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Research Article
Assessment of Levels of Noise Pollution at Wurukum and North Bank Areas of Makurdi, Benue State Nigeria

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Abstract

Background and Objective: Noise pollution is an emerging environmental problem in many developing countries including Nigeria. The control of environmental noise pollution has been hampered by lack of sufficient research as well as insufficient knowledge of its effects on humans. This study was aimed at assessing the levels of noise pollution at Wurukum and North Bank areas of Makurdi. **Materials and Methods:** A Digital sound level meter (Model: GM 1351) was used to measure noise levels at eight locations covering both areas. Noise was measured at the following periods of the day: Morning (7:30-8:00 am), afternoon (12:30-1:00 pm), evening (3:30-4:00 pm) and night (7:30-8:00 pm) on the following days of the week: Sunday, Monday, Wednesday and Friday for a period of 4 months (16 weeks). **Results:** Obtained results showed that the highest level of noise pollution (L_{NP}) obtained was 84.4 dBA with the least being 50.7 dBA. Traffic noise index (TNI) of 64.1 dBA recorded was the highest value while the least was 10.2 dBA. Analysis of variance showed that there were significant differences in the level of noise pollution ($p<0.001$) and traffic noise index ($p = 0.03$) between all the locations sampled. *Post hoc* test (LSD) further showed that Lafia Park and General hospital had no significant difference in the level of noise pollution when compared to other locations. **Conclusion:** Therefore, intensive public enlightenment on effects of noise pollution on human health as well as proper training and usage of suitable protection accessories should be encouraged.

Key words: Model GM 1351, digital sound level meter, permissible limit, traffic noise index, sound pressure level

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

One of the major environmental problem today due to anthropogenic activities is increased level of noise pollution. Noise is a byproduct of urbanization and industrialization and is now worldwide recognized as a major problem for the quality of life in urban areas[1]. WHO[2] reported that Over 5% of the world's population (that is 360 million people globally) had suffered from disabling hearing loss, 328 million were adults and 32 million were children and one of the causes attributed to this condition was exposure to excessive noise.

Noise is a sound, especially one that is loud or unpleasant or that causes disturbance[3]. It is an inevitable part of everyday life and can be defined by various ways, but essentially it can be described as "wrong sound, in the wrong place at the wrong time"[4].

Noise is certainly a normal phenomenon of everyday life and is understood to be one of the most active alarm systems in man's physical environment. However, it is continuously disturbing human peace and tranquility and it has gradually become a very important environmental pollutant and a threat to the quality of man's atmosphere[5]. Noise is considered to be the third most hazardous type of pollution, right after air and water pollution[6]. It is one of the physical environmental factors affecting human health in today's world and it is a pollutant that is rapidly increasing as a result of very high population, transportation, congestion and improvements in commercial, industrial and social activities[7].

Noise damages hearing, causes progression of cardiovascular disease, fatigue, increase frustration and anxiety in concentrating. Persistent loud noise can eventually lead to deafness and even at relatively low levels, can disrupt sleep and also hinder cognitive development in children[7,8]. It is identified that automobiles, motorcycles, vehicular traffic, pressure horns, construction or industrial noise, machinery noise, electricity generating plants, noise from religious worship and household noise are some the factors responsible for most of the noise experienced in Nigeria[9]. However, other sources include airplanes, garbage trucks and use of public address systems and large speakers at public places[4].

Noise levels are measured in decibels (dB) and one decibel is the threshold of hearing. However, in measurement of sound, two weighting network namely A and C network are employed. For environmental purposes, the measurement is made using an A-weighted scale (dBA) because this scale measures sound levels in approximately the same way as the human ear[7]. Federal Environmental Protection Agency (FEPA) was established in 1990 by the Federal government of Nigeria and was entrusted with the responsibility of law formulation, control and regulating impact of noise in the country. Unfortunately, the impact of FEPA was not felt and in 2009 National Environment Standards and Regulations Enforcement Agency (NESREA) was established and tasked with the responsibility[4]. Noise pollution is one aspect of environmental pollution that is taken lightly in Nigeria and has not been seen as dangerous and having adverse effect on the life of people and this is possibly the reason why not much research into environmental noise pollution has been carried out in Nigeria and Benue State in particular[4]. This study was essential because it will create the necessary awareness about noise pollution and its effect. This study was also considered necessary because it allowed a comparison of the measured levels with known levels already considered safe according to WHO[10] and NESREA[11] noise pollution guide line presented in Table 1. The aim of this research work was to assess the levels of noise pollution at Wurukum and North Bank areas of Makurdi, Benue State.

Table 1: Noise standard developed by WHO[10] and NESREA[11]

	Permissible noise levels dB (A) (Leq)			
	WHO		NESREA	
Location	Day	Night	Day	Night
Industrial area	75	65	70	60
Commercial area	65	55	60	50
Residential area	55	45	50	35
Silent zones	45	35	45	35

MATERIALS AND METHODS

Study area and site description

Study area: The study was conducted between October, 2015 to January, 2016. The study area was Makurdi the capital of Benue state, a town that lies between Latitude 7°44'N and Longitude 8°32'E covering an area of 820 km^2 with an estimated population of 348,990 people, "National Population commission of Nigeria" (2011). The main drainage system is River Benue with other smaller tributaries traversing the town. The vegetation type in Makurdi is guinea savannah with annual rainfall between 150-180 m and temperature of 26-29°C. The sites where noise measurements were made are: Wurukum and North Bank areas. Map of location is presented in Fig. 1.

Experimental design: The sample locations were randomly selected and this included densely populated, heavy traffic, silent, industrial and commercial areas (which included roads, roundabouts, passenger loading parks and junctions). Eight sampling locations were selected from both areas, four from each.

