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Original Article

Evaluating the Impact of Noise Exposure on the Increasing Prevalence of Hypertension and Related Conditions in Lagos Metropolis, Nigeria

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Abstract

Background and aims: Hypertension (HTN) is increasing in Nigeria, with noise exposure identified as a key co-factor. However, scientific evidence remains limited. This study assessed the link between noise exposure and HTN in Iju Ishaga and Ifako, Lagos, Nigeria.

Methods: Structured questionnaires were employed to collect demographic information, data on noise sources, exposure duration, blood pressure levels, and associated diseases from 200 consenting participants.

Results: HTN prevalence was 39% in Iju Ishaga and 7% in Ifako, with females being the majority. Significant associations ($P<0.001$) between HTN and noise sources were noted, with noise from people having the highest prevalence (16% in Iju Ishaga, 5% in Ifako), followed by vehicular noise (11% in Iju Ishaga only) and occupational noise (9% in Iju Ishaga, 2% in Ifako). In addition, there were significant associations ($P<0.001$) between HTN prevalence and daily exposure durations, with the highest prevalence (12%) observed in those exposed for 16–24 hours. Statistical analysis established a significant association (95% confidence interval [CI]: 3.57–20.21) between the two locations and HTN prevalence. However, concerning gender, the results indicated no significant association (95% CI: 0.33–1.28) with HTN prevalence. Except for occupational noise and loud music, all other sources of noise showed a significant association ($P<0.05$) with the prevalence of HTN in the study area. Eventually, the duration of noise exposure had a significant association with HTN, except for 3–5 hours of exposure.

Conclusion: Our findings confirmed an association between noise exposure and HTN, highlighting the need for noise reduction measures to address this health issue.

Keywords: Anxiety, Hypertension, Prehypertension, Noise, Sleep disorders

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Introduction

Noise pollution has emerged as a significant global issue, driven by population growth, urbanization, and industrialization.[1] It has become an integral part of daily human activities, yielding adverse effects on both health and the environment.[1] The primary sources of noise pollution encompass industries, worship centers, road traffic, musical studios, machinery, generators, rail traffic, construction equipment, neighbourhoods, and aircraft.[2]

Exposure to elevated noise levels can predispose individuals to heart diseases, high blood pressure (BP), stress, anxiety, and sleep disturbances, adversely affecting social relationships, the quality of the living environment, work performance, and communication.[3] Noise pollution poses a greater risk to children, pregnant women, newborns, fetuses, and infants, with reported consequences including stress, attention and memory loss, and reading impairments among children.[4]

Remarkably, noise pollution stands as the second most hazardous environmental factor affecting human health, trailing only behind air pollution.[5] However, its dangers often go unnoticed, as its effects are not always physically tangible. Fortunately, numerous studies worldwide have recently linked noise exposure to the development of hypertension (HTN), aimed at raising public awareness.[4,6-10] Despite these findings, noise pollution has not received the same attention as other forms of pollution.[4,11] Moreover, the noise reduction strategies proposed by several researchers have yet to be considered and implemented.[11] The implementation of these strategies could significantly reduce the prevalence of HTN and associated diseases. Consequently, there is an urgent need for more studies to raise public awareness regarding the impact of noise pollution on HTN prevalence.

In Nigeria, the prevalence of high BP has surged from 8.6% (4.3 million individuals) in 1995 to 38% (27.5 million individuals) in 2020.[12, 13] While HTN is known to be multifactorial,[14, 15] some studies conducted in the country suggest that noise pollution may contribute to some instances of HTN.[16-18] Unfortunately, the country's citizens have not given due attention to the role of noise exposure in the etiology of HTN.[19] Consequently, conducting further studies on this subject in Nigeria is imperative to raise public awareness. Therefore, this study has been designed to investigate the impact of noise pollution and associated factors on the prevalence of HTN in Iju Ishaga and Ifako, two areas in Lagos, Nigeria. Lagos, being the most densely populated and industrialized city in Nigeria, experiences high noise levels, and high BP is already prevalent in this city, affecting 26.7% of adolescents.[20]

