



Assessing the effect of urban noise pollution on pregnant women's health outcomes in Lagos Slums

Ochechi Joseph Ugbede¹, Dr. Dennis Iyidiobi Ochiaka², Dr. Ogbuyeme Jennifer Ngozika³, Offor Eusebius Chinedu⁴,
Dr. Martina Eze⁵

¹ Department of Public Health, Faculty of Allied Health State University of Medical and Applied Sciences, Enugu, Nigeria ²

Department of Public Health, Charisma University, Turks and Caicos Islands, British West Indies

³ Department of Public Health Godfrey Okoye University, Enugu, Nigeria

⁴ Department of Public Health Education, Enugu State University of Science and Technology, Enugu, Nigeria

⁵ Department of Public Health Education, Enugu State University of Science and Technology, Enugu State, Nigeria

Abstract

Urban noise pollution is an escalating environmental health concern in rapidly urbanizing cities, especially in the Global South. This study investigates the impact of chronic noise exposure on pregnant women's health in slum communities of Lagos, Nigeria. Using a cross-sectional design, data were collected from 360 pregnant women across three densely populated informal settlements. Environmental noise levels were measured using sound level meters, while clinical and survey data assessed maternal health outcomes including blood pressure, preeclampsia symptoms, sleep quality, and perceived stress. Findings revealed that noise levels significantly exceeded World Health Organization (WHO) safe thresholds in all communities, with strong associations between high noise exposure and elevated risks of hypertension, preterm labor, and poor sleep. Multivariate analysis identified noise exposure, third trimester status, and low education as significant predictors of adverse outcomes. The study underscores the compounded risks faced by marginalized women in unregulated urban environments and calls for targeted public health interventions and urban planning reforms to mitigate noise pollution and its effects on maternal health.

Keywords: Urban noise pollution, maternal health, pregnancy, slums, Lagos, environmental stressors, preeclampsia, sleep quality, informal settlements, public health

Introduction

Urban noise pollution has emerged as a pressing public health concern, particularly in rapidly growing cities of the Global South. In megacities like Lagos, Nigeria, where urbanization is largely unregulated, exposure to environmental noise has become a persistent and largely unaddressed hazard. Slum dwellers bear a disproportionate burden of this exposure due to proximity to busy roads, markets, construction sites, and power generators (Amegah & Jaakkola, 2022) [6]. Pregnant women in these settings are particularly vulnerable, with growing evidence linking noise pollution to a range of adverse maternal and fetal health outcomes.

Noise pollution, defined as unwanted or harmful outdoor sound created by human activities, has been increasingly associated with cardiovascular stress, hypertension, sleep disturbance, and mental health disorders (World Health Organization [WHO], 2022) [33]. For pregnant women, these stressors can compound physiological changes already occurring in the body, potentially increasing the risk of preeclampsia, gestational hypertension, and low birth weight (Basner *et al.*, 2021). Moreover, chronic noise exposure can elevate cortisol levels, interfere with sleep quality, and contribute to intrauterine growth restriction (Beutel *et al.*, 2020) [9].

Lagos, Africa's most populous city, is home to over 20 million residents, with more than 60% living in informal settlements or slums (UN-Habitat, 2022) [31]. These areas are characterized by overcrowding, poor housing, and infrastructural deficits, which amplify exposure to multiple environmental stressors—including persistent urban noise.

Yet, despite these risks, there is limited empirical research on how noise pollution specifically affects pregnant women living in Lagos slums. Most studies on environmental health in Nigeria have focused on air pollution and water sanitation, with noise pollution receiving comparatively little scholarly and policy attention (Olowoporoku *et al.*, 2023) [24].

Understanding the effect of urban noise on maternal health in these communities is therefore critical. Pregnant women in slums may face compounded risks due to socio-economic disadvantage, inadequate prenatal care, and heightened exposure to unregulated noise sources.

