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Environmental Noise and Hearing

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ABSTRACT

Undesirable sound is referred as noise. Common sources of noise are vehicular traffic, factories involved in the manufacturing process, and home appliances like vacuum cleaners and music systems. Noise pollution effects on human health are a matter of great concern. Exposure to noise can damage one of the most vital organs of the body, the ear. Hearing impairment due to noise can either be temporary or permanent. When the sound level crosses the 70dB mark, it becomes noise for the ear .Noise levels above 80 decibels produce damaging effects to the year. When the ear is exposed to extreme loud noise that is above 100dB, for a considerable period of time, it can cause irreparable damage and can lead to permanent hearing loss.

Keywords: Noise, auditory effects, cochlea, decibel

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INTRODUCTION

Noise is defined as unwanted sound, which pleases the listeners, is music and that causes pain and annoyance is noise. At times what is music for some can be noise for others(Parivesh,1996).

The word noise is derived from the Latin term nausea. It has been defined as unwanted, a potential hazard to health and communication dumped into the environment with regard to the adverse effect it may have on unwilling ears(Jaiswal,2003).

In Chambers 21st century Dictionary the definition of noise has undergone a change. Noise pollution stands carved out as phrase separately from noise. The two are defined as under noise-a sound; a harsh disagreeable sound or such sound: din. Pollution-an excessive or annoying degree of noise in a particular area e.g. .from traffic to aero plane engines.

Noise can be described as sound without agreeable music quality or as unwanted or undesired sound. Thus noise can be taken as a group of loud, non harmonious sounds or vibrations that are unpleasure and irritating to ears(Miglani,).

Measurement of Noise

Sound has two properties

Loudness

Loudness depends upon the amplitude of the vibrations initiated by noise. The loudness is measured in decibels (dB) it means a sound level where the sound pressure is equal to that of the reference level, sound pressure level is given in units of dB (A) or dBA. Sound pressure level on the dBA scale is easy to measure and is therefore widely used.

A decibel is the standard for the measurement of noise .the zero on the decibel scale is at the threshold of hearing, 0dB does not mean no sound, It is the lowest sound pressure that can be heard on the scale, 20dB is whisper, 40dB the noise in a quite office, 60 dB is normal conversation, 80dB is the level at which sound becomes physically painful.

Frequency

The frequency is denoted in Hertz (Hz).One hertz is equal to one wave per sound. Human ear can hear frequencies from about 20-20,000 Hz, but this range reduces with age. The range of vibration below 20Hz are infra-audible and those above 20,000Hz are ultrasonic.

The basic instruments used in studies on noise are

Sound Level Meter

It measures the intensity of sound in dB at particular place at particular time.



Audiometer

It measures the acuity of hearing of the individual.

Audiometry

Hearing loss can range from mild to profound deafness. Hearing loss is usually measured in units called dBHL-dB stands for decibel and HL for hearing level. A hearing test finds the softest sounds a person can hear-the threshold-across a range of frequencies (pitch of sounds).The greater the threshold level (in dBHL), the greater the hearing loss. 'high frequency' hearing loss means hearing is poorest for high pitch sounds. 'low frequency' hearing loss mean hearing is poorest for low pitch sounds and a flat hearing loss means a similar hearing loss across all frequencies.

When you have a hearing test, the chart that shows hearing level is known as audiogram, if hearing loss is caused by exposure to noise, test will produce a characterize pattern. The typical pattern usually consists of a 'dip' in hearing in the high frequency (at around 3-4KHZ), which means these pitches as well as others cannot be heard. If the noise exposure continues the dip in audiogram will spread and effect lower and higher frequencies too.

Sources of Noise Pollution

Broadly speaking, the noise pollution has two sources, i.e. industrial and non-industrial. The industrial source includes the noise from various industries and big machines working at a very high speed and high noise intensity. Non- industrial source of noise includes the noise created by transport/vehicular traffic and the neighborhood noise generated by various noise pollution can also be divided in the categories, namely, natural and manmade. Most leading noise sources will fall into the following categories: roads traffic, aircraft, railroads, construction, industry, noise in buildings, and consumer products.

Road Traffic Noise

In the city, the main sources of traffic noise are the motors and exhaust system of autos, smaller trucks, buses, and motorcycles. This type of noise can be augmented by narrow streets and tall buildings, which produce a canyon in which traffic noise reverberates.

