

EFFECTS OF NOISE ON HUMAN HEALTH AND BEHAVIOR

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ABSTRACT

Noise is a commonly misconceived environmental pollutant. It is often not classified with other pollutants because it seems to lack some of the general characteristics that other pollutants have, i.e. it cannot be seen, felt, smelled or tasted. It has however been recognized as a pollutant since 1972 by the WHO. Noise is a nuisance which is often imposed on us against our will and in ways and volumes over which we have no control. This review looks at noise as an environmental problem with detrimental effects on both human health and behavior. Several health and behavioral risks associated with noise have been considered in this paper which include hearing impairment, cardiovascular problems, sleep disturbance, interference with cognitive ability and annoyance. Noise disturbance in buildings is often caused by sounds from both within the building and from without. Various solutions to control and prevent noises have thus been proffered

Introduction:

Noise can be regarded as a major source of pollution which is increasingly becoming an environmental problem. This is mainly due to increase in global population and transportation systems as well as technological advancements. The World Health Organization (WHO) declared noise as a pollutant in 1972 (Vianna, Cardoso & Rodrigues, 2015). Over the years noise has made and is still making a tremendous impact not just on human life but also on the eco-system.

Over time, issues of environmental pollution have been gaining in importance due to the damage they have been causing to the earth's atmosphere and bio-diversity. A lot of emphasis has been given to tackling pollutants which affect the land, air and water. Not as much attention however

in this paper which can go a long way in controlling the detrimental effects of noise.

Keywords: *Sound, Noise Effects, Human Health, Human Behavior, Noise Control*

Seems to be given to noise pollution. This may be because many of the features which characterize other pollutants cannot readily be applied to noise. For instance, unlike other pollutants, noise cannot be seen, smelled, inhaled or handled and it disappears without a trace when its source is turned off. Also, in most cases, the point at which people begin having problems with their hearing capacity happens long after the beginning of the noise exposure. Again this is due to the fact that hearing impairment is often not instantaneous but occurs over a period of time due to prolonged exposure to loud noises.

Noise pollution also varies from other pollutants in that while most other pollutants such as those in air and water mainly affect human health, noise pollution has detrimental effects not just on human health but also on human behavior. For instance various studies have been carried out which link excessive noise exposure to high levels of aggression. Vianna, Cardoso & Rodrigues (2015), in a research they carried out were able to find some degree of association between noise exposure and increased annoyance.

Problem Statement

Noise often affects us and our environment even when we are not mindful of it. It also affects our level of indoor and outdoor comfort. This statement is buttressed by Elsevier who stated that “people's perceptions of acoustic comfort and satisfaction are influenced by the acoustical environment”.

Our ears, unlike our eyes, cannot be closed up to keep out unwanted sounds. It is therefore becoming increasingly clear that greater consideration must be given towards reducing noise pollution in the environment. This is for the betterment of all and will make for a more pleasant world to live in.

Aims and Objectives

This paper is a review about noise and has a sole aim of presenting a clearer picture of the characteristics of noise, its causes, magnitude levels and the effects it has on human health and behavior. The paper also aims to suggest possible interventions and preventive strategies for noise control in buildings and within the environment.

Methodology

The method used for writing this paper is purely qualitative, i.e. document survey. This involves reviewing related literature from journals, articles, past research works and online sources in order to obtain relevant information about the topic.

LITERATURE REVIEW

Sound

Sound has been defined by Ravi, Zhu & Cheema (2012) as “a vibration or a traveling wave that is an oscillation of pressure transmitted through a medium: solid, liquid or gas.” The pressure of these vibrations within a given frequency range stimulates sensation in the ears and enables hearing (Ravi, Zhu & Cheema, 2012). Sound, as a form of vibration, requires a medium for its propagation; it cannot exist in a vacuum. Such a medium could be air, liquid or solid.

Sound vibration is comprised of pressure and frequency and is measured in pascals or hertz (Pa & Hz). The frequency, also known as pitch, refers to the number of vibration cycles per second. The degree of loudness or volume of sound is measured in pascals or decibels (dB) and is the level of pressure which is exerted by sound. The human ear is said to discern sounds that fall between the range of 0dB (0.00002 Pa) and 120db (20Pa) (WHO).

Sound exists in various forms in our environment. Goines & Hagler (2007) state that sound can either be viewed as being necessary (desirable) or unnecessary (undesirable). Desirable sound is any sound which is not oppressive or to which a person is not opposed. They include sounds from

sources such as “garbage disposals, dishwashers, clothes washers, refrigerators, radios, television, children playing, emergency vehicles, jet engines, etc. These sounds are usually accommodated because we associate them with day to day activities which are a part of man’s daily life.

