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Public perception on environmental noise pollution: A case study in Zaria city, Kaduna state, Nigeria

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Abstract

Background: One of the key indicators of the degradation of the environment is the noise level. This has necessitated this study on the evaluation of the public, perceptional awareness, sources, effects, and mitigation measures on environmental noise pollution.

Methods: The population was estimated and 385 structured questionnaires were estimated and administered by random purposive sampling. About 358 questionnaires were retrieved. Data were analyzed using SPSS and Excel statistical software.

Results: About 90.2% of the respondents had relevant awareness and its effects on environmental noise while 9.8% of the respondent did not. Traffic, generators, commercial and light industry sources of noise, and their severity were ranked in a descending order using the Likert scale. Hearing impairment, annoyance, stress, distraction during exposure were ranked in a descending order using the Likert scale. Single-factor ANOVA on the sources of noise and their severity, awareness of the various effects of noise, and responses during exposure showed that there were significant differences as $P<0.05$ using a confidence level of 95%. About 61.7% of respondents complained of environmental noise, 72.6% respondents received complaints about environmental noise, 87.7% of respondents were not aware of any government agency monitoring noise pollution, 72.2% of the respondents had done nothing regarding noise prevention, and 91.1% respondents wanted a proactive decision in mitigating environmental noise pollution.

Conclusion: There is an inadequate coping strategy. Strategic planning in mitigating environmental noise in urban and semi-urban areas is a necessity and there is a need for public enlightenment by government monitoring agencies.

Keywords: Noise, Perceptions, Environment pollution, Questionnaires, Strategic planning and government

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Introduction

Environmental noise pollution continues to pose a significant threat to human health and the quality of life to millions of people worldwide. Noise pollution is a consequence of anthropogenic activities with its attendant health consequences. Several studies have asserted diverse effects of environmental noise pollution as a public health concern globally (1, 2). Noise is an unwanted sound. It has been emphasized that in developed countries quiet places are rare to come by while in developing countries, noise has been affirmed to be an integral way of life without much consideration for its associated consequences. This is a result of ignorance, negligence of unplanned urban and semi-urban areas which resulting in citing of industries, shops, busy city centers, roads, and commercial areas, and motor packs indiscriminately without due consideration to the effect of environmental noise. This issue has led to the consistent release and increase in noise threshold in urban and sub-urban areas globally (3-6). Also, migratory activities and inadequate policy implementation contribute to increases in noise pollution.

It had been reported that in 2014, about 125 million people were affected by noise levels greater than the maximum permissible of 55 dB (A) (2). According to a recent report by the World Health Organization (WHO) on the burden of disease from environmental noise, at least one million healthy life years were lost in Western Europe due to health effects arising from noise exposure. The WHO categorizes noise as the second worst environmental cause of health problems, behind water-borne diseases and ultra-fine particulate matter (PM2.5) air pollution (7-11). Irritability, tinnitus, hearing

impairment, cardiovascular effects, headache, stress, presbycusis, speech intelligibility, mental illness, decrease in performance and efficiency have been attributed to frequent exposure to noise pollution (2, 10-12). In New York City, the United States of America, noise had been consistently regarded as the number one quality of life issue, the authorities responsible for its mitigations and control received more than 40 000 noise complaints in 2012 (13). In China, 42.1% of environmental complaints were associated with acoustic pollution, 25.6% of which were attributed to construction noise. Very few countries appear to consider the health risks of environmental noise in their policy-making (14-16). The exponential increase in noise level is as a result of rapid urbanization and industrialization globally. There is therefore the need for routine evaluation to have a better understanding and mitigating measures (17-20).

In addition to measurable evaluation through field measurements to ascertain the level of pollution, there is a need for consultations with the inhabitants of the study area, which play a vital role in the investigation of noise level and its effects on the public health in developed and developing countries (21-23). Even though the health effects of environmental noise pollution have been explored over many decades, the body of evidence linking noise to various health effects but there are not many studies on the evaluation of its environmental consequences on homo-sapiens especially in developing countries (15, 16). Increasing awareness, not only on the magnitude of the noise level, but also, on the exposure effects such as annoyance, adaptation, and coping strategies is a necessity. As this would triggers interventions, management, mitigation measures, requisites policies on strategic environmental management from the government, and non-profit organization (NGO) on the consequences of the impact of environmental noise on the predisposed populations (21, 23-26). On this premise, this study aimed to evaluate the public perceptions of respondents on the environmental noise level and its mitigating measures in the Sabon-Gari Local Government area in Zaria Metropolitan City, Kaduna State, Nigeria.

Materials and Methods

Study area and population

Sabon-Gari Local Government area that was created in 1991 is one of the Local Government Areas in Zaria Metropolitan City in Kaduna State, Nigeria, as shown in Figure 1. It has a land area of 263 km^2 and a population

