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*Research Article*

# Urban Environmental Noise Pollution and Perceived Health Effects in Ibadan, Nigeria

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**ABSTRACT:** Urban environmental noise pollution has impact on the quality of life and it is a serious health and social problem. The aim of this study was to assess the sources and noise levels, and possible impacts in selected residential neighbourhoods of Ibadan metropolis. Structured questionnaire was used to elicit information from respondents on demographic and neighbourhood characteristics, sources of noise and perceived effects of noise pollution. Noise level meter was used to determine the noise levels. Results showed that noise levels, sources and the period the noise level reaches its peak vary with population density and are shown on GIS maps. The mean noise values for the three residential neighbourhood groups were low density (LD), 53.10±2.80dB; medium density (MD), 68.45± 2.10dB and high density (HD), 68.36±1.92dB with the medium density neighbourhoods having the highest mean value. There is a significant difference in the noise levels in the three neighbourhood groups (F value=11.88 and p=0.000). However, the difference in noise levels between HD/LD and LD/MD areas was significant (p=0.000) while that between HD/MD areas was not significant (p=0.975). Of the three residential neighbourhoods, the highest mean noise level (85.80dB) was recorded at Bere junction while the lowest was at the foot of Bowers tower at Oke Are (48.65dB). Based on WHO 16-hour DNL criteria of 55dB for residential areas, only 16 (23.2%) locations in the three residential neighbourhood groups had noise values that were within the recommended limit. The study concludes that there is a need for formulation and enforcement of permissible noise levels/standards for residential neighbourhoods by the Federal Ministry of Environment instead of using the current eight-hour standard of 90dB which is for industrial settings.

**Keywords:** *Environmental noise, health effects, Ibadan, pollution*

## INTRODUCTION

Environmental noise was defined by Schomer (2001) as the noise emitted from all sources except in the industrial workplace. Environmental noise in and around buildings and communities in which people live and work has gradually and steadily increased in magnitude and diversity as civilization has advanced (Cavanaugh and Tocci, 1998) and is currently a major public health problem in many cities worldwide. The major sources of environmental noise include: road, rail and air craft, construction and public works, and the neighborhood (Schomer, 2001). In the United States, over 40 per cent of the population are exposed to transport noise levels exceeding 55 dB(A), and in the EC and Japan, these percentages are even higher (WHO, 1995).

The effects of noise pollution may include population annoyance, interference with speech communication, leisure, or relaxation, and, at very high

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levels which may occur at work or during certain noisy leisure activities, it may result in hearing loss by causing damage to the hair-cells in the cochlea in the inner ear. Rather than leading to significant adverse physiological responses, however, noise is more often a major problem in terms of quality of human life in specific localities (WHO, 1995). In Nigeria, noise pollution also arise from loudspeakers from religious institutions such as churches and mosques, bells rung incessantly by peddlers, hawkers, and other salesmen to advertise their wares, highly amplified music from record shops, private electricity-generating plants and grinding machines. The noise from these sources cause irritation, and can in extreme cases even impair hearing (Nwaka, 2005).

In the developed nations, most member states have adopted legislation or recommendation setting emission limits for noise exposure in sensitive areas. These are often integrated into national abatement laws and used in land use plans especially for infrastructure development (EC, 1996). In Africa however, instituting an effective enforcement programme requires a firm commitment on the part of the Government and a stable leadership in the enforcement agency (Adegoke, 2007). In Nigeria for instance, even though the National Policy on Environment had been in place since 1989 to provide guidelines and strategies for attaining national environmental policy goals of which noise pollution is one (FEPA, 1989), not much has been done up to date. There are few or poorly enforced noise-pollution control laws in many parts of the country (Ighoroje *et al*, 2004).

