Health Impacts of Urban Road Traffic Noise

Pratik N. Ruparel, Dr. N. J. Mistry, and Dr. N. D. Jariwala

Abstract—Though technological advance has brought many conveniences, it has also resulted in many hazards. Pollution of various types is one of them. These include air pollution, water pollution, soil pollution and noise pollution. Noise and sound need to be carefully distinguished. Sound is a term used to describe wave-like variations in air pressure that occur at frequencies that can stimulate receptors in the inner ear. Noise implies the presence of sound but also implies a response to sound. Noise is often defined as unwanted sound. Road transportation plays a major role in the economic and social development of any country. With the increase in vehicle population, noise level will also increase. Noise pollution in urban cities is a serious problem and steadily increasing over the years. This has direct and indirect affect to the people. Exposure to excessive noise is the major unavoidable cause of permanent hearing impairment. Worldwide, 16% of the disabling hearing loss in adults is attributed to occupational noise. Noise-Induced Hearing Loss (NIHL) is bilateral and symmetrical, usually affecting the higher frequencies (3k, 4k or 6k Hz) and then spreading to the lower frequencies (0.5k, 1k or 2k Hz). Annoyance is the most widespread adverse effect of noise. Other major health effects of noise are lack of concentration, irritation, fatigue, headache, sleep disturbance etc.

Keywords— Annoyance, Health Effects, Noise Induced Hearing Loss, Road Transport.

I. INTRODUCTION

In common use, the word noise means any unwanted sound [1]. Noise can also be defined as the level of sound that exceeds the acceptable level and creates an annoyance [2]. Environmental Noise is the collection of offending sounds to which humans are involuntarily exposed. The principal sources of environmental noise are motor vehicles, aircrafts and, increasingly, entertainment from live or reproduced music [3]. Everyone reacts differently to noise. One person's maximum-volume music listening pleasure might be another's unbearable noise. Level of annoyance depends upon the loudness, time and frequency of noise. When speaking of noise in relation to sound, what is commonly meant is meaningless sound of greater than usual volume. Thus, a loud activity may be referred to as noisy. However, conversations of other people may be called noise for people not involved in any of them, and noise can be any unwanted sound such as the noise of dogs barking, road traffic sounds, or aircraft, spoiling the quiet [4].

Noise pollution is recognized as a major problem for the quality of life in urban areas all over the world. Because of the increase in the number of cars and industrialization, noise pollution has also increased. Noise in cities, especially along main arteries, has reached up disturbing levels. Residences far from noise sources and near silent secondary roads are currently very popular. People prefer to live in places far from noisy urban areas [5].

The most immediate and verifiable health effect presented by high sound levels is loss of hearing which is often reported as Noise Induced Hearing Loss. It can be caused by a one-time exposure to an intense “impulse” sound, such as an explosion, or by continuous exposure to loud sounds over an extended period of time. When a person is exposed to loud noise over a long period of time, symptoms will increase gradually [6]. The most widespread subjective response to noise is annoyance, which may include fear and mild anger, relating to a belief that one is being avoidably harmed. In western countries, sleep problems are increasing owing to lifestyle and environmental factors. Sleep disturbances are regarded as being among the most serious effects of environmental noise and one of the most common reasons for noise complaints [7].

II. NOISE POLLUTION

A. Basics of Noise

Sound is produced by any vibrating body and is transmitted in air only as a longitudinal wave motion. It is, therefore, a form of mechanical energy and is typically measured in energy-related units. For listeners sound is defined as acoustic energy in the frequency range from 20,000 Hz to below 20 Hz that is typical of the human auditory system [8]. The scale for measuring intensity of noise is the decibel (dB). Humans are equipped with very sensitive ears capable of detecting sound waves of extremely low intensity. The faintest sound which the human ear can detect is known as the threshold of hearing. The threshold of hearing is assigned a sound level of 0 decibels (abbreviated 0 dB); this sound corresponds to an intensity of 1*10^-12 W/m^2. A sound which is 10 times more intense (1*10^-1 W/m^2) is assigned a sound level of 10 dB. A sound which is 10*10 or 100 times more intense (1*10^-10 W/m^2) is assigned a sound level of 20 dB. A sound which is 10*10*10 or 1000 times more intense (1*10^-9 W/m^2) is assigned a sound level of 30 dB. The decibel scale is a logarithmic scale that measures the intensity of sound. The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called “A” filter. A sound level measured with this filter switched on is denoted as dB (A). Practically all noise is measured using the A filter. The sound pressure level in dB (A) gives a close indication of the subjective loudness of
the noise. $L_{eq,A}$ is a widely used noise parameter that calculates a constant level of noise with the same energy content as the varying acoustics noise signal being measured. The letter “A” denotes that the A-weighing has been included and “eq” indicates that an equivalent level has been calculated. Hence, $L_{eq}$ is the A-weighted-equivalent continuous noise level [9].

B. Urban Road Traffic Noise

Of all present day sources of noise, the noise from surface transportation – above all that from road vehicles – is the most diffused. In Europe and Japan, it is the source that creates the greatest problems. Everywhere it is growing in intensity, spreading to areas until now unaffected, reaching even further into the night hours and creating as much concern as air pollution. This is not surprising when it is realized that road vehicles generate 20 times more power than that developed by all other sources combined viz. aircraft, ships, power stations etc.

Nearly all the urban and suburban population is exposed to surface transportation noise, both as vehicle occupant and as bystander, and increasingly the rural population is also becoming similarly exposed – so that in a modern developed country, almost no one escapes. A rough estimate of the total US population thus affected indicates that as many as 3/4 of the entire population may be exposed to annoying levels of surface transportation noise [10].

