

Effects of Noise Pollution on the Residents of Port Harcourt Metropolis

Ukwu, Chikaebere Anthonia

Africa Centre of Excellence, School of Public Health and Toxicological Research, University of Port Harcourt. chikaebereukwu@gmail.com

Abstract

Objective: This study aims to assess the effects of noise pollution in Port Harcourt Metropolis and to determine its association with health, quality of life, and economic well-being of the people resident in the area.

Methods: A cross-sectional survey involving 422 adult residents of Port Harcourt Metropolis was conducted. Participants completed a questionnaire assessing their physical and mental health, as well as their economic well-being. Statistical analysis including descriptive and inferential analysis were used to assess the effect of noise pollution on the physical, mental and economic well-being of the residents, as well as the relationships between variables.

Results: The study reveals a mean noise level of 72.91dB in Port Harcourt Metropolis, highlighting the pervasive risk of annoyance and hearing damage. Findings indicate a low negative effect of noise pollution on the physical health (48%), moderate negative effect on both mental health and economic well-being 58% and 56% respectively, among residents of Port Harcourt Metropolis.

Conclusion: The study concludes that while noise pollution in Port Harcourt Metropolis has a moderate effect on mental health and economic well-being, it has a low effect on physical health. Additionally, strong positive correlations are found between gender and both physical and mental health, with females showing a stronger association. Recommendations include implementing measures to mitigate noise pollution and addressing gender disparities to improve overall well-being in the area.

Keywords: noise pollution, Port Harcourt metropolis, physical health, mental health, economic well-being

Introduction

Noise pollution is a major environmental problem that can lead to nuisances and health issues (Oguntunde, et al., 2019). It is the propagation of noise with a harmful impact on the physiological and psychological lives of humans and animal (Oloruntoba, 2012). Noise is more than a mere nuisance. At certain levels and duration of exposure, it can cause physical damage to the eardrum and the sensitive hair cells of the inner ear and result in temporary or permanent hearing loss, known as noise-induced hearing loss (Berg & Nathanson, 2023). It is an underestimated threat that can cause a number of short- and long-term health problems, such as sleep disturbance, cardiovascular effects, poorer work and school performance, hearing impairment (WHO, 2010).

Twenty percent (20%) of Europe's population are exposed to long-term noise levels that are harmful to their health (European Environmental Agency, 2020). Environmental noise contributes to 48,000 new cases of ischemic heart disease a year as well as 12,000 premature deaths, followed by 22 million people who suffer chronic high annoyance, 6.5 million people who suffer chronic high sleep disturbance, and 12,500 school children who suffer reading impairment in school due to aircraft noise, as estimated by European Environment Agency.

In Africa's most populous country and largest economy, noise is the price millions of people pay for living in a rapidly expanding urban jungle. From industries to notoriously heavy traffic, cities like Lagos, Nigeria's most densely populated, are a cacophonous assault on the eardrums (Idris, 2023).

Noise pollution can have various adverse effects on physical, and mental health as well as the economic wellbeing of the residents. Loud sounds can directly damage the inner ear and cause hearing loss, tinnitus, or distorted hearing (Goodwin & Millar, 2020; Dutchen, 2022). Prolonged exposure to high levels of noise has been linked to increased stress, hypertension, and cardiovascular problems (Basner et al., 2014; Goodwin & Millar, 2020). Additionally, it can disrupt sleep patterns, leading to sleep disturbances and associated health issue (Muzet, 2007; Goodwin & Millar, 2020; Dutchen, 2022). Noise pollution can activate the stress response and increase the levels of stress hormones, such as cortisol and adrenaline, which can impair the body's ability to cope with other stressors (Goodwin & Millar, 2020; Dutchen, 2022). Studies have shown that noise pollution from traffic, airports, or industrial sources can reduce the property value by 0.6% to 2.3% per decibel increase (Farooqi et al., 2022). This can result in a loss of income and wealth for the property owners, and a lower tax revenue for the government (Hagler, n.d). Noise pollution can also harm the natural environment and biodiversity, by affecting the behavior, communication, reproduction, and survival of animals (Farooqi et al., 2022).

The World Health Organization (WHO) recommends that noise exposure levels should not exceed 70 dB over a 24-hour period, and 85 dB over a 1-hour period to avoid hearing impairment (CDC, 2018). The WHO guidelines for community noise recommend less than 30 A-weighted decibels (dB(A)) in bedrooms during the night for a sleep of good quality and less than 35 dB(A) in classrooms to allow good teaching and learning conditions. The guidelines for night noise recommend less than 40 dB(A) outside of bedrooms to prevent adverse health effects from night noise (WHO, 2010). According to European Union (EU) publication: about 40% of the population in EU countries is exposed to road traffic noise at levels exceeding 55 db(A); 20% is exposed to levels exceeding 65 dB(A) during the daytime; and more than 30% is exposed to levels exceeding 55 dB(A) at night (WHO/EU, 2011).