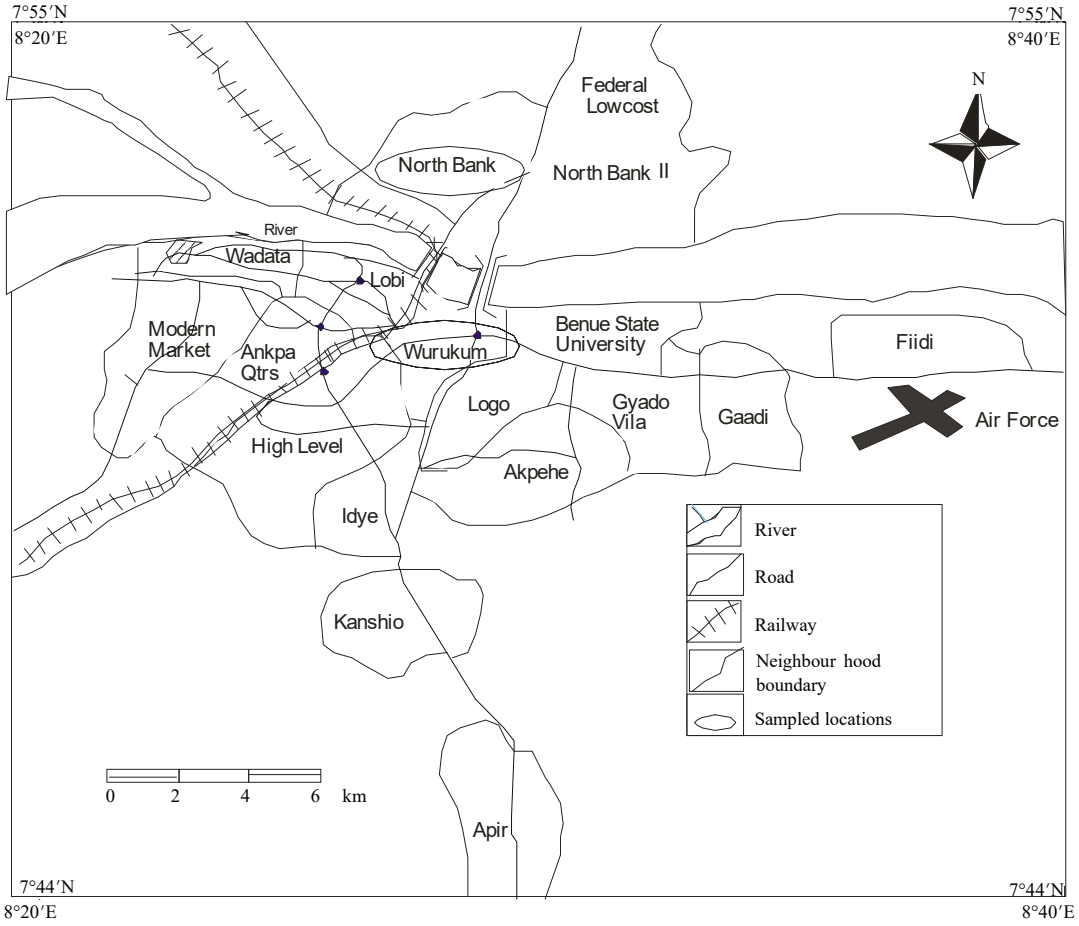

Fig. 1: Map of Makurdi Town showing study areas
Source: Ministry of lands and survey Makurdi

Wurukum area: Wurukum Roundabout, Wurukum Market keke Junction, Rice Mill and Pleasure Travel park.

North Bank area: The SRS Junction, NASME Junction, Lafia park and General Hospital.

Data collection: A digital sound level meter (Model: GM 1351) as shown in Fig. 2 was used to measure the sound level at each location with the instrument held in hand and the microphone pointing at the suspected noise source at an estimated distance of 1 m away from any reflecting object.

The noise measuring instrument had the following specifications:

- Measuring level range is 30-130
- Frequency weighing is A
- Time weighing is slow
- Operation temperature is 0-40°C
- Weight is 144 g

Fig. 2: Noise measuring instrument (Sound level meter)

The L_{Ai} (A-Weighted instantaneous sound pressure level) measurements were recorded at an interval of 30 sec for a period of 30 min/sampling location, giving 60 readings/period/sampling location.

This procedure was carried out on Mondays, Wednesdays, Saturdays and Sundays during, morning (7:30-8:00 am), afternoon (12:30-1:00 pm), evening (3:30-4:00 pm) and night (7:30-8:00 pm) periods of the day, giving a total of 240 readings a day and 960 readings a week for each location.

Assessment of noise descriptors: From the readings obtained, commonly used noise assessment quantities like: The exceedance percentiles L_{10} and L_{90}, the A-weighted equivalent sound pressure level (L_{Aeq}), the daytime average sound level (L_D), the day–night average sound level (L_{DN}), the noise pollution level (L_{Np}) and the Traffic noise index (TNI) were computed.

These noise quantities are defined as follows[12]:

$$L = 10 \log_{10}\left(\sum_{i}^{n} 10^{Ln/10}\right) \quad (1)$$

$$L_{Aeq} = 10 \log_{10}\left[\frac{1}{N}\sum_{i=1}^{N}\left(\text{anti}\log\frac{L_{Ai}}{10}\right) n_i\right] \quad (2)$$

$$L_D = 10 \text{ Log}_{10}\left[\frac{1}{2}\left(\text{anti}\log\frac{L_{AeqM}}{10} + \text{anti}\log\frac{L_{AeqA}}{10}\right)\right] \quad (3)$$

$$L_{DN} = 10 \text{ Log}_{10}\left[\frac{1}{24}\left(15\times\text{anti}\log\frac{L_D}{10} + 9\times\text{anti}\log\frac{L_N+10}{10}\right)\right] \quad (4)$$

$$L_N = 10 \text{ Log}_{10}\left[\frac{1}{2}\left(\text{anti}\log\frac{L_{AeqE}}{10} + \text{anti}\log\frac{AeqN}{10}\right)\right] \quad (5)$$

$$L_{NP} = L_{Aeq}+(L_{10}+L_{90}) \quad (6)$$

$$TNI = 4\,(L_{10}- L_{90}) +(L_{90}+30) \quad (7)$$

Where:

- L = Mean
- L_n = Average of the sound level reading in decibels
- L_{Ai} = ith A-weighted sound pressure level reading in decibels
- N = Total number of readings
- n_i = Number of readings/period
- L_{Aeq} = A-weighted equivalent sound pressure level
- L_{AeqM} = Equivalent sound pressure for the morning measurement
- L_{AeqA} = Equivalent sound pressure for the afternoon measurement
- L_{AeqE} = Equivalent sound pressure for the evening measurement
- L_{AeqN} = Equivalent sound pressure for the night measurement
- L_N = Night time noise level
- L_D = Daytime noise level
- L_{10} = Noise level exceeded 10% percent of the sampling time
- L_{90} = Noise level exceeded 90% of the sampling time
- L_{Np} = Noise pollution level
- L_{DN} = Day-night noise level
- TNI = Traffic noise index

The selected sampling locations were classified into different zones/areas according to the WHO[10] and NESREA[11] grouping as follows: Silent Zone/Area: General Hospital, Commercial Zone/Area: Wurukum Roundabout, Wurukum Market Keke Junction, Pleasure Travel Park, SRS Junction, NASME Junction and Lafia Park, Industrial Zone/Area: Rice Mill.

Statistical analysis: Data were entered into Microsoft Excel, managed and analyzed using SPSS. Data was presented using descriptive statistics and subjected to Analysis of variance (ANOVA) at 5% level of significance to check if there was a significant difference in the levels of noise produced from sampled locations.

RESULTS

Equivalent continuous noise level (L_{Aeq}): Figure 3-5 illustrates the equivalent continuous noise level (L_{Aeq}) of all locations sampled with respect to silent, commercial and industrial zones/areas. A glance through indicates that at Wurukum area of Makurdi the highest equivalent continuous noise level (L_{Aeq}) was recorded at Wurukum Market Keke Junction with a value of 80.7 dBA and the lowest was 58.8 dBA recorded at Lafia park, the highest equivalent continuous noise level (L_{Aeq}) was 81.8 dBA recorded at NASME Junction while the lowest was 49.5 dBA recorded at General Hospital. At Wurukum Roundabout the equivalent continuous noise level (L_{Aeq}) were, 79.2, 77.1, 77.3 and 74.3 dBA for morning, afternoon, evening and night periods, respectively. All these values exceeded standard permissible limits. Wurukum Market Keke Junction had equivalent continuous noise levels (L_{Aeq}) of

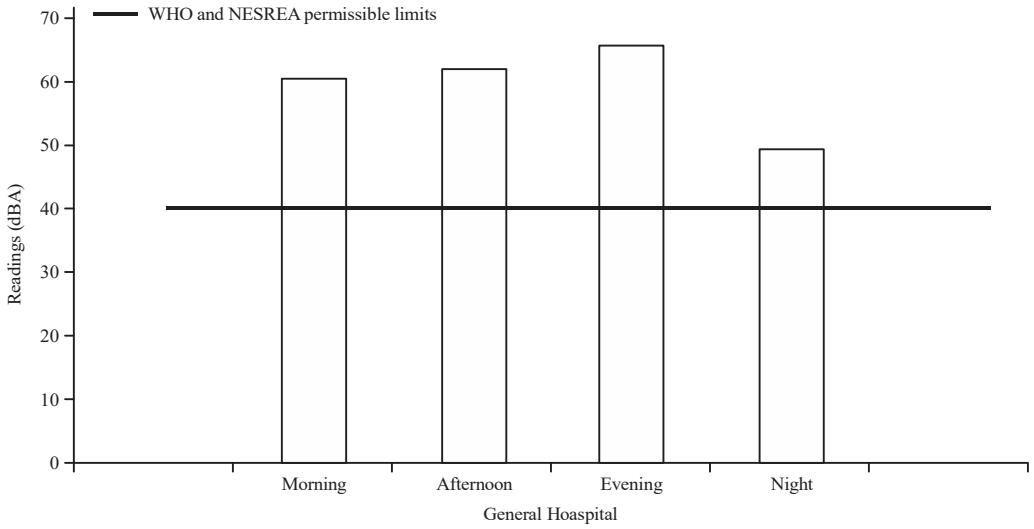

Fig. 3: Equivalent continuous sound pressure level from silent zone/area
Source: WHO[10] and NESREA[11]

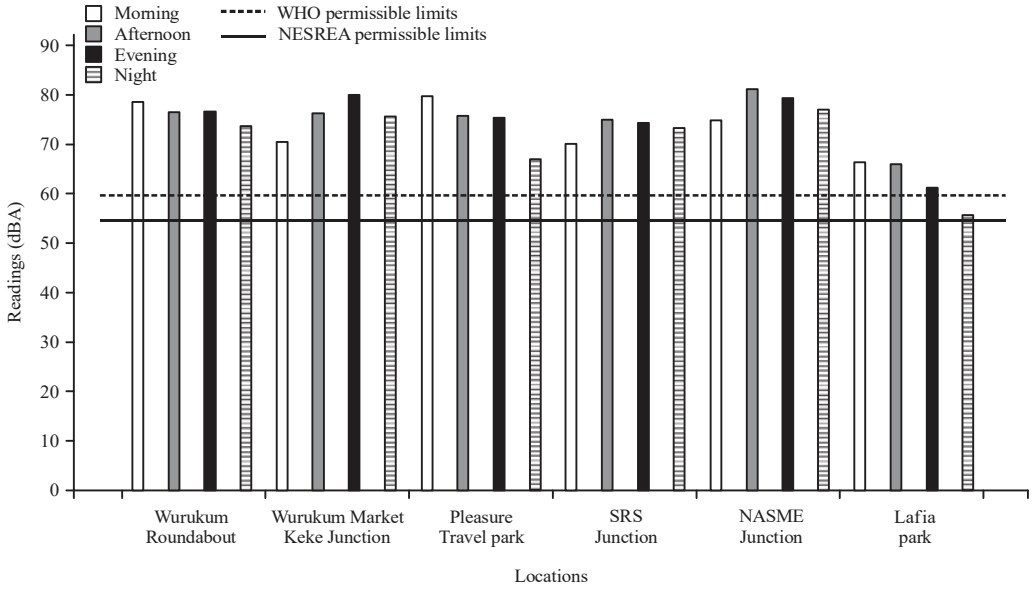

Fig. 4: Equivalent continuous sound pressure level from commercial zones/areas
Source: WHO[10] and NESREA[11]