Traffic related noise pollution accounts for nearly ⅔ of the total noise pollution in an urban area. Traffic noise on existing urban road-ways lowers the quality of life and property values for person residing in vicinity of these urban corridors. It is high time to realize the importance of protection against noise pollution on both local and global basis. Due to limited availability of land resources and finances, many highways and important roads in cities, they fall in the residential and commercial areas.

Hence, there will be adverse environmental effects of noise, including psychological and physiological effects to those living in the proximity of this urban traffic [11].

III. IMPACTS OF NOISE

A. Auditory Health Effects of Noise

Every day, we experience sound in our environment, such as the sounds from television and radio, household appliances, and traffic. Normally, we hear these sounds at safe levels that do not affect our hearing. However, when we are exposed to harmful noise - sounds that are too loud or loud sounds that last a long time - sensitive structures in our inner ear can be damaged, causing noise-induced hearing loss (NIHL). These sensitive structures, called hair cells, are small sensory cells that convert sound energy into electrical signals that travel to the brain. Once damaged, our hair cells cannot grow back. As the exposure time to loud noise increases, more and more hair cells are destroyed. As the number of hair cells decreases, ability to hear also decreases. There is no way to restore life to dear hair cells; the damage is permanent. Noise-induced hearing loss is typically greatest in the range of 1-4 kHz [12].

Measurement of Hearing Loss is known as Audiology. It is the process of examining ears of the patients and taking audiograms. Earphones are used to evaluate hearing. An audiogram is a graph that charts the way a person responds to specific sounds called pure tones. It is designed to record the response for the mechanical part of hearing. The audiologist measures patient’s hearing threshold at each frequency. An audiogram, generally can be said a ‘picture’ of own hearing. It indicates how much our hearing varies from normal [13].

B. Non-Auditory Health Effects of Noise

Noise acts on the body as stress, arousing us through a series of bodily reactions. Basically, the response involves putting the body into a state of shock, chiefly through release of the hormones cortisol and adrenalin. Noise-induced stress leads to irritability, tiredness and headaches which may increase blood pressure strain the heart and affect vision [4].

After prolonged exposure, susceptible individuals in the general population may develop permanent effects, such as hypertension and ischemic heart diseases associated with exposures to high sound pressure levels. If the exposure is of sufficient intensity and unpredictability, cardiovascular hormonal responses may appear, including increase in heart rate and peripheral vascular resistance; changes in blood pressure, blood viscosity and blood lipids; and shifts in electrolyte balance (Mg/Ca) and hormonal levels. Many studies in occupational settings have indicated that workers exposed to high levels of industrial noise for 5-30 years have increased blood pressure and statistically significant increase in risk for hypertension, compared to workers in control areas [14].

The most widespread problem created by noise is annoyance. Annoyance can be defined as a general feeling of displeasure or adverse reaction triggered by the noise. Among the ways it can express itself are fear, uncertainty and mild anger. In the human environment, traffic is the single most important source of noise annoyance. At a noise level of 55 dB (A), the guideline limit set by the WHO, approximately 30% of those exposed are annoyed by aircraft noise, about 20% by road traffic noise and about 10% by rail traffic noise. Some people begin to experience annoyance at traffic noise from noise levels of 40 dB (A) upwards [7].

Sleep disturbance, on the other hand, is considered to be major environmental noise effect. It is estimated that 80-90% of the reported cases of sleep disturbance in noisy environments are for reasons other than noise originating outdoors. The primary sleep disturbance effects are: difficulty in falling sleep (increased sleep latency time); awakenings; and alterations of sleep stages or depth. Other primary physiological effects can also be induced by noise during sleep, including increased blood pressure; increased heart rate; increased finger pulse amplitude; changes in respiration; cardiac arrhythmia; and an increase in body movements. Sleep is necessary to restore biological processes and the cycle of waking and sleeping provides a rhythm to life. Noise is one of many factors that can influence sleep. Noise interferes with sleep in a number of ways. These changes can affect mood and performance the next day. Noise affects people’s ability to gain the appropriate amount and type of sleep.
sleep needed for maintenance of good health. Noise can make it difficult to fall asleep, create momentary disturbances of natural sleep patterns. Noise can interfere with sleep even when the sleeper is not consciously awakened by noise [15].

IV. DISCUSSION

Noise pollution is a significant environmental problem in many urban areas. This problem has not been properly recognized despite the fact that it is steadily growing in developing countries. Noise has a significant impact on the quality of life, and in that sense, it is a health problem in accordance with the WHO’s definition of health which includes total physical and mental well-being, as well as the absence of diseases. Environmental noise is one of the most common pollutants. It is increasingly becoming a community concern internationally. Noise pollution affects both health and behaviour.

Exposure to impulse and continuous noise may cause only a temporary hearing loss. If a person regains hearing, the temporary hearing loss is called a Temporary Threshold Shift. The temporary threshold shift largely disappears 16 to 48 hours after exposure to loud noise. TTS is a warning sign that the hearing mechanism is being overloaded. If exposure to excessive noise is continued or repeated over a long period of time then it permanent damages the hearing ability which is known as Permanent Threshold Shift. Normally it is the hair cells in the human ear, which detect the 4-6 KHz frequencies, which deteriorate first. With further excessive noise exposure, the hearing loss increases and extends down to lower frequencies as well and the person begins to have trouble understanding speech. Noise can adversely affect task performance in a variety of circumstances.

Noise has a significant impact on the quality of life. It appears that the impact is at least as great and most probably greater, than it was 10 years ago, due to population growth, especially in urban areas.

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