IMPACT OF ENVIRONMENTAL NOISE ON INDIVIDUAL HEARING PROBLEMS. A CRITICAL LITERATURE REVIEW

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ABSTRACT

Purpose: A normal person cannot perceive sound to its minimum level of 0 dB or the sound of rustling leaves. Persons with excellent hearing capabilities can receive sound levels as low as 15 dB. On the higher end, sound levels that exceed 85 dB can cause damage as bad as permanent hearing damage. The period spent around loud sound determines the extent of damage that will occur. The calmer the sound, the longer one can withstand it without any alarming effect. The general objective of the study was to access the impact of environmental noise on individual hearing problems. A critical literature review

Methodology: The paper used a desk study review methodology where relevant empirical literature was reviewed to identify main themes and to extract knowledge gaps.

Findings: The study concludes that safety practices that can assist in preventing hearing losses and other harmful effects call for personal, physician, and administrative engagement. Administratively, employers have an obligation to provide safety devices that prevent hearing loss or impairment. Employers should provide personal protective equipment to abate noise levels and that employers should give all employees an opportunity select hearing protectors that vary from entire head enclosures, canal caps, earplugs, to ear mugs.

Recommendations: The study suggested that that personal hearing protective devices use should be enforced through education and inbuilt administrative mechanisms. Only consistent long term use of prevention produces positive impact. It is also recommended that utilization of safety strategies like shift rotations, leave scheduling, acoustic sound proofing of offices, quiet machinery and other strategies be enhanced through deliberate administrative effort.

Keywords: *impact, environmental, noise, individual, hearing problems*

INTRODUCTION

Background of the Study

Noise refers to unsolicited sound or any unwarranted sound disruption within a useful frequency band (Olayinka, 2013). Conversely, sound is considered to be a sensory perception induced by physiological processes in the auditory brain producing an intricate pattern of waves (Margaritis & Kang, 2017). According to Belojevic et al. (2016), environmental noise is also referred to as environmental noise, residential noise or domestic noise emanating from all other sources except the industrial workplace. The main sources of environmental noise include road, rail and air traffic,

industries, construction, public works and social activities (Hammersen, Niemann, & Hoebel, 2016). Noise is an increasingly omnipresent and growing menace, yet an underestimated form of pollution (Cohen et al., 2014). Long periods of exposure to relatively low levels of noise can have adverse effects on human health (UNEP, 2003). Different people in the U.S. suffer from different degrees of hearing loss directly caused by noise. Similarly, the European Union populations suffer unacceptable levels of continuous noise within that are hazardous to their wellbeing (Fan, Zhiyi, Zhujun, & Jiani, 2010). Noise pollution is a pervading issue in the United States. Over half of the American community is exposed to myriad types of noise pollutants such as traffic noise and noise from entertainment hubs among other social activities (Hammer et al., 2014). 2 Hammersen et al. (2016) argue that the annual exposures to noise are high enough to cause harm to human health. However, regardless of the fact that noise exposure is widespread, this type of pollution has been perceived and treated differently than other forms of pollution such as radiation and chemical hazards. Cohen et al. (2014) reports that noise exposure is on the increase, especially in the general living environment, both in industrialized nations and in developing world regions and emphasizes that the noise exposure in the twenty-first century is a major public health problem. According to Barbara and Rose (2011), maximum and minimum levels of noise should be recorded during community assessment of noise levels, if the level does not drop below 90dB (A) within a timeline of 8 hours a day an unsatisfactory noise exposure should be recorded. World Health Organization (2000) has recommended that an average standard of 70 dB (A) of environmental noise is harmful to health. In Kenya, Legal Notice No. 61; Environmental Management and Coordination (Noise and excessive vibration pollution) (Control) Regulation, 2009 provides 60dB (A) to be the standard of environmental noise level during the day in commercial zones in Kenya (Gongi, 2018). Noise is a more widespread pollution that may c