According to an online publication on Conserve Energy Future, noise pollution occurs when there is either an excessive amount of noise or an unpleasant sound that causes a temporary disruption in the natural balance. Noise can be classified as man-made-noise or environmental noise. Man-made-noise, is usually caused by man, ranging from construction work, noise from the air, vehicular traffic, household noise, or noise from pubs and bars to name a few. It ranges from 30 to a whopping 140 dB, which is extremely harmful to humans. Environmental Noise refers to the kind of noise occurring from a range of environmental activities. This can be anything from animals' mating call to thunderstorms and can often go up to 140 dB (Rinkesh, 2023).

National Geographic Society defines Noise pollution as any unwanted or disturbing sound that can have adverse effects on human health and the environment. It is measured in decibels (dB), which is a logarithmic unit of measurement that quantifies the intensity of sound. The normal sound a human ear can perceive is generally 1 Decibel (dB), anything over 30 dB is considered as noise pollution. If the sound level goes beyond 130 dB, it is a health hazard and can cause irreparable damage (Toppr, n.d). The possible effects of noise pollution on public could be measured in terms of health effects, quality of life, and economic impact.

Research Questions

1. What is the level of noise in Port Harcourt Metropolis?
2. What is the level of the effect of noise on the physical health of the residents of Port Harcourt Metropolis?
3. What is the level of the effect of noise on the mental health of the residents of Port Harcourt Metropolis?

4. What is the level of the effect of noise on the economic well-being of the residents of Port Harcourt Metropolis?

Methodology

This is a descriptive cross-sectional study which utilized quantitative methods to investigate the effects of noise pollution on the physical health, mental health and economic well-being of residents of Port Harcourt. It utilized a survey to gather data on physical and mental health as well as economic well-being, along with noise level measurements within the study area, with a calculated sample size of 422 participants using Cochran's method to ensure statistical significance. The study employed a combination of stratified random sampling, simple random sampling, and systematic random sampling at different stages of sample collection to ensure representation from various wards in Port Harcourt Metropolis. It utilized sound meter for noise level measurement and a survey questionnaire consisting of sections for informed consent, demographics, and inquiries about the effects of noise pollution on physical health, mental health, and economic well-being. It employed both manual and digital techniques for data collection, with paper surveys distributed by research assistants and data later digitized using Google Forms and MS Excel. Data analysis includes: descriptive statistics such as frequency, mean and percentage were used to assess the effects of noise pollution on residents' health and economic well-being. WHO noise regulation guidelines were used for categorizing noise levels. To assess the effects of noise pollution on residents' physical health, mental health and economic well-being, "Yes" responses were considered indicative of a negative effect, while "No" responses indicated no perceived effect. Results were categorized as follows: Low Negative Effect (0 – 49%), Moderate Negative Effect (50 – 59%), and High Negative Effect (60 – 100%). The study ensured ethical consideration as participants were well-informed about the study's objectives and procedures, obtained their consent, and guaranteed confidentiality. Participation was voluntary, and measures were in place to protect participants' privacy and data integrity.

Results

TABLE 1: Noise Level Across Selected Areas in Port Harcourt Metropolis

Location	Noise Level (dB)	WHO Indication
D-Line	72	Considered loud, can cause annoyance
Garrison	74	Considered loud, can cause annoyance
Ogbunabali	74	Considered loud, can cause annoyance
Rumukalagbo	72	Considered loud, can cause annoyance
Rumukrushu	73	Considered loud, can cause annoyance
Rumuodara	72	Considered loud, can cause annoyance
Rumuola	75	Considered loud, can cause annoyance
Rumuomasi	76	Very loud, can lead to hearing damage over time

Rumuosi	64	Moderate levels, may disturb some activities
Stadium Road	74	Considered loud, can cause annoyance
Trans-Amadi	76	Very loud, can lead to hearing damage over time
Mean Noise Level:	72.91	Considered loud, can cause annoyance

Table 1, shows the result which demonstrates widespread noise pollution across Port Harcourt Metropolis, surpassing WHO's acceptable levels. D-Line, Rumukalagbo, and Rumuodara registered 72dB, indicating potential annoyance. Garrison and Ogbunabali recorded 74dB, also within this range. Rumuola and Stadium Road hit 75dB, while Rumuomasi and Trans-Amadi reached 76dB, signifying very loud noise levels. Despite Rumuosi's lower 64dB, it still disrupts activities. The city's mean noise level of 72.91dB highlights the pervasive risk of annoyance and hearing damage. Urgent actions are needed, including stricter regulations, urban planning, and public awareness campaigns to curb noise pollution.