71.0, 76.9, 80.7 and 76.3 dBA for morning, afternoon, evening and night periods, respectively and all these values exceeded WHO[10] and NESREA[11] permissible limits. The equivalent continuous noise level (L_{Aeq}) at rice mill were, 73.3, 74.0, 72.1 and 58.8 dBA for morning, afternoon, evening and night periods, respectively. All these values except the night time value exceeded WHO[10] and NESREA[11] permissible limits. At Pleasure Travel Park the equivalent continuous noise level (L_{Aeq}) were, 80.3, 76.4, 75.9, 67.6 for morning, afternoon, evening and night periods, respectively and all these readings were higher standard permissible limits.

The equivalent continuous noise level (L_{Aeq}) at SRS Junction were 70.5, 75.5, 74.9 and 73.9 dBA for morning, afternoon, evening and night periods, respectively and all these readings were higher than standard permissible limits. The NASME Junction had equivalent continuous noise levels (L_{Aeq}) of 75.5, 81.8, 80.0 and 77.8 dBA for morning, afternoon, evening and night periods, respectively. All these readings were higher than standard permissible limits. At Lafia park equivalent continuous noise levels (L_{Aeq}) were 66.9, 66.5, 61.8 and 56.1 dBA for morning, afternoon, evening and night periods, respectively. All the noise levels were lower standard

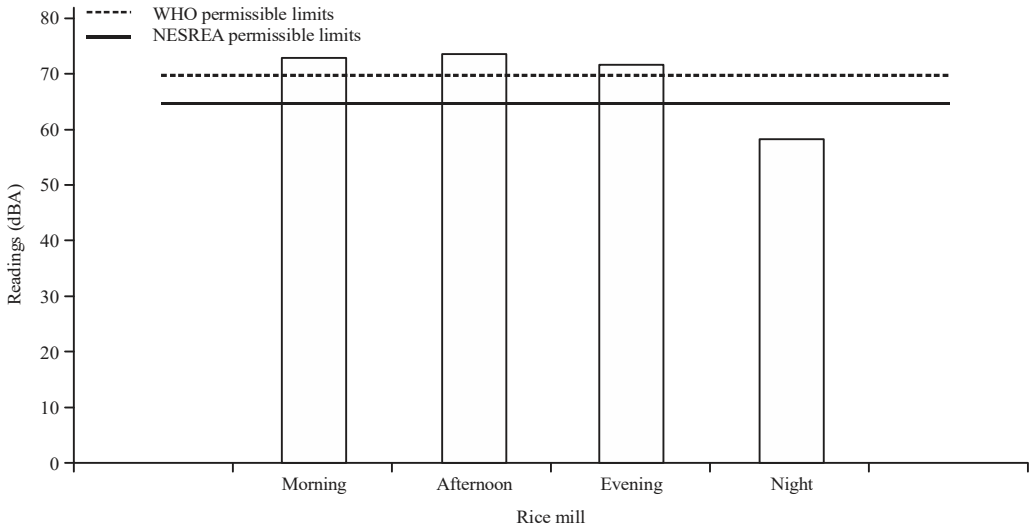

Fig. 5: Equivalent continuous sound pressure level from industrial zone/area (rice mill)
Source: WHO[10] and NESREA[11]

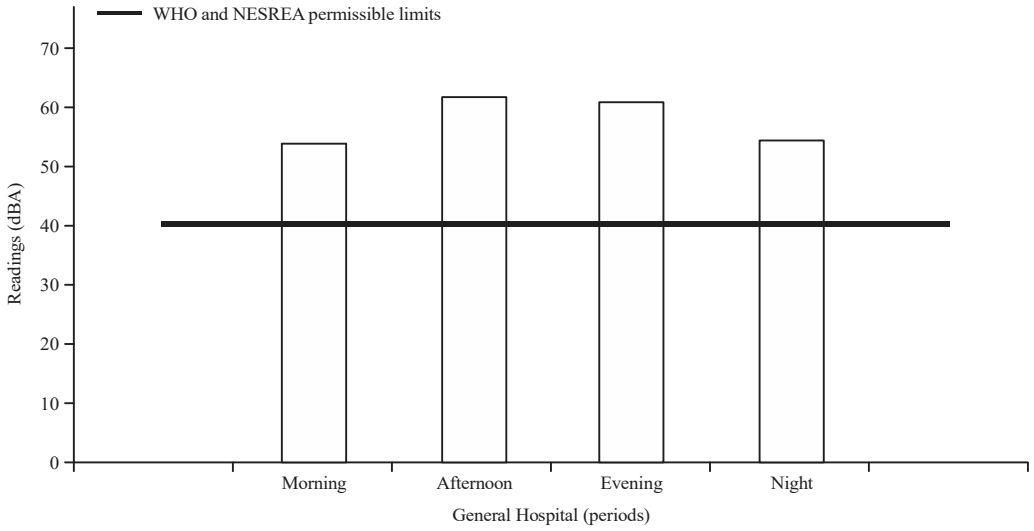

Fig. 6: Noise pollution level from silent zone/area
Source: WHO[10] and NESREA[11]

permissible limits. General Hospital had an equivalent continuous noise level (L_{Aeq}) of 60.7, 62.2, 66.0 and 49.5 dBA for morning, afternoon, evening and night periods respectively and all these values exceeded standard permissible limits.

Levels of noise pollution (L_{NP}): Figure 6-8 illustrates the levels of noise pollution (L_{NP}) from all locations with respect to silent, commercial and industrial zones/areas.

