

Noise Pollution

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Introduction:

Noise is all around us. It is an unavoidable part of our daily lives and has increasingly become a major burden on the quality of lives. Noise pollution is defined as a form of air pollution that is an audible unwanted sound that poses a threat to a person's health and well-being[1,2]. Noise pollution can be from simple sources such as an air-conditioner, traffic, a loud radio, human conversation, traffic, a dog barking, to more complex machinery such as large trucks and airplanes.

There are many vulnerable groups of people who are most affected by noise pollution such as the young, elderly, and the hospitalized. Young children are unable to protect their hearing and rely on their parents to keep them from constant exposure. Similarly, the elderly may not have the capabilities to protect their hearing if they are disabled by mental or physical illness. Patients in the hospital are not safe from the effects of noise as well. Patients who are in the hospital especially for orthopedic surgeries may be exposed to loud instruments during a procedure although they are not protected from it while under anesthesia[6].

Noise has numerous health effects making noise pollution a public health concern although it has not been well addressed. To name a few, these effects include elevated blood pressure, noise-induced hearing loss, sleep disorders, and irritability[1]. In addition, noise pollution also creates a decrease in the performance at work and school[1].

Noise is described in terms of loudness (intensity) and pitch (frequency) and noise exposure is measured using a logarithmic decibel (dB) scale[4]. The Occupational Safety and Health Administration (OSHA) recommends hearing protection in the workplace if there is exposure to noise greater than 85 dB for eight hours or more because of the potential of permanent hearing loss[4]. As a reference, below is a chart that lists some common sources of noise taken from an article published in the American Family Physician in 2001[3].

Sound	Loudness (dB)
Whisper	30-40
Quiet Room	50
Conversation	60
Lawnmower	90
Stereo Headphones	110-120
Rock Concert	110-120
Jet	140
Gunshot	140-170

HEALTH EFFECTS:

I. Noise-Induced Hearing Loss

Noise-induced hearing loss (NIHL) is a type of sensorinual hearing loss that is second only to age induced hearing loss or presbyacusis[3]. It occurs by exposure to

recreational and occupational noise that results in the damage of the hair cells of the cochlea in the inner ear[3]. These hair cells are important structures of the inner ear that are responsible for converting sound energy to electrical signals transmitted to the brain[4]. The damage is irreversible once it occurs[4]. Exposure is usually over prolonged periods of time however an intense sound such as an explosion, sometimes referred to as an acoustic trauma, heard at one instance can cause NIHL[3,4]. In general, the amount of noise required to cause permanent damage from chronic exposure is anything equivalent to 10 years or more at a level of 85 dB for more than 8 hours a day[3,5].

In 1998 to 2000, it was estimated that approximately 28 million Americans suffer from hearing loss and almost 10 million Americans suffer from NIHL with the cost estimated to be in the billions of dollars[3,5]. The National Institute of Deafness and Other Communication Disorders reports that about 22 million Americans between the age of 20 and 69 have hearing loss secondary to noise exposure[5]. Most exposures have been from occupational noise however recreational noise and noise from home have become important sources of exposure. Vulnerable populations are often thought of as workers involved in manufacturing, construction, transportation, agriculture, military, factory, and mining because of their exposure to hazardous noise levels[25,26,27]. Recreational activities such as target shooting, snowmobile or speedboat riding, woodworking, play in a band, listen to loud music or attend frequent rock concerts are examples of activities that increases the risk of NIHL[4,25,28].

Studies are also revealing that young children and young adults are showing signs of NIHL. Communication, cognition, social-emotional development, academics, and

future careers may all be affected in the young secondary to hearing loss[1]. The third National Health and Nutrition Examination Survey(NHANES) revealed that about 15% of US children between the ages 6-19 years have low and high frequency hearing loss[23]. Although NIHL is permanent, it is a 100 percent preventable disease by using ear protection such as earmuffs or earplugs, avoiding a noisy environment, and knowing what the harmful levels of noise are[5].

Mental Health:

Latent mental illness is thought to be exacerbated and intensified by noise pollution and not believed to be a cause of mental illness[1]. In one study, children who were exposed to noise levels above 55 dB had decreased attention, difficulty with social adaptation, and increased oppositional behavior to others compared to children not exposed to these noise levels[7]. Noise pollution via community noise also causes annoyance and disturbance among those with depression and anxiety and may make their symptoms worse[8]. Other studies have shown an increase in the use of sleeping pills and mental-hospital admission rates with those exposed to unwanted noise[1,8]. It is important to note that studies involving the relationship of mental illness and noise pollution are at best inconclusive because of the many possible confounding factors affecting the results[8,9]. Again, children and the elderly with depression who do not have control over their own hearing protection may be particularly vulnerable to the mental effects of noise pollution[1].