Air Craft Noise

Now-a-days , the problem of low flying military aircraft has added a new dimension to community annoyance, as the nation seeks to improve its nap-of the-earth aircraft operations over national parks, wilderness areas , and other areas previously unaffected by aircraft noise has claimed national attention over recent years.



Noise from railroads

The noise from locomotive engines, horns and whistles, and switching and shunting operation in rail yards can impact neighboring communities and railroad workers. For example, rail car retarders can produce a high frequency, high level screech that can reach peak levels of 120 dB at a distance of 100 feet, which translates to levels as high as 138, or 140 dB at the railroad worker's ear.

Construction Noise

The noise from the construction of highways, city streets, and buildings is a major contributor to the urban scene. Construction noise sources include pneumatic hammers, air compressors, bulldozers, loaders, dump trucks (and their back-up signals), and pavement breakers.

Noise in Industry

Although industrial noise is one of the less prevalent community noise problems, neighbors of noisy manufacturing plants can be disturbed by sources such as fans, motors, and compressors mounted on the outside of buildings. Interior noise can also be transmitted to the community through open windows and doors, and even through building walls. These interior noise sources have significant impacts on industrial workers, among whom noise-induced hearing loss is unfortunately common.

Noise in building

Apartment dwellers are often annoyed by noise in their homes, especially when the building is not well designed and constructed. In this case, internal building noise from plumbing, boilers, generators, air conditioners, and fans, can be audible and annoying. Improperly insulated walls and ceilings can reveal the sound of-amplified music, voices, footfalls and noisy activities from neighboring units. External noise from emergency vehicles, traffic, refuse collection, and other city noises can be a problem for urban residents, especially when windows are open or insufficiently glazed.

Noise from Consumer products

Certain household equipment, such as vacuum cleaners and some kitchen appliances have been and continue to be noisemakers, although their contribution to the daily noise dose is usually not very large.

Effects of Noise

The noise exposure causes auditory and non-acoustic effects on human body.

Auditory effects

The auditory effects of noise are auditory fatigue, tinnitus, and otalgia and hearing loss. Most of the time the victim is unaware of the hearing loss. Hearing loss is greatest for 4000Hz frequency. noise induced hearing loss can be classified into three categories namely temporary threshold shift(TTS),Permanent threshold shift(PTS),Acoustic trauma(AT).Temporary threshold shift is defined as temporary reduction of hearing acuity due to noise exposure; its duration may extend from hours to days(Bugliarello,1976).Permanent threshold shift occurs as a result of repeated TTS. Permanent threshold shift occurring following single noise exposure is termed as acoustic trauma. Hearing loss caused by noise is greatest between 3-6kHz,and recovery at 8kHz.Maximum hearing loss occurs at4 kHz.