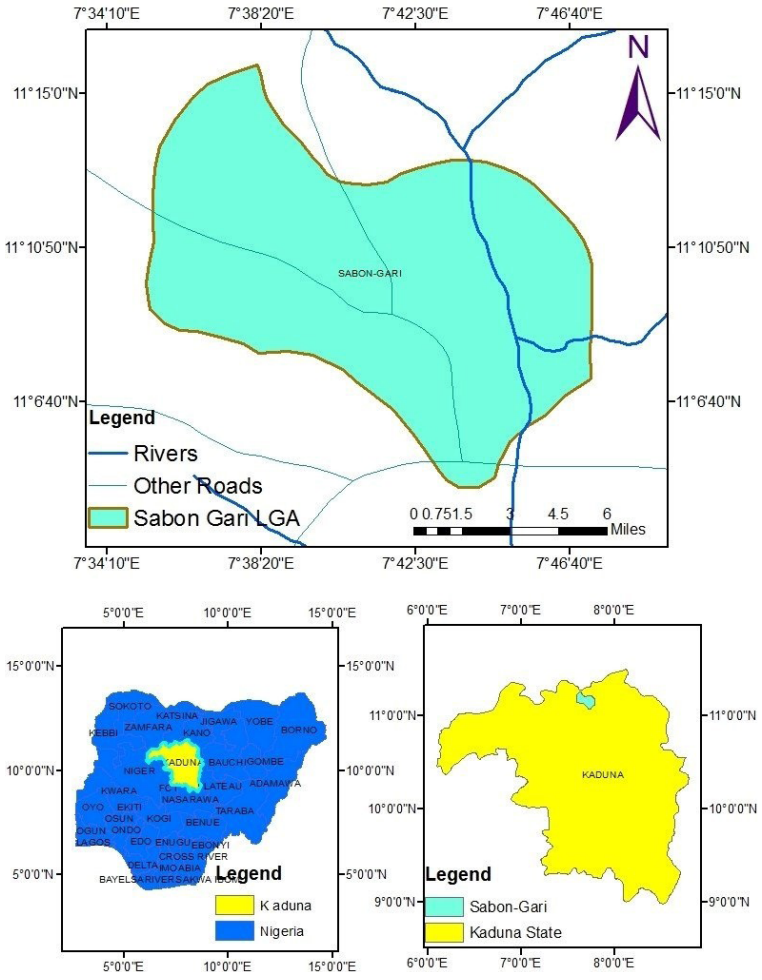

Figure 1. The location of the study area, Nigeria and Kaduna State .

density of 1495/km^2. Its geographical coordinates are 11.12310°N, 7.73220°E. According to the National Population Commission (NPC) population census data of 2006, Sabon-Gari has a population of 224,067 (27). Sabon-Gari is one of the fast developed cities in Zaria Metropolitan city with several high institutions such as Ahmadu Bello University, Leather Research Institute, National Institute of Transport Technology (NITT), Nigeria School of Aviation Technology, School of Nursing, several light industries, Motor Parks, several road networks for interstate and intrastate movement, several malls and commercial areas like Sabon-Gari Market, Samaru Market and boost of several green belt areas. The Kaduna climate is tropical. There is rainfall during the summers from April to October, while it is inadequate during the winters from November to March. The typical annual temperature in Kaduna is 25.2°C/77.4°F. About 998 mm/39.3 inches of rainfall fall annually.

Methodology

The local government consists of 11 ward districts for effective administrative purposes, from which 8 wards were purposefully selected for this research based on the population density and anthropogenic activities. The 2006 population census was used for the projection of the population of the local government to 2019 for the selected wards using equation 1. A total of 8 selected wards were used to estimate the population of 2019, using the growth rate of 3.2% annually to obtain (P_N). The total population of the 8 wards was used for the estimation of the questionnaires for the study location using Eq. 2 (28-30).

$$P_N = P_1 e^{rt} \quad (1)$$

Where P_N is the projected population, N is projection year, t is the time interval to projection year, r is the growth rate, and P_1 is the initial population.

$$S = \frac{X^2 NP(1-P)}{d^2(n-1)+\chi^2 p(1-P)} \quad (2)$$

Where S is the required sample size, X is the table value of the chi-square size for 1 degree of freedom at the desired confidence value (3.841); N is the estimated population, P is the population proportion and the maximum sample is giving as 0.5, d is the degree of accuracy (0.05), and n is the ex.

Design and administration of questionnaires

Designed questionnaires were based on the purposeful and peculiarity of Metropolitan city. They were structured into two sections, administered accordingly guaranteeing the anonymity and confidentiality of the respondents as it was meant for academic findings. Section (A) deals with the social demography and section (B) was related to the environmental noise awareness, sources of noise based on severity, awareness of the effect of noise pollution, personal effects of noise pollution during exposure by the respondents, government and personal responsibility in mitigating environmental noise from respondents aged 15 years and above. Considerations were given to respondents from all walks of life in the studied site. The questionnaires were structured with dichotomous and scaling questions, respectively. The responses to the dichotomous questions were presented using tables, figures, and pie charts, respectively. While the responses to scaling questions were based on the 5-point Linkert scale: HS= Highly Severe, S= Severe, M= Moderate, Mi= Mild, VM= Very mild, SÁ= Strongly agreed; A= Agree; UN= undecided; D= Disagree; SD= Strongly disagree, which were scored 5, 4, 3, 2, and 1 point, respectively. The findings of the research were analyzed based on the Likert scale and single-factor ANOVA. The Likert scale was used to evaluate the attitude of the response of respondents on the degree of strongly agree to strongly disagree on a particular statement, opinions, or observations (31). The mean, standard deviation, percentages, cumulative mean, and one-way ANOVA were evaluated using MS Excel (2019 version) and SPSS version 26. The estimated questionnaires were divided by numbers of the estimated population of each of 8 selected wards and validated by a team of professional environmental engineers' lecturers in the Department of Water Resources and Environmental Engineering, Faculty of Engineering, Ahmadu Bello University, Zaria, Kaduna State, Nigeria. The questionnaires were administered by purposeful random sampling across the selected sample population.

Population and demography of the administered questionnaire

Table 1, presents population data of the census conducted in 2006 for the studied sites as obtained from the Nigeria National Population Commission. The 2006 population data was used to estimate the population of 2019 for the administration of the questionnaire when the study was conducted.