TABLE 2: Effects of noise pollution on the physical health of the residents of Port Harcourt Metropolis

Sample Size = 422

ITEMS	Yes	No	Percentage	Outcome
Are you exposed to excessive noise pollution leading to discomfort and fatigue?	234 (55%)	188 (45%)	55%	Moderate Negative Effect
Are you exposed to prolonged noise pollution, leading to hearing problems?	152 (36%)	270 (64%)	36%	Low Negative Effect
Do you face increased stress levels and hypertension, as a result of prolonged noise pollution?	187 (44%)	235 (56%)	44%	Low Negative Effect
Does noise pollution disturb your sleep patterns, leading to poor overall health?	273 (65%)	149 (35%)	65%	High Negative Effect
Does noise pollution have a direct correlation with the occurrence of headaches and migraines, you usually experience?	251 (59%)	171 (41%)	59%	Moderate Negative Effect
Does noise pollution worsen existing health conditions such as cardiovascular diseases, you usually experience?	119 (28%)	303 (72%)	28%	Low Negative Effect
Grand Physical Health Effect:			48%	Low Negative Effect

Table 2 illustrates the impact of noise pollution on the physical health of Port Harcourt residents. A significant portion, 55%, reported moderate discomfort and fatigue, indicating prevalent issues in the area. However, only 36% reported hearing problems, suggesting it's less common. Stress and hypertension were reported by 44%, indicating a less pronounced impact. Disturbed sleep was prevalent, affecting 65% of respondents, followed by headaches and migraines at 59%. Worsening of existing health conditions, such as cardiovascular diseases, was reported by 28%, indicating a less significant impact. Overall, 48% reported some negative effects, suggesting variations in individual experiences despite significant impacts on specific health aspects.

TABLE 3: Effect of noise pollution on the mental health of the residents of Port Harcourt Metropolis

Sample Size = 422

ITEMS	Yes	No	Percentage	Outcome
Do you experience increased levels of anxiety and nervousness due to noise pollution?	247 (59%)	175 (41%)	59%	Moderate Negative Effect
Do you experience irritability and mood swings, due to prolonged noise pollution?	237 (56%)	185 (44%)	56%	Moderate Negative Effect
Does noise pollution hamper your concentration and productivity level?	382 (91%)	40 (9%)	91%	High Negative Effect
Do you experience depression due to noise pollution?	129 (31%)	293 (69%)	31%	Low Negative Effect
Noise pollution affects your overall sense of well-being and happiness.	247 (59%)	175 (41%)	59%	Moderate Negative Effect
Do you socially withdraw and isolate yourself due to noise pollution?	227 (54%)	195 (46%)	54%	Moderate Negative Effect
Grand Mental Health Effect:			58%	Moderate Negative Effect

Table 3 reveals that in Port Harcourt Metropolis, 55% of respondents reported increased anxiety and nervousness due to noise pollution, indicating a moderate negative effect on mental health. Similarly, 56% experienced irritability and mood swings, again suggesting a moderate negative effect. A significant majority (91%) reported hampered concentration and productivity levels, indicating a high negative effect. Depression was reported by 31% of respondents, considered a low negative effect compared to other factors. Additionally, 59% noted an impact on overall well-being and happiness, suggesting a moderate negative effect, while 54% reported socially withdrawing due to noise pollution, indicating a similar negative

effect. Overall, the mental health impact is moderately negative, with 58% of respondents affected by noise pollution.

TABLE 4: Effect of noise pollution on the economic well-being of the residents of Port Harcourt Metropolis

Sample Size = 422

ITEMS	Yes	No	Mean	Percentage	Outcome
Does noise pollution reduce property values in affected area?	278 (66%)	144 (34%)		66%	High Negative Effect
Does business located in noisy areas experience decreased productivity?	244 (58%)	178 (42%)		58%	Moderate Negative Effect
Does health-related costs increase due to noise pollution-related illnesses?	242 (57%)	180 (43%)	0.57	57%	Moderate Negative Effect
Do you think noise pollution leads to increased absenteeism in workplaces?	190 (45%)	232 (55%)	0.45	45%	Low Negative Effect
Do you think tourism and investment are deterred by high levels of noise pollution?	217 (51%)	205 (49%)	0.51	51%	Moderate Negative Effect
Does noise pollution impose additional costs on residents for soundproofing or relocation?	247 (59%)	175 (41%)	0.59	59%	Moderate Negative Effect
Grand Economic Well-Being Effect:			0.56	56%	Moderate Negative Effect

Table 3 reveals that in Port Harcourt Metropolis, 55% of respondents reported increased anxiety and nervousness due to noise pollution, indicating a moderate negative effect on mental health. Similarly, 56% experienced irritability and mood swings, again suggesting a moderate negative effect. A significant majority (91%) reported hampered concentration and productivity levels, indicating a high negative effect. Depression was reported by 31% of respondents, considered a low negative effect compared to other factors. Additionally, 59% noted an impact on overall well-being and happiness, suggesting a moderate negative effect, while 54% reported socially withdrawing due to noise pollution, indicating a similar negative effect. Overall, the mental health effect is moderately negative, with 56% of respondents affected by noise pollution.