Noise induced hearing loss (NHIL) refers to the characteristic hearing loss which results from exposure to noise for excessive intensity and long duration (Fox, (1985: 1062-1083) in Ballenger 1985, Hsu et al. 2003). Excessive noise damages the outer hair cells of the organ of Corti in the inner ear. This loss corresponds to the audiometric finding of a sensorineural hearing loss that does not recover (Fernandes et al. 2006). Occupational NIHL is the cumulative hearing loss that develops due to exposure to excessive noise levels as a consequence of one's work environment. Noise induced threshold shift (NITS) is the hearing threshold level shift attributable to noise (Amanda et al. 2001). Depending on the loudness and duration of noise, it can be temporary or permanent. Acute noise exposure like an explosion can produce immediate permanent NITS. Chronic exposure to less intense sounds such as loud music can accumulate over time to gradually produce irreversible NIHL. Noise arises from occupational sources like factory machinery and recreational sources such as rifle shooting and discos. Hard surfaces in rooms aggravate the situation by acting as noise reflectors. Worldwide NIHL is a common problem with about 600 million people working in potentially hazardous noisy places (Irwin, 2000). It is estimated that up to 20% have some degree of NIHL. The damage is dose dependent with more damage from noisier environments and long term exposure periods. High pitched sounds are more harmful than low pitched sounds. Objective studies on NIHL are done using pure tone audiometry and steady state evoked potentials. The human ear is able to pick sound at frequency range between 20 Hz to 20

KHz. The initial effects of noise exposure affect perception of sound between 3 kHz and 6 kHz, often at 4 kHz where it appears to progress at a steady 2 rate for the first 10 years of exposure then slows. The lower frequencies of 1 and 2 kHz take as long as 30 years to become involved, then progress rapidly thereafter. There is a wide individual variation, with a 30dB difference between the 25th and 75th quartiles after 30 years of exposure.

Sound is a mechanical wave that propagates through a medium. The propagation of sound constitutes a creation of regions of compression and rarefaction in the transmission media. The vibration of an object generates sound.Jensen (2013) defines noise as unwanted sound. It is a major environmental pollutant and a health hazard. The human ear can respond to sound frequencies in the range 20 Hz – 20 kHz (Hakala et al. 2010). Noise level is an important parameter in determining indoor environmental quality (IEQ) or indoor air quality (IAQ). Noise is among the factors that can cause discomfort, annoyance and result in headache and fatigue (Kibert, 2005). Permanent hearing loss may occur due to exposure to high levels of noise (Bruce et al. 1998). A person‟s motivation to complete certain tasks might be reduced by exposure to noise. Furthermore, noise may also negatively affect learning and performance in schools (Evans and Stecker, 2004). Noise consideration is an important part of office design which greatly affects workers productivity. It is third among factors determining productivity behind lighting and spatial arrangement (Hameed and Amjad, 2009). Thus timely monitoring of audio noise from all the sources is crucial in mitigating these effects (Kovacevic et al. 2013).

Statement of the Problem

Exposure to extremely high levels of noise is a major avoidable cause of permanent hearing impairment worldwide. In developing countries, environmental noise (especially traffic noise) is an increasing risk factor for hearing impairment and other health-related risks (Rom & Markowitz, 2007). WHO (2008a) states that 16% of the disabling hearing loss among adults emanates from environmental noise, with a range of 7% to 21% from region to region. Hammer et al. (2014) reports that noise-induced hearing loss (NIHL) affects 10 to 15 million people in the USA. In the UK, research shows that the young adults have severe hearing difficulties that point to noise at work (Prendergast et al., 2017). Furthermore, Basner et al. (2014) indicated that cases of tinnitus emerge as a result of exposure to concert noise around Nottingham and England. The International Labor Organization (ILO, 2004:9) has noted the lack of reliable data on the situation of persons with disabilities in Kenya, mostly the hearing disability. However, according to 2009 national census 1.3 million Kenyans are living with disabilities whereby fourteen percent of these cases are hearing disabilities (KNBS, 2010).. The current study will bring into light the the impact of environmental noise on individual hearing problems.

Objectives of the Study

The general objective of the study was to access the impact of environmental noise on individual hearing problems. A critical literature review

Justification and Significance of the Study

Environmental noise pollution has not received adequate attention in Kenya as evidenced by unavailability of data on noise pollution. In addition rapid urban growth 6 coupled with poorly coordinated public transport has been associated with excess production of noise within urban cities such as Nairobi. On the other hand there is lack of adequate enforcement of environmental laws to effectively control noise level. On overall, there is need to assess awareness on health effects of excessive noise among the general public since adequate public awareness is critical in adoption of measures to prevent generation of excessive noise. Therefore, it is important to investigate levels of environmental noise and its perceived health implications among community members. Community members need to understand that exposure to noise contributes to both short and long term health consequences. Hence the implementation of the recommendations of this study might help in the reduction of noise pollution through public education on noise control and safety practices. In generating public awareness campaigns and sensitisations bus termini operators and business vendors will understand the implications of environmental noise on health of individuals operating within the terminus, as such this might motivate them to participate in noise control initiatives. Consequently, this might help decrease the prevalence of the noise-related health risks in the population.