Figure 2 presents pictorial views of different designated locations of the administered questionnaires by purposeful random selections of the respondents.

Results

Socio-demographic profile of the respondents

Plot 1. Distribution of the questionnaire on the perception of noise effects in Sabon-Gari LGA

Figures 3A-3F present the socio-demographic profile of the respondents. Figure 3A represents the gender variables of the respondents, 226 respondents (63.1%) were male and 132 respondents (36.9%) were female. Figure 3B represents the age distribution of the respondents, 19% of the respondent aged 15-18 years, 60.3% aged 21-35 years, 19% aged 36-60 years, and about 1.7% of the respondent aged 60 years and above. Figure 3D represents the

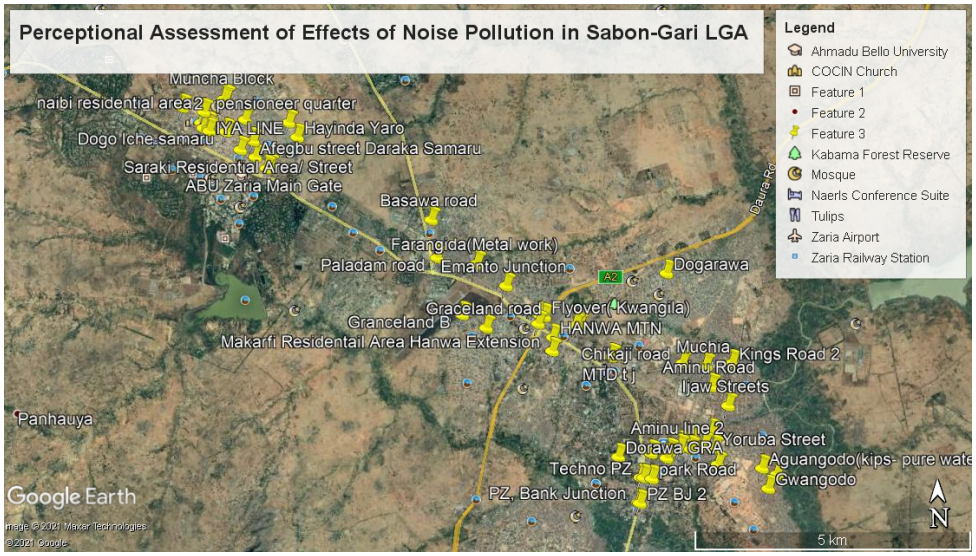

Figure 2. Different designated locations of the administered questionnaires by purposeful random selections of the respondents.

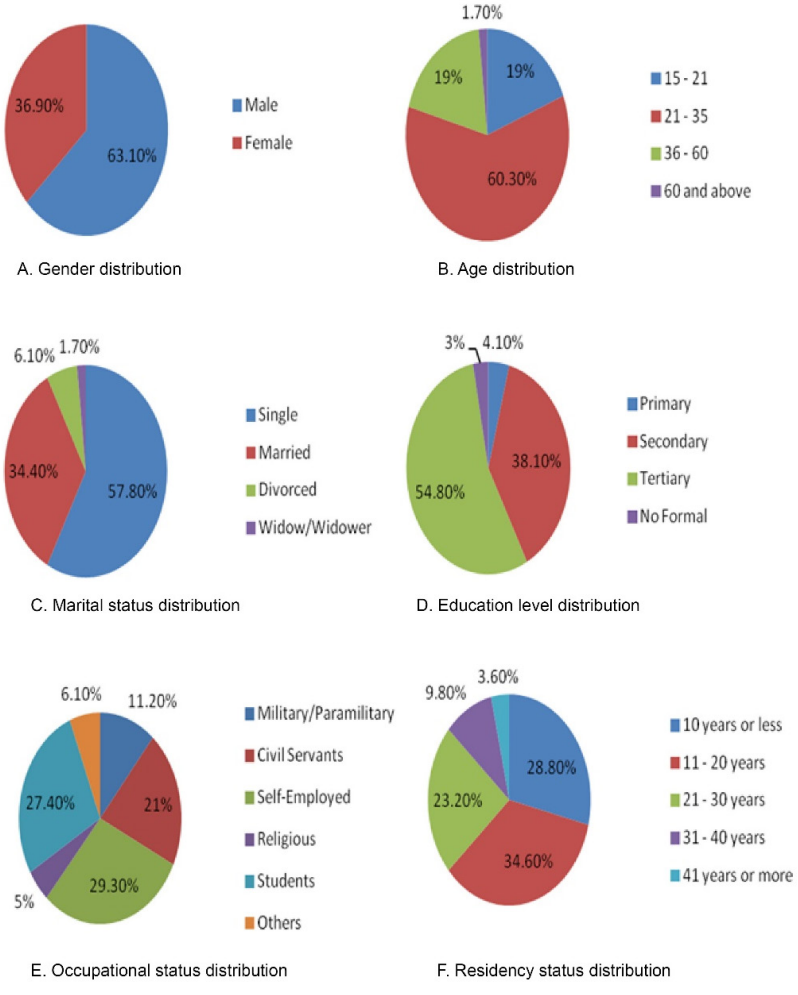

Figure 3. The socio-demographic profile of the respondents.

education level of the respondents. Fifteen respondents (4.2%) had primary education, 139 (36.9%) had secondary education, 200 (55.9%) had higher education, and 11 respondents (2.1%) did not have any formal education. Figure 3E represents the occupational status of the respondents, 40 respondents (11.2%) were military/paramilitary respondents, 75 (20.9%) were civil servants, 105 (29.3%) were self-employed, 5% of the respondents were religious leaders, 98 (27.4%) were students, and 22 respondents (6.1%) were applicants. Figure 3F represents the year of residence of the respondents, 103 respondents (28.8%) have been residing in the study location for the

last 10 years, 124 respondents (34.6%) have been residing since the last 20 years, and 83 respondents (23.2%) have been living Sabon-Gari for the last 30 years. Thirty-five respondents (9.8%) have been living in the study area for the last 31-49 years; 13 respondents (3.6%) have been living in the study site since the last 41 years and above, respectively.