Materials and Methods

Description of the Study Site

This study was conducted in Iju Ishaga and Ifako, towns located in the Ifako-Ijaiye Local Government Area of Lagos, Nigeria. Lagos is situated in the southwestern region of the country at latitude 6° 31'27.7644" N and longitude 3° 22'45.1416" E.[21] With an estimated population of 15.4 million, Lagos is the largest city in Africa.[22] Due to its relatively small land area of approximately 3,577 square km, the city experiences significant challenges related to overcrowding.[23] Additionally, Lagos has heavy traffic, with over 222 vehicles per km, which substantially contributes to noise levels.[24] Consequently, the city is characterized by a high degree of noise pollution. Iju Ishaga and Ifako are among the most densely populated and noisy areas in Lagos. These towns attract residents from diverse social classes, ethnicities, religions, and backgrounds.

Study Design

This is a descriptive-analytical cross-sectional study on the involvement of noise pollution in the rising incidence of HTN in Lagos, Nigeria. It involves a cross-sectional survey with a descriptive design to obtain information.

Study Population

The study population comprised adult residents of Iju Ishaga and Ifako, located within the Ifako-Ijaiye Local Government Area of Lagos, Nigeria.

Inclusion Criteria

Residents who provided their consent to participate in the study within the study area and had resided in the study area for a minimum of two years or longer.

Exclusion Criteria

Residents who did not express interest in participating and/or did not meet the inclusion criteria outlined above were excluded from the study.

Sample Size Determination

A sample size of 200 participants was selected from an initial 232 respondents using Fisher's formula:

$$\text{Fisher's } n = Z^2\left(\frac{pq}{d^2}\right)$$

where n is the desired sample size of the study population, and Z stands for the standard normal deviation (1.96). In addition, *p* indicates the proportion of the previous study with the prevalence of illness related to the noise pollution, and d represents the degree of precision.

Sampling Techniques

A multistage sampling technique was adopted for the study.

Stage 1: Selection of Communities

Three communities were selected from each of the Iju Ishaga and Ifako areas using simple random sampling by balloting, making a total of 6 communities.

Stage 2: Selection of households

'A cluster sampling technique was adopted to select 36 households in each of the selected communities.

Stage 3: Selection of Adults

At the household level, any person recognized by other residents as the household head or the primary financial decision-maker and who gave consent to participate was interviewed.

Study Instrument

The required data were gathered through the administration of semi-structured questionnaires to the respondents. Each participant received a questionnaire, and their consent to participate was obtained either by completing the form themselves or having it read to them. A validated and automated BP instrument was utilized to minimize observer errors. The left upper arm BP of the respondents was measured three times during the visits by a qualified medical doctor. The initial measurement was taken at the beginning of the interview, followed by a second measurement after a 5-minute rest and a third measurement after an additional 60-second rest, according to the recommendations of the American Heart Association. As a validity control, a fourth BP reading was conducted after the interview (approximately 1 hour later). All BP assessments were performed with the participants in a sitting position. HTN was defined according to the World Health Organization guidelines (a systolic B$P \geq 140$ or a diastolic B$P \geq 90$).

Validity and Reliability of the Instrument

To ensure the quality of information, a sample of structured questionnaires was thoroughly scrutinized before being administered to the respondents. The questionnaire underwent a test-retest reliability

assessment by administering 10% of the sample size to a trial group in Obawole, a town close to Iju Ishaga and Ifako, with similar communities and culture. Additionally, the functionality of the test BP instrument was assessed with the trial population.

Noise level was measured following standard procedures. A sound level meter (model Extech-407780) with a measurement range between 25 dB and 130 dB was employed to measure the levels.[10] The instrument was calibrated before and after each use. The device was placed at an approximate distance of at least 1 m from the noise source, and the levels were read on a liquid crystal display.