LITERATURE REVIEW

Health Risks

Noise is currently one of the most common complaints amongst urban dwellers and workers in a huge metropolis. Restaurants, transportation systems, and other sources of noise in urban environments have been reported as a serious social and serious health. Residents of urban dwellers report myriad perceived effects of high noise levels that have contributed to the formulation of laws and regulations to manage noise. Currently, in advanced nations, town planners are setting up myriad means to mitigate the effects of noise emanating from generating plants, religious activities, vehicular movement, and other noise pollutants (Margaritis & Kang, 2017; Olayinka, O2013).

In a nutshell, the effects of noise have become a common point of worry among many people from different communities (Winter & Koger, 2014). In France, the Ministry of Employment conducted a survey that indicated that around 7% of employees are exposed to extreme noise levels that are over 85 dB (A) for at least 20 hours every week, and around 25% are exposed to hazardous noise exceeding 85 dB(A) working 20 hours per week (Lie et al., 2016). Further, most of the exposed workers belong to industry (18%) and, the agricultural sector, and house building sector (12%). In Europe, more than 90 million people suffer from unacceptable noise levels, and this necessitated the inauguration of the Environmental Noise Directive (END), 2002/49/EC for the region (European Commission News, 2005).

The prevalence of hearing loss due to environmental noise is estimated to be 63 million (6.3%) in India and it is a common cause of Years lived with disability (Jamir et al., 2014). In an environmental evaluation of noise in Abuja City, Nigeria, a study in 35 locations indicated that the

Central Business District of Abuja has values ranging between 75.8 to 83.6dB(A) which is above recommended tolerable values by WHO, therefore urgently calls for awareness and legislative regulations (Anomohanran, 2013).

Furthermore, little or no concern has been raised for noise pollution, and only very few studies are available in this regard, On the other hand, existing studies in Nigeria have described noise as a slow and subtle killer through its hazardous effects on humans (Eludoyin, 2016). In Morogoro Tanzania study reported the main impacts of exposure to excess noise were headache, hearing problem, sleeplessness, difficulty to concentrate and conversation disruption (Gaganija et al., 2012). High noise levels from PSVs in Nairobi put city dwellers at risk of adverse effects of noise as noise-induced hearing loss (NIHL); physiological and psychological noise effects; speech interference, sleep disturbance; annoyance, social and behavioural effects and this calls not only for intensified noise law enforcement in the city, but also puts to question the effectiveness of existing noise laws to control noise in the city (Otieno et al, 2015). Münzel, Gori, Babisch, and Basner (2014) found that long-term exposure to environmental noise can lead to adverse effects on the cardiovascular system, leading to hypertension, ischemic heart diseases, or even stroke. Also, numerous studies pointed to associations between environmental noise exposure and sleep disturbance, children's cognition, and negative effects in hospitals for both patients and staff (Stickland, Clayton, Sankey, & Hill, 2016).

Traffic-related noise pollution accounts for nearly two-third of the total noise pollution in an urban area (Bhosale et al., 2010). Traffic noise on existing urban roadways lowers the quality of life and property values for a person residing in the vicinity of these urban corridors. Thus, the study of road traffic noise in big cities is an important issue (Bhosale et al., 2010). Due to limited availability of land resources and finances, many highways and important roads are in the residential and commercial areas. Hence there will be some adverse and environmental effects including psychological and physiological effects to those living in proximity of these corridors Tandei et al (2011).

According to Lerner et al. (2010), annoyance is a feeling of displeasure related to any condition or agent believed by an individual to adversely affect him or her. Annoyance increases in a significant when noise is accompanied by vibration or by low-frequency components (Hammersen et al., 2016). The term annoyance does cover a broad range of undesirable reactions associated with noise pollution; these include resentment, dissatisfaction, disappointment, extraction, feebleness, despair, anxiety, distraction, nervousness, or fatigue. According to Bodin, Björk, Ardö, and Albin (2015), lack of control over the noise intensifies these effects. Social and behavioral influences of noise exposure are complex, subtle, and indirect. Alterations in social behavior that occur because of noise include aggressiveness, unfriendliness, nonparticipation, or disengagement and variations in other social indicators (Slovic et al. 2014).