Discussions

The findings of both the previous study conducted by Wokekoro (2020) and the current study on the effect of noise pollution on the physical health of Port Harcourt residents provide insights into the detrimental impact of noise pollution on human health. While Wokekoro's study primarily focused on exploring public awareness regarding the adverse effects of noise pollution, the current study delves deeper into quantifying and categorizing the physical health effects experienced by residents of Port Harcourt. Both studies underscore the prevalence of adverse health impacts associated with noise pollution. Wokekoro (2020) highlighted various negative health consequences such as headaches, insomnia, psychological disorders, decreased work concentration, hearing loss, learning difficulties, stroke, hypertension, and diminished quality of life. These findings align with the current study's identification of discomfort, fatigue, hearing problems, stress, hypertension, disturbed sleep patterns, headaches, migraines, and exacerbation of existing health conditions like cardiovascular diseases due to noise pollution. Furthermore, Wokekoro's study emphasized the awareness among respondents regarding the health implications of noise pollution, suggesting that residents are cognizant of the risks associated with excessive noise exposure. This aligns with the current study's findings, which indicate a significant portion of respondents reporting various health effects attributed to noise pollution. Both studies advocate for public education on the dangers of noise pollution and the enforcement of noise pollution control laws to mitigate its adverse effects. While Wokekoro's study recommended extensive public education, the current study's findings also underscore the need for awareness campaigns and regulatory measures to address noise pollution in Port Harcourt.

The findings of the previous study conducted by Begam and Bashar (2020) on the auditory effects and consequences of noise pollution in humans provide valuable insights into the long-term impacts of noise pollution on physical health, particularly focusing on Noise-Induced Hearing Loss (NIHL). The study emphasizes the prevalence of NIHL in occupational settings and highlights the increasing trend attributed to exposure to social and environmental noise. It also underscores the significant progress made in understanding the molecular basis of NIHL, with advancements in genetics potentially offering avenues for preventive and treatment strategies. Aligning these findings with the current study on the effect of noise pollution on the physical health of residents in Port Harcourt, several parallels can be drawn. Both studies recognize the adverse impact of noise pollution on physical health, albeit from different perspectives. Firstly, the current study acknowledges the prevalence of hearing problems among respondents, albeit not as predominant as other health effects. This aligns with the emphasis on NIHL in the previous study, indicating that noise pollution can indeed lead to auditory consequences such as hearing impairment.

Secondly, the previous study's focus on genetics and molecular understanding of NIHL resonates with the current study's findings on the varied impacts of noise pollution on different aspects of physical health. While the current study does not delve into the molecular mechanisms, it underscores the multifaceted nature of health impacts, ranging from discomfort and fatigue to sleep disturbances and headaches. This suggests that the overall physical health effects of noise pollution may stem from complex interactions involving genetic predispositions and environmental factors, as hinted at in the previous study. Furthermore, both studies emphasize the importance of effective prevention and mitigation strategies to address the health consequences of noise pollution. While the previous study suggests potential avenues in genetics for preventive and treatment strategies, the current study underscores the need for comprehensive measures to mitigate the diverse impacts of noise pollution on physical health. In general, while the previous study by Begam and Bashar (2020) focuses on the auditory effects of noise pollution, the findings align with the current study's broader examination of the

physical health impacts among residents of Port Harcourt. Together, these studies emphasize the urgent need for concerted efforts to address noise pollution as a public health concern, considering its multifaceted impact on human health.

The previous study conducted by Tunde & Abdulquadri (2021) in Ilorin, Kwara State, identified various primary sources of noise pollution, including traffic, music studios, hotels/night clubs, and power generating sets. The study found that noise levels exceeded the recommended limits set by NESREA in both commercial and commercial/residential locations, which our current study did not studied. Additionally, it highlighted that the males exhibited a higher susceptibility to the effects of noise pollution compared to females. Aligning these findings with the current study conducted in Port Harcourt, we can observe similarities and differences. Both studies highlight the adverse effects of noise pollution on sleep patterns. The current study in Port Harcourt found disturbed sleep patterns to be the most prominent effect, while the previous study in Ilorin did not specifically mention sleep disturbances but focused more broadly on the perceived health consequences of noise pollution. However, there are some differences between the two studies. For instance, the current study in Port Harcourt found that noise pollution also had significant effects on discomfort, fatigue, hearing problems, headaches, migraines, stress levels, hypertension, and worsened existing health conditions such as cardiovascular diseases. In contrast, the previous study in Ilorin did not delve into these specific health impacts. Furthermore, while the previous study in Ilorin identified gender-based differences in susceptibility to the effects of noise pollution, the current study in Port Harcourt did not explicitly explore gender differences in its findings.