Public perceptions on the awareness of environmental noise pollutions

Table 2 shows the responses of the respondents on the awareness of environmental noise, about 326 respondents (91.1%) knew about noise pollution and 32 (8.9%) did not know what noise pollution is. Three hundred and twenty-six respondents (91.1%) experienced noise in their daily activities, while 37 (8.9%) did not. Three hundred and twenty-four respondents (90.5%) agreed that noise pollution was increasing; while 34 (9.5%) had opposite opinion. Three hundred and twenty-one respondents (89.7%) knew that unplanned urbanization and inadequate awareness were exacerbating noise pollution and 37 (10.3%) had opposite opinion. Three hundred and seventeen respondents (88.5%) were aware of the new effects of noise pollution, while 41 (11.5%) were not aware of the effects of noise pollution.

Table 1. Projected population and questionnaires administered

Ward	2006	2019	Questionnaire administered
Jushi	45120	68582	84
Gabas	14580	22162	27
Chikaji	22815	34679	43
Jama'A	23415	35591	44
Hanwa	24205	36792	45
Dogorawa	22335	33949	42
Muchia	25648	38985	48
Samaru	27550	41876	52
Total	**205668**	**312616**	**385**

Table 2. The responses of the studied population on awareness of environmental noise pollution

Questions	Yes, n (%)	No, n (%)
Do you know what noise pollution is?	326 (91.1)	32 (8.9)
Are unplanned urbanization and inadequate awareness increasing noise level?	321 (89.7)	37 (10.3)
Do you think the noise level is increasing?	324 (90.5)	34 (9.5)
Are you aware of the effects of noise pollution?	317 (88.5)	41 (11.5)
Do you experience noise in your daily activities?	326 (91.1)	32 (8.9)

Response on the sources and severity of noise pollution

Table 3 shows the percentages and mean percentages of the various sources of noise and their severity by the respondents. For the residential sources of noise, about 58 respondents (16.2%) reported household noise as highly severe, 65 (18.2%) reported it as severe, 151 (42.2%) reported it as moderate, 40 (11.2%) reported it as mild, and 44 respondents (12.3%) reported it as very mild. For the traffic sources of noise, 165 respondents (46.1%) reported traffic noise as highly severe, 97 (27.1%) reported it as severe, 53 (14.8%) reported it as moderate, 19 (5.3%) reported it as mild, and 24 respondents (6.7%) reported it as very mild. For the light industry, 121 respondents (33.9%) reported it as highly severe, 80 (22.3%) reported it as severe, 72 (20.1%) reported it as moderate, 46 (12.8%) reported it as mild, and 36 respondents (10.9%) reported it as very mild. For construction source of noise, 93 respondents (26%) reported it as highly severe, 64 (19.9%) reported it as severe, 80 (22.3%) reported it as moderate, 60 (16.8%) reported it as mild, and 61 respondents (17.0%) reported it as very mild. For the generator sources of noise, 154 respondents (43%) reported it as highly severe, 109 (30.4%) reported it as severe, 49 (13.7%) reported it as moderate, 22 (6.1%) reported it as mild, and 24 respondents (6.7%) reported it as very mild. For the commercial sources of noise, 111 respondents (31.0%) reported it as very severe, 107 (29.9%) reported it as severe, 78 (20.3%) reported it as moderate, 37 (9.6%) reported it as mild, and 25 respondents (6.5%) reported it as highly severe, respectively.

Evaluation of perception of awareness on the various effects of environmental noise

Table 4 shows the results of the statistical analysis of the respondents on the awareness of the various effects of environmental noise. For stress effects resulting from noise exposure, 150 (41.9%) and 140 (39.1%) respondents were agree and strongly agree that they were aware that noise pollution leads to stress. While, 32 (8.9%), 26 (7.3%), 10 (2.8%) respondents were undecided, disagree,

Table 3. Perceptional analysis of different sources of environmental noise and their severity

Noise Source	HS (%)	S (%)	M (%)	MI (%)	VM (%)	Total (%)	Mean	STD	RA	RE
Residential	58 (16.2)	65 (18.2)	151 (42.2)	40 (11.2)	44 (12.3)	358 (100.1)	3.15	1.19	6	SF
Traffic	165 (46.1)	97 (27.1)	53 (14.8)	19 (5.3)	34 (6.7)	368 (100.0)	4.01	1.20	1	SF
Light industry	121 (33.9)	80 (22.3)	72 (20.1)	46 (12.8)	39 (10.9)	358 (100.0)	3.55	1.36	4	SF
Construction	93 (26.0)	64 (19.9)	80 (22.3)	60 (16.8)	61 (17.0)	358 (102.0)	3.19	1.43	5	SF
Generator	154 (43.0)	109 (30.4)	49 (13.7)	22 (6.1)	24 (6.7)	358 (99.0)	3.97	1.19	2	SF
Commercial	111 (31.0)	107 (29.9)	78 (20.3)	37 (9.6)	25 (6.5)	358 (97.3)	3.68	1.21	3	SF