The impact of occupational exposure to noise has been extensively studied by many investigators in Italy (Abbate *et al*, 2005), Nepal (Joshi *et al*, 2003), Lebanon (Korfali and Massoud, 2003), and Nigeria (Oleru, 1994, Avwiri and Nte, 2003; Omokhodion and Sridhar, 2003; Sonibare *et al*., 2004; Ighoroje at al., 2004, and Ologe *et al*., 2006). In Port Harcourt city, Nigeria, noise pollution has increased as a result of increased commercial and industrial activities; population growth, expansion of highways and increase in the number of automobiles. The noise from these sources is generally higher than 80 decibels (Izeogu 1989). A study carried out in three hospitals (1 tertiary and 2 secondary) in Ibadan by Omokhodion and Sridhar (2003) showed that children's clinics and wards recorded the highest noise levels at 68 – 73 dB(A) and 55 – 77 dB(A) and higher noise levels [up to 89dB(A)] were recorded in the operating rooms. However, despite the importance of environmental noise, only scanty information is presently available on environmental noise exposure in residential neighbourhoods in Nigeria. This study hypothesized that there is a significant relationship between population density of residential neighbourhood and noise levels. The outcome of the study will provide information that will assist government in reviewing the present policy in order to protect the health of the population which is and will continue to be the primary motive of all public efforts to control individual and community exposure to noise.

## MATERIALS AND METHODS

### Study sites

The study area, Ibadan metropolis was stratified into three based on population density as low (LD), Medium (MD) and high (HD) density residential neighbourhoods. The National Population Commission (1991) delineated Ibadan into 100 localities with 17LD, 46MD and 37HD residential neighbourhoods respectively from which 10% was randomly selected to give a total of 11 localities (5 for LD, 2 for MD and 4 for HD). Thereafter, 5% of the houses in the localities selected for each neighbourhood type were randomly selected. In all, a total of 341 houses were picked (57 for LD, 164 for MD, and 120 for HD). Structured questionnaire was administered to residents at every tenth house from the identified benchmark chosen for a particular area in each locality. Also, the noise levels at selected locations in the LD, MD and HD residential neighbourhoods were measured with a Type 2digital integrating sound level meter CEL 269 (CEL Instruments UK, Ltd) with low and high measuring ranges. Noise levels were measured on the weighted scale of decibels dB.

### GIS data capture and processing

Sampling spots were also documented using Global Positioning System (GPS) to facilitate development of a Geographic Information Systems (GIS) database in order to perform spatial modeling of noise levels in Ibadan. GIS is very useful at spatial editing, data handling, interpolation, and visualization capabilities that are lacking in most models. The concept of GIS examines spatial distribution and relationships between geographic objects or phenomenon, for instance, noise is a location-specific event. GIS is being used to monitor and forecast noise pollution patterns in many countries around the world (Kucas, *et al*. 2007, Mehdi *et al*., 2002). GIS could be an indispensable tool for noise analysis and management even in developing countries as Nigeria. In addition to its powerful capabilities in spatial database development, spatial data processing, managing and modeling, it provides visualization and map-making tools that can be used to effectively present the spatial variability of noise intensity.

**Geostatistics and Kriging Interpolation**

*Geostatistics* is the generic name for a family of techniques which are used for mapping surfaces from limited sample data and the estimation of values at *unsampled* locations. First developed 40 years ago by Georges Matheron and named in honour of Danie Krige, these methods are now widely used in the minerals industry and have disseminated out into many other fields where 'spatial' data is studied. Geostatistical estimation is a two stage process: (i) studying the gathered data to establish the predictability of values from place to place in the study area from which a graph (semi-variogram) was generated. The graph models the difference between a value at one location and the value at another location according to the distance and direction between them; (ii) estimating values at those locations which have not been sampled. This process is known as *'kriging'*. The basic technique "ordinary kriging" uses a weighted average of neighbouring samples to estimate the 'unknown' value at a given location. Weights are optimized using the semi-variogram model, the location of the samples and all the relevant inter-relationships between known and unknown values. The technique also provides a "standard error" which may be used to quantify confidence levels. Ordinary kriging method in Geostatistical Analyst of ArcGIS 9.3 (ESRI, 2008) was used to compute noise level surfaces for the study area using the georeferenced noise data.