Material and Methods

Problem Statement

Urban noise pollution is an increasingly critical public health concern, particularly in rapidly growing cities of the Global South. In Lagos, Nigeria's most populous and densely populated urban center, noise levels frequently exceed the World Health Organization (WHO) recommended limits of 55 dB during the day and 40 dB at night (WHO, 2022). Sources of urban noise—such as traffic congestion, market activities, generators, and construction—are pervasive in informal settlements and slum areas where urban planning and regulatory enforcement are often lacking (Adegunwa & Falade, 2023; [3] Oloruntoba *et al.*, 2021) [23]. Pregnant women living in these environments may be particularly vulnerable to the adverse health effects of chronic noise exposure. Emerging evidence links sustained environmental noise to elevated stress levels, sleep disturbances, hypertension, and adverse birth outcomes such

as low birth weight and preterm delivery (Basner *et al.*, 2022; Obasohan *et al.*, 2023) ^[19]. Noise exposure may also exacerbate existing inequalities in maternal health, especially among women in low-income, high-density slums where access to prenatal care is limited (Uche *et al.*, 2022) ^[30]. Despite the mounting evidence, there is a significant gap in localized studies examining the impact of urban noise pollution on pregnant women's health in African megacities like Lagos, where informal settlements house millions of people under precarious environmental conditions. Most existing research focuses on high-income contexts, leaving a blind spot in understanding how noise-related stress interacts with socio-economic vulnerabilities unique to urban slum settings (Ezeh *et al.*, 2021) ^[16]. Without context-specific data, public health interventions remain poorly targeted, and noise pollution continues to be under-prioritized in maternal health programming.

Given this background, it is crucial to assess the specific health outcomes of pregnant women exposed to urban noise in Lagos slums. This study aims to fill that gap by generating empirical evidence to inform policy responses and improve maternal health outcomes in noise-stressed urban environments.

Literature Review

1. Conceptual Framework and Definitions

Urban Noise Pollution

Urban noise pollution refers to unwanted or harmful outdoor sound created by human activities, measured in decibels (dB). According to the World Health Organization (WHO), average outdoor noise levels should not exceed 55 dB during the day and 40 dB at night to prevent adverse health effects (WHO, 2018). In urban settings like Lagos, major sources include road traffic, electricity generators, industrial activities, and open markets (Olayiwola *et al.*, 2021) ^[22]. Chronic exposure to noise levels above these thresholds is associated with a range of health issues, particularly for vulnerable populations.

Pregnancy-related Health Outcomes

Pregnancy-related health outcomes refer to maternal and fetal health conditions influenced by environmental and physiological stressors. Key outcomes include increased stress levels, gestational hypertension, poor sleep quality, low birth weight, preterm birth, and impaired fetal development (Sacks *et al.*, 2023) ^[28]. Environmental factors such as noise pollution can elevate maternal cortisol levels, leading to complications in both mother and fetus (Basu *et al.*, 2022) ^[8].

Slum Conditions in Lagos

Slum conditions in Lagos are characterized by overcrowded housing, inadequate sanitation, poor infrastructure, and limited access to healthcare services. These conditions increase exposure to environmental hazards such as persistent noise, air pollution, and poor waste management (Akinyemi & Adewale, 2022) ^[5]. Pregnant women in these areas are particularly at risk due to lack of prenatal care and increased stress from constant exposure to high-decibel environments and socioeconomic challenges (Ezeh *et al.*, 2023).

2. Overview of Urban Noise Pollution

Global Perspective

Urban noise pollution is a growing concern in major cities worldwide due to rapid urbanization and increased transportation activities. In New York City, studies have shown that noise levels frequently exceed the recommended limits by the World Health Organization (WHO), particularly near airports and major roadways (Casey *et al.*, 2023) ^[10]. In Mumbai, average daytime noise levels in high-traffic areas were found to exceed 80 dB(A), far above the Central Pollution Control Board's prescribed limits (Patel & Joshi, 2022) ^[26]. Similarly, research in Nairobi has linked excessive urban noise, primarily from vehicular traffic and informal commercial activities, to negative public health outcomes including sleep disturbances and cardiovascular stress (Otieno *et al.*, 2023) ^[25].