 Susan et al. (2010) indicated that noise exposure per sec is not believed to elicit hostile behavior. Notwithstanding, in combination with niggling, preexisting anger or hostility, alcohol or other psychoactive agents, noise may trigger aggressive behavior. The level of infuriation invoked by noise may change with the time of day, the unpleasant features of the sound, the duration, and

intensity of the noise, the implication associated with it, and the nature of the action that the noise interrupted. Annoyance is greater when noise progressively increases rather than remaining constant. Reliable studies now link high noise levels and activation of certain hormones and reactions in the human body. According to Saidatul, Mohammad, and Tamjis (2009), noise activates the sympathetic-adrenal-medullary axis and the pituitary adrenal-cortical axis, while other scholars have frequently found significant changes in the levels of stress hormones including norepinephrine, epinephrine, and cortisol in acute as well as chronic noise experimentations (Wright, Peters, Ettinger, Kuipers, & Kumari, 2014).

Noise is known to disrupt sleep and sleep patterns, and it also affects judgment and mental functioning significantly. Students in noisy environments cannot concentrate or focus on any particular thing for a significant amount of time, and when they do, the retention capacity is low. Noise does impact human behavior and psychological assessments such as heart rate, blood pressure, and blood flow (Field, Diego, & Hernandez-Reif, 2001). These and other popular studies attest to the fact that those who work, live, or spend considerable time in busy and noisy metropolis are susceptible to myriad health risks owing to high levels of noise pollution (Gongi, 2018). Adverse health impacts seem to be associated with total noise exposure that emanates from all sources and not noise from any single source. The evidence related to lowfrequency noise is adequately high to warrant immediate concern (WHO, 2008a). Adverse health effects from low-frequency noise are thought to be more severe than from other forms of environmental noise. This type of noise is underestimated with the usual types of sound measuring equipment. However, because there is widespread ignorance of the hazard, awareness must be increased about the harmful impacts of noise on hearing and the deterrence and regulator of noise-induced hearing loss (Haynes, Moran, & Pindzola, 2012). Morata and Johnson (2012) argue that a positive 15 image of hearing ought to be promoted, including its contribution to the daily quality of life.

Empirical Review

Joshua (2014) conducted a study to determine the occurrence, socio demographic attributes, risk factors and prevention strategies for NIHL at lKIA. It was a cross sectional descriptive and analytical study. Stratified random sampling was used to recruit 249 workers of whom 162 were ground crew and 87 air crew. Data were collected using questionnaire interview, unobtrusive observations, clinical otoscopy and audiometric testing. Data was described by sample size, frequency, mean, median and standard deviation. Comparison of means was done using t-test. Chi square test and ANOV A was used to assess association of hearing level and various predictors. Pearson's correlation was used to assess variation of mean hearing threshold with age and exposure durations. Logistic regression was used to compare variables between those with and those without hearing loss. Prevalence ofNIHL was 15.3%, with ground crew at 14.9% and air crew 16.1%. Male workers were affected more than female workers with a Male to female ratio of 4:3. 97% of those affected were non-managers, 3% managers. 68% resided in Embakasi Division close to the airport. Median duration of exposure to noise for the NIHL group was 8 years, range 1 to 27. Mean hearing threshold level (HTL) at 3, 4 and 6kHz for ground crew was poorer than air crew (p=0.0 15) and for unionized employees better than non-unionized (p=0.021). Mean HTL at 3, 4 and 6 kHz

correlated positively with age of workers, duration of exposure and history of involvement in an accident at work. Those exposed for less than 10 years had significantly better mean HTL than those exposed for more than 10 years.

