of **environmental noise** that put them at risk for hearing loss, stress, sleep disruption and annoyance, which over time **increases risk of cardiovascular disease.**[13]

KEY RESEARCH RESULTS AND DISCUSSION

A previous **NHANES** survey included participants aged 20-69 years. The weighted prevalence of an audiometric notch *(a dip or notch in the audiogram maximal at 4 kHz with recovery at 6 and 8 kHz)* among U.S. adults aged 20-69 years was 39.4 million or 24.4% (6.2% bilateral notch and 18.2% unilateral notch).

Twenty-one million U.S. adults (19.9%) who reported no exposure to loud or very loud noise at work had an audiometric notch (bilateral or unilateral). Persons exposed to loud noise at work were twice as likely to have bilateral or unilateral notches than those not exposed.[12]

Noise is only one of many factors that impact the risk of **CHD** and even taking other lifestyle and environmental factors (such as air quality) into account, a majority of the studies found significant, positive relationships between environmental noise and **CVD**.[9]

Babisch and colleagues' meta-analysis on the relationship between road noise and CHD associated a 10 dB LDN increase in road traffic noise with an 8% increase in CHD.[14]

This exploratory analysis evaluates **the impact of environmental noise on** two key components of **cardiovascular health** – CHD and hypertension.

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The results from Models 1 and 2 suggest that a 5 dB LDN reduction in environmental noise would reduce hypertension cases by 1.2 million and CHD cases by 279,000. The associated cost savings equal $2.4 billion annually in health care costs and $1.5 billion annually in productivity gains. Together, the estimated economic impact of the reduction scenario is over $3.9 billion annually.[9]

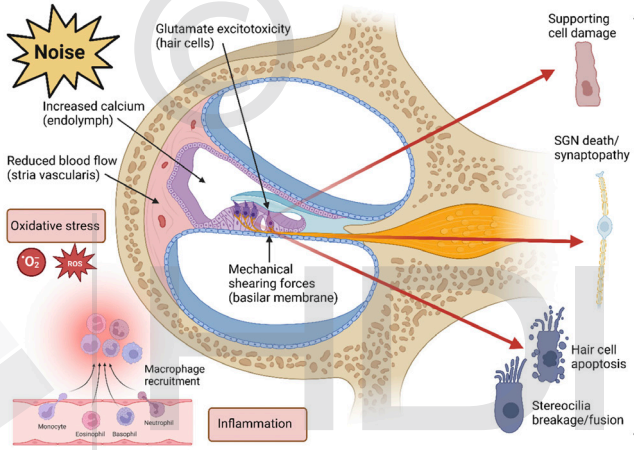
However, 23.5% of persons who self-reported excellent or good hearing (irrespective of noise exposure reported) had bilateral or unilateral notches (5.5% and 18.0%, respectively). These numbers were higher (31.0%) among persons reporting exposure to noise at work and lower (20.1%) among those who were not exposed to noise at work.

Persons with auditory damage caused by noise frequently do not recognize it; one in four U.S. adults who reported excellent or good hearing had an audiometric notch. Among persons who reported work exposure to loud noise, one third had a bilateral or unilateral notch.[12]

Many of the respondents said they would be motivated to use **ear protection** if they were aware of the potential of permanent hearing loss (66%) or **if such protection were advised by a medical professional** (59%).[15]

Neuroinflammation, a critical component of maintaining homeostasis in the central and peripheral nervous system, has been implicated in a wide range of pathological processes, including NIHL. [100 –104]

A study of 258 **military** personnel found that **vestibular damage** from **intense noise exposure** was corelated with asymmetric NIHL [138].



Mechanisms of damage in NIHL. Abbreviations: ROS, reactive oxygen species; SGN, spira ganglion neurite.

The mechanisms by which loud noise induces hearing loss include mechanical damage of cochlear structures, reduction in blood flow, sterile inflammation, and oxidative stress and excitotoxicity due to overstimulation of hair cells and nerves. [54, 55]

PRACTICAL AND CLINICAL APPLICATIONS

A patient who reports significant exposure to noise should be informed that **noise-induced hearing loss,** although permanent and not fully treatable, **is virtually 100 percent preventable.**

Noise exposure at younger ages needs particular attention. Damage to hearing accumulates over time so that hazardous exposure that begins earlier in life has the potential to be more damaging as persons age.[12]

Hearing screenings can help reduce delays in diagnosis and improve access to hearing aids for those with hearing loss,

During routine exams, primary care providers can examine patients' hearing; ask about patients' hearing and noise exposures and inform them about the benefits of hearing protection; monitor patients with hearing loss symptoms, recommend or provide hearing tests when indicated and counsel patients with hearing loss.[18]

Noise represents an important public health problem that can lead to hearing loss, sleep disruption, cardiovascular disease, social handicaps, reduced productivity, impaired teaching and learning, absenteeism and increased drug use and accidents.[11]

Further, NIHL is associated with a substantial economic burden to governments and society at large, expected to increase as the global population ages and experiences increased costs of NIHL related healthcare and disability.

Thus, the prevention of noise-induced cochlear injury, via the use of hearing protection in loud occupational and recreational settings, remains the cornerstone of reducing the enormous burden of NIHL.

Governmental regulations and safety-focused organizations play essential roles in advising the public and industry on safe noise exposure levels and in implementing educational programs.

The impact of NIHL is not limited to decreased quality of life of affected individuals but can extend to lower productivity of the workforce and impaired performance of military personnel.

For example, a cost-effectiveness analysis of a military hearing conservation program estimated a lifetime savings of USD $10,657 per person in service-related compensation on implementation of the program [320].

Disclaimer: Research excerpts provide helpful references for those interested in learning more about these important healthcare topics. They are intended to empower providers, patients and loved ones with additional input for personal consultation. For those seeking additional educational references, it is suggested they research specific topics of interest via publicly available resources such as pubmed.gov or Google Scholar. Please personally consult with expert health providers to make well-informed decisions.

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