## RESULTS AND DISCUSSION

### Environmental noise levels in residential neighbourhoods

Noise levels within the study residential neighbourhoods were observed based on field measurements and peoples' perception. Figure I shows the sampling points, while Figure 2 shows the satellite image of Ibadan with the noise sampling points from Google Earth. Results in Table 1 show that the mean noise values for the three residential neighbourhood groups are low density (LD), 53.10±2.80dB; medium density (MD), 68.45± 2.10dB and high density (HD), 68.36±1.92dB with the medium density neighbourhoods having the highest mean value.



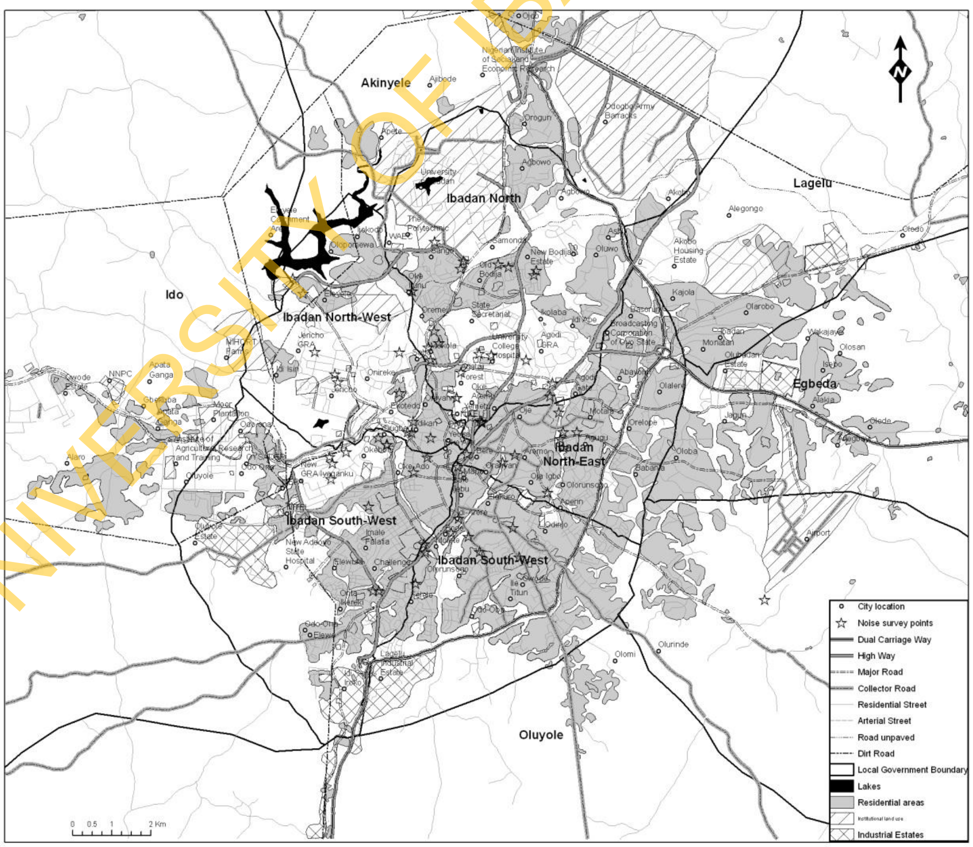


**Figure 1:**
Map of Ibadan showing the sampling points

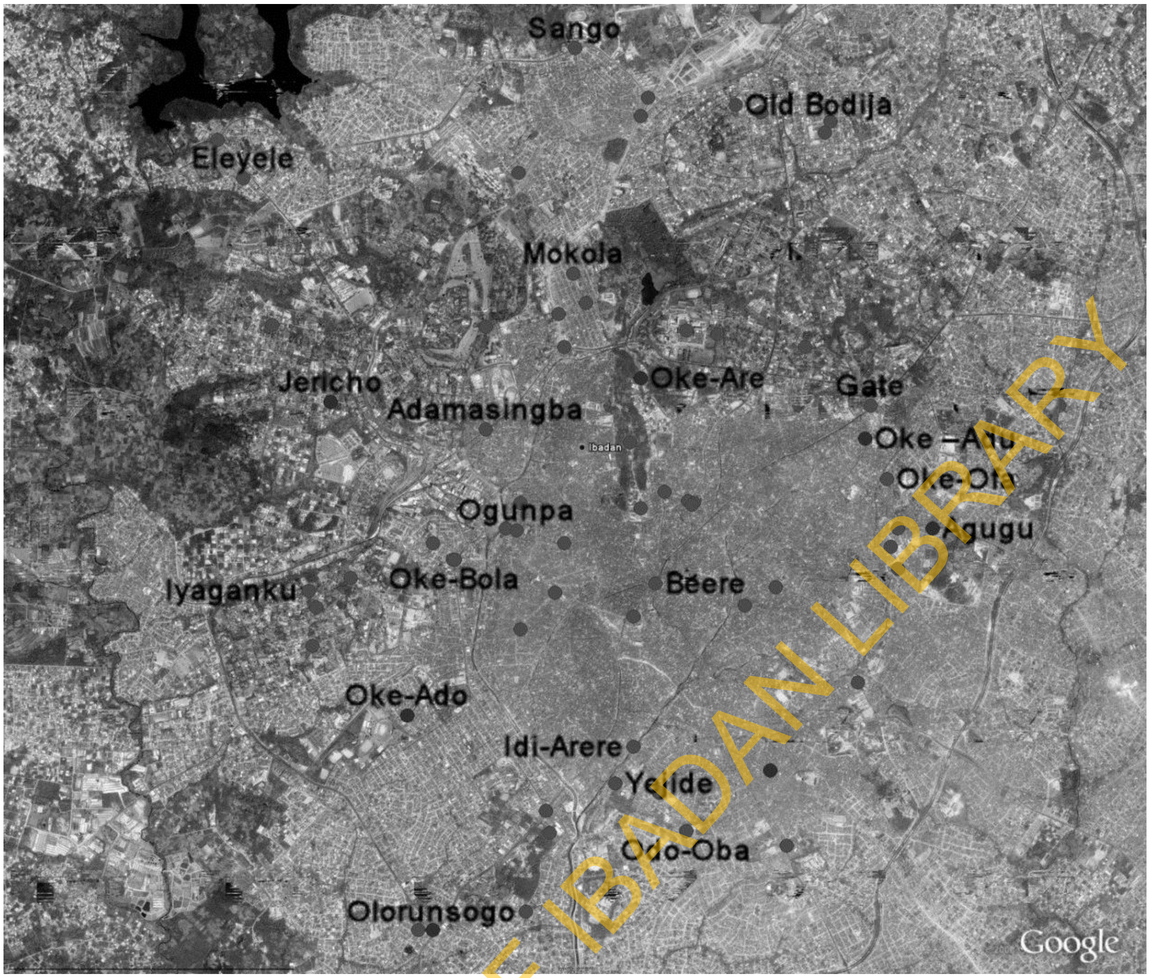


**Figure 2:**
Satellite Image of Ibadan showing the noise sampling points from Google Earth 2009 (*earth.google.com): High density and low density residential areas can be seen from the image*
Note: *The image above is like a picture taken from satellite. Image interpretation is similar to photo interpretation. Eleyele water works is depicted as black water body*



There is a significant difference in the noise levels in the three neighbourhood groups (F value=11.88 and p=0.000). The difference in noise levels between HD/LD and LD/MD areas were significant (p=0.000) while that between HD/MD areas was not significant (p=0.975). Of the three residential neighbourhoods, the highest and the lowest mean noise levels (85.80dB and 48.65dB respectively) were recorded in the high density areas although the lowest mean score was obtained in a hilly area. Noise map of Ibadan is shown in Figure 3.

The Federal Environmental Protection Agency - FEPA (1991) of Nigeria recommends a permissible limit of 90dB for a maximum of 8 hours in an occupational setting. However, according to Schomer (2001) nearly all Agencies and Boards, Standards setting bodies, and international organizations (for instance the World Health Organization, WHO; The World Bank Group and the International Organization for Economic Cooperation and Development) that have cognizance over noise producing sources use a Day-night sound level (DNL) criterion value of 55 dB as the threshold for defining noise impact in urban residential areas. Since the residential neighbourhoods are exposed to noise levels over duration exceeding 8hours, the WHO 16-hour DNL criteria of 55dB for residential areas was used in this study. Therefore, based on WHO criteria, only 16 (23.2%) locations in the 3 residential neighbourhood groups had noise levels below the recommended limit. Of this number, 9, 4 and 3 locations were from low, medium and high density residential neighbourhoods respectively. The implication of this result is that many of the residents in the study locations were frequently exposed to high environmental noise levels which could have a significant impact on their quality of life as well as their health.