Undesirable sounds on the other hand are often viewed as unnecessary or unwanted sound. Such sounds are seen as environmental nuisance. Examples of such include: extreme sound levels at concerts, theaters or sporting events. They also include street noises, car horns, sounds from peddler’s public address systems, etc. Another name for such sounds is “noise”. A lot of the sound that is experienced in the environment today falls into this category because they do not really serve any useful function.

Noise

Noise has been described as sound that is “unwanted”, “undesirable” or “objectionable”. It is associated with unpleasantness and can cause strife and conflict between people. In the US, complaints about noise have been identified as the most common complaint by residents in urban areas (Goines & Hagler, 2007).

When noise begins to interfere with the natural activities carried out by humans or wildlife such as communication, sleeping, breeding or otherwise reducing quality of life, it is regarded as pollution. Noise pollution can emanate from both living and non-living sources; such could be humans, animals, or machinery.

Noise exposure can again be classified as being either “environmental” or “social” (Gonzalez (2014). Environmental noise exposure refers to exposure to high noise levels which is not chosen by the receiver but which the receiver is not able to reject”. In such instances, the receiver of the noise finds him or herself in a noisy situation which he/she has no control over and which he/she cannot change. The only option available therefore is to endure the noise. Such noises include: noise from traffic, music from stores or noise from neighborhood activities.

Gonzalez (2014) goes on to explain that social noise, on the other hand is chosen by the receiver. She explains that exposure to and ingestion of such noise is a “voluntary” decision. In other words, the hearer of the noise deliberately subjects him/herself to such noisy environments and consumes the noise willingly. Such noises could be from the use of personal music devices at high levels, participating in loud activities such as bands or getting involved in sports such as shooting.

Statistics Related to Noise

The statistics which relate to noise and its effects on human health and behavior are quite astounding. According to the WHO, 10% of the world’s population is exposed to sound pressure levels that could potentially cause noise-induced hearing loss (WHO cited by Matthias et al, 2014). The WHO also estimates that about 45,000 dis-ability adjusted years are lost yearly in high-income western European countries for children between the ages of 7-19 due to the effects of environmental noise (WHO cited by Matthias et al, 2014). According to Gonzalez (2014) the WHO regional office for Europe has attributed the loss of at least one million life years every year to traffic related noise in the western part of Europe.

Noise levels have continually been on the increase over the years. This can be directly related to increase in human population. Basner et al (2014) state that noise levels in hospitals have increased by about 10 dB since the 1960’s.

The location of noise sources is another factor which is important when discussing noise exposure. Studies involving millions of British residents living near airports reported an association between noise exposure to aircraft noise and increased hospital admissions for cardio-vascular disease (Holzman, 2014). It has also been found that children living near airports tend to have lower reading scores and develop language skills more slowly (Passchier & Passchier, 2000). Noise has also been identified with increases in mental disorders. This accounts for higher numbers of psychiatric hospitals being located in noisy communities (Passchier & Passchier, 2000).

Levels of Sound Intensity

Noise levels vary in intensity or loudness and have different effects on their hearers. Table 1 shows various sound levels with their estimated equivalent sound source.

Table 1. Sound source and intensity

Sound Source	Intensity (dB)
Rocket Launch Equipment	Approx. 164
Threshold of Pain	134
Hearing Damage during Short Term Effect	Approx. 120
Jet Engine, 100m distant	110-140
Jackhammer 1m distant / Discotheque	Approx. 100
Hearing Damage From Long Term Exposure	Approx. 85
Traffic Noise on Major Road 10m Distant	80-90
Moving Automobile 20m Distant	80-90
TV Set at Typical Home Level 1m Distant	Approx. 60
Normal Talking 1m Distant	40-60
Very Calm Room	20-30
Quiet Rustling Leaves / Calm Human Breathing	10
Auditory Threshold at 2KHz for Undamaged Human Ears	0

Source: Mehta, Zhu & Cheema, (2012)

Causes of Noise

Sources of noise pollution have remained fairly constant within the last half of the 20th century (Gonzalez, 2014). Vianna et al (2015) describe urban noise as one of the main sources of pollution. This can largely be attributed to rising urbanism which has led to the continual increase of noise pollution.