At Wurukum Roundabout the level of noise pollution (L_{NP}) was 81.6, 78.2, 75.2 and 69.7 dBA for morning, afternoon, evening and night periods, respectively. Wurukum Market Keke Junction had levels of noise pollution (L_{NP}) of 72.2, 79.4, 84.4 and 73.0 dBA for morning, afternoon, evening and night periods, respectively. The level of noise pollution (L_{NP}) at rice mill was 72.0, 73.3, 73.0 and 56.1 dBA for morning, afternoon, evening and night periods, respectively. At pleasure travel park the level of noise pollution (L_{NP}) was 78.6, 75.9, 70.2 and 63.1 dBA for morning, afternoon, evening and night periods, respectively.

The level of noise pollution (L_{NP}) at SRS Junction was 71.8, 70.2, 68.4 and 73.6 dBA for morning, afternoon, evening and night periods, respectively. At NASME Junction the level of noise pollution (L_{NP}) was 74.5, 81.5, 78.0 and 77.0 dBA for

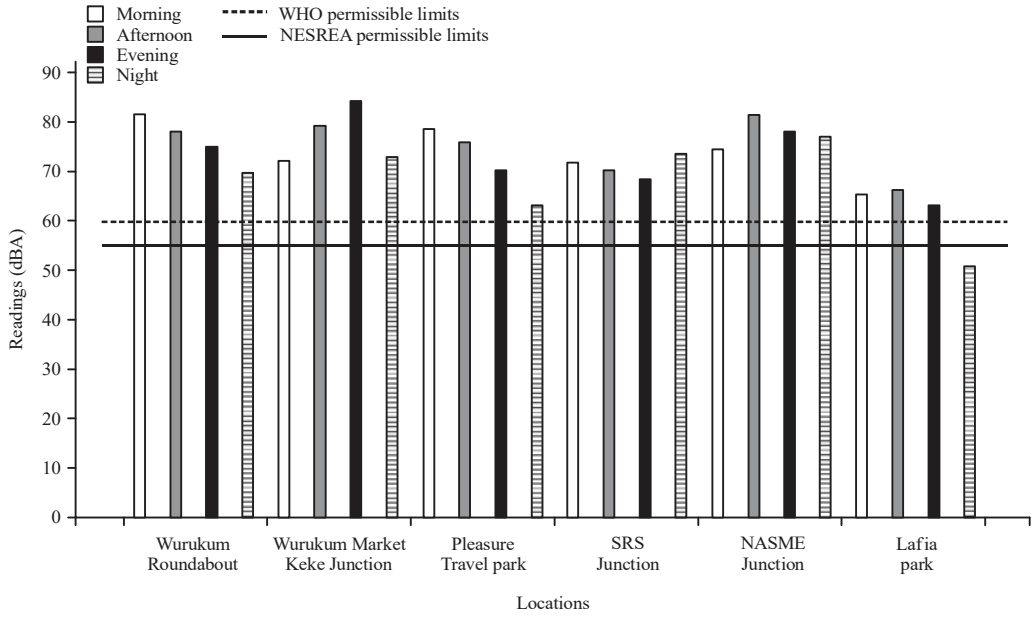

Fig. 7: Noise pollution level from commercial zones/areas
Source: WHO[10] and NESREA[11]

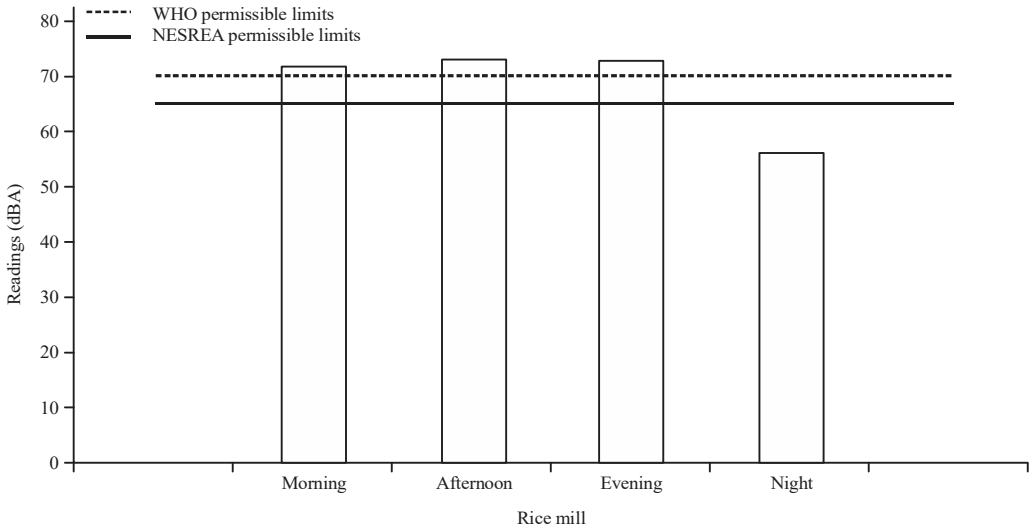

Fig. 8: Noise pollution level from industrial zone/area (rice mill)
Source: WHO[10] and NESREA[11]

morning, afternoon, evening and night periods, respectively. Lafia park had a noise pollution level (L_{NP}) of 65.4, 66.2, 63.2 and 50.7 dBA for morning, afternoon, evening and night periods, respectively. General Hospital North Bank had levels of noise pollution (L_{NP}) of 54.1, 61.9, 61.1 and 54.6 dBA for morning afternoon, evening and night periods, respectively.

Variation of traffic noise index (TNI): Traffic noise index as presented in Fig. 9 refers to a measure of annoyance response to various sources of noise which could be vehicular noise, aircraft noise, train noise or machinery noise.