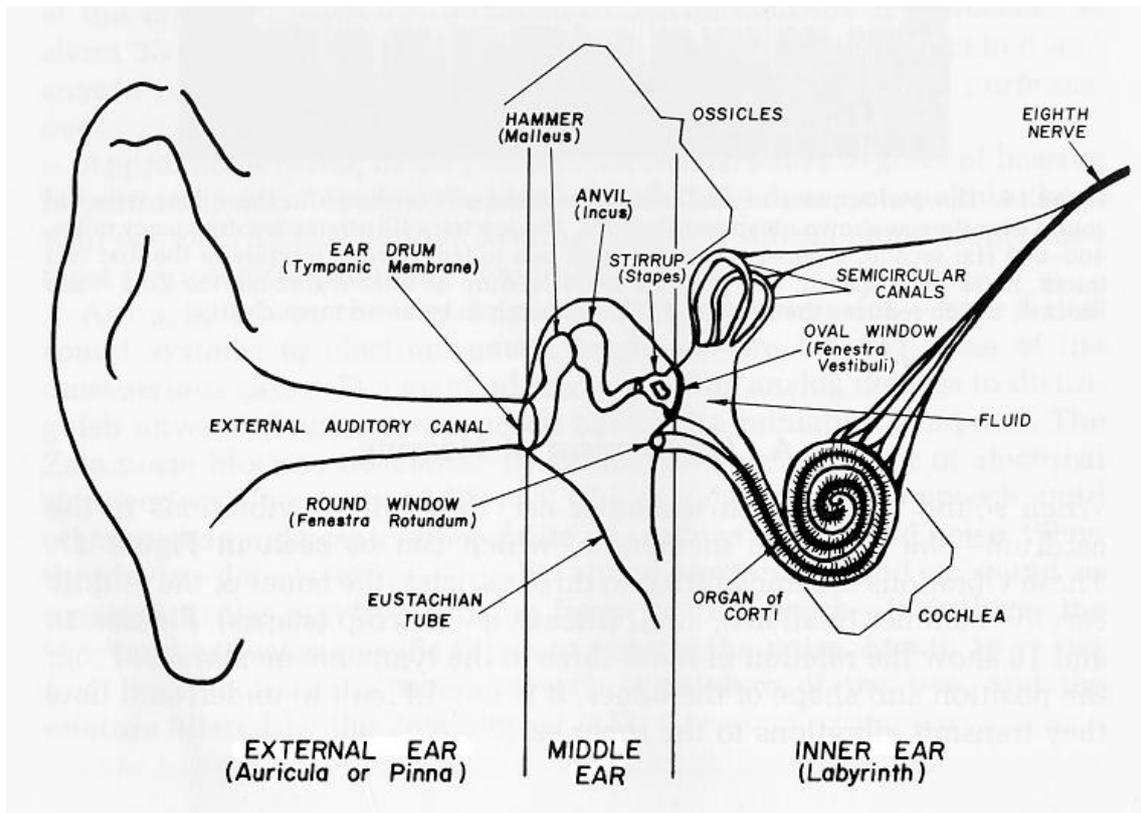


Figure 1: Anatomy of the Ear (von Bekesy, 1957)

The ears are our organs of hearing and balance. They have three sections

- The outer ear
- The middle ear
- The inner ear

Sound waves enter the outer ear (the pinna and external ear canal) and are channeled down in the ear canal until they reach the eardrum. The sound waves make our eardrums vibrate and the vibrations then pass into the middle ear. The middle ear is an air-to the cochlea (the hearing organ within the inner ear) and it is these three bones that pick



up the vibrations of the eardrum, causing the bones to move and mechanically conduct the sound waves through the middle ear to the cochlea.

The cochlea is fluid-filled chamber that looks a bit like snail shell. When the sound waves enter the cochlea, the fluid moves and special hair-like cells trigger an electric signal in the auditory nerve, different hair cells (organ of Corti) pick up different parts of the sound spectrum depending on where they are positioned in the cochlea. The auditory nerve then passes electric signals to the brain. Which recognizes them as sound?

Cochlea is sensory organ of hearing, first described by Alfonso Corti. Noise pollution causes adverse impact on hearing. Noise induced hearing loss is defined as reduction in auditory acuity associated with noise exposure. Noise exposure causes knife sharp demarcation between damaged and undamaged area. Cochlear pathology does not correlate with the degree of permanent threshold shift but it is related to duration of exposure, intensity and frequency. Hearing loss is fast up to 30dB. Outer hair cells are more readily damaged by noise than inner hair cells. Noise causes hearing loss by direct mechanical damage of hair cells, metabolic disturbances by altering permeability and circulation and degeneration of the cochlear nerve endings and fibers.

Sensorineural hearing loss is caused by damage to the hair cells in the cochlea. These cells cannot be repaired or replaced. Damage of this kind may happen by meningitis, ageing is the most common cause. In addition, the hair cells can be permanently damaged by exposure to loud noises. Exposure to loud noise can cause temporary or permanent hearing loss due to noise damaging the sensitive hair cells in the cochlea. The loss of hearing is likely to become permanent if exposure to noise is prolonged or repeated.

Temporary hearing loss is sometimes referred to as 'temporary threshold shift'. In this temporary dullness is noticed after exposure to loud noise. The hearing may recover, normally within about two days. But this depends upon factors such as the loudness of the noise, length of exposure. In these circumstances, dull hearing is often an indicator that hearing system has been exposed to damaging levels of noise.

Permanent hearing loss is sometimes referred to as 'Permanent threshold shift'. If hearing does not recover completely within 48 hours, the remaining loss is considered to be permanent. Hearing can be affected permanently due to either noise or acoustic trauma.