Both the current study focusing on noise pollution in Port Harcourt and the previous study conducted by Omogbiya et al. in Abraka, Delta State, Nigeria, shed light on the detrimental effects of noise pollution on the mental health of residents in urban environments. The previous study by Omogbiya et al., highlighted how noise pollution stemming from clubhouses affected the mental well-being of individuals living nearby. The findings indicated a range of negative consequences, including disturbances in sleep patterns, feelings of nervousness, headaches, fear, stress, and even depression. Importantly, individuals residing closer to the sources of noise pollution exhibited higher prevalence rates of sleep disorders, anxiety, and depressive symptoms compared to those living farther away. This study underscores the direct impact of noise pollution on mental health, emphasizing how exposure to loud and disruptive noise can lead to a variety of psychological distress symptoms. Aligning these findings with the results of the current study on noise pollution in Port Harcourt, we observe a similar pattern of adverse effects on mental health. While the specific percentages may differ, both studies highlight common themes such as increased anxiety, irritability, mood swings, difficulty concentrating, decreased productivity, depression, and social withdrawal among residents exposed to noise pollution. In both cases, noise pollution is shown to disrupt individuals' mental well-being, affecting their overall quality of life and social interactions. Moreover, both studies emphasize the importance of addressing noise pollution as a public health concern. The findings underscore the need for policy interventions and urban planning strategies aimed at mitigating noise pollution to promote better mental health outcomes in affected communities. By recognizing the significant impact of noise pollution on mental health, policymakers can implement measures to regulate noise levels, enforce noise ordinances, and implement soundproofing measures in urban areas to protect residents' mental well-being. In a nutshell, both studies provide valuable insights into the multifaceted relationship between noise pollution and mental health. By critically examining the findings of both studies, we can discern a clear consensus on the detrimental effects of noise pollution on mental health, highlighting the urgency of addressing this issue to foster healthier and more livable urban environments.

Both our current study conducted in Port Harcourt and the previous study by Egbenta et al. (2021), conducted in Enugu Urban, Nigeria, shed light on the economic implications of noise pollution on residents' well-being, particularly in terms of property values and related economic activities. The previous study by Egbenta et al. (2021) found that residential properties exposed to noise pollution experienced a decrease in rental value compared to unaffected properties. This decrease in property value directly affects homeowners' economic well-being, as it diminishes their potential returns on investment. Similarly, the current study in Port Harcourt indicates that noise pollution adversely affects property values, potentially leading to a decrease in the overall economic value of residents' assets. Moreover, both studies highlight the impact of noise pollution on businesses. The current study suggests that businesses operating in noisy environments face reduced productivity, which can have detrimental effects on their economic performance. Similarly, the previous study by Egbenta et al. (2021) indicates that noise pollution could potentially impact various aspects of human life, including economic activities, as it affects physical well-being and could disrupt normal business operations. Furthermore, the current study in Port Harcourt indicates that noise pollution contributes to increased health-related costs due to associated illnesses. This aspect aligns with the findings of the previous study by Egbenta et al. (2021), which suggests that noise pollution could impact residents' physiological well-being. Increased healthcare expenses directly affect residents' economic well-being by imposing additional financial burdens. Additionally, both studies highlight the potential deterrent effect of noise pollution on tourism, investment, and property transactions. The previous study mentions variations in noise levels across different neighborhoods, which could influence investors' decisions regarding property acquisition or development projects. Similarly, the current study suggests that noise pollution can deter potential investors and tourists, negatively impacting economic growth and development in the area.

In our current study conducted in Port Harcourt regarding noise pollution and its impact on the physical, mental, and economic well-being of residents, the findings regarding gender and age reveal interesting insights. The study suggests a strong positive relationship between gender and physical health, mental health, and economic well-being in the context of noise pollution. Specifically, both males and females exhibit a strong positive association with these aspects of well-being, with females potentially showing a slightly stronger association. This implies that regardless of gender, residents of Port Harcourt experience improved well-being in relation to noise pollution, with females possibly experiencing slightly better outcomes. Comparing this with the findings of the previous study conducted by Maraş and Uslu (2015) in Samsun, Turkey, which explored noise annoyance and its correlation with various demographic factors including gender, there are notable differences. In the Samsun study, no statistically significant relationships were observed between noise annoyance and gender. This suggests that while there may be no discernible gender differences in noise annoyance, the current study in Port Harcourt indicates that gender may play a role in how individuals perceive and are affected by noise pollution in terms of their overall well-being. Regarding age, both studies highlight significant correlations between age and various aspects of well-being in the context of noise pollution. In our current study in Port Harcourt, there are strong negative correlations between age and physical health, mental health, and economic well-being. As individuals age, their well-being tends to decline significantly amidst noise pollution, suggesting that older residents may be more vulnerable to the adverse effects of noise pollution compared to younger individuals. Similarly, the previous study by Maraş and Uslu (2015) in Samsun, Turkey, noted inconsistencies regarding the association between age and noise annoyance type. While there were no statistically significant relationships observed between age and noise annoyance, the study did identify differences across age groups in terms of when

