



EVALUATION OF NOISE LEVELS IN AN URBAN MARKET, FEDERAL CAPITAL TERRITORY, NIGERIA

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ABSTRACT

This study assessed noise pollution levels in and around Gwagwalada urban market and the likely effects on human health. Measurements of noise level were done using sound level meter (Smart Sensor Model AR854), at ten (10) selected points, whose coordinates were predetermined. The measurements were carried out at different times of the day (6-8am, 1-3pm and 5-7pm) for five (5) days, i.e. two traditional and three non-traditional market days. The data obtained were used to assess the variation in temporal and spatial noise level in and around the market, as well as the difference in noise level between the traditional and non-traditional market days, using ANOVA and t-test statistical tools. Results showed that highest noise level were generated in the evening hours (5-7pm) and the analysis of variance (ANOVA) in noise level at the different times showed significant variation at $F(2) = 13.982, P \leq 0.05$. Spatially, points PCC and AIS had the highest mean noise level of 84.64dB and 81.38dB, respectively and were higher than NESREA and WHO permissible limits. The ANOVA test for spatial noise level in the selected locations showed significant spatial variation with $F(9) = 6.029, P \leq 0.05$. Furthermore, paired t-test in the analysis of noise level between traditional ($70.28 \pm 10.15\text{dB}$) and non-traditional ($66.16 \pm 8.28\text{dB}$) market days, showed statistically significant difference at $t(9) = 2.766, P \leq 0.05$. The high noise levels were due to sounds from power generators, use of sound amplifiers for product marketing among others. Noise pollution poses significant health risk and there is need to monitor and control noise level in and around the market, through the combined efforts of government, professionals and citizens. Additionally, there should be periodic assessment of the health status of traders in Gwagwalada market.

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1.0 Introduction

Noise pollution has been one of the numerous environmental problems encountered in Nigeria and other developing and developed countries of the world. This is evident in our day-to-day life as noise is generated in almost all aspects of human activities. Noise pollution is an unpleasant sound that is created by people or machines that can cause infuriation, distraction and physical pain on humans. Noise pollution can be generated from outdoor sources, such as road traffics, jet planes, garbage trucks, construction equipment, manufacturing processes, lawn mowers, leaf blowers; and from indoor sources, including boom boxes, heating and air conditioning units, and metal chairs scraping on doors (Akintunde et al., 2022). Adekunle et al. (2021) noted that noise pollution in our environments has been discovered by researchers in recent times to contribute adversely to health conditions, social challenges and occupational efficiencies of its victims. Jariwala, et al. (2017) stated that "environmentally, noise pollution is a form of air pollution, and it is a threat to health and well-being". Noise pollution has become more severe and widespread than ever before and will continue to increase in magnitude and severity because of population growth and urbanization (Oyedepo et al., 2018), as well as the associated growth and increase in factories, machines, industries, highway, rail, and air traffic, which remain major sources of environmental noise. Noise has been closely related to technological advancement

and industrial growth (Reddy, 2020; Ijabor et al., 2024). Being a product of urbanization and industrialization, it has been recognized as an emerged environmental nuisance with an underestimated threat that can cause a number of short and long-term health problems, such as sleep disturbance, cardiovascular effects, poorer work, poor school performance, hearing impairment, among others (WHO, 2012; Yohanna et al., 2020). According to Liu et al. (2020), "speech interference, reduction in productivity, high blood pressure, hearing defects, health disorders, sleep interference, cardiovascular effects, loss of concentration, absenteeism, and fatigue are some of the health implications of high levels of noise". Additionally, noise has also been described as a slow and subtle killer through its hazardous effects on humans (Chaudhary and Chaudhary, 2020). Noise pollution can also come from sounds that aren't necessarily overly loud, but which are particularly annoying or troublesome in nature (Matthews, 2018).