At Wurukum area, the highest traffic noise index (TNI) value of 64.1 dBA was at Wurukum Market Keke Junction during the evening period while the lowest was 23.2 dBA at

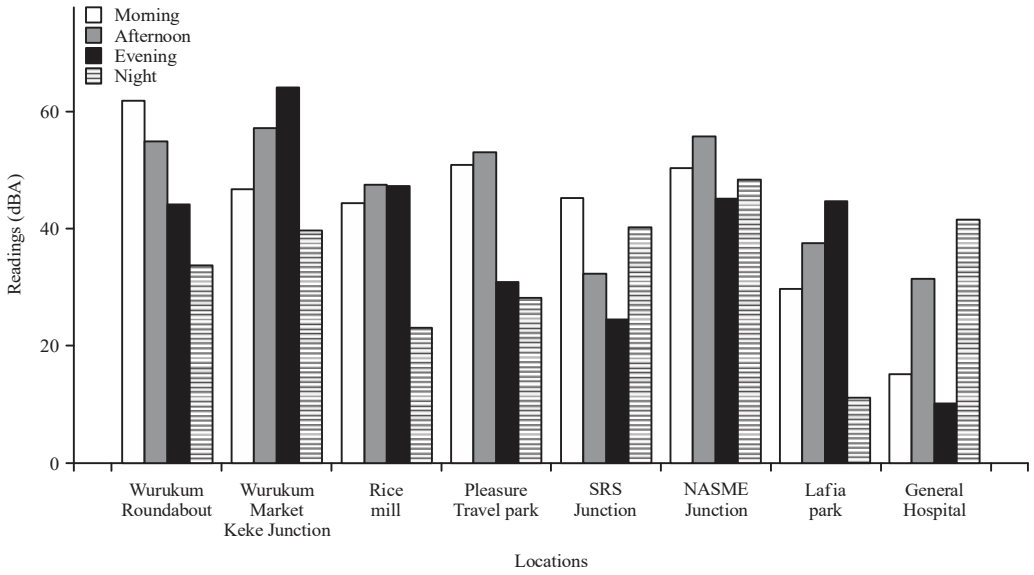

Fig. 9: Traffic noise index levels from Wurukum and North Bank areas

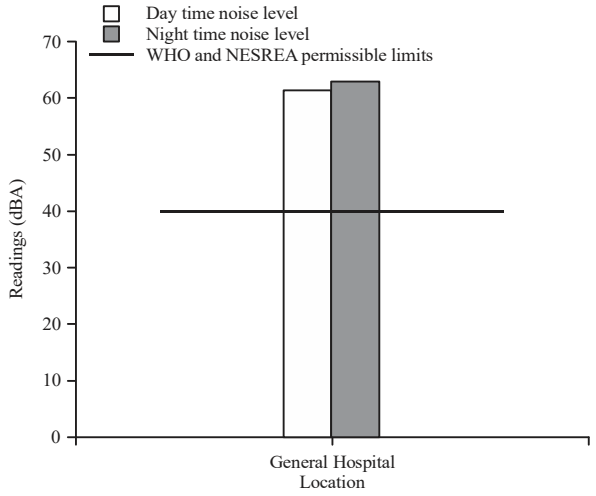

Fig. 10: Day time and night time noise levels from silent zone/area
Source: WHO[10] and NESREA[11]

rice mill during the night period. The highest traffic noise index value at North Bank area was 55.8 dBA at NASME Junction during afternoon period and the lowest was 10.2 dBA at General Hospital during the evening period. At Wurukum Roundabout the traffic noise index (TNI) was 61.9, 54.9, 44.1 and 33.8 dBA for morning, afternoon, evening and night periods, respectively. Traffic noise index (TNI) at Wurukum Market Keke Junction was 46.9, 57.2, 64.1 and 39.8 dBA for morning, afternoon, evening and night periods respectively. Rice mill had traffic noise index (TNI) values of 44.5, 47.5, 47.4, 23.2 dBA for morning, afternoon, evening and night periods, respectively. The traffic noise index (TNI) at pleasure travel park was 51.0, 53.1, 31.0 and 28.2 dBA for morning, afternoon, evening and night periods, respectively.

At SRS Junction the traffic noise index (TNI) was 45.3, 32.3, 24.4 and 40.3 dBA for morning, afternoon, evening and night periods, respectively. The NASME Junction had traffic noise index of 50.3, 55.8, 45.2 and 48.5 dBA for morning, afternoon, evening and night periods, respectively. At Lafia park the traffic noise index (TNI) was 29.7, 37.5, 44.7 and 11.3 dBA for morning, afternoon, evening and night periods, respectively. The traffic noise index (TNI) at General Hospital North Bank was 15.1, 31.4, 10.2 and 41.7 dBA for morning, afternoon, evening and night periods, respectively.

Level of noise during the day time (L_D) and night time (L_N): Figure 10-12 shows the level of noise during the day time (L_D) and night time (L_N) from all locations with respect to industrial, commercial and silent zones/areas. At Wurukum area, the day time (L_D) level of noise was 78.3, 74.9, 73.7 and 78.8 dBA for Wurukum Roundabout, Wurukum Market Keke Junction, rice mill and Pleasure Travel park, respectively. While the mean day time (L_D) level of noise was 76.9 dBA. At North Bank area, the day time (L_D) level of noise was 73.8, 79.7, 66.7 and 61.5 dBA for SRS Junction, NASME Junction, Lafia park and General Hospital, respectively. While the mean level of noise was 74.9 dBA.