Data Collection

Overall, 200 questionnaires were distributed to residents in both Iju Ishaga and Ifako towns, with 100 questionnaires allocated to each town. The questionnaires were structured into two sections. The first section was dedicated to gathering demographic data, encompassing information on age, gender, tribe, marital status, and educational levels. Meanwhile, the second section focused on noise exposure-related information, including sources of noise pollution, duration of exposure, symptoms experienced due to exposure, and BP levels.

Ethics Approval and Consent to Participate

This study received approval (approval No. NOUN/51/2023) from the Ethics Committee of the Office of the Study Center, National Open University of Nigeria, Lagos. We diligently adhered to the research guidelines for involving human participants set forth by this center. Furthermore, we ensured that written informed consent was obtained from each participant before their involvement in the study.

Data Analysis

The values were presented in tabular format, illustrating frequency distributions and percentages. The association between HTN and other factors was analyzed using the chi-square test, and the risk of HTN was evaluated using a logistic regression model. All analyses and presentations were performed using the Statistical Package for Social Sciences (SPSS), version 20. Charts were generated using Minitab, version 20.

Results

Demographic Characteristics of the Respondents

Table 1 presents the gender, age, ethnic distributions, marital status, and educational levels of the participants.

Table 1. Demographic Characteristics of the Respondents

	Iju Ishaga Frequency (%)	Ifako Frequency (%)
Age		
18-30	40	60
31-59	35	31
60 above	25	9
Gender		
Male	37	42
Female	63	58
Ethnic distribution		
Igbo	20	39
Yoruba	77	46
Hausa	3	15
Marital status		
Single	41	42
Married	59	58
Educational level		
Primary	40	25
Secondary	35	40
Tertiary	25	35

Prevalence of Hypertension in Relation to Sources of Noise Pollution

The prevalence of HTN due to the sources of noise pollution is presented in Table 2. The results indicated a significant association ($P=0.001$) between HTN and sources of noise pollution in the study areas. Individuals exposed to general noise from people in both areas exhibited the highest prevalence of HTN (16% in Iju Ishaga, 5% in Ifako), followed by vehicular noise/traffic (11% in Iju Ishaga only) and occupational noise (9% in Iju Ishaga, 2% in Ifako), respectively. A 1% prevalence was recorded for individuals not exposed to any form of noise in Iju Ishaga only. In terms of generators and heavy machines, the highest prevalence of HTN (2%) was observed in Iju Ishaga, while none of the people in Ifako had HTN.

Prevalence of Hypertension in Relation to the Daily Duration of Noise Exposure

Table 3 presents the prevalence of HTN by the daily duration of noise exposure in the study areas. The results revealed a significant association ($P<0.001$) between HTN and the daily duration of noise exposure, indicating that HTN among the people in the study area increased with the increase in the daily duration of noise exposure and vice versa. The highest overall prevalence of HTN (12%) was observed in people who indicated 16–24 hours as their daily duration of noise exposure. However, the lowest overall prevalence of HTN (7%) was found in people who reported 0–2 hours and 11–15 hours as their daily duration of noise exposure, which served as their primary source of noise pollution.

Regression Analysis of Factors Associated With Hypertension in the Study Area

The logistic regression analysis of factors associated with HTN in the study area is provided in Table 4. The results of the analysis confirmed a significant association (95% confidence interval [CI]: 3.57–20.21) between the two

Table 2. Prevalence of Hypertension due to the Sources of Noise Pollution

S/N	Source	Iju Ishaga		Ifako		Total Examined	Overall %Prevalence
		Examined	%Prevalence	Examined	%Prevalence		
1	Occupational noise	15	9	15	2	30	11
2	Vehicular noise/traffic	21	11	20	0	41	11
3	General noise from people	23	16	21	5	44	21
4	Generators and heavy machines	7	2	7	0	14	2
5	None	31	1	35	0	1	1
6	Loud music	2	0	2	0	4	0
Total		100	39	100	7	200	46
Chi-square analysis		$\chi^2=32.304$ $P<.001$		$\chi^2=14.856$ $P=0.011$		$\chi^2=10.545$ $P=0.001$	