Impairment of Task Performance:

There are many potential detrimental effects of noise pollution on task performance involving both children and adults. Cognitive task performance at school and at work has been well documented in several studies[1]. However, the task to be performed is usually described to be complex and cognitively demanding[10]. Children exposed to noise in the home or at school may have difficulty with learning, cognitive and language development, and problem solving[1]. A study in London involving 340 children between the ages of 8 and 11 who were exposed to high aircraft noise showed an association with increased annoyance and poorer reading comprehension[11]. Another study revealed that a children's immediate and delayed recall of memory are impaired by a dose-response relationship to aircraft noise at home[12]. The children in this study attended a primary school in London near an airport. Many of these studies reveal the importance of the adverse effects on children in particular because of the potential future problems in their lives arising from this early exposure.

The strongest effect of noise is on reading attention, problem solving, and memory[1]. Working under noisy conditions can profoundly affect a person's ability to perform well. Noise may impair concentration, decrease motivation, increase rates of errors and can thus lead to preventable accidents in the workplace[1, 13]. In addition, communication may be affected leading to misinterpretation of instructions further reducing an employees effectiveness and accuracy[13].

Negative Social Behavior and Annoyance Reactions:

Noise levels have been associated with increased negative reactions such as increased agitation, exhaustion, dissatisfaction, anger, and distraction[1,14]. This may cause social and behavioral effects including attempts to avoid environmental noise by closing windows or doors, acting out aggression, and even result in a change of residence[1,14]. In general, exposure to levels above 80 dB are associated with increase aggressiveness when combined with alcohol, provocation or existing anger and hostility[1].

Annoyance is described as feelings of displeasure when individuals believe an agent or condition has an adverse effect on them[1,14]. The level of annoyance is dependent on the type of noise, the time of day at which it occurs, and the activity interrupted by the noise[1,14]. In addition, individual sensitivity to the exposure also plays a role in annoyance levels. People who have a lack of a sense of control over noise have higher levels of annoyance especially when the noise is accompanied by low-frequency components, loud impulse noises, or a crescendo noise effect[1,14]. Negative social behaviors and annoyance reactions to noise cause significant declines to one's sense of well-being.

Sleep Disturbances:

Adequate well rested sleep is essential to maintain good health and mental function[15]. Noise is a common identified offender of interrupting sleep and it causes both primary and secondary sleep disturbances. The primary effects include difficulty falling asleep, differences of sleep patterns, and awakenings[9]. Secondary effects

describe the consequences of interrupted sleep including fatigue, decreased well-being and performance[9]. In addition to these primary and secondary effects, environmental noise exposure during sleep is accompanied by several physiological effects. For example, there is an increase in high blood pressure, finger pulse amplitude and heart rate[1,9,16]. Other changes include abnormal cardiac rhythms, changes in breathing patterns, and increased body movements[1]. These findings suggest an increase in the fight or flight response during a period of time when the body is attempting to rest and restore itself. Levels attributable to disturbed sleep can be as low as a continuous noise greater than 30 dB or an intermittent noise that increases the amounts of awakenings per night[1].

There have been numerous studies associating sleep disturbance and noise. One study revealed that populations living in noisy areas of Urban populations were at risk for increased neuroticism, subjective noise sensitivity, and noise annoyance[17]. The participants of this study reported difficulty falling asleep, frequent awakenings throughout the night, difficulties falling back to sleep, increased fatigue, poorer sleep quality, and the need for increased use of sleeping agents[17].

Cardiovascular Disturbances:

There is now a growing body of evidence associating noise pollution with cardiovascular disease. These effects are secondary to the body's "fight or flight" response leading to autonomic nervous and endocrine effects seen with chronic daily levels of noise greater than 65 dB or acute exposure to levels above 80 to 85 dB[1].

These effects lead to elevated blood pressure, heart rate, and peripheral resistance by the release of hormones such as norepinehrine, epinephrine, and cortisol[1,9].

A study by Rosenlund et al, have demonstrated an increase prevalence of high blood pressure with people exposed to aircraft noise[18]. The subjects in this study were between the ages of 18 and 80 and effects were greatest among the elderly. Another study by Jarup et al also revealed a relationship of daily traffic noise and nighttime aircraft noise and an increase in blood pressure[19]. This study included participants between the ages of 45-75 years living near one of six major European airports for a minimum of 5 years.

Cardiovascular effects of noise pollution are not unique to adults. Unfortunately, there is evidence that young children are also at risk. In one study performed in 1995, blood pressure and heart rate was measured in 1,542 children between the ages of 3-7 years old who attended kindergartens in areas with traffic noise was greater than 60 dB. The results showed that the preschool children had a higher mean systolic and diastolic blood pressure and lower heart rate than those children in quite areas. Additionally, these children had higher blood pressure readings above the 95th percentile[2].