individuals experienced heightened annoyance from noise. For instance, individuals under 25 tended to be predominantly bothered by daytime noise, while those over 60 experienced greater annoyance during nighttime.

Conclusion

The study on noise pollution in Port Harcourt Metropolis reveals significant implications for residents' well-being across physical, mental, and economic domains. Noise levels exceed WHO guidelines, potentially leading to annoyance and health issues such as disturbed sleep and headaches. Mental health is also affected, with notable impacts on anxiety, irritability, concentration, and overall well-being. Economically, noise pollution reduces property values, business productivity, and increases healthcare costs. Gender analysis suggests both genders are impacted, with older individuals particularly vulnerable. Urgent measures are needed to mitigate noise pollution and promote a healthier, more prosperous community.

Recommendations

The study on noise pollution in Port Harcourt Metropolis yields several recommendations:

1. Enforce stricter regulations on noise emissions in transportation, industry, and construction.
2. Incorporate noise reduction strategies in urban planning, like sound barriers and green spaces.
3. Launch public awareness campaigns about the health effects of noise pollution.
4. Offer financial incentives for soundproofing buildings and infrastructure.
5. Enhance healthcare services to address noise-related health issues.
6. Encourage investment in quieter technologies and industries for sustainable economic growth.
7. Provide targeted support for the aging population affected by noise pollution.

References

- Abdulkarim, Z., Emeka, N., & Clementine, I. (2021). Influence of environmental factors and its associated health risks of noise pollution in Owerri Metropolis, Imo State, Nigeria. *GSC Advanced Research and Reviews*, 8(1), 001-010.
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179-211.
- Awosusi, A. O., & Akindutire, I. O. (2014). Perceived health effects of environmental noise pollution on the inhabitants of Ado-Ekiti Metropolis. Ekiti State, Nigeria. *Journal of Biology, Agriculture and Healthcare*, 4(26), 106-113.
- Becker, M. H. (1974). The health belief model and personal health behavior. *Health Education Monographs*, 2(4), 324-508.
- Begam, Nazia & Bashir, Abu. (2020). Auditory effects and consequences of noise pollution in humans: A scoping review. *Journal of Family Medicine & Community Health*.
- Berg Richard & Nathanson Jerry. (2023). Noise Pollution. Fact-checked by The Editors of Encyclopedia Britannica. Last Updated: Nov. 18, 2023.
- Brandon Pam (2018). Noise Pollution and Older Adults-A Real Health Hazard. *Family Caregiver Hospital Professionals Senior Care Professionals*. <https://www.ageucate.com/blog/?p=1377>.
- Britannica. (n.d). <https://www.britannica.com/science/noise-pollution/Noise-regulation-and-mitigation>.

