Health Effects from Noise

Authored by

mohammad looti

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Traffic is the main source of noise pollution in cities.

Noise health effects are the health consequences of regular exposure, to consistent elevated sound levels. Elevated workplace or environmental noise can cause hearing impairment, hypertension, ischemic heart disease, annoyance, and sleep disturbance. Changes in the immune system and birth defects have been also attributed to noise exposure.

Although some presbycusis may occur naturally with age, in many developed nations the cumulative impact of noise is sufficient to impair the hearing of a large fraction of the population over the course of a lifetime. Noise exposure also has been known to induce tinnitus, hypertension, vasoconstriction, and other cardiovascular adverse effects.

Beyond these effects, elevated noise levels can create stress, increase workplace accident rates, and stimulate aggression and other anti-social behaviors. The most significant causes are vehicle and aircraft noise, prolonged exposure to loud music, and industrial noise. In Norway, road traffic has been demonstrated to cause almost 80% of the noise annoyances reported.

There may be psychological definitions of noise as well. Firecrackers may upset domestic and wild animals or noise-traumatized individuals. The most common noise-traumatized persons are those exposed to military conflicts, but often loud groups of people can trigger complaints and other

behaviors about noise. Infants are easily startled by noise.

The social costs of traffic noise in EU22 are more than €40 billion per year, and passenger cars and lorries (trucks) are responsible for bulk of costs. Traffic noise alone is harming the health of almost every third person in the WHO European Region. One in five Europeans is regularly exposed to sound levels at night that could significantly damage health.

Noise also is a threat to other species in marine and terrestrial ecosystems alike.

Hearing loss

A sound level meter, a basic tool in measuring sound.

The mechanism of hearing loss can be attributed to aging, infection, surgery, prolonged use of some medications, trauma, and to stereocilia of the cochlea, the principal fluid filled structure of the inner ear. The pinna combined with the middle ear amplifies sound pressure levels by a factor of twenty, so that extremely high sound pressure levels arrive in the cochlea, even from moderate atmospheric sound stimuli. Underlying pathology to the cochlea are reactive oxygen species, which play a significant role in noise-induced necrosis and apoptosis of the stereocilia.

Exposure to high levels of noise have differing effects within a given population, and the involvement of reactive oxygen species suggests possible avenues to treat or prevent damage to hearing and related cellular structures.

The elevated sound levels cause trauma to cochlear structure in the inner ear, which gives rise to irreversible hearing loss. A very loud sound in a particular frequency range can damage the cochlea's hair cells that respond to that range, thereby reducing the ear's ability to hear those frequencies in the future, however, loud noise in any frequency range has deleterious effects across the entire range of human hearing. The outer ear (visible portion of the human ear) combined with the middle ear amplifies sound levels by a factor of 20 when sound reaches the inner ear.

Age-related (presbycusis)

Hearing loss is somewhat inevitable with age. Though older males exposed to significant occupational noise demonstrate significantly reduced hearing sensitivity compared to non-exposed peers. Differences in hearing sensitivity decrease with time and the two groups are indistinguishable by age 79. Over time, the detection of high-pitched sound frequencies becomes more difficult. This affects speech perception, particularly of those words involving sibilants and

fricatives. Both ears tend to be affected.

Women exposed to occupational noise do not differ from their peers in hearing sensitivity, although they do hear better than their non-exposed male counterparts. Consistent exposure to loud music, young people in the United States have a rate of impaired hearing 2.5 times greater than their parents and grandparents. An estimated 50 million individuals will have in 2050.

Occupational hearing loss

Hearing loss as a result of occupational exposure is one of the most common work-related illnesses. In fact, every year in the United States, more than 22 million workers are exposed to hazardous noise and an additional 9 million are exposed to ototoxic chemicals. Those in certain occupations are at a higher risk of developing hearing loss as a result of the nature of their job. For example, musicians, miners, and those in manufacturing and construction may be exposed to higher and more constant noise levels.

Any workplace that exposes workers to excessive sound levels is required to ensure that the hearing function of their workers is adequately protected. The Occupational Safety and Health Administration (OSHA) provide laws and regulations clarified by the United States department of labor. Generated by the Occupational Safety and Health Act of 1970, OSHA was created with the mission to assure all working conditions are safe and healthy. All employers must follow this hearing amendment, including private sector employers, and excluding those who are self-employed, family farm workers, and government workers. Separate laws and regulations are enacted for specialized working environments. These include the Mine Safety and Health Administration (MSHA) and the Federal Railroad Administration (FRA), which provide specific regulation for miners and railroad workers.