Markets serve as assemblies where buyers and sellers convene to engage in commercial, economic, and social transactions, contributing to the formation and sustenance of communities. Their collective activities generate noise pollution as they gather. Urban Markets, which are commonly open-air and rowdy, attract large number of people and are characterized by all forms of activities that generate a lot of noise ranging from power generators, loudspeakers, grinding machines, blade filing engines, vehicles, religious activities, buying and selling of commodities and so on. All these pollute the environment and in turn affect the auditory performance of people, thereby leading to hearing impairment when exposed to it over a long period of time. The intensity of the noise in marketplaces has increasingly become an environmental public health issue (Osisanya et al., 2023) because of its direct effects on human performance and the reduction in the quality of health of the people exposed to it. Persistent exposure to high noise level, as is the case in most urban markets is injurious to health (Mucci et al., 2020; Tunde and Abdulquadri, 2021; Ijabor et al., 2024). A lot of people have hearing loss as a result of prolonged exposure to high noise that goes beyond tolerable levels (Priya and Hohman, 2023; WHO, 2024). Gwagwalada market is an urban physical market, which despite its upgrade by the Federal Capital Territory (FCT) administration, still maintains its traditional periodic market days. The market forms the heart of the town's shopping scene, and it is known for its vibrant atmosphere and diverse array of goods from fresh farm produce and local crafts to clothing and household items, as well as services, especially among the local population, in exchange for money from buyers. It's a bustling hub where both residents and visitors can immerse themselves in the local culture and shop for a wide range of products. The traditional periodic market days has intervals of four days and are usually more populated than the non-traditional market days. The different activities in the market generate different kinds of noise and the exposure to this noise may pose health risks to both the buyers and sellers. It is against this background that this research sets out to assess the spatiotemporal noise level in selected parts of the market with the view to examine its possible health effects on the human health.

2.0 Materials and Method

2.1 The study Area

Gwagwalada, being part of the Federal Capital Territory (FCT) is located between latitudes 8°50'N and 9°00'N and between longitudes 6° 50'E and 7° 09'E, with an altitude of about 400 - 600m above sea level (Figure 1). Gwagwalada is characterized by two main seasons namely, wet season from April to October and dry season from November to March (Makwe and Ahmad, 2017). The temperature varies between 30°C to 37°C or higher during the dry season. During the rainy season, the afternoon relative humidity gives the area a "heat trap" effects which make it uncomfortably hot (Adakayi, 2000). The annual rainfall ranges from 1403 to 1632mm (Makwe et al., 2020). The study was conducted in and around Gwagwalada urban market. Goods sold in the market include local farm produce such as yam, millet, groundnut, etc. as well as crafts, foods and other services that encourages exchange for money. Buyers and sellers come from Gwagwalada, the neighboring towns and as well as from other parts of the F.C.T. On non-traditional market days day to day buying and selling of goods takes place but with less population than the traditional market days.