Kogutu,(2018) conducted a study to assess noise levels and it's perceived health effects across bus termini in Central Business District of Nairobi City. Using a cross-sectional study design and fishers et al (1983) to determine the sample size, a random sample of 422 community members working within nine bus termini for more than 8 hours a day were approached and recruited in the study. Noise levels were measured using Calibrated sound level meter (Model # 8926). A selfadministered semi-structured questionnaire was used to collect data to identify perceived health risks of noise and safety practices across bus termini. Univariate Chisquare test of independence was used to test the association between noise levels and reported health implications. The response rate was 94.7% (n= 397). The study revealed that 66.8% of respondents (n=265) had awareness on effects of excessive noise exposure as compared to 33.2% (n=132).This study revealed that a higher proportion of respondents spending more than 3 days a week working at the bus termini visited the doctor for a perceived noise induced hearing problem. As such there was a significant association between the number of days spend working at the bus termini in a week and visiting a doctor for a noise induced hearing problem ($\chi2$=16.52, df=2; p).

Simon, (2011) conducted a study to establish the levels of noise produced at these workplaces and the prevalence of noise-induced hearing loss. Current noise exposure was estimated by noise-dosimeter while past exposure was estimated by interview questionnaire. Conventional pure tone audiometry was used to assess the hearing ability in each subject. Hearing thresh hold levels (HTL) were calculated using the WHO revised criteria based on pure-tone average over the frequencies 0.5, 1, 2 and 4 for the better hearing ear (M4 BE). The study revealed that 86.4% of all workers were exposed to noise levels way above 85dBA and only 40% of these use any form of hearing protection. Some 43.5% of the workers in the studied industrial plants were noted to have some degree of hearing impairment ranging from mild to profound. It was also noted that workers exposed to the above recommended noise levels had more incidences of deafness than the general population (44% against 9%). A majority of those exposed to dangerous noise levels were noted to be machine operators and in the age group 20-40 years and were all male. In spite of the grim statistics on hearing loss among this population of workers, both the employees and the employers did not make use of hearing protectors seriously and there is a need to enforce the same. One of the major reasons for non-use of these devices was noted to be discomfort. Employers have an obligation to ensure provision of user-friendly hearing protector appliances and any other appropriate method to reduce hazardous noise exposure to the workers. Governments the world over have a duty to protect workers against one of the commonest occupational hazards by enacting registration and enforcing the relevant laws especially on hearing conservation programs. The findings of his study could inform the ministries of Labour and Human Resources Development and Health in designing and enforcing relevant occupational and safety regulations and legislation to protect the otherwise very vulnerable workforce exposed to these hazardous noise levels.

Samuel,(2016) conducted a study on using neural networks to reduce noise in internet of things data streams. Noise in the Internet of Things is threatening to drown out sensor data. The problem is growing as more and more devices are being connected to the internet. The noise comes from the electric components both within and without the IoT devices. Other sources of noise include poor calibration. There is thus a need to ensure accurate data is collected in a cost effective way as noisy data might prove disastrous. This study sought to find out the suitability of using neural networks as a filter and also compared its performance to a Kalman filter. An Artificial Neural Network filter application was developed using rapid application prototyping using simulated data to test. The results showed that the Artificial Neural Network filter was reliable to filter out the noise compared to other filtering solutions such as the Kalman filter. Despite the Artificial Neural Network being about 15 times slower than the Kalman filter, it was found to be more accurate. It was thus found that an Artificial Neural Network is much more accurate than a Kalman filter and makes a good noise filter for IoT devices

2.5 Research gaps

Geographical gap is a knowledge gap that considers, the untapped potential or missing/limited research literature, in the geographical area that has not yet been explored or is under-explored. For instance Kogutu,(2018) conducted a study to assess noise levels and it's perceived health effects across bus termini in Central Business District of Nairobi City. Using a cross-sectional study design and fishers et al (1983) to determine the sample size, a random sample of 422 community members working within nine bus termini for more than 8 hours a day were approached and recruited in the study. This study revealed that a higher proportion of respondents spending more than 3 days a week working at the bus termini visited the doctor for a perceived noise induced hearing problem. As such there was a significant association between the number of days spend working at the bus termini in a week and visiting a doctor for a noise induced hearing problem ($\chi2=16.52$, df=2; p). The studies presented a geographical gap as they were conducted in Kenya while our current study focused on the impact of environmental noise on individual hearing health.

Methodological gap is the gap that is presented as a result in limitations in the methods and techniques used in the research (explains the situation as it is, avoids bias, positivism, etc.). Joshua (2014) conducted a study to determine the occurrence, socio demographic attributes, risk factors and prevention strategies for NIHL at lKIA. It was a cross sectional descriptive and analytical study. Stratified random sampling was used to recruit 249 workers of whom 162 were ground crew and 87 air crew. Mean HTL at 3, 4 and 6 kHz correlated positively with age of workers, duration of exposure and history of involvement in an accident at work. Those exposed for less than 10 years had significantly better mean HTL than those exposed for more than 10 years. The studies presented a methodological gap as it used descriptive research design while our current study adopted a desktop literature review method.