Nigeria and Lagos-specific Studies:

In Lagos, Nigeria's most densely populated urban center, noise levels are consistently above permissible thresholds. Recent field studies report average daytime noise levels ranging from 76 to 92 dB(A) in commercial and residential areas, surpassing the Federal Ministry of Environment's recommended maximum of 70 dB(A) for urban zones (Adebayo & Udeh, 2023) ^[1]. Primary sources include road traffic, generator use, industrial operations, and religious activities. Despite the existence of noise control regulations, enforcement remains weak due to institutional constraints and lack of public awareness (Ogunleye & Okonkwo, 2022) ^[20].

Measurement Techniques

Noise pollution assessment typically involves the use of sound level meters (SLMs) to record real-time sound intensity levels. Advanced methods also include the use of geographic information systems (GIS) for spatial analysis and noise mapping, as well as predictive modeling software like CadnaA and SoundPLAN to simulate noise distribution and assess mitigation strategies (Chen *et al.*, 2024) ^[11]. These tools provide comprehensive insights that aid in urban planning and policy formulation.

Health Effects of Noise Pollution on the General Population

Noise pollution significantly affects both physical and mental health in the general population. Physically, prolonged exposure to high noise levels is linked to cardiovascular diseases, including hypertension and ischemic heart disease, due to chronic stress responses in the body (World Health Organization [WHO], 2023) ^[32]. Hearing loss, especially in urban and industrial areas, is also a direct consequence of persistent loud noise exposure (Basner *et al.*, 2022). Moreover, sleep disorders such as insomnia and disrupted sleep cycles are prevalent among individuals living near high-traffic areas or airports (Munzel *et al.*, 2023) ^[18].

On the mental health front, chronic noise exposure is associated with increased anxiety and depression, particularly in densely populated urban centers (Stansfeld & Clark, 2022) ^[29]. Children exposed to noise pollution are at risk of cognitive decline, including reduced attention span, memory, and learning abilities (Clark & Paunovic, 2023) ^[12].

The indirect impacts of noise pollution are equally concerning. It can lead to reduced workplace productivity due to impaired concentration and fatigue (WHO, 2023). Persistent environmental noise may also contribute to social unrest by increasing stress and tension in communities. Furthermore, it impairs communication, especially in educational and healthcare settings, where clear verbal interaction is critical (Basner *et al.*, 2022).

3. Specific Impacts on Pregnant Women

Stress and Hormonal Changes: Chronic exposure to environmental noise during pregnancy has been shown to elevate stress hormone levels, particularly cortisol and adrenaline. These hormonal disruptions can cross the placental barrier, potentially affecting fetal neurodevelopment and maternal well-being (Dzhambov *et al.*, 2022) ^[15]. Prolonged noise exposure activates the hypothalamic-pituitary-adrenal (HPA) axis, leading to sustained stress responses detrimental to both mother and fetus (Basner & McGuire, 2018) ^[7].

Hypertensive Disorders of Pregnancy: Studies have linked environmental noise with an increased risk of hypertensive disorders such as pre-eclampsia and gestational hypertension. Exposure to high levels of traffic or industrial noise correlates with elevated blood pressure levels in pregnant women, which may compromise placental function and increase risks for both mother and child (de Kluizenaar *et al.*, 2021) ^[13].

Fetal Development: Evidence suggests that maternal exposure to noise pollution during pregnancy is associated with adverse fetal outcomes, including low birth weight, fetal growth restriction, and preterm birth. A meta-analysis by Ristovska *et al.* (2018) ^[27] found significant associations between ambient noise exposure and reduced birth weight, highlighting noise as a modifiable environmental risk factor.

Birth Outcomes in Low-income Settings: The impact of noise pollution is often more severe in low-income and informal settlements where women face multiple stressors, including poor housing, inadequate healthcare, and high ambient noise levels. Research in urban slums in South Asia and sub-Saharan Africa has demonstrated that these compounded exposures can amplify risks of adverse birth outcomes, particularly preterm births and intrauterine growth restriction (Grace *et al.*, 2021; ^[17] Dzhambov *et al.*, 2022) ^[14].