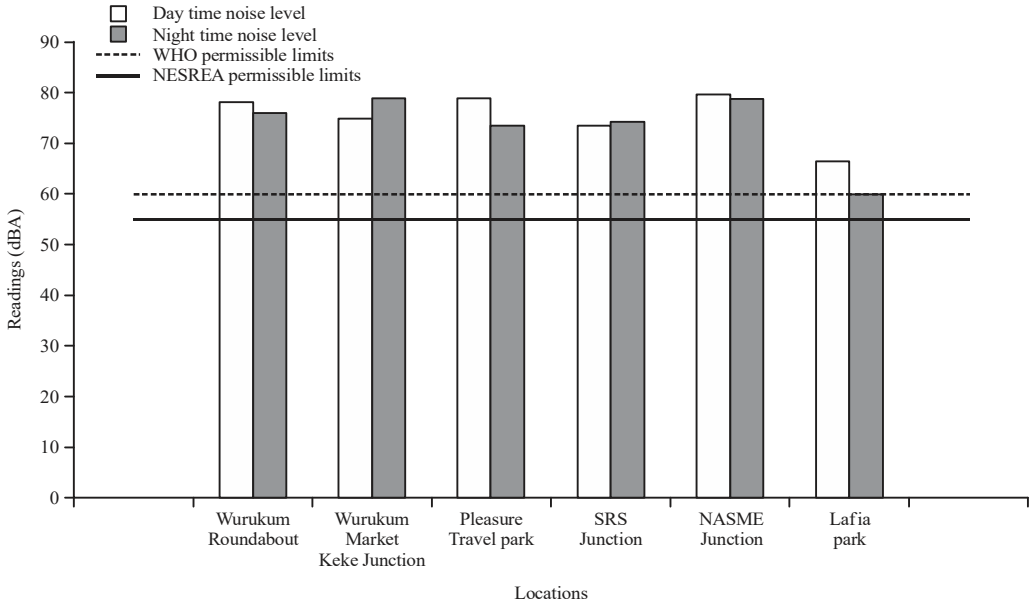

Fig. 11: Daytime and nighttime noise levels from commercial zones/areas
Source: WHO[10] and NESREA[11]

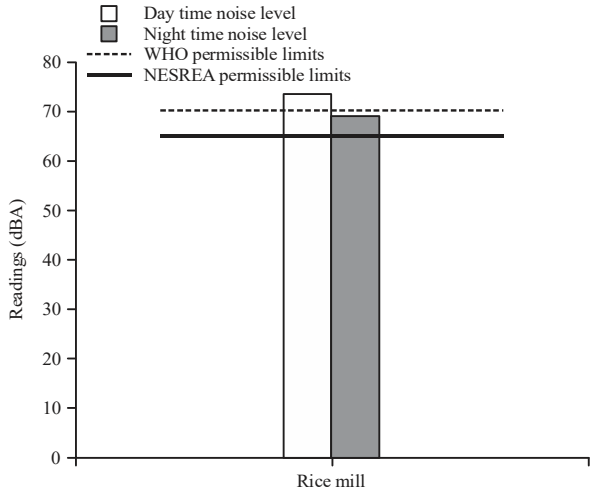

Fig. 12: Day time and night time noise level from industrial zone/area (rice mill)
Source: WHO[10] and NESREA[11]

The level of noise during the night (L_N) at Wurukum area was 76.1, 79.0, 69.3 and 73.5 dBA for Wurukum Roundabout, Wurukum Market Keke Junction, Rice mill and Pleasure Travel park, respectively. While the mean noise level during the night (L_N) was 75.8 dBA. The level of noise during the night (L_N) at North Bank area was 74.4, 79.0, 59.8 and 63.1 dBA for SRS Junction, NASME Junction, Lafia park and General Hospital, respectively. While the mean level of noise during the night (L_N) was 74.4 dBA. All the locations at Wurukum and North Bank area recorded day and night time levels of noise that were higher than standard permissible limit. However, Wurukum area recorded higher levels of noise during the day and night time respectively.

Statistical analysis: There was a significant difference ($p = 0.05$) in the level of noise pollution (L_{NP}) between all the locations as determined by one-way ANOVA ($F(7, 24) = 2.42$, $p<0.001$). Multiple comparisons were done using *post hoc* test, least significant difference (LSD).

Wurukum Roundabout had a significant difference with Lafia park ($p = 0.001$) and General Hospital ($p<0.001$). Wurukum Market Keke Junction had a significant difference with Rice mill ($p = 0.042$), Lafia park ($p = 0.001$) and General Hospital ($p<0.001$). Rice mill had a significant difference with Wurukum Market Keke Junction ($p = 0.042$), NASME Junction ($p = 0.032$) and General Hospital ($p = 0.014$). Pleasure Travel park had a significant difference with Lafia park ($p = 0.015$) and General Hospital ($p = 0.014$). The SRS Junction had a significant difference with Lafia park ($p = 0.025$) and General Hospital ($p = 0.003$). The NASME Junction had a significant difference with Rice mill ($p = 0.032$), Lafia park ($p<0.001$) and General Hospital ($p<0.001$). Lafia park had a significant difference with Wurukum Roundabout ($p = 0.001$), Wurukum Market Keke Junction ($p = 0.001$), Pleasure Travel park ($p = 0.015$), SRS Junction ($p = 0.025$) and NASME Junction ($p<0.001$). General Hospital had a significant difference with Wurukum Roundabout ($p<0.001$), Wurukum Market Keke Junction ($p<0.001$), Rice mill ($p = 0.014$), Pleasure Travel park ($p = 0.002$), SRS Junction ($p = 0.003$) and NASME Junction ($p<0.001$).

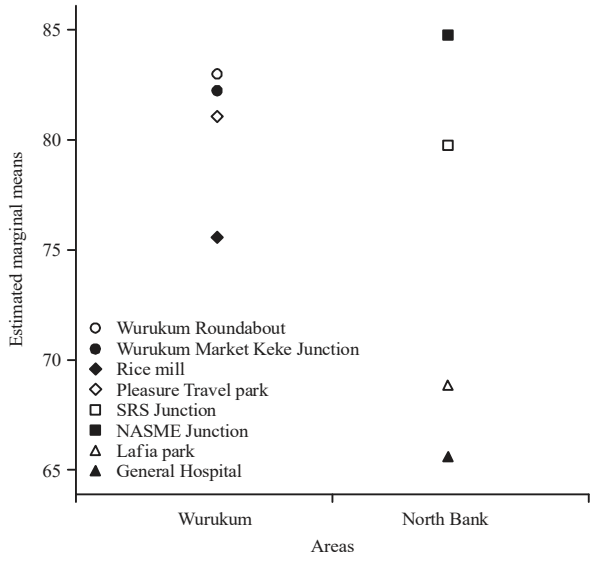

Fig. 13: Profile plot of two-way ANOVA

There was a significant difference in the traffic noise index of all the locations as determined by one-way ANOVA ($F(7, 24) = 2.42$, $p = 0.030$). Multiple comparisons using *post hoc* test (LSD) showed: Wurukum Roundabout had a significant difference with Lafia park ($p = 0.041$) and General Hospital ($p = 008$). Wurukum Market Keke Junction had a significant difference with Lafia park ($p = 0.071$) and General Hospital ($p = 0.003$). Rice mill, Pleasure Travel park and SRS Junction had no significant difference when compared with all the locations ($p>0.05$). The NASME Junction had a significant difference with Lafia park ($p = 0.030$) and General Hospital ($p = 0.005$). Lafia park had a significant difference with Wurukum Roundabout ($p = 0.041$), Wurukum Market Keke Junction ($p = 0.017$) and NASME Junction ($p = 0.030$). General hospital had a significant difference with Wurukum Roundabout ($p = 0.008$), Wurukum Market Keke Junction ($p = 0.003$) and NASME Junction ($p = 0.005$).