- BYJU'S. (2023). Noise Pollution. <https://byjus.com/physics/noise-pollution-prevention/>.
- Center for Disease Control (CDC) (2018). Page last reviewed: December 11, 2018. Content source: National Center for Environmental Health. Public Health and Scientific Information NCEH | CDC.
- Dutchen, Stephanie. (2022). Noise and Health\Harvard Medicine Magazine.
- Egbenta, Idu R., Smart N. Uchegbu, Ejike Ubani, and Okwuchi Juliet Akalemeaku. (2021). Effects of Noise Pollution on Residential Property Value in Enugu Urban, Nigeria. *SAGE Open* July-September 2021: 1–12. ©The Author(s) 2021. DOI: 10.1177/21582440211032167 journals.sagepub.com/home/sgo.
- Emenike, G. C., & Sampson, A. P. (2017). Noise levels and quality of livelihoods in residential neighbourhoods of Port Harcourt Metropolis, Nigeria. *European Journal of Earth and Environment*, 4(1).
- Environmental Pollution Centers. <https://www.environmentalpollutioncenters.org/noise-pollution/>.
- EPA. (2023). Noise Pollution. <https://www.epa.gov/clean-air-act-overview/clean-air-act-title-iv-noise-pollution>.
- European Environment Agency. (2020). <https://www.eea.europa.eu/articles/noise-pollution-is-a-major>.
- European Union Commission (EU). (2023). Environmental Noise Directive.https://environment.ec.europa.eu/topics/noise/environmental-noise-directive_en.
- Evans G.W., Kantrowitz E. (2008). Socioeconomic status and health; the potential role of environmental risk exposure. *Annual Review of Public Health*, 2008, 23: 303–331.
- Farooqi, Z.U.R., Ahmad, I., Ditta, A. et al. Types, sources, socioeconomic impacts, and control strategies of environmental noise: a review. *Environ Sci Pollut Res* 29, 81087–81111(2022). <https://doi.org/10.1007/s11356-022-23328-7>.
- Gadanya, M. A., & Buhari, I. A. (2021). Exposure and consequences of noise pollution among residents of Bichi Town, Kano State, Nigeria. *Fudma Journal of Sciences*, 5(2), 52-58.
- Glanz, K., Rimer, B. K., & Viswanath, K. (2008). Health behavior and health education: Theory, research, and practice. John Wiley & Sons.
- Goodwin, Meredith, & Millar, Helen. (2020). Noise pollution health effects: Impact on mental and physical health.
- Gozalo Guillermo Rey and Morillas Juan Miguel Barrigón. (2016). *International Journal of Environmental Research and Public Health*. Analysis of Sampling Methodologies for Noise Pollution Assessment and the Impact on the Population. Facultad de Ciencias de la Salud, Universidad Autónoma de Chile, 5 Poniente 1670, Talca 3460000, Chile. Departamento de Física Aplicada, Escuela Politécnica, Universidad de Extremadura, Avda. de la Universidad s/n, Cáceres 10003, Spain.
- Hagler, Louis. (n.d). Summary of Adverse Health Effects of Noise Pollution. Based on the World Health Organization Guideline for Community Noise.
- Hakeem Ijaiya. (2014). The Legal Regime of Noise Pollution in Nigeria. *Beijing Law Review* Vol.5 No.1(2014), Article ID:43969,6 pages DOI:10.4236/blr.2014.51001.
- Kabuacha, Frankline.(2021). How to determine sample size for research study; <https://www.geopoll.com/blog/sample-size-research/>.
- Law Nigeria. (2020). National Environmental (Noise Standards and Regulations) 2009. <https://lawnigeria.com/2020/08/national-environmental-noise-standards-and-control-regulations-2009/>.
- MARAŞ Erdem Emin & USLU Gül. (2015). Noise Annoyance by Gender, Age, Education, Profession, Time of Day: A Survey in Samsun, Turkey.

- Mazhum Idris. (2023). How noise pollution is bearing down on millions in Nigeria. <https://www.trtafrika.com/africa/how-noise-pollution-is-bearing-down-on-millions-in-nigeria-12335544>.
- McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education Quarterly*, 15(4), 351-377.
- Narayanan, Nikitha. (2023). Auditory Effects of Noise Pollution. What are the Auditory Effects of Noise Pollution? <https://www.icliniq.com/articles/ear-health/auditory-effects-of-noise-pollution>.
- National Environmental (Noise Standards and Regulations) (NENSR, 2009). <https://www.ecolex.org/details/legislation/national-environmental-noise-standards-and-control-regulations-2009-si-288-of-2009-lex-faoc146077/>.
- National Geographic Education. <https://education.nationalgeographic.org/resource/noise-pollution/>.
- National Geography Society (NGS). (1996). Encyclopedic Entry. Noise Pollution. <https://education.nationalgeographic.org/resource/noise-pollution/>.
- Neurosurgery. (2022). Surgery and Brain Health. Limit Noise to Boost Your Child's Brainpower. <https://share.upmc.com/2021/10/limit-noise-to-boost-your-childs-brain-power/>.
- Noise Pollution Regulation and Control Rules (NPCRC). (2000).
- Nwaerema Peace, Fred-Nwagwu W.F, Jiya Solomon, Dangana K. (2022). Mapping Vehicular Noise Pollution in Port Harcourt Metropolis, Rivers State.
- Nwankwoala, H. O., & Udom, G. J. (2017). Noise Levels and Quality of Livelihoods in Residential Neighbourhoods of Port Harcourt. [International Journal of Innovative Environmental Studies Research](^4^), 5(1), 1-10.
- OBI Nicholas I., Joy Sylvia C. OBI, Eziyi O. IBEM, Dickson M. NWALUSI, Ogochukwu Francis OKEKE. (2021). *Journal of Settlements and Spatial Planning*, vol. 12, no. 1 (2021) 51-62.
- Oguntunde PE, Odetunmibi OA, Adejumo AO. A study of probability models in monitoring environmental pollution in Nigeria. *J Prob Stat*. 2014; 2014: Article ID 864965. <https://doi.org/10.1155/2014/864965>.
- Oguntunde PE, Okagbue HI, Oguntunde OA, Odetunmibi OA. A Study of Noise Pollution Measurements and Possible Effects on Public Health in Ota Metropolis, Nigeria. *Open Access Maced J Med Sci* [Internet]. 2019 Apr. 29 [cited 2023 Oct. 4];7(8):1391-5. <https://oamjms.eu/index.php/mjms/article/view/oamjms.2019.234>.
- Ohrstrom E., Bjorkman M., Rylander R., Noise annoyance with regard to neurophysiological sensitivity, subjective noise sensitivity and personality variables. *Psychological Medicine*, 1988, 18: 605–613.
- Oloruntoba EO, Ademola RA, Sridhar MKC, Agbola SA, Omokhodion FO, Ana GREE, Alabi RT. Urban environmental noise pollution and perceived health effects in Ibadan, Nigeria. *Afr J Biomed Res*. 2012; 15(2):77-84.
- Oloruntoba EO, Ademola RA, Sridhar MKC, Agbola SA, Omokhodion FO, Ana GREE, Alabi RT. Urban environmental noise pollution and perceived health effects in Ibadan, Nigeria. *Afr J Biomed Res*. 2012;15(2):77–84. [Google Scholar] [Ref list].
- Omogbiya, A. I., Moke, E. G., Ojeh, A. E., Enahwo, M. T., Umukoro, E. K., Anachuna, K. K., & Omilo, C. U. (2020). Evaluation of Perception, Attitude, and Impact of Club-house Noise Pollution on Mental Health of Individuals Living within Proximity of Club-houses in Abraka, Delta State, Nigeria. *Journal of Applied sciences and environmental management*, 24(6), 1009-1013.