Environmental and Socioeconomic Factors in Lagos Slums

Lagos slums are characterized by multiple environmental and socioeconomic challenges that exacerbate residents' exposure to noise pollution. Noise-amplifying conditions are prevalent due to the close proximity of informal settlements to major motorways, bustling markets, and industrial hubs, creating constant high-decibel environments (Akinbode *et al.*, 2022) ^[4]. Lack of urban planning further intensifies the issue, with housing developments occurring without formal approval or consideration for noise zoning, thereby placing homes and schools in acoustically hazardous zones (Olajide *et al.*, 2023) ^[21]. Additionally, poor access to healthcare undermines the early detection and treatment of noise-induced conditions. Many slum residents face delays in

antenatal care and are frequently misdiagnosed due to limited awareness and inadequate health infrastructure (Ezeh *et al.*, 2022). The gendered dimensions of this crisis are also significant; women, especially pregnant and caregiving individuals, often have limited mobility and decision-making power, restricting their ability to avoid or reduce harmful noise exposure (Adedokun & Akinyemi, 2021) ^[2].

Methods

Study Design

This study employed a cross-sectional analytical design to assess the effect of urban noise pollution on the health outcomes of pregnant women residing in selected slum areas of Lagos, Nigeria. The design integrated environmental noise measurements with clinical and survey data to determine correlations between noise exposure levels and maternal health indicators.

Study Area

The study was conducted in three densely populated slum communities in Lagos State: Makoko (Lagos Mainland), Ajegunle (Ajeromi-Ifelodun), and Ilaje-Bariga (Somolu). These locations were selected due to their high levels of ambient urban noise, proximity to major roads and industrial activities, and the vulnerability of their populations to environmental health risks.

Study Population

The study population consisted of pregnant women aged 18–45 years residing in the selected slum communities. Eligibility criteria included permanent residency of at least six months in the area and attendance at local antenatal clinics. Women with pre-existing chronic illnesses unrelated to pregnancy were excluded to reduce confounding.

Sampling Technique and Sample Size

A multistage sampling technique was used. First, the three slum areas were purposively selected. Within each area, two primary healthcare centers offering antenatal services were randomly selected. From clinic registers, systematic random sampling was used to recruit participants, resulting in a final sample size of 360 pregnant women (120 per community). Sample size was determined using Cochran's formula with an assumed 5% margin of error and an anticipated noise-related health effect prevalence of 50%.

Data Collection Instruments

1. Noise Measurement

Environmental noise levels were recorded using calibrated digital sound level meters (SLMs) placed at central points in residential and market areas of each community. Measurements were taken three times daily (morning, afternoon, evening) over 14 consecutive days, and averaged as daily equivalent noise level (Leq dB(A)).

2. Questionnaire and Clinical Data

A structured, interviewer-administered questionnaire collected data on:

Demographic characteristics

1. Residential and occupational noise exposure
2. Perceived stress levels
3. Sleep quality
4. Obstetric history

Clinical records were reviewed for each participant to extract data on:

- Blood pressure levels
- Gestational age
- Weight gain
- Incidence of preeclampsia
- Preterm labor or delivery

The Perceived Stress Scale (PSS) and Pittsburgh Sleep Quality Index (PSQI) were also used for standardized assessment.

Data Collection Procedure

Data were collected between February and April 2025 by trained field assistants fluent in Yoruba and Pidgin English. Ethical approval was obtained, and informed consent was secured from all participants. Ambient noise measurements were conducted concurrently with participant interviews. Data collectors used tablets with preloaded questionnaires to reduce transcription errors.

Data Analysis

Quantitative data were analyzed using SPSS Version 26. Descriptive statistics summarized participant characteristics and noise exposure levels. Bivariate analysis (Chi-square, t-

tests) assessed relationships between noise levels and health outcomes. Multivariate logistic regression was used to determine predictors of adverse pregnancy outcomes, controlling for confounders such as age, parity, and socioeconomic status. Statistical significance was set at $p < 0.05$.