Grand cumulative mean = 3.61, Standard decision mean =3.00, The single factor ANOVA showed $P<0.05$

and strongly disagree that noise led to stress effects, respectively. For the awareness of annoyance due to the noise effects, 171 (47.7%) and 130 (36.3%) respondents were strongly agree and agree, while 32 (8.9%), 16 (4.5%), and 10 (2.5%) respondents were undecided, disagree, and strongly disagree, respectively. For the awareness of the respondents on the effects of noise on hearing impairment, 140 (39.1%) and 160 (45%) respondents were agree and strongly agree. While 28 (7.8%), 12 (3.4%), and 17 (4.7%) respondents were undecided, disagree, and strongly disagreed, respectively. For the risk of accidents due to the effects of noise, 131 (36.6%) and 126 (35.2%) respondents were agree and strongly agree, respectively. While 23 (6.4%), 62 (17.3%), and 16 (4.5%) respondents were undecided, disagree, and strongly disagree, respectively. For the impairment of efficiency and productivity, 153 (42.7%) and 95 (26.5%) respondents were agree and strongly disagree while 53 (14.8%), 28 (7.8%), 27 (7.5%) respondents were undecided, disagree, and strongly disagree, respectively. For the effects of noise on the facilitation of mental illness, 141 (39.4%) and 97 (27.1%) respondents were agree and strongly agree, respectively. While 67 (18.7%), 28 (7.8%), 25 (7%) respondents were undecided, disagree, and strongly disagree, respectively. For the effects of noise on distraction, aggressiveness, and restlessness, 133 (37.2%) and 152 (42.5%) respondents were strongly agree and agree, respectively. In addition, 31 (8.7%), 23 (6.4%), and 19 (5.3%) respondents were undecided, disagree, and strongly disagree, respectively.

Perceptional reactions during personal exposure to the effects of environmental noise

Table 5 presents the percentage and the results of the evaluation of personal reactions to noise exposure by the respondents using the Likert scale. For the responses to annoyance, 152 respondents (42.5%) reported highly severe annoyance, 125 (34.9%) reported severe annoyance, 52 (15.5%) reported moderate annoyance, 14 (3.9%) reported mild annoyance, and 15 respondents (4.2%) reported very mild annoyance during exposure. One hundred and thirty-two (36.9%), 130 (36.9%), 60 (36.3%), 22 (16.8%), 22 (6.1%), and, 14 (3.9%) respondents reported that aggressiveness and distraction during noise exposure were severe, moderate, mild, and very mild during exposure. One hundred and eight-four (51.5%), 96 (26.8%), 48 (16.8%), 17 (4.7%), and 13 (3.6%) respondents reported that sleep disturbance during noise exposure was highly severe, severe, moderate, mild, and very mild, respectively. One-hundred and seven (32.7%), 118 (33%), 69 (19.3%), 32 (8.9%), and 22 (6.1%) respondents reported that information distortion during noise exposure was highly severe, severe, moderate, mild, and very mild, respectively. One-hundred and six (29.6%), 109 (33.4%), 79 (22.1%), 48 (13.4%), and 44 (12.3%) respondents reported that hearing impairment during noise exposure was highly severe, severe, moderate, mild and very mild,

Table 4. Precautional analysis of various effects of noise pollution

EONP	SA (%)	A (%)	UN (%)	D (%)	SD (%)	Total (%)	Mean	STD	RA	RE
Stress	140 (39.1)	150 (41.9)	32 (8.9)	26 (7.3)	10 (2.8)	358 (100.0)	4.070	1.01	3	S
Annoyance	171 (47.3)	130 (36.3)	32 (8.9)	16 (4.5)	9 (2.5)	358 (99.5)	4.220	0.96	2	S
Hearing impairment	161 (45.0)	140 (39.1)	28 (7.8)	12 (3.4)	17 (4.7)	358 (100.0)	4.240	1.84	1	S
Risk of accident	126 (35.2)	131 (36.6)	62 (17.3)	23 (6.4)	16 (4.5)	358 (100.0)	3.916	1.08	6	S
Information distortion	122 (34.1)	164 (45.8)	39 (10.9)	14 (3.9)	19(5.3)	358 (100.0)	3.994	1.04	5	S
Impaired efficiency and productivity	95 (26.5)	153 (42.7)	55 (15.3)	28 (7.8)	27 (7.5)	358 (99.8)	3.729	1.15	8	S
Facilitation of mental illness	97 (27.1)	141 (39.4)	67 (18.7)	28 (7.8)	25 (6.9%)	358 (99.9)	3.858	2.94	7	S
Distraction, aggressiveness and restlessness	152 (42.5)	133 (37.2)	31 (8.6)	23 (6.4)	19 (5.3)	358 (100.0)	4.050	1.12	4	S

Grand cumulative mean= 4.011, Standard decision mean = 3.000, The single factor ANOVA showed P<0.05.
SA = Strongly Agree (5), A= Agree (4), UN = Undecided (3), D = Disagree (2), SD = Strongly Disagree (1), STD = Standard Deviation, RA = Rank, RE= Remarks.