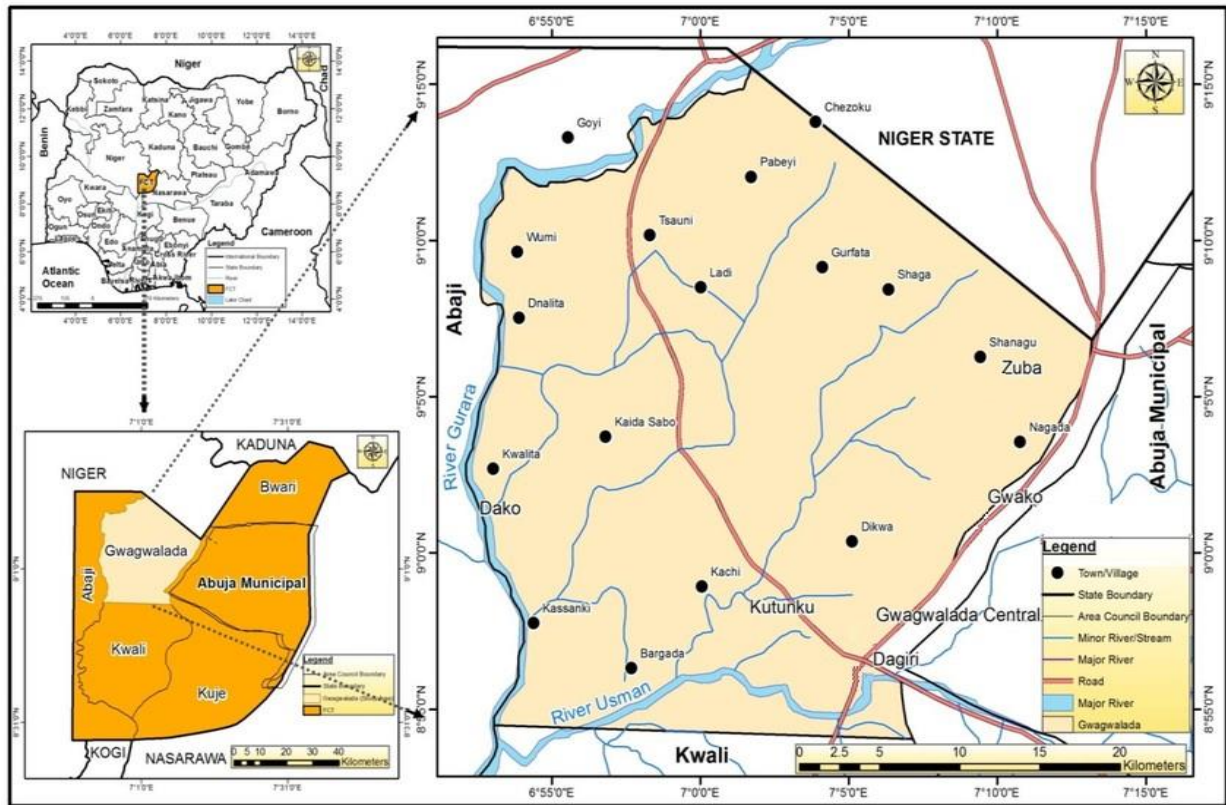


Figure 1: Map of Nigeria showing the Federal Capital Territory and Gwagwalada Area Council

2.2 Sampling

An initial reconnaissance survey was carried out for two days in and around Gwagwalada market, during which the sampling locations were randomly selected. Monitoring was carried out at the pre-determined locations within and around the market using Smart Sensor (Model AR854) sound level meter which gave instant, real time readings. The instruments were calibrated and set on fast response before taking measurements at each of the ten (10) selected sampling locations (Table 1), whose coordinates were also determined using a handheld GPS. The measurements were taken at 3 to 10m above the ground and away from walls in accordance with ISO 9614-3 (2002) sound measurement procedure. Each measurement per sample point is done three times and the average is taken (Ugbebor et al., 2017). The noise levels were measured in the Morning (6-8am), Afternoon (1-3pm) and Evening (5-7pm) over a period of 5days (ie two traditional and three non-traditional market days) in the month of March, 2024. This was so as to determine the temporal and spatial variations in noise levels as well as to compare the noise level between the traditional and non-traditional market days for effective assessment of the noise level in and around Gwagwalada market.

Table 1: Sampling points description

Location	Code	Coordinates		
		latitudes	Longitudes	Elevation
1	PCC	8°56'20.5"	7°04'46.6"	197m
2	PLS	8°56'20.1"	7°04'44.2"	196m
3	HDS	8°56'20.7"	7°04'39.9"	191m
4	BLC 39	8°56'21.4"	7°04'38.1"	202m
5	FDS	8°56'24.1"	7°04'38.6"	202m
6	AIS	8°56'24.1"	7°04'41.5"	197m
7	MT	8°56'24.1"	7°04'45.9"	199m
8	W/H	8°56'28.4"	7°04'42.9"	203m
9	TAC	8°56'22.1"	7°04'46.0"	196m
10	WDC	8°56'19.3"	7°04'46.6"	203m

Note: PCC-Phone Charging Centre, PLS- Plastic Store, HDS- Hairdressing Saloon, BLC 39- Block 39, FDS- Food store Stand, AIS-Alhaji Idris Store, MT- Meat Stand, W/H-Warehouse, TAC- The Apostolic Church, WDC- Women Development Centre

The data obtained from the measurement of noise levels were analyzed by evaluating the temporal variation of Noise level at different times (6 - 8am, 1 - 3pm and 5 - 7pm) of the day in Gwagwalada market and comparing them to the World Health Organization Guideline values for community noise in commercial shopping areas (WHO, 1999, 2005) and also with the National Environmental Standards and Regulations Enforcement Agency noise standards and control regulations (NESREA, 2009). Further analyses were done by assessing the variations in the results obtained at different times at the different sampling locations, using the analysis of variance (ANOVA) statistical tool. In addition, analysis of variation in noise level between traditional market days and non-traditional market days was also carried out using the Student T-test statistical tool. All these analyses were carried out using the Statistical Package for Social Sciences (SPSS) Version 23.