Current policies:

Cleveland, Ohio has local ordinances under the Noise Pollution Clearinghouse to prevent excessive noise pollution. Chapters 683 and 605 specifically deal with the playing of any sound devices, the playing of sound devices in a motor vehicle, and unnecessary noises[20]. In summary, all noises must not disturb or annoy the quiet except for an organized event where a permit is granted. Initial violations are given a

misdemeanor charge and are fined \$75.00[20]. Citations may also be given to offenders. If another violation is performed with 36 hours of the first offence, they will be guilty of a misdemeanor of the third degree. Fines at this point may not be less than \$100.00 and no more than \$500.00[20]. There are also several other rules regarding unnecessary noise that is not permitted within 150 feet of a church, school, hospital, or court[20]. Excessive noise from tools, mechanical devices, motorcycles, or any constant noise is also prohibited[20]. To learn more about these ordinances, visit <http://www.noisepollution.org> and search under Cleveland, Ohio.

Prevention:

Current Organizations:

There are numerous grassroots community groups that support a quiet environment. A complete list can be found under the website:

<http://www.nonoise.org/resource/related/noiseorg>.

The National Institute of Deafness and Other Communication Disorders (NIDCD) created a national public education movement to prevent NIHL called “WISE EARS.” This campaign was initiated in 1999 by the National Institute of Deafness and Other Communication Disorders (NIDCD), the National Institute of Occupational Safety and Health (NIOSH) and many other national, regional, state, and local organizations and governments[21]. Their main goals are to educate as many people about NIHL and to motivate them to take action against NIHL. Recently, they are focusing on expanding their mission to reaches children between the ages of 8-12 and their parents[21].

NIOSH is a rich federal resource that provides vast amounts of information regarding Noise and Hearing Loss Prevention. They offer educational materials about noise exposure in the workplace and offer advice about choosing hearing protectors. Their website has information regarding current research and hearing conservation programs[22]. Their website address can be found at <http://www.cdc.gov/niosh/topics/noise>.

Additionally, there are many nonfederal organizations that all have a similar goal to promote quality hearing, prevent NIHL, and to help improve communication for those who are hearing impaired or have other communication disorders. Some of these organizations can be located at <http://www.cdc.gov/nceh/hsb/noise/links.htm>.

NIHL Prevention:

NIHL is becoming a major public health concern. As mentioned above, it is estimated that as many as 22 million people are affected by hearing loss secondary to noise exposure and the cost is in the billions[3,5]. It is also estimated that 30 million people are exposed to noise at the workplace[24]. For this reason, efforts have been made to develop programs to help avoid this preventable disease.

The NIDCD recommends the use of earplugs or earmuffs when near loud activities weather it is for recreation such as a rock concert or at work. They recommend an increase in self awareness of harmful noises that can cause damage and to help increase efforts to make friends, families, and colleagues aware of these dangers[4]. They also advise the protection of the ears of children who are unable to protect their own

hearing and recommend an examination by a health care professional who specializes in hearing accompanied by a formal audiology test[4].

The success of a hearing loss prevention program is determined by several components. These components should include the following: 1) Noise exposure monitoring, 2) The presence of a noise control process, 3) Provision of hearing protection, 4) Education of all employees and notification of hazardous noise areas, 5) Availability of audiometric testing for workers, 6) Record keeping of the program's events, and 7) An effective program evaluation[29].

Today, the literature is lacking in terms of deeming a noise prevention program successful. Perhaps the success in the field is the enforcement of prevention programs in workplaces across the nation as determined by organizations such as OSHA, EPA, and NIOSH. Currently, there are on-going studies to determine the efficacy of noise prevention programs such as hearing conservation programs for miners and carpenters. Results should be available in approximately 5-6 years[30].

Conclusion:

Noise pollution is becoming a major public health concern with all of its potential biological and social effects on the body such as cardiovascular, hearing, performance at school and at work, and psychological. This is an especially concerning area for children who are experiencing hearing loss at younger ages that may ultimately affect their learning. These children may be at risk for performing poorly in school and in turn will affect their future career potential. The cardiovascular effects on children may also lead to chronic illness in adulthood. On the other hand, NIHL is affecting more and more

people although this is a 100 percent preventable disease. Furthermore, NIHL has ineffective and unsatisfactory options for treatment. Local policies on noise seem inadequate in the prevention of annoyance, disturbance of the peace, and noise related physical effects. There is an obvious need for increased efforts to enforce more policies so that fewer people will be adversely affected by noise.

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