 Conceptual gap arises because of some difference between the user's mental model of the application and how the application actually works. Samuel,(2016) conducted a study on using neural networks to reduce noise in internet of things data streams. Noise in the Internet of Things

is threatening to drown out sensor data. The problem is growing as more and more devices are being connected to the internet. The noise comes from the electric components both within and without the IoT devices. Other sources of noise include poor calibration. The results showed that the Artificial Neural Network filter was reliable to filter out the noise compared to other filtering solutions such as the Kalman filter. Despite the Artificial Neural Network being about 15 times slower than the Kalman filter, it was found to be more accurate. The study focused on noise in the internet of things is threatening to drown out sensor data, while the current study examined impact of environmental noise on individual hearing health.

METHODOLOGY

The study adopted a desktop literature review method (desk study). This involved an in-depth review of studies related to impact of environmental noise on individual hearing health. Three sorting stages were implemented on the subject under study in order to determine the viability of the subject for research. This is the first stage that comprised the initial identification of all articles that were based on impact of environmental noise on individual hearing health from various data bases. The search was done generally by searching the articles in the article title, abstract, keywords. A second search involved fully available publications on the subject on impact of environmental noise on individual hearing health. The third step involved the selection of fully accessible publications. Reduction of the literature to only fully accessible publications yielded specificity and allowed the researcher to focus on the articles that related to impact of environmental noise on individual hearing health which was split into top key words. After an in-depth search into the top key words (impact, environmental, noise , individual ,hearing health), the researcher arrived at 4 articles that were suitable for analysis. The 4 articles were findings from Joshua (2014) who conducted a study to determine the occurrence, socio demographic attributes, risk factors and prevention strategies for NIHL at lKIA. It was a cross sectional descriptive and analytical study. Stratified random sampling was used to recruit 249 workers of whom 162 were ground crew and 87 air crew. Mean HTL at 3, 4 and 6 kHz correlated positively with age of workers, duration of exposure and history of involvement in an accident at work. Those exposed for less than 10 years had significantly better mean HTL than those exposed for more than 10 years.

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SUMMARY, CONCLUSION AND POLICY IMPLICATION FOR FURTHER STUDY

Summary

Active hearing protectors are level dependent or sound restoration hearing protectors that block sound as well as employ electronic circuitry to transmit sounds that are of low levels. They are advantageous, as users do not have to remove them in the absence of noise to hear well. Users can also benefit from earmuffs with communication features such as FM, infrared, or wired technology for communication.

Conclusion

The study concludes that safety practices that can assist in preventing hearing losses and other harmful effects call for personal, physician, and administrative engagement. Administratively, employers have an obligation to provide safety devices that prevent hearing loss or impairment. Employers should provide personal protective equipment to abate noise levels and that employers should give all employees an opportunity select hearing protectors that vary from entire head enclosures, canal caps, earplugs, to ear mugs. Moreover, employers should conduct frequent tests on the effect of noise and treatments. Physicians have the responsibility to supervise hearing conservation programs within large, noisy plant.

Recommendations

The study suggested that that personal hearing protective devices use should be enforced through education and inbuilt administrative mechanisms. Only consistent long term use of prevention

produces positive impact. It is also recommended that utilization of safety strategies like shift rotations, leave scheduling, acoustic sound proofing of offices, quiet machinery and other strategies be enhanced through deliberate administrative effort. Shift rotations may ensure fewer workers are exposed at times of peak noise levels depending on their work requirements. It is recommended that access to safety information be improved through posters, public announcement, training seminars and others. 105 It is recommended that regular noise safety education training be conducted to inform and encourage workers with the aim of developing a safety culture and ensuring long term impact on health

REFERENCES

Anomohanran, O (2013). Evaluation of environmental noise pollution in Abuja, the Capital city of Nigeria, IJRRAS 14(2):470-476.

Arenas, J. P., & Suter, A. H. (2014). Comparison of occupational noise legislation in the Americas: an overview and analysis. Noise and Health, 16(72), 306.