Two-way analysis of variance (ANOVA) showed that there is a significant difference ($p = 0.003$) between the 2 areas (Wurukum and North Bank). In terms of estimated marginal mean readings of noise level, North Bank had the highest and the lowest marginal means shown in Fig. 13. The Two-way Analysis of variance (ANOVA) also shows that the distribution of the estimated marginal mean readings at Wurukum area is more homogenous than those of North Bank area.

DISCUSSION

The equivalent continuous sound pressure levels (L_{Aeq}) recorded in this study from all the locations has variation with a maximum and minimum value of 81.8 and 49.5 dBA. This variation and range could be as a result of varying population at each location, excessive use of vehicle horns, commercial centers and presence of compact disc sellers within these areas. This is similar to the findings of Oyedepo and Saadu[1] in Ilorin who recorded maximum and minimum values of 89.0 and 47.0 dBA and also similar to the findings of Essandoh and Armah[13] at Cape Coast city in Ghana who recorded maximum and minimum values of 80.0 and 51.0 dBA. However, differs from the findings of Oluwasegun *et al.*[14] in Lagos and Ebozoje and Umoh[15] in Gusau, who recorded higher maximum and minimum values of 70.6 and 103, 72 and 81 dBA, respectively, with the reason being as a result of higher commercial activities, higher population density, more industrial activities, as well as a higher traffic volume at these areas.

The highest level of noise pollution (L_{NP}) of 84.4 dBA observed in this research work at Wurukum Market Keke Junction could be as a result of a cluster of commercial activities that take place at this location, the presence of the nearby market and continuous movement of vehicles and other automobiles while the least L_{NP} of 50.7 dBA observed at Lafia park could be as a result of the park located further away from the highway, low level of commercial activities that take place at this park and low level of vehicular traffic at this park. In comparing this maximum and minimum L_{NP} values obtained in this research study with other related works, it differs from those reported by Oluwasegun *et al.*[14] in Lagos, Ebozoje and Umoh[15] in Gusau and Oyedepo and Saadu[1] in Ilorin who all recorded higher maximum and minimum L_{NP} values and attributed this to high traffic volume at these areas, high industrial and commercial activities that take place at these areas and a high population density.

Current research showed that Wurukum Market Keke Junction had the highest traffic noise index (TNI) of 64.1 dBA and this could be as a result of high traffic density which included vehicle engines, vehicle horns and activities of traders and pedestrians interacting with each other. Lowest TNI of 10.2 dBA recorded at General hospital could be as a result of the low amount of vehicular traffic and location of the hospital which is further away from the highway. The maximum and minimum TNI values observed in this study was low as compared to the findings of 89.8 and 60.1 dBA observed in Lagos by Oluwasegun *et al.*[14], 94.0 and 67 dBA recorded in Gusau by Ebozoje and Umoh[15] and also values of 128.0 and 57.0 dBA observed in Ilorin by Oyedepo and Saadu[1] who all attributed this high TNI values to high traffic density and high level of commercial activities in these areas.

Day time noise (L_D) observed from all locations within Wurukum and North Bank exceeded WHO and NESREA permissible limit and this could be as a result of the morning rush hour when people and children transits to their normal

businesses and schools, high commercial activities and interactions that take place during the day time and the volume of vehicles plying the network of roads close to these areas. This agrees with the findings of Oluwasegun *et al.*[14] in Lagos, Anomohanran[7] in Abuja, Ebozoje and Umoh[15] in Gusau and Oyedepo and Saadu[1] in Ilorin as they observed day time noise that was higher than WHO and NESREA permissible limit.

Night time noise (L_N) recorded from all locations within Wurukum and North Bank area exceeded WHO[10] and NESREA[11] permissible limit and the reason could be as a result of the evening rush and high traffic volume by people returning to their homes, as well as some evening commercial activities that involve the use of equipment (like electrical generators) that contribute to increased level of noise at night. This agrees with the works carried out by of Oluwasegun *et al.*[14] in Lagos, Oyedepo and Saadu[1] in Ilorin, Ebozoje and Umoh[15] in Gusau who all recorded night time noise that was higher than WHO and NESREA permissible limit.

CONCLUSION

The noise assessment presented in this research have revealed that all locations at Wurukum and North Bank areas of Makurdi have noise levels that are above WHO and NESREA permissible limit during the day and night time. Comparison of the traffic noise index among all locations showed that areas with high traffic density such as Wurukum Market Keke Junction, Wurukum Roundabout, NASME Junction and Pleasure Travel Park had high traffic noise index values with Wurukum Market Keke having the highest of 64.1 dBA as compared to areas with low traffic density (like General Hospital) with a value of 10.2 dBA. From the observations in this research work, the present status of noise pollution in these areas of Makurdi potentially pose a threat as the high volume of noise emanating from various sources can pose a health risk to the populace and this can negatively affect their physical and mental well-being as concurred by several researchers cited in the work.

SIGNIFICANCE STATEMENT

This study discovers that levels of noise pollution at sampled are as exceeded WHO and NESREA permissible limits and this potentially pose a threat to the general public. This study will help researchers have baseline data for levels of noise pollution in Makurdi. Thus, help garner public knowledge and attention in order to help curb environmental noise pollution as proper measures will be taken to limit noise effects in the environment.

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