# Health Hazard of Traffic Noise: Perceptions of Dwellers on Tanke – University Road, Ilorin, Nigeria.

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## ABSTRACT

The corresponding qualitative wellness (health) by the residents and roadside businesses around a motorized urban arterial was reported. The traffic sound level manifesting on the nodes and links was quantified by the equivalent noise level ($L_{eq}$) of 73.5 dB (A), a value that is higher than the WHO (World Health Organization) allowable threshold for the comfort and wellness of residential communities was obtained. The perception of the dwellers around the studied arterial about the prevailing traffic induced noise pollution agreed with the common health stress indicators of headache, insomnia and annoyance, among others. It is recommended that the Nigerian noise level bench mark of 90 dB (A) be reviewed to a lower value in order to reflect the global best practices on noise pollution control and wellness of human dwellers around a motorised corridor.

(Keywords: noise pollution, sound related health hazard, traffic noise index, traffic equivalent)

## INTRODUCTION

Noise is basically defined as sound in excess of an acceptable level. Generally in cities, noise is considered to be the third most hazardous type of pollution, right after air and water (World Health Organization (WHO), 2004). Noise is also considered as unwanted interferences with communication, work, rest, recreation, or sleep, which can result in health hazards with symptoms of hypertension, headache, indigestion, peptic ulcers, etc. (OECD 1995).

Khadka and Shrestha (2011) identified that the effect of industrialization and urbanization coupled with the high population growth rate has induced many environmental problems in South Asian Sub-continent. Therefore, Environmental Impact Assessment (EIA) has been adopted to address the environmental problem in the region, Begum et al., 2011. There are different sources of pollution which, could be fumes from industrial activities, traffic noise from human and vehicular activities (Arunachalam et al., 2009).

Other hazardous effects of noise (particularly traffic induced noise) include mental stress, annoyance and or hearing loss/impairment, cardiovascular problems, and under-performance in task works (Zannin et al., 2001). Traffic noise is produced from tire-road contact, engines running at high speeds, blaring of horns, and shifting of gears of vehicles that are in poor condition or not properly maintained. This fact makes the noise caused by traffic to gain an increasing importance and relevance due to the ever expanding growth in the number of circulating private and public cars and trucks in urban areas as direct consequences of increase in population and volume of roadside businesses. Increase in noise pollution would therefore exacerbate eventually.

In Nigeria and until recently, noise pollution has not been considered as hazards to health as other contaminants in the environment (Abam and Unachulwu, 2009; Saadu et al., 1998). However, the awareness of noise pollution as either health, social and or economic hazard might have encouraged the setting up of the Nigerian Federal Environmental and Protection Agency (FEPA) and the National Environmental Standards and Regulations Enforcement Agency (NESREA); the agencies saddled with the responsibility of controlling the environmental and noise pollution in Nigeria.

Other parts of the world have for long, set up legislations on the regulation of noise pollution of

all sources. For instance in the USA, noise was recognized as pollutant in the 1960s and the country's legislation was modified as National Environmental Policy Act of 1969 to the Noise Control Act of 1972. Also the UK Construction and Use Regulations of 1986 and the Road Traffic Act of 1972 forced car owners to fix an efficient exhaust silencer to ensure that the car should be without excessive noise while running the engine and even when stationary too. The Act includes strict regulation of blaring motor horns between hours considered to be rest hours.

In a study on traffic generated noise pollution in selected cities in Nanjing, Noble, (1980) observed that the noisiest areas were always along major roads with 51-55 dB (A), while in the urban Kuwaiti cities, the level of traffic noise was high enough to adversely affect the welfare, activities and productivities of its residents; (Al-Mutairi et al., 2008). Mirhossaini, et al. discovered that the noise level was 14db higher than the environmental standards in Khoramabad, a city in Iran, due to street traffic and peculiar geo-morphological structures of the town. Noise level in Al-Dammam, a Saudi Arabia city, is 90.6 dB(A). Al-Ghonamy, 2010 measured sound level which significantly exceeds permissible limits. He further recommended that Town Planning should create new highways and overpasses to reduce the noise produced and its attendant effects on the populace. Also in downtown area of Kerman, South East Iran, Mohammadi, (2009) recorded a high noise equivalent level of between 66-79 dB (A) while those for Nepal, (Krishna et al., 2007) for instance were up to 110.2 dB (A). In Nigeria, the works of Abam and Unachukwu (2009) revealed the growing risk of traffic related noise whose level was measured to range from 58.5-72.4 and 70-75 dB (A), respectively, in Calabar and Lagos. Industrial activities carried out in developing countries, coupled with the weak legislation and regulation of infrastructure led to environmental pollution and health quality of the inhabitants, Eneh, 2011. Therefore, update of edits and laws to conform with the present environmental realities with people participartion as observed by Eneh and Agbazue 2011 is required.