3. Results and Discussion

3.1 Temporal Variation in Noise Levels

From the data obtained, the highest level of noise was generated within Gwagwalada market in the evening hours (5-7pm), with the noise levels varying from 61.4dB to 98.6dB. Sampling points PCC, PLS, AIS and MT had the highest average noise levels of 98.6dB, 72.2dB and 96.4dB and 74.2dB respectively (Figure 2). These were higher than the WHO (2005) LAeq limit while the noise level for points PCC and AIS were higher than the NESREA (2009) LAeq limit of 75dB for daily noise exposure in commercial areas. The high noise level in the evenings are most likely due to the high influx of people into the market at the close of work, traders advertising their goods with the use of loudspeaker and at the top of their voice, as well as vehicular movements around the market premises as traders are moving their goods signifying end of sales for the day. On the other hand, the lowest noise levels were measured in the morning hours (6-8am), with noise level values ranging from 54.5dB to 61.5dB (Figure 2). This was when the market gate was just opened to people for their daily businesses and the population of people in the market was still low. The measured morning noise levels were within the NESREA (2009) and WHO (2005) LAeq limit of 70dB. The analysis of the temporal variation in noise level (ANOVA) within the Market at $F(2) = 13.982$, $P \leq 0.05$ clearly indicates that there is high significant variation in the noise level at different sampling times (6 – 8am, 1 – 3pm and 5 – 7pm) in Gwagwalada market. This result corroborates the works of Datti and Nduka (2020) as well as Tunde and Abdulquadri (2021) in their assessment of noise pollution in commercial areas of Delta and Kwara States, Nigeria respectively.

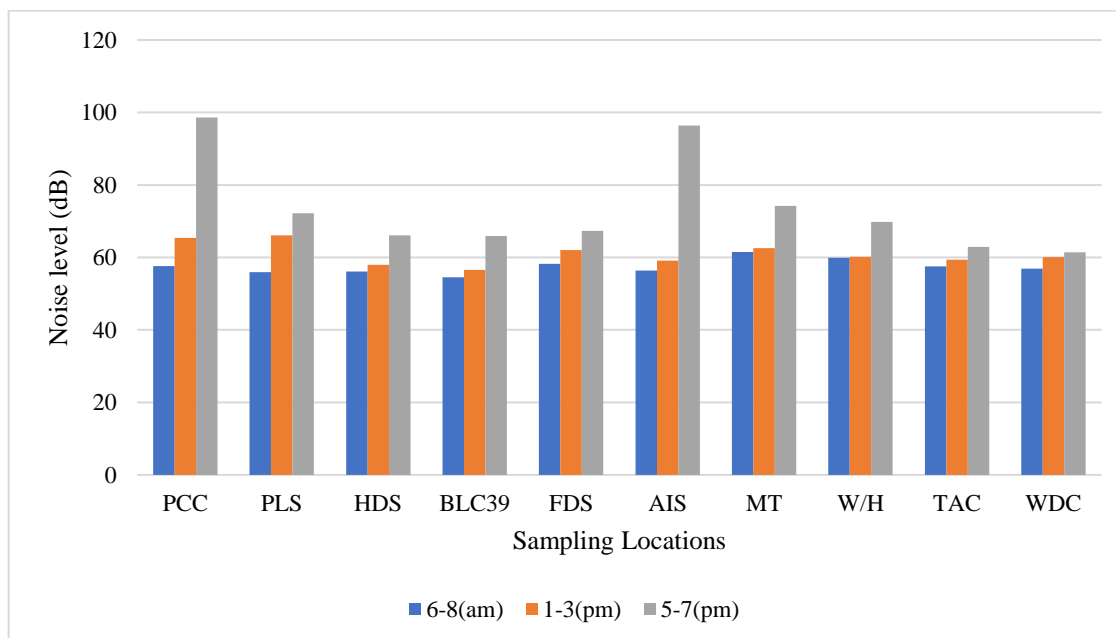


Figure 2: Average Temporal Noise Level at sampling Locations

Note: PCC-Phone Charging Centre, PLS- Plastic Store, HDS- Hairdressing Saloon, BLC 39- Block 39, FDS- Food store Stand, AIS-Alhaji Idris Store, MT- Meat Stand, W/H-Warehouse, TAC- The Apostolic Church, WDC- Women Development Centre

3.2 Spatial Variation in Noise Level

Noise level varies from place to place within and around Gwagwalada market. The mean noise level at the selected sampling points showed points PCC and AIS having the highest mean noise level of 84.64dB and 81.38dB respectively. These were higher than the NESREA (2009) and WHO (2005) standards of 75dB and

70dB respectively for noise level in a commercial area. The high noise level at these locations can be attributed to the sounds from power generating sets, clusters of buyers and sellers as well as the use of sound amplifiers for product marketing and advertisement. High noise level poses significant health risk to people when exposed to them for a long period of time. The remaining eight sampling locations have mean noise levels that ranged from 59.24dB to 69.46dB, which are within the acceptable standards for commercial areas. The analysis of variation (ANOVA) in noise level in the selected sampling locations within and around Gwagwalada market at $F(9) = 6.029$, $P \leq 0.05$ showed that there is a significant spatial variation in the noise level at the selected sampling points (Table 2). This result conforms the study by Anejionu *et al.* (2022) in their assessment of noise pollution impacts in Enugu, Nigeria.