The National Institute for Occupational Safety and Health (NIOSH) generated a criteria document consisting of a "best practice guide" recommended by OSHA to all employers. This document is recommended to be followed, but is not required as OSHA laws and regulation are. The regulations provided by NIOSH are much more conservative, and it provides scientific basis for occupational safety and health standards. For example, the permissible exposure limit for OSHA is >90 dBA, while NIOSH is >85 dBA. They recommend the implementation or promotion of these conservative standards alongside the standards of the designated administration (OSHA, MSHA, or FRA) of the employer.

OSHA, NIOSH, MSHA, and FRA were all created in response to an increase in noise induced hearing loss resulting from hazardous sound levels in industrial work environments. Noise can cause detrimental effects to the outer, middle, and inner ear, as well as the auditory nerve and central auditory system. In the outer ear, with high noise exposure the eardrum can rupture and

bleed. In the middle ear, dislocation of the bones that reside in the middle ear (the ossicles) can occur. These problems occur when exposed to extremely high sound levels. In the inner ear, low, middle, and high sound levels can all cause damage to structures residing in the cochlea. This damage can cause what is called a 'noise notch' and hearing loss is evident at 3000 - 6000 Hz frequencies.

Cardiovascular effects

Noise has been associated with important cardiovascular health problems. In 1999, the World Health Organization (WHO) concluded that the available evidence suggested a weak correlation between long-term noise exposure above 67-70 dB(A) and hypertension. More recent studies have suggested that noise levels of 50 dB(A) at night may also increase the risk of myocardial infarction by chronically elevating cortisol production.

Fairly typical roadway noise levels are sufficient to constrict arterial blood flow and lead to elevated blood pressure; in this case, it appears that a certain fraction of the population is more susceptible to vasoconstriction. This may result because annoyance from the sound causes elevated adrenaline levels trigger a narrowing of the blood vessels (vasoconstriction), or independently through medical stress reactions. Other effects of high noise levels are increased frequency of headaches, fatigue, stomach ulcers, and vertigo.

Stress

Research commissioned by Rockwool, a UK insulation manufacturer, reveals in the UK one third (33%) of victims of domestic disturbances claim loud parties have left them unable to sleep or made them stressed in the last two years. Around one in eleven (9%) of those affected by domestic disturbances claims it has left them continually disturbed and stressed. More than 1.8 million people claim noisy neighbours have made their life a misery and they cannot enjoy their own homes. The impact of noise on health is potentially a significant problem across the UK given that more than 17.5 million Britons (38%) have been disturbed by the inhabitants of neighbouring properties in the last two years. For almost one in ten (7%) Britons this is a regular occurrence.

The extent of the problem of noise pollution for public health is reinforced by figures collated by Rockwool from local authority responses to a Freedom of Information Act (FOI) request. This research reveals in the period April 2008 - 2009 UK councils received 315,838 complaints about noise pollution from private residences. This resulted in environmental health officers across the UK serving 8,069 noise abatement notices, or citations under the terms of the Anti-Social Behaviour (Scotland) Act.

Westminster City Council has received more complaints per head of population than any other

district in the UK with 9,814 grievances about noise, which equates to 42.32 complaints per thousand residents. Eight of the top 10 councils ranked by complaints per 1,000 residents are located in London.

Annoyance

Because some stressful effects depend on qualities of the sound other than its absolute decibel value, the annoyance associated with sound may need to be considered in regard to health effects. For example, noise from airports or sudden Impulse noises are typically perceived as more bothersome than noise from traffic of equal volume. Annoyance effects of noise are minimally affected by demographics, but fear of the noise source and sensitivity to noise both strongly affect the 'annoyance' of a noise. Even sound levels as low as 40 dB(A) (about as loud as a refrigerator or library) can generate noise complaints and the lower threshold for noise producing sleep disturbance is 45 dB(A) or lower.