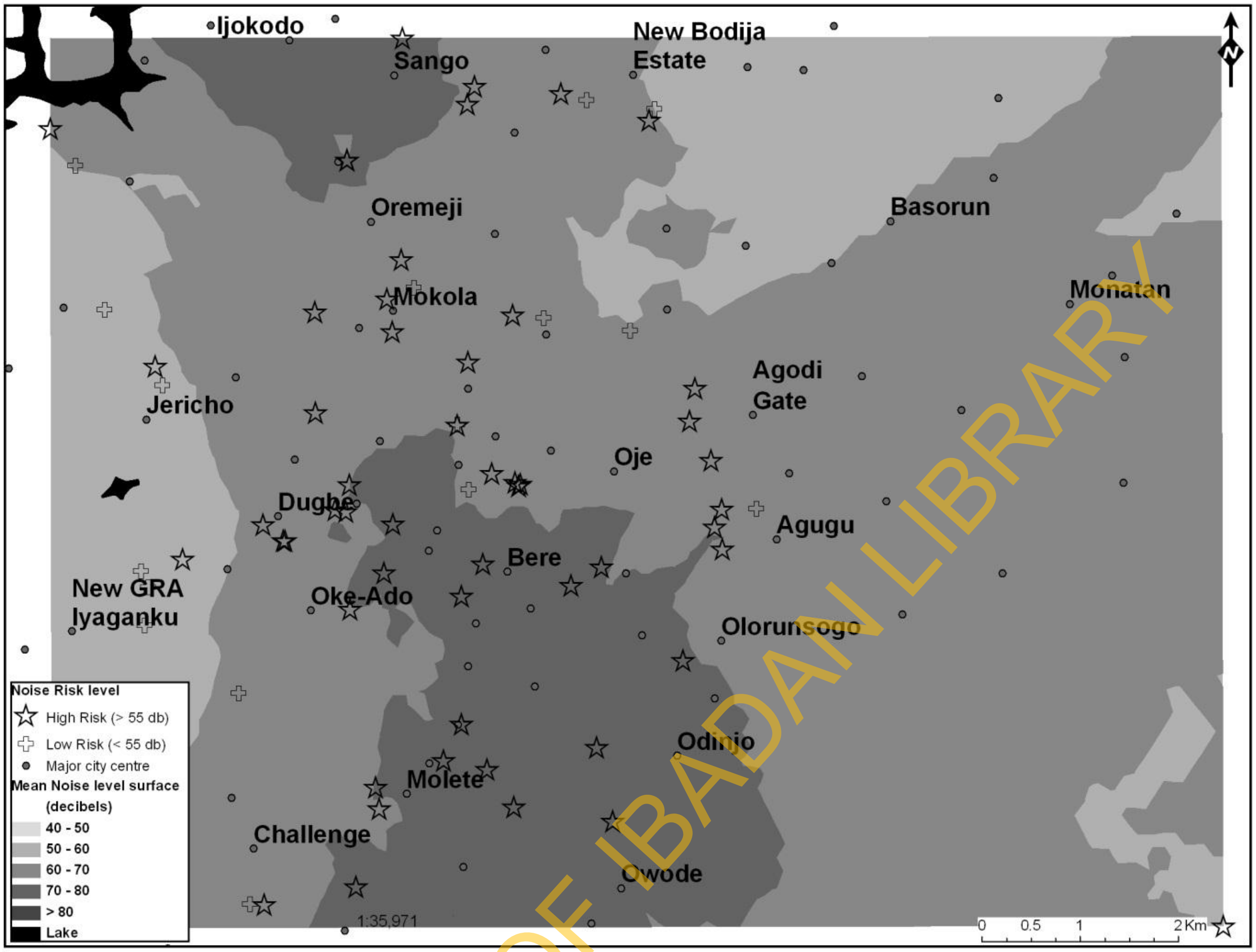


Figure 3: Noise surface of Ibadan City using Kriging Interpolation

**Table 1:**
Mean Noise level in residential neighbourhoods

| Population Density | Low noise level (dB) | High noise level (dB) | Mean noise level (dB) |
|---|---|---|---|
| Low Density | | | |
| Mean | 49.98 | 56.33 | 53.10 |
| SE | 2.67 | 3.11 | 2.80 |
| Medium Density | | | |
| Mean | 63.92 | 72.99 | 68.45 |
| SE | 2.00 | 2.33 | 2.10 |
| **High Density** | | | |
| **Mean** | **64.20** | **71.78** | **68.36** |
| **SE** | **1.82** | **2.12** | **1.92** |

However, Omokhodion *et al.* (2008) in a study to explore the effect of noise levels on hearing impairment of among workers in an urban community in Ibadan concluded that noise levels within residential areas ranged from 39-41 dBA in low density areas to 55-59 dBA in high density areas. These values are slightly lower than what were obtained in this study. Also, a study of the environmental impacts of urban road transport in Southwestern Nigeria by Osuntogun (2006) [21] recorded noise levels of 112.8dB at Oshodi bus stop in Lagos, 120dB at Iwo road bus stop in Ibadan and 115dB at Old garage junction in Ado-Ekiti which are far above the values obtained in this study.

**Perceptions of the respondents on sources/places of noise and associated effects**

The results of the survey on perceptions of residents on noisy locations, sources of noise, period of noise nuisance, health effect and effect on job performance are shown in Tables 2-6. Out of the 341 questionnaire administered, 245 (71.9%) were