Table 5. Perceptional effects of personal responses and reactions during noise exposure

Personal reactions	HS (%)	S (%)	M (%)	MI (%)	VM (%)	Total (%)	Mean	STD	RA	RE
Annoyance	152 (42.5)	125 (35.0)	52 (14.5)	14 (3.9)	15 (4.2)	358 (100.1)	4.08	1.05	2	S
Aggressiveness	132 (36.9)	130 (36.3)	60 (16.8)	22 (6.1)	14 (3.9)	358 (100.0)	4.07	2.42	3	S
Sleep disturbance	184 (51.4)	96 (26.8)	48 (13.5)	17 (7.5)	13 (3.6)	358 (102.8)	4.18	1.06	1	S
Distortion of information	117 (32.7)	118 (33.0)	69 (19.3)	32 (8.9)	22 (6.1)	358 (100.0)	3.77	1.18	6	S
Hearing impairment	106 (29.6)	119 (33.2)	79 (22.1)	27 (7.5)	27 (7.5)	358 (99.9)	3.70	1.19	7	S
Ringing in the ears	96 (26.8)	109 (30.4)	61 (17.0)	48 (13.4)	44 (12.3)	358 (99.9)	3.46	1.24	8	S
Headache	135 (37.7)	112 (31.3)	61 (17.0)	33 (9.2)	17 (4.7)	358 (99.9)	3.88	1.16	4	S
Stress	104 (29.1)	115 (32.1)	67 (19.0)	39 (11.0)	33 (9.2)	358 (100.4)	3.61	1.26	5	S

HS= Highly Severe (5), S = Severe (4), M= Moderate (3), MI= Mild (2), VM= Very mild (1), STD = Standard deviation, RA= Rank, RE = Remarks.
Grand cumulative mean= 3.84, Standard decision mean = 3.00, The single factor ANOVA showed *P*<0.05.

respectively. Ninety-six (26.8%), 109 (30.4%), 61 (17%), 48 (13%), and 44 (12.3%) respondents reported that ringing in the ear (tinnitus) during exposure to noise pollution was highly severe, severe, moderate, mild, and very mild, respectively. One-hundred and thirty-five (37.7%), 112 (31.3%), 61 (17%), 33 (9.2%), and 17 (4.7%) respondents reported that headache during the exposure was highly severe, severe, moderate, mild, and very mild, respectively. One-hundred and four (29.1%), 115 (32.1%), 67 (18.7%), 39 (10.9%), and 33 (9.2%) respondents reported that stress during the exposure was highly severe, severe, moderate, mild, and very mild, respectively.

Analysis of respondents on the knowledge perception of personal and government

Table 6 presents the perceptional responses on personal and government responsibility during environmental noise exposure. About 221 respondents (61.7%) complained of environmental noise exposure, while 137 (38.3%) did not complain during noise exposure. On receiving complaints on environmental noise pollution, 260 respondents (72.6%) did not receive complaints on environmental noise pollution in their daily activities, while 98 (27.4%) did. On the assessments of the awareness of government agencies responsible for the regulation of environmental noise, 44 respondents (12.3%) were aware, while 314 (87.7%) were not. On individual personal mitigation of environmental noise pollution, 99 respondents (27.7%) affirmed it, while 259 (87.7%) were unconcerned. On whether the government had done enough in providing mitigation measures to environmental noise pollution, 54 respondents (15.1%) affirmed that the government has been doing the best while 304 respondents (84.9%) had opposite opinion. On whether the government should take proactive and strategic actions in mitigating noise pollution, 329 respondents (91.9%) affirmed it, while 29 respondents (8.1%) disagreed.

Personal actions taking during noise exposure

Figure 4 presents the actions taking during environmental noise exposure by the respondents. About 146 respondents (40.8%) reported that they endured noise during the exposure. Thirty-five respondents (9.8%) affirmed that they reported to the police doing the exposure. Seventy-four respondents (20.7%) affirmed that they confronted the sources to turn down the noise level. One-Hundred and three respondents (28.8%) affirmed that they left the place of the sources of noise.

Table 6. Personal and government responsibility on environmental noise pollution

Respondents	Yes, n (%)	No, n (%)
Noise effect complaints	221 (61.7)	137 (38.3)
Third party noise effect complaints	260 (72.6)	98 (27.4)
Awareness of government monitoring agency	44 (12.3)	314 (87.7)
Personal noise mitigating measures	99 (27.7)	259 (72.3)
On whether the government has done enough on mitigation of noise pollution?	54 (15.1)	304 (84.9)
On taking more proactive and strategic actions by government	329 (91.9)	29 (8.1)

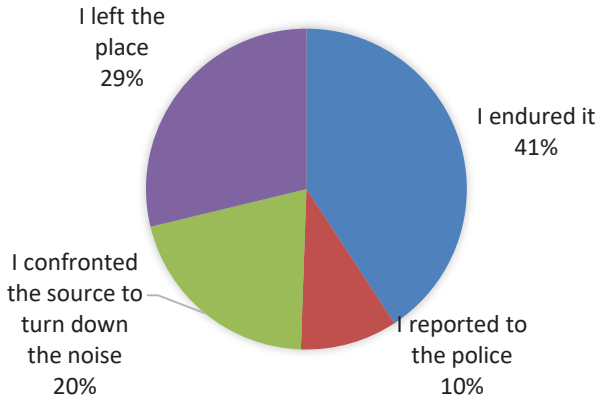

Figure 4. Actions taking during environmental noise exposure.

Awareness of agencies responsible for monitoring and regulating environmental noise in Nigeria

Figure 5 presents the evaluation of the knowledge of respondents on the agencies responsible for environmental noise monitoring in Nigeria. About 12 (3.6%), 15 (4.2%), 7 (2%) respondents respectively identified Nigeria National Environmental Standard Regulation enforcement Agency (NESREA), Kaduna Environmental Protection Agency (KEPA), and others as the agencies responsible for monitoring noise pollution. While 323 respondents (90.2%) were unaware of any environmental agencies for monitoring noise pollution.