Banerjee, D., Chakraborty, SK., Bhattacharyya, S., & Gangopadhyay, A (2008). Evaluation and analysis of road traffic noise in Asansol: an industrial town of Eastern India. Int J Environ Res Public Health, 5(3):165-71.

Barbara, C., & Rose, V. E. (2011). Patty's Industrial Hygiene, 4-Volume Set. John Wiley & Sons.

Basner, M., Babisch, W., Davis, A., Brink, M., Clark, C., Janssen, S., & Stansfeld, S. (2014). Auditory and non-auditory effects of noise on health. The Lancet, 383(9925), 1325-1332.

Belojevic, G., Brink, M., Heroux, M.E., Janssen, S., Lercher, P., Paviotti, M., Pershagen, G., Persson Waye, K., Preis, A., Stansfeld, S. & Van Den Berg, F., 2016, August. WHO Environmental Noise Guidelines for the European RegionWhat is New? 3. Guideline recommendations and supporting evidence-What is new?. In INTER-NOISE and NOISE-CON Congress and Conference Proceedings (Vol. 253, No. 1, pp. 6947-6950). Institute of Noise Control Engineering.

Bhosale, B.J., Late. A., Nalawade, P.M., Chavan, S.P. & Mule, M.B. (2010). Studies on assessment of traffic noise level in Aurangabad city. Noise Health, 12, 195-198.

Bluhm, G., Nordling, E., & Berglind, N. (2004). Road traffic noise and annoyance--an increasing environmental health problem. Noise & Health, 6(24), 43–49.

Bodin, T., Björk, J., Ardö, J., & Albin, M. (2015). Annoyance, sleep and concentration problems due to combined traffic noise and the benefit of quiet side. International journal of environmental research and public health, 12(2), 1612-1628.

Carlson, N. R. (2013). Physiology of Behavior. Pearson. Chadha, S., & Cieza, A. (2017). Promoting global action on hearing loss: World hearing day.

Cohen, P., Potchter, O., & Schnell, I. (2014). The impact of an urban park on air pollution and noise levels in the Mediterranean city of Tel-Aviv, Israel. Environmental Pollution, 195, 73-83.

Cole, C. (2016). Noise Exposure in Electric and Natural Gas Utility Transmission and Distribution Operations. Creswell, J. W., & Clark, V. L. P. (2007). Designing and conducting mixed methods research.

Curhan, S. G., Shargorodsky, J., Eavey, R., & Curhan, G. C. (2012). Analgesic Use and the Risk of Hearing Loss in Women. American Journal of Epidemiology, kws146. http://doi.org/10.1093/aje/kws146

Eludoyin, O. M., (2016). Perceptions on Noise Pollution among the Residents of a Medium-Size Settlement in Southwestern Nigeria – A Preliminary Study. J Pollut Eff Cont 4: 160. doi:10.4172/2375-4397.1000160

Fan, Y., Zhiyi, B., Zhujun, Z., & Jiani, L. (2010). The investigation of noise attenuation by plants and the corresponding noise-reducing spectrum. Journal of environmental health, 72(8), 8-15.

Gaganija, M.S., Mkoma, S.L. & Lema, E.S (2012). Attitudes of community to urban traffic noise in Morogoro, Tanzania. Ethiopian Journal of Environmental Studies and Management EJESM Vol. 5(3):280.

Gillver, M., Williams, W., & Beach, E. (2014). Noise exposure in the balance: Managing occupational and leisure risks to hearing health.

Gongi, S. P., Kaluyi, J., & Kanali C. L. (2016). Industrial Noise Pollution and its Health Effects on Wokers in Nairoby City. International Journal of Engineering and research and Technology, 181 (5), 426 -435.

Gongi, S. P. (2018). Assessment of the Extent and Perceived Effects of Noise Pollution in Manufacturing Industries in Nairobi City (Doctoral dissertation, JKUAT COETEC).

Hammer, M.S., Swinburn, T.K. & Neitzel, R.L., (2014). Environmental noise pollution in the United States: developing an effective public health response. Environmental health perspectives, 122(2), p.115.

Hammersen, F., Niemann, H., & Hoebel, J. (2016). Environmental noise annoyance and mental health in adults: findings from the cross-sectional German Health Update (GEDA) Study 2012. International journal of environmental research and public health, 13(10), 954.