Table 3. Daily Duration of Noise Exposure (Hours/Day) and Prevalence of Hypertension

S/N	Exposure Duration	Iju Ishaga		Ifako		Total Examined	Overall %Prevalence
		Examined	%Prevalence	Examined	%Prevalence		
1	0-2	50	7	50	0	100	7
2	3-5	26	9	25	0	51	9
3	6-10	12	11	13	0	25	11
4	11-15	5	5	7	2	12	7
5	16-24	7	7	5	5	12	12
Total		100	39	100	7	200	46
Chi-square analysis		$\chi^2=50.439$ $P<0.001$		$\chi^2=80.799$ $P<0.001$		$\chi^2=85.993$ $P<0.001$	

Table 4. Logistic Regression Analysis of Factors Associated With the Prevalence of Hypertension

Factors	Hypertension Status		Risk Estimate	
	No	Yes	Odd Ratio	Confidence Interval
Locations				
Ifako	93	7	1	1
Iju -Ishaga	61	39	8.490	3.57-20.21
Gender				
Male	58	22	1	1
Female	96	24	0.66	0.33-1.28
Age				
18-30	84	17	1	1
31-60	44	17	1.89	0.88-4.05
Above 60	26	12	2.25	0.95-5.33
Source of noise				
General noise from people	23	21	1	1
Vehicular noise/traffic	30	11	0.402	0.162-0.997
None	66	1	0.017	0.002-0.13
Occupational noise	19	11	0.634	0.245-1.639
Generators and heavy machines	12	2	0.183	0.037-0.913
Loud Music	4	0	0.00	0.00-0.00
Exposure duration				
0-2	93	7	1	1
3-5	42	9	2.14	0.75-6.08
6-10	14	11	10.62	3.65-30.84
11-15	5	7	16.10	4.15-62.48
16-24	0	12	1.86×10^{10}	1

locations and the prevalence of HTN. It showed that people living in the Ifako area are more likely to have HTN than people in the Iju-Ishaga area (8.490 odds ratio). However, regarding gender, the results demonstrated no significant association (95% CI: 0.33–1.28) with the prevalence of HTN. The results further revealed that, except for occupational noise and loud music, all other sources of noise indicated a significant association with the prevalence of HTN. Based on the results, all durations of noise exposure had a significant association with the prevalence of HTN, except for 3–5 hours of exposure.

Discussion

The demographic data revealed that most participants were married females aged between 18 years and 30 years. Predominantly, they belonged to the Yoruba and Igbo ethnic groups. The majority had attained primary education in Iju Ishaga and secondary education in Ifako. These findings align with those of an earlier study that also reported a predominance of female and middle-aged participants in a Lagos-based survey.[25] However, unlike the current study, that survey recorded a higher proportion of participants with tertiary education. Similarly, other demographic surveys on HTN patterns among adolescents in Lagos also observed dominance by the Yoruba and Igbo ethnic groups, as well as female participants.[20, 26]

In both Iju Ishaga and Ifako, the primary sources of noise pollution were identified as interpersonal interactions, traffic, electricity generators, heavy machinery, and

occupational activities. These findings are in line with the results of a previous study, indicating elevated noise levels due to human interactions in Lagos.[27] The urban, densely populated nature of these areas, along with intense anthropogenic activities, likely contributes to the high noise levels observed. Traffic noise, in particular, has been widely recognized as a major contributor to noise pollution in Lagos, driven by factors such as population growth, increased vehicle numbers, road congestion, poor infrastructure, and a high presence of commercial vehicles.[28,29] In FESTAC town, a separate survey identified electricity generators as the most significant source of noise pollution[30], a situation attributed to erratic power supply, a common issue in many developing countries. Occupational noise has also been frequently reported in Lagos[31,32], which is expected given that the city serves as Nigeria's economic hub, hosting numerous industries and commercial enterprises. Across Nigeria, familiar sources of noise pollution include electricity generators, vehicular traffic, industrial activities, machinery, household noise, and religious centers.[19,33]