Ethical Considerations

Ethical approval was obtained from the Lagos State University Teaching Hospital Health Research Ethics Committee (LASUTH-HREC/07/2024/021). All participants provided written informed consent, and confidentiality was maintained throughout the study. Participants identified as having high blood pressure or other complications were referred for further medical care.

Results

1. Demographic Characteristics of Respondents

A total of 360 pregnant women participated in the study, with a mean age of 29.4 ± 5.8 years. The majority were in their third trimester (52.2%), and over half had completed only primary education (56.1%). Most participants were engaged in informal occupations such as petty trading and domestic work.

Table 1: Socio Demographic Characteristics of Respondents (n = 360)

Variable	Frequency (%)
Age Group (years)	
18–24	84 (23.3)
25–34	198 (55.0)
35–45	78 (21.7)
Education Level	
No Formal Education	42 (11.7)
Primary	202 (56.1)
Secondary	86 (23.9)
Tertiary	30 (8.3)
Trimester	
First	36 (10.0)
Second	136 (37.8)
Third	188 (2.2)

2. Noise Exposure Levels in Study Areas

Average noise levels exceeded WHO safe limits (55 dB for daytime) in all three communities. Makoko recorded the highest average Leq of 78.4 dB(A).

Table 2: Average Daily Noise Exposure by Community

Community	Mean Noise Level (Leq dB(A)) ± SD
Makoko	78.4 ± 5.2
Ajegunle	74.9 ± 4.6
Ilaje-Bariga	72.7 ± 4.9
WHO Recommended Limit	55.0 (for comparison)

3. Health Outcomes Among Respondents

Among participants, 23.3% had elevated blood pressure (>140/90 mmHg), and 19.4% had experienced symptoms consistent with preeclampsia. Preterm labor occurred in 14.7% of cases, and poor sleep quality (based on PSQI score ≥ 5) was reported by 61.1%.

Table 3: Distribution of Key Health Outcomes (n = 360)

Health Outcome	Frequency (%)
High Blood Pressure	84 (23.3)
Preeclampsia Symptoms	70 (19.4)
Preterm Labor/Delivery	53 (14.7)
Poor Sleep Quality	220 (61.1)
High Perceived Stress (PSS > 20)	174 (48.3)

4. Association Between Noise Exposure and Health Outcomes

There was a statistically significant association between high noise exposure (≥ 75 dB(A)) and adverse outcomes such as high blood pressure, poor sleep quality, and preterm labor ($p < 0.05$).

Table 4: Association Between Noise Exposure and Selected Health Outcomes

Health Outcome	High Noise Exposure (≥ 75 dB)	Moderate Noise (65–74 dB)	Low Noise (< 65 dB)	<i>p</i> -value
High Blood Pressure	56 (66.7%)	22 (26.2%)	6 (7.1%)	< 0.001
Preterm Labor	34 (64.2%)	15 (28.3%)	4 (7.5%)	0.002
Poor Sleep Quality	160 (72.7%)	46 (20.9%)	14 (6.4%)	< 0.001

5. Predictors of Adverse Health Outcomes

Logistic regression identified high noise exposure (OR = 3.85, CI: 2.10–7.04), third trimester status (OR = 1.76, CI: 1.01–3.06), and low educational attainment (OR = 2.14, CI: 1.21–3.78) as significant predictors of preeclampsia and poor sleep quality.

Discussion

This study reveals a significant relationship between urban noise pollution and adverse maternal health outcomes among pregnant women living in slum areas of Lagos. The findings highlight a critical environmental health challenge that disproportionately affects vulnerable populations in urban low-income settings.

The average noise exposure levels in all three communities far exceeded the World Health Organization's recommended limit of 55 dB(A), with Makoko recording the highest at 78.4 dB(A). These elevated levels likely stem from high population density, proximity to traffic corridors, marketplaces, and industrial activities—common characteristics of unplanned urban slums. Similar trends have been reported in other low-resource urban settings globally (Basner *et al.*, 2014; Oyedepo & Saadu, 2010).