This happens due to exposure to damaging levels of noise over a long period of time and gradually results in a sensorineural hearing loss which is usually more severe in the high frequencies. The hearing loss will get worse in continuous exposure to noise.

Acoustic trauma occurs due to exposure to a very high sound level for a short period of time like explosion, or gunfire. This type of sound causes a sudden hearing loss that is often more severe in the ear closest to sound. This causes sensorineural hearing loss. A very intense sound can perforate eardrum, although this can heal in time.

Tinnitus is the first sign of the damaged ear by noise. The tinnitus can occur suddenly or very gradually. It is temporary but continued exposure to loud noise may make it permanent.

Non-auditory effects

These are of several kinds

Cardiovascular Issues

A noisy environment can be a source of heart related problems. Studies have shown that high intensity sound cause a dramatic rise in blood pressure as noise levels constrict the arteries, disrupting the blood flow. The heart rate (the number of heart beats per minute) also increase. These sudden abnormal changes in the blood increase the likelihood of cardiovascular diseases in the long run.

Sleep Disturbances

This is one of the noise pollution effects that can deter your overall well being. Noise can interrupt a good night's sleep, and when this occurs, the person feels extremely **annoyed** and uncomfortable. People deprived of uninterrupted sleep show a sharp dip in their energy levels which often results into extreme fatigue. This can considerably decrease a person's ability to work efficiently.

Interference in Verbal Communication

A noisy environment that produces more than 50-60 decibels simply does not allow 2 people to communicate properly. Interpreting the speech of a second person becomes quite difficult and may lead to misunderstandings.

Mental Health Problems

Exposure to loud sound can lead to elevated stress levels as well as stimulate violent behavior. A constant noise in the vicinity can also trigger headaches, make people tense and anxious, and disturb emotional balance.

CONCLUSION

Of all the Environmental problems, noise is the easiest to control". But the question of control will arise only after there in awareness among the people of the need for control (Daniel G. Nunez, 1998).

This paper discusses and concentrates upon important aspects of a complex socio-technological problem, noise pollution. Large segments of the population and industrialized society are exposed to high levels of noise, not only at their place of work, but also in their residences and in their leisure activities. Noise can be controlled by adopting a two way strategy that is control of noise as well as prevention of Noise induced hearing loss.

Control of Noise

Reduction of Noise at Source

The first approach has been to reduce noise at source. Design and fabrication of silencing devices and their use in aircraft engines, trucks, cars, motorcycles, industrial machines and home appliances would be an effective measure. Protection to workers can be provided through wearing devices such as earplugs and earmuffs.

- Making a change in design and operation of machines, vibration control, sound proof cabins and sound-absorbing materials can reduce it.
- It can get reduced by prescribing noise limits for vehicular traffic, ban on honking of horns in certain areas and planning main traffic arteries, industrial establishments, amusement areas, residential colonies, creation of silent zones near schools and hospitals and resigning of building to make them noise proof. Other measures can involve reduction of traffic density in residential areas giving preferences to mass public transport system.

Control of Indoor Noise

Where outdoor noise levels have been high, the following methods can be applied for reducing their effect.

- Locate in the building as far as possible from noise source. The noise level drops about 6dB each time the distance is doubled.
- Trees and shrubs may be planted in front of building to provide some absorption for the sound.

Road Noise

Vegetation buffer zones must be created in different parts of the city. Efforts should be made for roadside plantations.

An Urgent Need for Legislation to Control Noise Pollution

We have seen that in India, in absence of a specific legislation for control and prevention of the noise pollution, one has to seek provisions in various branches of law and regulations. There has been no doubt that the available provisions in various branches of law and regulations. There has been no doubt that the available provisions in various branches of law are adequate, unscientific and crude. In most of the developed countries specific legislations have been made and scientific methods for investigation of noise pollution have been invented. The science of audiometer and other branched related to sound have been developed and it becomes comfortable to device various legal provisions to control and prevent noise pollution.

As present, there is no specific and detailed legislation to control the noise pollution. However, there is an urgent need that the Central Government of India should manage to



get a legislation passed for the control of noise pollution. Some legislation regarding water and air pollution has been made in India.