Table 2: Analysis of spatial variation in noise level in selected sampling points

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	3465.009	9	385.001	6.029	.000
Within Groups	2554.468	40	63.862		
Total	6019.477	49			

Df = degree of freedom

3.3 Variation in Average Daily Noise Level

Noise levels measured on Day 1 in comparison with the NESREA (2009) and WHO (2005) LAeq limit showed that the minimum noise levels were all within the recommended standard limit. However, the maximum noise levels at points PCC (95.1dB), AIS (70.2dB), MT (77.2dB) and W/H (70.4dB) were higher than the WHO permissible limits of 70dB (Table 3), while only those of points PCC and MT exceeded the NESREA (2009) standard limit of 75dB. These sampling points were characterised by loud noise from power generating sets and from the clusters of people buying and selling at the general goods shops, meat stands and warehouses.

Table 3: Average daily minimum and maximum noise level at sampling points

Location	Day1		Day2		Day3		Day4		Day5	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
PCC	66.5	95.1	49.5	62.2	47.5	89.2	51.7	86.0	67.6	90.7
PLS	55.9	63.1	52.3	59.2	56.3	79.6	51.9	66.4	63.5	76.1
HDS	54.4	59.6	48.8	50.1	50.3	63.2	48.9	59.3	54.4	64.1
BLC39	53.1	68.6	50.8	52.3	51.7	52.9	51.8	62.1	52.6	60.3
FDS	53.7	61.6	59.3	62.9	51.9	65.6	59.6	66.9	58.6	64.6
AIS	57.5	70.2	59.4	59.7	57.6	90.8	54.9	91.1	57.5	95.1
MT	58.9	77.2	64.1	64.7	63.2	69.4	63.7	70.6	59.9	65.4
W/H	61.3	70.4	52.6	63.5	52.5	57.2	52.6	69.5	59.3	70.9
TAC	52.1	60.6	53.1	58.7	58.2	63.9	52.3	65.5	60.4	63.2
WDC	57.8	63.9	59.7	61.3	56.4	59.1	58.6	61.9	56.8	64.9

Note: PCC-Phone Charging Centre, PLS- Plastic Store, HDS- Hairdressing Saloon, BLC 39- Block 39, FDS- Food store Stand, AIS-Alhaji Idris Store, MT- Meat Stand, W/H-Warehouse, TAC- The Apostolic Church, WDC- Women Development Centre

Noise level measured on Day 2 showed that the minimum and maximum noise levels were within the NESREA and WHO permissible limits (Table 3). Coincidentally, Day 2 was the day after the Traditional market day and was characterised by low turnout as many people had purchased what they needed the previous day.

Day 3 noise level measurements showed high maximum values at points PCC (89.2dB), PLS (79.6dB) and AIS (90.8dB), which were higher than the NESREA and WHO permissible limits of 75dB and 70dB respectively. The minimum noise level values for Day 3 were within the recommended standard limits. The results of Day 4 noise levels measurement in comparison with the NESREA and WHO standard showed that the minimum

values at all the sampling locations were within the permissible limits of 75dB and 70dB. The maximum noise levels for the same day however shows elevated values at PCC (86.0dB), AIS (91.1dB) and MT (70.6dB) sampling locations. These values are higher than the WHO permissible limit of 70dB.

The minimum noise level measurements for Day 5 were similar to those of the previous four days, with values that are within the 70dB (WHO, 2005) and 75dB (NESREA, 2009) permissible limit. The maximum values were however elevated at sampling points PCC (90.7dB), PLS (76.1 dB), AIS (95.1dB) and W/H (70.9dB) and higher than the regulatory standard. The evaluation of noise levels in markets located in Rivers and Delta States by Ugbebor *et al.* (2017) and Ijabor *et al.* (2024) respectively further corroborates this result. Generally, the elevated maximum noise level at points PCC, PLS, AIS, MT and W/H were as a result of the power generating sets, the sounds from cutting and butchering, as well as the large cluster of people who are buying and selling at these locations. The elevated noise level in these locations poses significant health risk to traders and buyers exposed to them for a long period of time. High noise level is capable of causing psychiatric disorder (Ijabor *et al.*, 2024). These elevated noise levels can potentially trigger symptoms such as headaches, nausea, as well as other psychological symptoms such as argumentativeness, changes in mood and anxiety as noted by Hahad *et al.* (2019). According to a review, there is evidence that short-term exposure to noise pollution can temporarily raise blood pressure and increase blood viscosity. There is also an association between long-term exposure to noise and higher rates of cardiovascular disease (Jariwala *et al.*, 2017).