Discussion

From the perceptional responses of the respondents on the environmental noise in Zaria City, the demographic profiles as presented in Figure 3A shows that male respondents were willing in receiving and providing responses, as about 60.3% male and 29.1% female elicited responses to the administered questionnaire. One of the factors that contributed to these differences as observed during the study was due to availability of male respondents, individual and cultural ideologies in the studied site. In a study conducted by Eludoyin et al, affirmed that most of the respondents were male and, which was consistent with the results of this study (9). According to Figure 3B that showed the age distribution, about 60.3% of the predominant populations were youths who showed more willingness and concerns to know about environmental noise pollution and were the most exposed to environmental noise, as they engaged more in daily, inhuman activities in locations where the noise was emitted. There were several higher institutions in the metropolitan city as reflected in the responses of the respondents, in where noise level was increasing. This result is consistent with the results of a study conducted in the Southwest of Nigeria (9). The self-employed had the

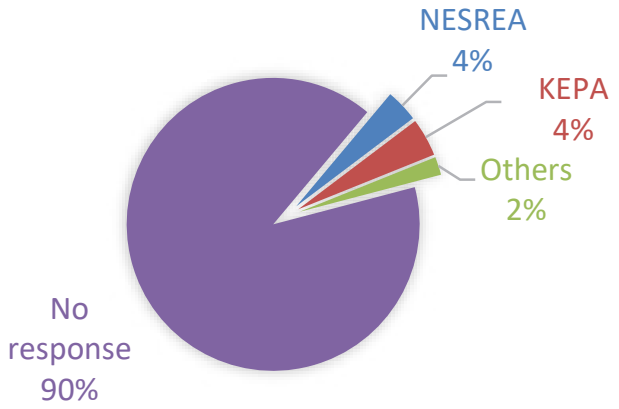

Figure 5. Respondent's awareness of environmental mitigation agencies. NESREA= Nigeria Environmental Standard Regulation and Enforcements Agency. KEPA= Kaduna Environmental Protection Agency.

highest responses as they were more likely to engage more in anthropogenic activities, more willingness to respond to the administered questionnaire, and had the tendencies to be predisposed to the environmental effects of noise level exceeding human specified receiving threshold as recommended by the WHO for different categories of anthropogenic activities (3-6). This finding is inconsistent with the findings of Eludoyin et alwhere most of the respondents were unemployed, this might likely to be due to geographical differences (9). As presented in Table 2, there were high responses on the knowledge of what is noise pollution, which could be necessitated as presented in Figure 3D as most of the respondents were literate. This might be due to several institutions in the study locations while only 3% of the respondents did not have any forms of formal education. In a study conducted in different locations in Nigeria reported that there was a significant relationship between the level of education and various effects of noise as reaffirmed in this study (9, 11). There was a high daily experience of noise level as affirmed by responses of about 89.7% of respondents, this might likely be as a consequence of the responses elicited from the respondents in Figure 3E as about 29.3% of the respondents were merchants, self-employed, who frequently found themselves engaged in locations with high human activities, and consequently, were predisposed to the noise level above the recommended threshold. This is inconsistent with the findings of Eludoyin et al where about 58.3% of the respondents were unemployed (9). Most of the respondents have been residing in the study locations as presented in Figure 3B to 3E for several years, they were educated and self-employed who knew the benefit of efficient urban planning would necessitate the reductions of the noise level. This is reaffirmed by the findings of Eludoyin et al, suggesting that effective urban and peri-urban planning would enhance the mitigation of noise level (9). Table 3 shows the responses of the respondents on the sources of noise and their severity. The standard deviation of 3 was less than the grand cumulative mean value (3.61) of the various sources of noise and their severity. Therefore, there was a high identification of the various sources of noise and their severity as traffic noise, generator noise, commercial noise, light industry noise, construction noise, and residential noise were ranked in a descending order as the most noticeable sources of noise and degree of severity using the Likert scale. Related studies conducted by Ristovska in Macedonia showed that about 47% of the respondents were annoyed of various degrees (32). In different studies conducted by Oyedepo and Saadu in Ilorin (Nigeria) (25), in European countries by the WHO (2-7), Kumar et al in India (30), Schwela in South Florida in USA (12), Ugbebor et al in Port Harcourt city in Nigeria (1), and Gerges in Brazil (27), traffic activities have been identified as the main sources of noise. In a study conducted in eight European countries by WHO on European Housing and Health Status, the most sources of noise identified by the respondents were traffic activities with about 38% high (13). These related findings, though with different approaches, all confirmed the sources of noise and severity as observed in the study. Traffic sources noise were the most identified sources of noise and its severity was reported as highly severe by 46.1% of respondents, severe by 27.1% of respondents, and moderate by 14.8% of respondents. Traffic source of noise was the most graded sources of noise in the studied location using the Likert Scale as presented in Table 3, and reaffirmed by previous studies with different approach (1, 4, 12, 13, 25). The single factor ANOVA for the text of variance on the sources of environmental noise and severity shows the $P<8.93\times10^{-5}$ at 95% confidence level; therefore, there was a significant difference between the various sources of noise and their severity in the studied population. This could be reaffirmed from the variation of population concentrations in Table 1 and with their attendant variations in human activities across the different locations surveyed. This finding is consistent with the findings of Awosusi and Akindutire, in Edo-Ekiti metropolitan city (Nigeria) (11). Table 4 shows the responses of the respondents on their awareness of the various effects of environmental noise. It was revealed that the respondents were aware of the various effects of various environmental noise as justified by the Likert scale analysis as the cumulative mean value (4.011) was greater than the standard deviation value (3). Hearing impairment, annoyance, stress, information distortion, impairment of efficiency, metal deteriorations, and distractions were ranked as the most pronounced effects of environmental noise pollution using the Likert scale and the percentages in a descending order in terms of awareness, which is consistent with the results of several studies (4, 9, 11, 25, 30, 33, 34). The single-factor ANOVA analysis on the awareness of the various perceptional effects of environmental noise pollution using the confidence level of 95%, showed that there was a significant variation in the identification of the awareness on the various effects of noise pollution in the sampled populations ($P<4.61\times10^{-}$