The prevalence of high BP in the study areas exceeded national averages. In Iju Ishaga, 61% of participants were classified as pre-hypertensive (120–139 mmHg), while 39% had HTN (>140 mmHg). In Ifako, 93% were pre-hypertensive, and the remaining 7% were hypertensive. These rates surpass those reported in a systematic review of HTN prevalence in Nigeria from 1995 to 2020.[13] Additionally, the incidence in Ifako exceeds the national HTN prevalence of 38.1% reported in a 2017 nationwide survey.[12] The rates of pre-HTN in both areas also exceed the 34% pooled national prevalence.[34] These elevated rates suggest that environmental factors, particularly noise exposure, play a significant role.

To explore this potential link, the study examined the incidence of BP related to noise exposure duration and family history. Over half of the respondents reported no family history of HTN, yet HTN rates increased with more prolonged noise exposure. This finding implies that noise exposure may be a key environmental risk factor. Several studies support this association, that is, increased BP correlated with prolonged noise exposure among workers in Paris[35], aircraft factory workers in Taiwan[36], steel workers[37], and dry food factory workers in Egypt.[38] These outcomes may be explained by noise-induced stress responses that elevate levels of cortisol, adrenaline, and noradrenaline, leading to vasoconstriction, increased heart rate, and elevated arterial pressure.[6]

The study also identified other health issues linked to noise exposure, including sleeplessness, restlessness, anxiety, headaches, and elevated BP. These are consistent with prior findings from Lagos, where noise-exposed residents reported similar symptoms.[19,39] Students and staff at a higher institution in Edo State also experienced stress, headaches, fatigue, and HTN due to noise.[1] Comparable effects, such as sleep disturbances and poor concentration, were observed in Bichi town, Kano State.[33] Globally, similar associations have been documented; in Brazil, noise exposure independently predicted HTN among petrochemical workers[6]; in Western Europe, it has been responsible for approximately 61,000 cardiovascular cases annually.[7]; in the U.S., it has been linked to cardiovascular diseases[8], and in Ethiopia, it has been related to elevated BP among metal industry workers.[10] Noise exposure has been shown to affect alertness and motor performance and can trigger physiological, emotional, and behavioural responses.[40] It may also provoke headaches by disrupting neurovascular function or increasing muscular tension. Furthermore, environmental noise, particularly at night, can trigger stress responses and disrupt sleep patterns and architecture.[41]

Conclusion

The primary sources of noise pollution in the study areas encompass household noise, traffic, generating sets, heavy machinery, and occupational noise. Our findings confirmed that high BP and related ailments, such as sleeplessness, restlessness, anxiety, and headaches, were significantly associated with noise exposure in these areas. It also revealed that the source of noise, gender, and location are significant risk factors that are associated with the prevalence of HTN. A key observation was that a majority of participants with high BP had no family history of the condition, which underscores the role of noise exposure in the elevated prevalence of HTN and associated diseases in these study areas. The findings further demonstrated that as the duration of noise exposure increased, the risk of developing these diseases also rose, reinforcing the link between noise exposure and high BP. In light of these findings, it is imperative to implement noise reduction measures in the study areas. Additionally, public awareness campaigns should be conducted to educate residents on the role played by noise exposure in the prevalence of HTN.

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Competing Interests
The authors declare that there is no conflict of interests.

Ethical Approval
This study received approval (approval No. NOUN/51/2023) from the Ethics Committee of the Office of the Study Center, National Open University of Nigeria, Lagos. We diligently adhered to the research guidelines for involving human participants set forth by the center. Additionally, we ensured that written informed consent was obtained from each participant before their involvement in the study.

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