Education

People can be educated through radio, TV, newsreels in cinema halls about noise pollution. In the family, elders can teach children to keep the radio volume low, low voice talking not to horn unnecessarily on the roads, avoid quarreling amongst each other and so on. There should be complete ban of loudspeakers from 8 p.m. to 7 a.m.

Public Awakening and the Control

It is also important that public awakening is also very essential for the control and prevention of the noise pollution. In India, most of the persons lack any idea about the ways in which noise pollution could be controlled. Very few scientists are aware of the problem and its control. Masses are still ignorant of the grave effects of the noise pollution. In this regard television, radio, internet, and newspapers should give a campaign for wide publicity.

Prevention of NIHL

NIHL is 100 percent preventable. All individuals should understand the hazards of noise and how to practice good hearing health in everyday life.

Treatment of NIHL

If the noise has damaged ears, then and there is no treatment-no medicine, no surgery, not even a hearing aid, that truly corrects hearing once it is damaged by noise. The only thing is to protect remaining hearing. The things can be done are-

Avoidance

The best way to prevent future injury from noise is to avoid exposure to noise. One should be alert to hazardous noise in the environment and should also make family, friends, and colleagues aware of the hazards of noise. Noise levels at or above 85 decibels can cause hearing damage.

On hearing loss, a medical examination by an otolaryngologist (a physician who specializes in diseases of the ears, nose, throat, head, and neck) and a hearing test by an audiologist (a health professional trained to measure and help individuals deal with hearing loss) is necessary.

Hearing Protection

Hearing protective devices should be used when involved in a loud activity. Hearing protection devices decrease the intensity of sound that reaches the eardrum. They come in two forms: earplugs and earmuffs.

Earplugs are small inserts that fit into the outer ear canal. To be effective they must totally block the ear canal with an airtight seal. They are available in a variety of shapes and sizes to fit individual ear canals and can be custom made. For people who have trouble keeping them in their ear, they can be fitted to a headband. Simple foam ear-plugs are available at very low cost from the drugstore. Custom made earplugs can be obtained from audiologists. Earplugs must be snugly sealed so the entire circumference of the ear canal is blocked. An improperly fitted, dirty or worn-out plug may not seal and can irritate the ear canal. Ordinary cotton balls or tissue paper was stuffed into the ear canals are very poor protectors; they reduce noise only by approximately 7 dB.

Earmuffs fit over the entire outer ear to form an air seal so the entire circumference of the ear canal is blocked, and they are held in place by an adjustable band. Earmuffs will not seal around eyeglasses or long hair, and the adjustable headband tension must be sufficient to hold earmuffs firmly around the ear.

Properly fitted earplugs or muffs reduce noise 15 to 30 dB. The better earplugs and muffs are approximately equal in sound reduction, although earplugs are better for low frequency noise and earmuffs for high frequency noise. Simultaneous use of earplugs and muffs usually adds 10 to 15 dB more protection than either used alone. Combined use should be considered when noise exceeds 105 dB. Note that for such situations, it may be that there is no type of hearing protection that will stop a very loud noise from affecting you.

Investigational Treatments

The mechanism of noise induced damage is proposed to include reactive oxygen species (Le Prell, 2003), which can cause cell death. Reactive oxygen species are removed by antioxidants. Antioxidants that have been studied include N-acetylcysteine, magnesium, salicylate, vitamin E and ebselen (Coleman et al 2007, Le Prell et al 2007, Lynch & Kil 2005, Sendowski et al 2006, and Suckfuell et al 2007). Two recent studies have demonstrated a degradation of cell-cell junctions (important for structural and function purposes) and genetic transcriptional changes in animal models. This means that noise-induced damage can modify “genetic maintenance” of the cochlea (Cai et al 2012, Zheng & Hu 2012).

Glucorticoids, such as cortisol, may modulate hearing sensitivity (Canlon et al 2007) and also shows some protective effects (Le Prell et al 2003, Oishi & Schacht 2011). Increasing interest is developing with regard to oral antioxidant treatment/prevention of NIHL. D-methionine (D-met), salicylate, ebselen, N-acetylcysteine (NAC), ACE Mg, and sodium thiosulfates are all in or near clinical trials. Gene therapy and stem cell therapy are also under investigation for the treatment of sensorineural hearing loss (Sun et al 2011).

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