^{15}). These could be reaffirmed as a result of the rate of anthropogenic activities varies across the study location as present in Figure 3D, which was affirmed by Awosusi and Akindutire (11). Table 5 shows that the perceptional individual responses of the respondents feeling during exposure using the Likert scale was significant as the decision mean value (3) was lower than the grand cumulative mean value (3.84). Sleep disturbance, annoyance, aggressiveness, headache, stress, distortion of information, hearing impairment, and ringing in the ear were ranked in a descending order of severity during personal exposure using the Likert mean scale. This finding is consistent with the results of studies conducted in Federal Capital Territory (FCT) in Abuja (10), Eludoyin et al in a southwestern state (9), and Awosusi and Akindutire in Edo-Ekiti (11) (in Nigeria respectively. The single-factor ANOVA of the personal feeling of the effects of noise during exposure shows that there was a significant variation in the various effects of noise pollution during exposure by the respondents ($P<4.68\times10^{-15}$), which is consistent with the findings of a study by Awosusi and Akindutire (11) where there was a significant difference in the effects of noise in different locations. Table 4 presented the responses on personal and government responsibility on mitigating noise level and revealed that there was a high noise complaint as confirmed by about 61.7% of respondents. There was inadequate awareness of government agencies regarding monitoring and mitigation of noise as confirmed by about 87.7% of respondents. The government had not done enough measures in mitigating environmental noise levels as affirmed by 84.9% of respondents and about 91.1% of the respondents reported that there was a need for a proactive decision for the mitigations of the noise level by the government. A related study conducted on the evaluation of noise pollution-related perception in University Campus in Brazil (35), European Union on the attitudes of European citizens towards the environment (3, 4, 13), and Oloruntoba et al on the perceived health of urban noise pollution in Ibadan metropolitan area (30), which is consistent with the findings of this study. Figure 4 reveals the individual actions taking during exposure to noise level, about 40.8% endured it, which could necessitate into noise-related disease and 28.8% left the place of the sources of noise which could affect their productivity and economic life while about 20.7% endured it. This result is consistent with the findings of the study in the Southwestern state of Nigeria (9). As shown in Figure 5 on the knowledge of agencies responsible for monitoring environmental noise in Nigeria, about 90.2% of the respondents had inadequate knowledge of it, although the majority of the respondents were literate as presented in Table 2. Subjective responses from respondents on environmental noise were established to have an influence on health than objective noise exposure. As revealed in this study, the results may be influenced by the tendency of respondents with other related health challenges to be more likely to give exaggerated responses about their ill-health to be associated with as a result of noise exposure, though they might not be stressed by noise. The results of this study may influence future noise policies. This study justified the concerns of the studies conducted in Skopje Urban Centre in Macedonia on noise-induced sleep disturbance (32, 36).

Conclusion

The study provided useful information on the perceptional analysis of environmental noise pollution in Sabon-Gari LGA in Zaria Metropolitan city of Kaduna State. Most of the respondents reported that they have basic knowledge of noise pollution. About 89.7% of the respondents reported that they experience noise daily. Traffic, generators, commercial activities, light industries, construction activities, and domestic sources of noise were ranked in a descending order. Hearing impairment, annoyance, stress, restlessness, information distortion, facilitation of mental illness, and impaired efficiency were ranked in a descending order using the Likert scale based on the knowledge of the effects of noise pollution. Sleep disturbance, annoyance, aggressiveness, distraction, stress, hearing impairment, distortion of information, and tinnitus were ranked as the personal effects of noise during exposure using the Likert scale and percentages of degree in a descending order. For the single-factor ANOVA test of variance, there was a significant difference between sources of noise and their severity, awareness of the various sources of noise, and personal feeling during noise exposure ($P<0.05$) using the confidence level of 95%. Most of the respondents were not unaware of the government agency responsible for the monitoring of noise pollution. On action taking during personal exposure, most of the respondents endured the noise during exposure. Majority of the respondents (91.1%) wanted a proactive and strategic decision in mitigating noise pollution.

Government, non-government, private institutions and concern individuals should take proactive and decisive actions in mitigating noise measures by conducting public enlightenment, deploying social media in advertising to business owners, light industrial scale, and engaging religious leaders on the danger of environmental noise pollution. Strategic urban and suburban planning that will give priorities in siting commercials areas, residential areas, roads/streets, efficient transportation planning (parking areas and transportation park) by complying with the national standard would necessitate the abatement of environmental noise pollution. All aspects of education should emphasize educating students on the environmental health consequences of noise pollution.

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Ethical issues

The ethical consideration for the study was considered and obtained from the team, through a panel of professionals from the Department of Water Resources and Environmental Engineering, Ahmadu Bello University Zaria, Kaduna State, Nigeria on September 6, 2019.

Competing interests

The authors declare that there are no conflicts of interests.

Authors' contributions

All authors contributed to the study commencement, design, and critical review. Idoko Abraham Apeh contributed to the questionnaire development, the questionnaire administration, data analysis, and the manuscript preparation. Professor Sunday Bamidele Igboro and Dr. Saulawa Badrudden Sani, an environmental engineering specialist, provided technical advice, directions, and review of the manuscript. Dr. Umar Alfa Abubakar and Engr Steven James Ijimdiya helped in the final preparation of the manuscript.

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