Causes of outdoor noise pollution are majorly from transportation systems, machine-based occupations or neighborhood activities. Transportation systems however seem to be the primary source of noise pollution in urban centers. Vianna et al, (2015) state that road, rail and air transport systems are the main sources of excessive noise pollution in the US. They attribute the principal source of noise and the most bothersome in most urban centers to road traffic noise. Occupational noise, on the other hand emanates mostly from large machinery in industries and factories, construction equipment, agricultural machinery and defense equipment among others. Neighborhood noises emanate from different human activities such as bands, concerts, or playing of loud music through loudspeakers or microphones.

Indoor sounds can be classified as either airborne sound or impact sound. Airborne sound is borne from the source to the receiver on airwaves. The sources are diverse ranging from ambient or background sounds coming in from outside to noise from various domestic equipment such as dishwashers & vacuum cleaners. Airborne sound also emanates from different forms of indoor noise generating activities such as electronic gadgets and sounds of children at play.

Impact sound on the other hand is generated as a result of direct contact with a solid surface. It is carried through a solid material such as a wall or table through sound waves to the receivers' ears. Examples of such sounds are heavy footsteps, scraping of furniture on an overhead floor, the banging of a door or window or vibrations from loud music.). Other noises which are common in buildings include noises from water and plumbing systems, mechanical systems (such as elevators), and noises transmitted from adjacent spaces to an indoor space (Mak et al, 2015).

Building design and location can affect the amount of noise that penetrates a building. This may be due to the type of building materials and sound insulation used or due to inappropriate land use zoning. For instance, residential buildings situated near airports or subway stations undoubtedly have greater noise disturbance than those located in quieter

areas. Another factor which determines levels of indoor noise in an indoor space is the nature of acoustics within the space.

How Noise Affects Human Health and Behavior

Various health conditions and negative behavioral patterns have been attributed to the effects of exposure to noise. Among the various conditions are the following:

1. Loss of Hearing

Among the various causes of hearing loss, noise is considered to be the major preventable cause (Basner et al, 2014). If the human ear is subjected to an intense sudden sound, such as gunfire, the likelihood is that the eardrum will suffer permanent damage. Evidence reveals that hearing loss is the only occupational disease caused by exposure to noise (Ising & Kruppa, 2004). This form of hearing loss however does not occur if the emission levels are below 80dB in normal working conditions of 40 working hours per week (Ising & Kruppa, 2004).

2. Cardiovascular Disturbances

Various heart related disorders have been linked to long term exposure to noise. The assertion is that noise elicits 'fight' or 'flight' responses in the human body which can increase the likelihood of heart problems (Goines & Hagler, 2007). This effect occurs even during sleep because even though the human body may be able to tune out disturbing noises, the cardiovascular system still remains alert (Muzet, 2002)

3. Sleep Disturbances

One of the greatest hindrances to uninterrupted sleep is environmental noise. Noise levels above 30dB increase difficulty in falling asleep and also cause frequent and early awakenings (Goines & Hagler, 2007). These have various repercussions such as: fatigue, lack of concentration at place of work or school, decreased working capacity, increased accidents and injuries, etc. See Table 2 for health effects at different average night noise levels. High noise levels

during sleep also lead to increased body movement, increased blood pressure and increased heart rates during sleep.

4. Rise in Mental Disorders

Though noise might not in itself cause mental health problems, it has been known to aggravate mental conditions. The conditions manifest as increased stress, aggravation, anxiety, aggressive behavior and emotional instability. (Goines & Hagler, 2007, Baxy, 2014, Gonzalez, 2014)).

5. Other Health Issues

Other health problems associated with exposure to noise include: weakening of the immune system, headaches, dizziness, sexual impotence, neurosis, nervousness and stress leading to ulcers, (Gonzalez, 2014, Goines & Hagler, 2007, web.archive.org.).

6. Annoyance

One of the primary effects of exposure to noise is annoyance. Noise exposure is known to cause disruptive behaviors which can negatively affect peoples' inter-personal relationships with each other. Such behaviors include: aggravated aggression, violence, bad tempers, misunderstandings, irritation, bad moods and depression (Passchier, 2000, Goines & Hagler, 2007, Gonzalez, 2014).

7. Reduced Cognitive Abilities

Decreased cognitive performances have been associated with noise. Kristiansen et al (2013) in their article "effects of classroom acoustics and self-reported exposure on teachers' well-being" have stated that classrooms and environments with high noise levels can hinder effective conversations and make it harder for children to hear what is being said. This can lead to impaired academic performance (Goines & Hagler, 2007).

Noise exposure has also been associated with interference in verbal communication and resulting feelings of frustration, social isolation and helplessness (Gonzalez, 2014). Children who grow up in noisy homes tend

to have less ability to develop language skills and also have lower reading abilities (Goines & Hagler, 2007).