In this paper, the traffic induced noise level was measured and its effects on the life of the inhabitants subjectively assessed. The import of the study was that an effective identification of health hazards of traffic induced noise pollution, as perceived by the dwellers themselves, shall assure the desired improvement of the health and wellness of the urban dwellers around the road based on an interactive communication. The noise from the motorized traffic is the third most hazardous type of pollution in an urban area and its control shall be a significant reduction in the intensity of the noise pollution in the fast growing vehicle population.

The study area, the Tanke - University route, is an urban arterial situated in the Ilorin South Local Government Area of Kwara State, Nigeria. It is the urban arterial that connects the fast growing township to the university community and is characterized by several commercial, residential and noise sensitive areas. These include the health institutions and clinics, schools, roadside neighbourhood and markets.

## MATERIALS AND METHODS

### Sound Level Measurement

The A-weighted sound level meter (GA 202 Sound Level Meter Type 2, Model IEC 651 BS5969 ANSI, S1-4 manufactured by Castle Associates Limited, England) was used to obtain the noise levels during the morning and afternoon peak hours along the road at the intersections and along the arterials, the links; and in accordance with FHWA procedure. The sound level meter consists of a microphone, amplifiers and a voltage meter. The microphone converts the pattern of sound pressure fluctuations into the voltage meter which is calibrated to the read out in decibel, in accordance with Equation 1. Noise level depends on the perception of the hearer about its intensity or loudness while its measurement depends on the magnitude of the pressure fluctuations.

$$SL = 20Log_{10}\left(P/P_0\right) \qquad \textbf{(1)}$$

Where, SL -sound pressure level,
P -root mean square of sound pressure, $N/m^2$
$P_0$ -standard reference sound pressure, $N/m^2$

The intensity of generated traffic noise at four selected positions on the arterial, (2 nodes and 2 links) was taken at morning (between 07:00 and 10:00) and afternoon (between 14.00 and 17.00)

rush hours, the Nigerian time; while respectively the prevailing level of traffic was noted for four consecutive weekdays in 2010. The locations were GRA, Ostrich, Tipper garage and University gate junctions of the arterial. Noise levels were measured at the road divide (median); the most convenient and safe position and nearest to the source of noise from the traversing traffic (vehicles). Several measurements were made and the average sound levels were recorded from where the various and statistical noise parameters were determined.

## The Noise Level and Computation of Statistical Parameters

The traffic noise measured show a substantial level of variation and to properly capture the variability, the energy equivalent continuous noise level, Leq expressed in dB (A) was used. This is the average rate at which energy is received by the human ear which is an indicator of the physiological disturbance to the hearing mechanism. This is expressed mathematically by Equation 2.

$$L_{eq} = 10\log_{10}\left[\frac{1}{N}\sum_{i} 10^{(L_i/10)}\right] \quad \textbf{(2)}$$

where, $L_i$, average noise level at interval *i*.

Other parameters include the noise pollution level, $L_{np}$ which is the measure of varying level of noise taken into account the variations in sound signal; the traffic noise index (TNI), a parameter that indicates the degree of variation in traffic flow and traffic noise climate (NC), which is the range over which the sound levels fluctuate in an interval of time; each of which was respectively expressed by Equations 3, 4 and 5 (Alam et al,. 2006).

$$L_{np} = L_{50} + \frac{(L_{10} - L_{90})^2}{60} + (L_{10} - L_{90}) \quad \textbf{(3)}$$

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

$$NC = (L_{10} - L_{90})\ dB(A) \quad \textbf{(5)}$$

Where, $L_{10}$, $L_{50}$, $L_{90}$ - levels exceeded for 10%, 50% and 90% of time, respectively.

Table 1, 2, 3, and 4 present the respective traffic noise data set determined for the various parameters at the two traffic rush hours on the arterial nodes and links.