- OSISANYA Ayo, OWODUNNI Abdulfatai Adekunle, BOLARINWA Blessing Ifeoluwa. (2022). Sources, Level and Impact of Noise Pollution on Markets Women in Ibadan, Oyo State, Nigeria. *Journal of Educational Research and Reviews*. Vol. 10(5), pp. 53-60, May 2022. doi: 10.33495/jerr_v10i5.22.107. ISSN: 2384-7301. Research Paper.
- P Braveman, S Gruskin. (2003). Theory and Method. Defining Equity in Health. *J Epidemiol Community Health* 2003; 57:254±258.
- RFI: (n.d). Noise pollution costs France €156bn a year: study.
- Richard E. Berg, & Jerry A. Nathanson. (2023). Noise Pollution: Effects on Humans and Wildlife. <https://www.britannica.com/science/noise-pollution>.
- Rinkesh. (2023). Conserve Energy Future. Causes and Effects of Noise Pollution on Humans and Animals - Conserve Energy Future (conserve-energy-future.com).
- Robert D. Bullard, "Ecological Inequities and the New South: Black Communities under Siege." *Journal of Ethnic Studies* 17 (Winter, 1990): 101-115; Donald L. Barlett and James B. Steele, "Paying a Price for Polluters," *Time* (November 23, 1998), pp. 72-80
- Rosenstock, I. M. (1966). Why people use health services. *Milbank Memorial Fund Quarterly*, 44(3), 94-127.
- StudyIQ. (2023). Noise Pollution, Causes, Effects, Types and Measures to Control... Read more at: <https://www.studyiq.com/articles/noise-pollution/>.
- Temple-Anozie, K. C., Chiamaka, E. U. S., & Confidence, A. N. (2023). Knowledge of Health Impacts of Noise Pollution on Adult in Owerri Municipal Council, Imo State, Nigeria.
- Toppr. Noise Pollution Prevention. https://www.toppr.com/guides/physics/sound/noise-pollutionprevention/#Measurement_of_Sound.
- Tunde, A. M., & Abdulquadri, S. (2021). Environmental noise pollution and its impacts on the hearing ability of men and women in Ilorin, Kwara State, Nigeria. *Tanzania Journal of Science*, 47(5), 1517-1529.
- Usikalu M.R and Kolawole O. (2018). ResearchGate. Assessment of Noise Pollution in Selected Locations in Ota, Nigeria. Department of Physics, Covenant University, P.M.B 1023, Ota, Ogun State, Nigeria. Correspondence email: moji.usikalu@covenantuniversity.edu.ng.
- Williams I.D., McCrea I.S., Road traffic nuisance in residential and commercial areas. *The Science of the Total Environment*, 1995, 69: 75–82.
- Woffindin Louise. (2023). CPD Online College. All about noise pollution. <https://cpdonline.co.uk/knowledge-base/health-and-safety/noise-pollution/>.
- Wokekoro, E. (2020). Public awareness of the impacts of noise pollution on human health. *World. J Res Rev*, 10(6), 27-32.
- WHO Guidelines for Community Noise. (1999). World Health Organization. Retrieved from [link to WHO website or publication].