Table 2. WHO Definitions of Health Effects at Different Average Night Noise Levels

Noise Level	Effect
Below 30 dB	- No Substantially observed biological effect for night noise
30-40 B	- Effects include body movements, awakenings, self-reported sleep disturbance arousals - The intensity of the effect depends on the nature of the source and the number of events - Vulnerable groups are more susceptible
40- 55dB	- Many people have to adapt their lives to cope with the night noise - Effects are observed among the exposed population.
Above 55 dB	- Situation is considered increasingly dangerous for public health - A large proportion of the population is highly annoyed and sleep disturbed. - There is evidence that cardiovascular disease increases.

Source: Basner et al (2014)

Noise Prevention and Control

Noise can be controlled or prevented at three basic points: (1) at the source, (2) at the listener's location and (3) along the path that the sound travels from the source to the receiver. The following are methods which can be used to control or prevent noise:

1. Legislative Measures

Proper legislations, when set in place and strictly enforced can go a long way in reducing noise in our environments. For instance, Mitra (2013) suggests that laws can be set in place to prevent people from creating noise in silent zones such as hospitals and schools or from generating extremely disturbing sounds, e.g. lighting firecrackers. She also recommends that vehicles which generate a lot of noise

could be banned from plying the streets and that standards be set in place for controlling noise in working environments and communities. Another suggestion is that existing ordinances and acts against various environmental pollutants and their effects should be reviewed from time to time.

2. Noise Education

Educating people on the dangers of extreme noise exposure is important for noise prevention and control. For example, people need to be made aware that excessive noise can cause deafness and that damage caused to the ear by noise is often irreversible.

3. Acoustic Zoning

One of the main causes of noise disturbance to residents is poor zoning of land uses. Poor noise zoning involves placing of noise generating sources such as factories, bus and transport terminals, railway stations and airports in close proximity to residential areas and other silent zones. Such will undoubtedly cause disturbance to those living around such areas. Good noise zoning therefore will ensure that sensitive facilities such as schools, hospitals, mental institutions and old people's homes are placed away from noise sources.

4. Good Site Planning

When buying or siting land, it is important that noise sources around the land are duly noted. This will ensure that the building is properly oriented such that noise disturbance is prevented as much as possible. This could be done through placing of walls, fences and vegetation between the noise source and the home as a buffer. Placing of driveways and garages away from bedrooms and living rooms will also help to reduce noise disturbance.

5. Building Layout and Design

A good building layout is essential for noise control and prevention. This involves locating quiet rooms as far away as possible from noisy areas. For instance, laundries, bathrooms and living rooms should, as much as possible, not be placed next to, above or below bedrooms

except adequate sound insulation is provided. Appliances which generate noise should also be mounted on sound absorbing pads. The size, type and location of windows is also important in reducing penetration of noise into buildings.

6. Sound Insulation

The best time to tackle noise problems in buildings is often at the construction stage. At this stage sound absorbing material such as acoustical tiles, hair felt, perforated plywood, etc. can be integrated into or fixed unto different parts of the building to reduce noise penetration. Sound absorbing material can also be used to fill cracks that are often found between doors and walls while sound insulation can be used to fill the gaps in between double and triple panes of glass.

7. Sound Proofing of One's Space

Hard surfaces are known to reflect noise and to also create impact sound. To reduce these effects, soft furnishings such as drapes and rugs should be placed over the hard surfaces in order to absorb any sound which is generated. Another way to reduce sound penetrating one's space is to put furniture along the surface through which noise penetrates.

8. Control at Receiver's End

People who are subjected to excessive noise such as in loud working environments, can protect their ears from damage by using ear protection aids like earplugs, earmuffs, headphones, etc. These are small measures which can go a long way to reducing the ill-effects of noise. Noise can also be masked or covered up with more pleasant sounds such as wind chimes, running water features, etc.

CONCLUSION

Noise pollution is an important issue which needs to be given due attention so that it can be tackled effectively. This is because of the profound effect it has on both humans and the ecosystem in general. A quieter environment will lead to reduction in so many ills in the society

such as accidents, stress, and many forms of diseases. It will also improve human comfort, human relations and lead to a more productive society. It is therefore important that all hands be on deck in tackling noise pollution in the environment. It is a pollutant generated by all of us and the solution towards tackling it rests with all of us. With proper control measures set in place, it is possible for noise and its effects to be effectively prevented and controlled thus ensuring a healthier and more pleasant environment to live in.

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