retrieved. However, some of the respondents did not respond to some questions as shown in Tables 2-5; this brought the total number down. About 35% of the respondents in the three residential neighbourhoods reported that the major source of noise pollution was vehicular (Table 2) followed by generator sets (12.3%). However, the sources vary in the different neighborhood type.

**Table 2:**
Perception of respondents about sources of noise in the selected neighbourhoods

| Location | Moving vehicle | Market place | Motor park | Traffic | Generator set | Grinding machine | Music system | Religious worship | Others | None | No response | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| High | 30 (51.7%) | - | - | | 6 (10.3%) | 3 (5.2%) | 8 (13.8%) | 4 (6.9%) | - | 3 (5.2%) | 4 (6.9%) | 58 |
| Medium | 39 (28.7%) | 6 (4.4%) | 2 (1.5%) | 3 (2.2%) | 12 (8.8%) | 13 (9.6%) | 14 (10.3%) | 18 (13.2%) | 4 (2.9%) | 7 (5.2%) | 18 (13.2%) | 136 |
| Low | 17 (33.3%) | - | - | | 12 (23.5%) | - | 2 (3.9%) | 1 (2.0%) | 1 (2.0%) | 6 (11.8%) | 12 (23.5%) | 51 |
| Total | 86 (35.1%) | 6 (2.5%) | 2 (0.8%) | 3 (1.2%) | 30 (12.3%) | 16 (6.5%) | 24 (9.8%) | 23 (9.4%) | 5 (2.0%) | 16 (6.5%) | 34 (13.9%) | 245 |

* Figures in parentheses are percentages

**Table 3:**
Period of Noise Nuisance

| Location | 4-7am | 7-11am | 11-3pm | 3-7pm | 7-11pm | After 11pm | No response | Total |
|---|---|---|---|---|---|---|---|---|
| | - | 5 | - | 4 | 14 | 11 | 10 | 58 |
| Medium | 5 | 10 | 21 | 29 | 38 | 6 | 27 | 136 |
| Low | 1 | 2 | - | 4 | 9 | 16 | 19 | 51 |
| Total | 6 | 17 | 21 | 37 | 61 | 33 | 56 | 245 |