Other factors that affect the 'annoyance level' of sound include beliefs about noise prevention and the importance of the noise source, and annoyance at the cause (i.e. non-noise related factors) of the noise. For instance, in an office setting, audible telephone conversations and discussions between co-workers were considered to be irritating, depending upon the contents of the conversations. Many of the interpretations of the level of annoyance and the relationship between noise levels and resulting health symptoms could be influenced by the quality of interpersonal relationships at the workplace, as well as the stress level generated by the work itself. Evidence for impact on annoyance of long-term noise versus recent changes is equivocal.

Estimates of sound annoyance typically rely on weighting filters, which consider some sound frequencies to be more important than others based on their presumed audibility to humans. The older dB(A) weighting filter described above is used widely in the U.S., but underestimates the impact of frequencies around 6000 Hz and at very low frequencies. The newer ITU-R 468 noise weighting filter is used more widely in Europe. The propagation of sound varies between environments; for example, low frequencies typically carry over longer distances. Therefore, different filters, such as dB(B) and dB(C), may be recommended for specific situations.

Furthermore, studies have shown that neighborhood noise (consisting of noise from neighboring apartments, as well as noise within one's own apartment or home) can cause significant irritation and noise stress within people, due to the great deal of time people spend in their residences. This can result in an increased risk of depression and psychological disorders, migraines, and even emotional stress.

In the workplace, noise pollution is generally a problem once the noise level is greater than 55 dB(A). Selected studies show that approximately 35% to 40% of office workers find noise levels

from 55 to 60 dB(A) extremely irritating. The noise standard in Germany for mentally stressful tasks is set at 55 dB(A), however, if the noise source is continuous, the threshold level for tolerability among office workers is lower than 55 dB(A).

One important effect of noise is to make a person's speech less easy to hear. The human brain compensates for background noise during speech production in a process called the Lombard effect in which speech becomes louder with more distinct syllables. However, this cannot fully remove the problems of communication intelligibility made in noise.

Infrasound (low-frequency sound)

Infrasound, sometimes referred to as low-frequency sound, is sound that is lower in frequency than 20 Hz (hertz) or cycles per second, the "normal" limit of human hearing. Hearing becomes gradually less sensitive as frequency decreases, so for humans to perceive infrasound, the sound pressure must be sufficiently high.

20 Hz is considered the normal low-frequency limit of human hearing. When pure sine waves are reproduced under ideal conditions and at very high volume, a human listener will be able to identify tones as low as 12 Hz.

One study has suggested that infrasound may cause feelings of awe or fear in humans. It also was suggested that since it is not consciously perceived, it may make people feel vaguely that odd or supernatural events are taking place.

Child physical development

The U.S. Environmental Protection Agency authored a pamphlet in 1978 that suggested a correlation between low-birthweight (using the World Health Organization definition of less than 2,500 grams (88 oz) and high sound levels, and also high rates of birth defects in places where expectant mothers are exposed to elevated sound levels, such as typical airport environs. Specific birth abnormalities included harelip, cleft palate, and defects in the spine.

According to Lester W. Sontag of The Fels Research Institute (as presented in the same EPA study): "There is ample evidence that environment has a role in shaping the physique, behavior, and function of animals, including man, from conception and not merely from birth. The fetus is capable of perceiving sounds and responding to them by motor activity and cardiac rate change." The effects of noise exposure are highest when it occurs between 15 and 60 days after conception, a period in which major internal organs and the central nervous system are formed.

Later developmental effects occur as vasoconstriction in the mother reduces blood flow and therefore oxygen and nutrition to the fetus. Low birth weights and noise were also associated with

lower levels of certain hormones in the mother. These hormones are thought to affect fetal growth and to be good indicators of protein production. The difference between the hormone levels of pregnant mothers in noisy versus quiet areas increased as birth approached.

In a 2000 publication, a review of studies on birthweight and noise exposure note that while some older studies suggest that when women are exposed to >65 dB aircraft noise a small decrease in birthweight occurs, in a more recent study of 200 Taiwanese women including noise dosimetry measurements of individual noise exposure, the authors found no significant association between noise exposure and birth weight after adjusting for relevant confounders, e.g. social class, maternal weight gain during pregnancy, etc.

Cognitive development

When young children are regularly exposed to levels of noise that interfere with speech, they may develop speech or reading difficulties, because auditory processing functions are compromised. Children continue to develop their speech perception abilities until they reach their teens. Evidence has shown that when children learn in noisier classrooms, they have more difficulties understanding speech than those who learn in quieter settings.