**Table 1:** Mean Values of Noise Parameters at the University Gate (dB(A)).

| | Morning | | | Afternoon | | |
|---|---|---|---|---|---|---|
| | **7:00-8:00** | **8:00-9:00** | **9:00-10:00** | **14:00-15:00** | **15:00-16:00** | **16:00-17:00** |
| **$L_{eq}$** | 76.6 | 74.2 | 71.2 | 69.5 | 71.6 | 74.1 |
| **$L_{max}$** | 85.0 | 85.0 | 79.0 | 79.0 | 79.7 | 83.3 |
| **$L_{min}$** | 61.7 | 56.3 | 59.0 | 50.7 | 58.3 | 57.0 |
| **TNI** | 94.2 | 94.8 | 84.2 | 100.7 | 82.6 | 81.1 |
| **$L_{90}$** | 65.3 | 61.6 | 61.6 | 54.3 | 63.0 | 66.1 |
| **$L_{50}$** | 72.8 | 70.3 | 68.3 | 63.0 | 68.7 | 71.5 |
| **$L_{10}$** | 80.0 | 77.4 | 74.7 | 73.4 | 75.4 | 77.4 |

**Table 2:** Mean Values of Noise Parameters at the Tipper Garage Intersection (dB(A)),

| | Morning | | | Afternoon | | |
|---|---|---|---|---|---|---|
| | **7:00-8:00** | **8:00-9:00** | **9:00-10:00** | **14:00-15:00** | **15:00-16:00** | **16:00-17:00** |
| $L_{eq}$ | 76.6 | 77.6 | 72.2 | 69.6 | 72.7 | 77.4 |
| $L_{max}$ | 85.7 | 84.7 | 78.0 | 76.7 | 81.0 | 86.3 |
| $L_{min}$ | 68.3 | 69.7 | 66.7 | 63.3 | 64.0 | 66.0 |
| **TNI** | 74.1 | 79.8 | 62.9 | 64.0 | 70.6 | 78.7 |
| $L_{90}$ | 70.3 | 71.0 | 68.6 | 65.6 | 67.0 | 71.0 |
| $L_{50}$ | 73.8 | 74.7 | 71.7 | 68.8 | 70.5 | 75.0 |
| $L_{10}$ | 76.8 | 80.7 | 74.7 | 72.7 | 75.4 | 80.4 |

**Table 3:** Mean Values of Noise Parameters at the Megastation Intersection (dB(A)).

| | Morning | | | Afternoon | | |
|---|---|---|---|---|---|---|
| | **7:00-8:00** | **8:00-9:00** | **9:00-10:00** | **14:00-15:00** | **15:00-16:00** | **16:00-17:00** |
| $L_{eq}$ | 76.2 | 75.1 | 73.6 | 70.2 | 71.3 | 76.0 |
| $L_{max}$ | 82.7 | 81.0 | 79.3 | 77.3 | 79.3 | 81.7 |
| $L_{min}$ | 65.0 | 65.3 | 61.3 | 58.0 | 59.0 | 63.0 |
| **TNI** | 86.1 | 80.3 | 83.6 | 75.3 | 80.7 | 83.9 |
| $L_{90}$ | 68.0 | 67.7 | 65.3 | 62.3 | 62.3 | 68.3 |
| $L_{50}$ | 74.2 | 73.8 | 71.5 | 68.5 | 68.8 | 75.0 |
| $L_{10}$ | 80.0 | 78.3 | 77.4 | 73.0 | 74.4 | 79.7 |

**Table 4:** Mean Values of Noise Parameters at the GRA Intersection (dB(A))

| | Morning | | | Afternoon | | |
|---|---|---|---|---|---|---|
| | **7:00-8:00** | **8:00-9:00** | **9:00-10:00** | **14:00-15:00** | **15:00-16:00** | **16:00-17:00** |
| $L_{eq}$ | 74.8 | 73.7 | 71.1 | 71.2 | 72.0 | 74.6 |
| $L_{max}$ | 84.3 | 82.0 | 79.0 | 80.3 | 80.3 | 84.0 |
| $L_{min}$ | 60.3 | 65.7 | 62.0 | 63.0 | 64.3 | 62.0 |
| **TNI** | 87.4 | 71.9 | 74.7 | 76.1 | 70.0 | 79.7 |
| $L_{90}$ | 65.0 | 68.3 | 64.3 | 64.7 | 66.3 | 66.6 |
| $L_{50}$ | 70.8 | 71.3 | 68.3 | 69.2 | 69.7 | 71.0 |
| $L_{10}$ | 78.1 | 76.7 | 74.4 | 75.0 | 74.7 | 77.4 |

## The Noise Perception Study

The perception study of the effects of the traffic noise pollution on the dwellers within the vicinity of the road was carried out with a structured questionnaire distributed to 1000 sampled individuals around the arterial comprising of males and females. The questions in the questionnaire were in respect of respondents' personal attributes, the accommodation characteristics and proximity (nearness) to the road, the perception level, indices and the corresponding vectors (indicators) of health hazard and wellness. The effect of the time of the day or night on the noise pollution was also enquired.