**Table 4:**
Health Effects of Noise pollution

| Location | Headache | Hearing difficulty | Lack of concentration | Irritability | Tiredness | Any other | No response | Total |
|---|---|---|---|---|---|---|---|---|
| High | 26 (44.8%) | 4 (6.9%) | 14 (24.1%) | - - | 4 (6.9%) | 4 (6.9%) | 6 (10.4%) | 58 (100%) |
| Medium | 38 (27.9%) | 16 (11.8%) | 33 (24.3%) | 21 (15.4%) | 5 (3.7%) | 2 (1.5%) | 21 (15.4%) | 136 |
| Low | 10 (19.6%) | 6 (11.8%) | 11 (21.6%) | 9 (17.6%) | 6 (11.8%) | 3 (5.9%) | 6 (11.7%) | 51 |
| *Total* | 74 (30.2%) | 26 (10.6%) | 58 (23.7%) | 30 (12.2%) | 15 (6.1%) | 9 (3.7%) | 33 (13.5%) | 245 |

** Figures in parentheses are percentages*

In the high and medium density neighbourhoods, the sources of noise (mostly moving vehicles, music systems, grinding machine, generating sets and religious worship) were similar, while in the low density area moving vehicles and generating sets contribute the greatest sources of noise. The period the noise level reaches its peak varies with the neighbourhood (Table 3). In the high density area, it was between 7 and 11p.m when most people would be relaxing after a hard day's work. Activities producing noise include music playing or watching television at a gathering either in-front of a club, beer parlour or houses in a community. In the medium density area it was between 11a.m and 11p.m. Considerable level of noise is also experienced between 7.00am and 11am when residents are just setting out to go to their various places of work. However, in the low density area, the period of noise nuisance was from 7 to after 11pm; noise generated was mostly from moving vehicles and generators.

**Table 5:**
Effect of noise on job performance

| Location | Very much | A little | Not at all | No response | Total |
|---|---|---|---|---|---|
| High | 15 | 13 | 24 | 6 | 58 |
| Medium | 26 | 56 | 47 | 7 | 136 |
| Low | 9 | 16 | 23 | 3 | 51 |
| Total | 50 | 85 | 94 | 16 | 245 |
| % | 20.4 | 34.7 | 38.4 | 6.5 | 100.0 |

**Health and social impacts**

Headache (30.2%), followed by lack of concentration (23.7%) and thereafter irritability (12.2%) were the major health effects the respondents in the study area claimed to experience as a result of noise exposure (Table 4). By neighbourhood, 44.8%, 27.9% and 19.6% from high, medium and low density areas respectively associated headache with noise pollution. Also, 38.4% of the respondents claimed that noise had no effect on their job performance, 34.7% claimed that the effect was minimal while 20.4% claimed that noise had a significant effect on their job performance (Table 5). Of the three neighbourhood types, low density areas had the lowest number of respondents (9) claiming that noise had a significant effect on their job performance. Study by Avwiri and Nte (2003) revealed that the average noise levels of 81.72dB and 84.74dB generated by selected flow stations in the Niger Delta area of Nigeria were lower than the FEPA recommended value of 90dB for an 8-hour period, and would therefore have minimal effect on the workers. However, they concluded that the values could be considered hazardous for the host communities due to the day-long exposure period for the inhabitants. Also, study by Joshi *et al*. (2003) in India revealed that the major health effects induced by environmental noise were lack of concentration, followed by irritation, fatigue and headache.

In conclusion, the study has shown that noise levels, sources and effects vary with neighbourhood type. The level of noise in high density areas is significantly different from that of low density area. However, the levels in both medium and high density areas were similar. Generally action to reduce environmental noise has had a lower priority than that taken to address other environmental problems such as air and water pollution. Therefore, in order to tame the invisible pollutant of environmental noise and improve quality of life of people in Ibadan metropolis, there is a need to pay adequate attention to noise management in the residential neighbourhoods because of its adverse effect on the populace. This will require formulation and enforcement of permissible noise levels/standards for residential neighbourhoods by the Ministry of Environment (former known as Federal Environmental Protection Agency, FEPA) as against the current 8-hour standard of 90dB which is for industrial settings.



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