A core finding of this study is the strong association between high noise exposure and poor maternal health outcomes, particularly elevated blood pressure, preeclampsia symptoms, and preterm labor. Pregnant women exposed to noise levels ≥ 75 dB were over three times more likely to experience these outcomes than those in less noisy areas. This supports existing evidence that chronic exposure to environmental noise acts as a physiological stressor, triggering neuroendocrine responses that can contribute to hypertensive disorders of pregnancy and disrupt fetal development (Nieuwenhuijsen *et al.*, 2017).

The study also found that poor sleep quality and elevated perceived stress were highly prevalent among participants, especially those in high-noise environments. Over 61% of the women reported disturbed sleep patterns—an established risk factor for gestational hypertension, immune suppression, and mental health challenges during pregnancy. The correlation between noise, stress, and poor sleep has been well-documented in environmental health literature (Halperin, 2014), reinforcing the need to address noise pollution as a public health priority.

Sociodemographic factors such as low education levels and third-trimester status were also significant predictors of poor outcomes. Women with less formal education may be less equipped to mitigate environmental risks or advocate for better living conditions. Additionally, the heightened physiological demands in the third trimester may increase susceptibility to environmental stressors like noise.

Overall, the findings underscore how environmental injustices—like unregulated urban noise—compound the

risks faced by pregnant women in marginalized settings. These stressors can silently undermine maternal and neonatal health, particularly in contexts where formal prenatal care and environmental regulations are weak or inaccessible.

Comparison with Previous Studies

Our results align with studies conducted in similar contexts, such as urban slums in India and Brazil, where noise pollution was linked with increased risk of preeclampsia, intrauterine growth restriction, and poor maternal mental health (Goines & Hagler, 2007; de Souza *et al.*, 2019). However, few studies have focused specifically on sub-Saharan African slum environments, making this research one of the first to quantitatively link noise exposure to maternal outcomes in Nigerian urban slums.

Strengths and Limitations

A major strength of this study is its integration of objective noise measurements with clinical health outcomes, providing a more robust understanding of the problem. However, the cross-sectional design limits causal inference, and potential confounders such as air pollution and occupational noise exposure were not fully controlled. Self-reported sleep and stress measures may also be subject to recall or social desirability bias.

Conclusion

This study highlights the critical impact of urban noise pollution on maternal health, particularly in the under-resourced slum communities of Lagos. Pregnant women exposed to sustained noise levels above recommended thresholds were significantly more likely to experience adverse outcomes, including hypertension, preeclampsia, poor sleep quality, and preterm labor. These effects were compounded by socioeconomic vulnerabilities such as low education and limited access to mitigating resources.

The findings emphasize that urban noise is not merely a nuisance, but a serious public health hazard, particularly for marginalized groups like pregnant women in informal settlements. Addressing noise pollution in slums is therefore not only an environmental issue, but also a matter of maternal and child health equity.

Recommendations

1. Integrate Noise Pollution Control into Urban Planning

- The Lagos State Ministry of Environment and Urban Planning should prioritize enforcement of noise regulations in slum areas, particularly around markets, transport hubs, and industrial zones.
- Introduce zoning reforms and soundproofing strategies in new housing developments and antenatal facilities within noise-prone areas.

2. Strengthen Maternal Health Services in Slums

- Primary healthcare centers in slum areas should screen routinely for noise-related health risks such as hypertension and sleep disturbances during antenatal visits.
- Increase access to counseling services and maternal education on how to manage environmental stressors during pregnancy.

3. Community Awareness and Behavioral Interventions

- Launch public health campaigns in local languages to educate residents on the effects of noise pollution, particularly on pregnancy.
- Encourage community-level initiatives to reduce noise—for example, limiting loud music or engine idling near residential compounds.

4. Research and Monitoring

- Establish longitudinal studies and noise surveillance systems to track changes in urban noise levels and their health impacts over time.
- Support research on low-cost mitigation technologies for noise control that can be applied in informal settlements.

5. Multisectoral Collaboration

- Facilitate partnerships between health, environment, transport, and housing sectors to design holistic strategies for urban noise reduction.
- Involve community leaders and NGOs to promote local ownership and sustainability of noise mitigation initiatives.

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