## RESULTS AND DISCUSSION

## The Traffic Induced Noise Level

The traffic flow per hour observed during the study was moderate to high (1400 – 2950 passenger car units (pcu)) with a small proportion of heavy goods vehicles. The percentage of heavy duty vehicles ranges from 3.85% for buses and 0.66% for trucks in the arterial. Most of the

sides of the arterial are lined with commercial establishments which make pedestrians sprawl on the road with the attendant traffic congestion and significant high traffic noise. Another major contributory factor to the high noise level was the commuting taxis and buses whose drivers frequently and always keep horning to alert the crossing pedestrians and or attract would be passengers/commuters, the road side traders and other vehicles on the road. During the peak hours, the vehicular movements increase, thereby leading to high level of traffic noise, because higher traffic volumes contribute to higher noise pollution (Jimoh et al., 2011).

The noise sound level prevailing at the nodes and links of the University Gate – Tanke Road, Ilorin arterial was determined and it varied from 76.67 to 86.33 dB(A) with the highest obtained value manifesting at the Tipper Garage. Also the computed statistical traffic noise parameters of Leq, Lmax, $L_{10}$, $L_{50}$, $L_{90}$ and TNI for the Tanke road indicate extremely high values and variation on the different portions (nodes and links) of the arterial.

The computed average values of the $L_{eq}$ obtained range from 70.20 to 77.58 dB(A) at the intersections and 69.48 to 76.59 dB(A) at the sections (links) and the overall average $L_{eq}$ obtained for the entire arterial is 73.5 dB(A). The noise equivalent level, Leq, varied from between 69.5 to 77.6 dB(A). The minimum and maximum Leq of 69.4 and 77.6 dB (A) both exceed the approved WHO recommended standard of 55 - 65 dB(A) to be enforced for the comfort and wellness of the residential and or commercial dwellers, (WHO 2004, OECD, Zanin et al., 2001). This high level of noise pollution as recorded along the arterial is an indication that noise related illness must have accounted for the frequent complaint of illness.

## Perceptions of Dwellers on the Traffic Noise Level

Close to sixty percent (57.5%) of the respondents dwelling around the traffic corridor were engaged in roadside commercial activities (business) and majority's opinion (92%) is that the source of the noise is traffic. Sixty-six percent (66%) were very conscious of the prevailing effect of noise (Leq) at high level of 73.5 dB (A) recorded. Indeed most of the respondents (89 %) felt that the effect of noise at that level within a distance of 0 – 20 m proximity of the road arterial was significantly high while at distance 20–50 m, only 11% felt the same. There was no effect of the noise beyond the 50 m shield as observed in the study. It may therefore be necessary to develop a green belt at 20 m from the road median in order to bring down the effect of the prevailing noise levels to tolerable limits for people dwelling along Tanke Road Ilorin, Nigeria.

The corresponding safe distance for traffic pollution off the center line of the road for a traffic of 2950 pcu at the peak hour at an operating urban mean space speed of 90 km/hr (60 mph) design speed in Nigeria and sound level of 69.48 - 76.59 dB (A) at a typical intersection on the arterial, was estimated with Golmohammadi et al., (2007) model using Equation 6 and was found to be 18 m (53 feet). This estimated distance agrees reasonably with the tolerable limits of 20 m identified by the urban road side dwellers in this study when the effect of the traffic noise begins to be felt.

$$L = 10\,Log\,q - 10\,Log\,d + 20\,Log\,u + 20 \quad \textbf{(6)}$$

Where, L -noise sound level (dB (A)),
q -traffic volume (pcu)/hr),
u -space mean speed observed (km/ph),
d -distance from source of noise (m),
pcu -passenger car unit.

A little less than half (45%) were moderately annoyed, a third (31.5%) slightly, and 15% were really obsessed. The respondents felt that the traffic noise prevailing can lead to the health problems of insomnia (33%), hearing loss (35.5%), loss of concentration (41%) and headache (22%). The majority of the people (75.5%) must shout while making calls in order to get their messages across. The result further implied that over 70% (slightly - extreme) were annoyed by traffic at the morning (7 - 10 am) and afternoon hours (5 – 7 pm) corresponding to traffic rush hours. Another 68.5% of the respondents were of the strong opinion that the old vehicles are the major sources of the noise which should be banned from the streets.