3.4 Variation in Noise Levels between Traditional and Non-Traditional Market Days

Table 4 shows the average noise level generated between traditional and non-traditional market days in Gwagwalada urban market. It is clearly seen that the average noise generated on traditional market days were higher in most of the sampling points than the noise generated on non-traditional market days. This is because on traditional market days people from all parts of Gwagwalada, the neighboring towns and states come to the market to buy and make sales thereby, resulting in increased population, as well as increased activities such as the use of grinding machine. The use of electricity generating set in area close to PCC increases the amount of noise generated in this area within the market especially on traditional market days. The use of loudspeakers and other sound amplifiers as well as the sounds from cutting and butchering in areas close to AIS and MT also account for the high level of noise in these parts of the market. On a general note, places around PCC and AIS experience higher noise level than other areas on traditional market days. The non-traditional market days on the other hand are characterized by lower population, which results to lesser activities and hence lesser noise level compared to the traditional market days.

Table 4: Average noise level on traditional and non-traditional market days

Location	Non-Traditional Market Days	Traditional Market Days
PCC	79.1	92.9
PLS	68.2	69.6
HDS	57.5	61.9
BLC39	55.8	64.5
FDS	65.1	63.1
AIS	80.5	82.7
MT`	68.2	71.3
W/H	63.4	70.7
TAC	62.7	61.9
WDC	60.8	64.4

Note: PCC-Phone Charging Centre, PLS- Plastic Store, HDS- Hairdressing Saloon, BLC 39- Block 39, FDS- Food store Stand, AIS-Alhaji Idris Store, MT- Meat Stand, W/H-Warehouse, TAC- The Apostolic Church, WDC- Women Development Centre

In the analysis of noise level between traditional and non-traditional market days, the paired t-test result shows that there is a statistically significant difference between the noise level generated on traditional market days ($70.28 \pm 10.15\text{dB}$) and that of the non-traditional market days ($66.16 \pm 8.28\text{dB}$), $t(9)=2.766$, $P \leq 0.05$. The implication of this result is that it further stresses the fact that there is higher noise level generated on traditional market days compared to the non-traditional market days.

4. Conclusion

The study assessed the spatiotemporal level of noise pollution in and around Gwagwalada urban market and the likely effects on human health. The measurement of noise level was carried out at ten (10) randomly selected points within and around the market at different times of the day (6 - 8am, 1 - 3pm and 5 - 7pm) for Corresponding author's email address: edith.makwe@uniabuja.edu.ng

a period of five (5) days (i.e. two traditional market days and three non-traditional market days). The data obtained showed that noise levels were highest at the selected points in the evening hours (5-7pm) and lowest in the morning hours (6-8am) for most of the sampled locations. The analysis of variance (ANOVA) in the noise level at the different times showed that there is a significant variation at $F(2) = 13.982$, $P \leq 0.05$. Spatially, points PCC and AIS had the highest mean noise level of 84.64dB and 81.38dB respectively, with their noise level being higher than the NESREA and WHO permissible limits for noise level in commercial areas. The analysis of variation (ANOVA) in the spatial noise level in the selected locations showed significant spatial variation with $F(9) = 6.029$, $P \leq 0.05$. Furthermore, the paired t-test in the analysis of noise level between traditional and non-traditional market days shows a statistically significant difference between the noise level generated on traditional market days (70.28 ± 10.15 dB) and that of the non-traditional market days (66.16 ± 8.28 dB), $t(9)=2.766$, $P \leq 0.05$. The study attributed the high noise level to sounds from power generating sets, clusters of buyers and sellers as well as the use of sound amplifiers for product marketing. Noise pollution poses significant health risk to traders, buyers as well as anyone exposed to it over time, it can cause health issues such as headaches, nausea, and other psychological and cardiovascular issues such as argumentativeness, changes in mood, anxiety, raised blood pressure and increase blood viscosity. There is need to monitor and control noise level in Gwagwalada urban market and its environs due to the health risks associated with prolonged exposure to noise. This requires the combined efforts of the government, professionals and citizens. There is also the need to educate the general public about the dangers of long-term exposure to high noise level and also have periodic assessment of the health status of the traders who are daily exposed to high noise levels in Gwagwalada market.

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