In a study conducted by Cornell University in 1993, children exposed to noise in learning environments experienced trouble with word discrimination, as well as various cognitive developmental delays. In particular, the writing learning impairment dysgraphia is commonly associated with environmental stressors in the classroom.

High noise levels have also been known to damage the physical health of small children. Children from noisy residences often have a heart rate that is significantly higher (by 2 beats/min on average) than those of children from quieter homes.

Dementia

A study by Public Health Ontario showed a 7 per cent higher risk in developing dementia among those living within 50 metres of a road. Some scientists said that the study does not rule out items like poverty and having a lower education.Some Scientists also noted that the air pollution may be part of the cause. The study found that here was a linear decline in deaths for people that lived further away from roads.

Regulations

Environmental noise regulations usually specify a maximum outdoor noise level of 60 to 65 dB(A), while occupational safety organizations recommend that the maximum exposure to noise is 40

hours per week at 85 to 90 dB(A). For every additional 3 dB(A), the maximum exposure time is reduced by a factor 2, e.g. 20 hours per week at 88 dB(A). Sometimes, a factor of two per additional 5 dB(A) is used, however, these occupational regulations are acknowledged by the health literature as inadequate to protect against hearing loss and other health effects. In an effort to prevent noise-induced hearing loss, many programs and initiative have been created, like the Buy Quiet program, which encourages employers to purchase quieter tools and equipment, and the Safe-In-Sound Award, which recognizes organizations with successful hearing loss prevention strategies.

With regard to indoor noise pollution in residences, the U.S. Environmental Protection Agency (EPA) has not set any restrictions on limits to the level of noise. Rather, it has provided a list of recommended levels in its Model Community Noise Control Ordinance, which was published in 1975. For instance, the recommended noise level for indoor residences is less than or equal to 45 dB.

Noise pollution control in residences is not funded by the federal government in part because of the disagreements in establishing causal links between sounds and health risks, since the effect of noise is often psychological and also, because it leaves no singular tangible trace of damage on the human body. For instance, hearing loss could be attributed to a variety of factors including age, rather than solely due to excessive exposure to noise. A state or local government is able to regulate indoor residential noise, however, such as when excessive noise from within a home causes disturbances to nearby residences.

In canines

While people are often educated on the effects of noise exposure in humans, there are also different noise exposure effects in animals as well. An example of this would be in canines, and the noise exposure levels occurring within kennels. Canines experience this noise exposure whether it be a long stay at an animal shelter, or a weekend stay at a boarding facility.

Organizations like NIOSH and OSHA have different regulations when it comes to the noise exposure levels in industrial workers. Currently there are no regulations related to the noise exposure in canines even with such damaging effects related to their health. Health risks dogs are exposed to include ear damage and behavioral changes.

The average noise exposure in a kennel is greater than 100 dB SPL. According to OSHA these levels would yield in the use of hearing protection for the workers of those kennels due to the risk of noise induced hearing loss. The anatomical structures of the human and canine ear are very similar, so it is thought that these levels will negatively impact the hearing of canines in kennels. The ABR can be used to estimate the hearing threshold of canines, and can be used to show

either a temporary threshold shift or permanent threshold shift after being exposed to excessive sound levels.

Behavioral effects to excessive noise exposure include hiding, urinating, defecating, panting, pacing, drooling, disregard to commands, trembling, and barking. These behavioral patterns pose a much greater problem to canines than meets the eye. All of these behavioral patterns are characteristics that result in a longer stay at the kennels before being adopted. A longer stay at the shelter results in a longer duration of noise exposure and therefore more likely to show either a temporary or permanent threshold shift in the canine's hearing.

These excessive noise levels are not only harming the canines physical and psychological state, but the workers and potential adoptive families physical and psychological state as well. The workers psychological state could affect the care provided to the canines. These loud noise exposures also have the potential to reduce the amount of time that potential adoptive families spend in the facility. This can result in less dogs being adopted and more time being exposed to excessive sound levels.

To reduce the level of noise exposure poses a little more difficulty because the majority of the noise is coming from the canines (barking), but structural changes can be made to the facilities in order to reduce the noise. Structural changes could include how many dogs are put in one area, more absorbing material rather than metal cages and cement walls and floors, and possibly in the future use of hearing protection devices (HPD) for the canines. All of these structural changes would also benefit the humans involved as well as the use of HPD's (ear plugs).