Of all the respondents, 95% identified traffic noise as the major source of noise and distantly

followed by 58% of the respondents who identified other sources in the neighbourhood as the disturbing noise. About 66% of the respondents indicated that a high level of traffic noise is prevalent while 26% considered the noise as being normal. As observed, the average noise level in the study area is 77.6 dB (A) which is higher than the maximum recognized day time standard of 65 dB (A); laying credence to the fact that majority of the dwellers are able to perceive the level of traffic as being the major source of noise pollution in the city's urban roads at such a high sound level. This implies that majority of the urban dwellers can appreciate a traffic induced noise at 77.6 dB (A) as very disturbing and annoying. About 45% were moderately annoyed, only 12.5% perceived the sound at that level as very annoying while the remaining 31.5% of the respondents were indifferent to the noise. About 85% of the population identified the disturbance in the evening to be more significant, followed by the early morning period (from 7:00 am local time). This implies that the lower noise bench mark for daytime and night time should be different and enforced to manifest within the corridors of travel ways.

## Health Hazards of Traffic Noise and Suggestions on Abatement

Table 5 gave the distribution of the respondents' perception on the vectors of health hazards and suggestions on abatement actions. There were a lot of overlaps in the responses. The study reveals that traffic noise accounts for health nuisance in this urban commercial axis. Most inhabitants reported several effects of the noise pollution which are insomnia, bad temper, loss of concentration, shouting in conversation and when making calls including study disruption and headaches. In fact all the respondents identified the most common vectors of noise pollution to manifest in headache, bad temper, hearing problem and insomnia. Further, 75 % agreed that noise pollution make them shout excessively in conversation or when receiving or making telephone calls. This shows that higher level of sound exists around an urban arterial in Nigeria and which can adversely affect the health and wellbeing of the dwellers. Noise also leads to loss of concentration and in fact, majority of student respondents agreed that noise is a great disturbance to studies.

The findings of this study have shown that the level of traffic generated noise pollution in Tanke is high enough to adversely affect the activities of its residents and that vehicle have been identified as one of the major sources of noise pollution in an urban arterial. With the general increase in car ownership, it is almost certain that the problem of noise pollution in Tanke will soon assume a critical dimension and should therefore be a cause of increasing concern for both transportation managers and policy makers. Schools and health clinics, examples of noise sensitive zones, should be planned and located about 50 m away from the roadside where the noise intensity were perceived insignificant. Indeed the respondents have suggested strongly (67%) that old vehicles and horns by drivers be banned on the roads as abatement to the bad effect of traffic noise.

**Table 5:** Perception of Vectors of Health Hazard from Traffic Noise and Abatement.

| Vector | Popularity (%) | Abatement method | Popularity (%) |
|---|---|---|---|
| Insomnia | 33 | Ban horns | 67 |
| Headache | 18 | Ban old vehicles | 68.5 |
| Bad temper | 23.5 | Improve on traffic control | 15 |
| Hearing problem | 35.5 | Zoning of towns to sound levels | 18 |
| Loss of concentration | 41 | | |
| Disturbance to study | 34.5 | | |
| Must shout while making calls | 75.5 | | |

## CONCLUSIONS AND RECOMMENDATIONS

This paper considered the noise levels generated by traffic movement and the impact it has on the health and wellness as perceived by the dwellers (living and transacting businesses) around the vicinity of the road. The following conclusions and recommendations were deduced as the outcome of the study:

a. The noise level generated by traffic at Tanke Road, Ilorin Nigeria was 76.7–86.3 dB (average) and 73.5 dB (A) equivalent noise level ($L_{eq}$) which is above the global (World Health Organization (WHO)) acceptable level for residential areas.

b. The prevailing noise level on the studied arterial, falls below the Nigerian Federal Environmental Protection Agency (FEPA) limit of 90 dB (A).

c. Majority of the dwellers (95%) around the arterial identified that traffic is the highest source of noise pollution and only 58 % were able to perceive it to cause discomfort and other health hazard at that sound level of Leq of 73.5 dB (A) and only about a third (31%) did not feel so.

d. The large proportion of the dwellers (85%) was of the opinion that evening traffic noise pollution pose more health disturbance as against the morning traffic while the major health vectors of traffic noise pollution identified include loss of concentration, headaches, insomnia, bad temper, and general discomfort and un-wellness, in that order.

e. The prevention of the effect of the noise level on human health should be undertaken by Government to reduce auditory and non-auditory health impacts on the population with strict control and regulation of the source of the generation of the noise. The most popular abatement strategy is the installation of barriers between the noise source and the receiver for appropriate attenuation of noise levels.

f. The design of buildings should include the use of noise absorbing materials from walls/doors/windows/ceiling and also raise the level of awareness of the populace to the negative effect on health on the long exposure to traffic noise, and that the Nigeria FEPA noise limit of 90 dB(A) should be urgently reviewed to lower bench marks.


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