ASSESSMENT OF NOISE LEVEL AND ITS EFFECTS ON TEACHING AND LEARNING PROCESS IN PRIMARY AND SECONDARY SCHOOLS IN ZARIA METROPOLIS, NIGERIA

By

ADEYEMI AKEEM OWOJORI

DEPARTMENT OF BIOLOGY
FACULTY OF LIFE SCIENCES
AHMADU BELLO UNIVERSITY, ZARIA
NIGERIA.

APRIL, 2017

ASSESSMENT OF NOISE LEVEL AND ITS EFFECTS ON TEACHING AND LEARNING PROCESS IN PRIMARY AND SECONDARY SCHOOLS IN ZARIA METROPOLIS, NIGERIA

By

Adeyemi Akeem OWOJORI, B.Sc. (Ed.) BIOLOGY (EKSU) 2013
P14SCBS8029

A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER OF SCIENCE DEGREE IN EDUCATIONAL BIOLOGY.

DEPARTMENT OF BIOLOGY,
FACULTY OF LIFE SCIENCES
AHMADU BELLO UNIVERSITY, ZARIA
NIGERIA.

APRIL, 2017

DECLARATION

I declare that the work in this dissertation entitled **"Assessment of Noise Level and its Effects on Teaching and Learning Process in Primary and Secondary Schools in Zaria Metropolis, Nigeria"** has been carried out by me in the Department of **Biology, Ahmadu Bello University, Zaria**. The information derived from literature has been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diploma at this or any other institution.

OWOJORI ADYEMI AKEEM	______________________	____________
P14SCBS8029	**SIGNATURE**	**DATE**

CERTIFICATION

This dissertation entitled **"ASSESSMENT OF NOISE LEVEL AND ITS EFFECTS ON TEACHING AND LEARNING PROCESS IN PRIMARY AND SECONDARY SCHOOLS IN ZARIA METROPOLIS, NIGERIA"** by **ADEYEMI AKEEM OWOJORI** meets the regulations governing the award of the degree of Master of Science (M.Sc.) in Educational Biology of Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

Dr. I.M.K. Gadzama ____________________ ______________
Chairman, Supervisory Committee Signature Date
Department of Biology,
Ahmadu Bello University, Zaria

Dr. G.J. Sow ____________________ ______________
Member, Supervisory Committee Signature Date
Department of Zoology,
Ahmadu Bello University, Zaria

Prof. M.L. Balarabe ____________________ ______________
Head of Department Signature Date
Department of Biology,
Ahmadu Bello University, Zaria

Prof. S. Z. Abubakar ____________________ ______________
Dean, School of Postgraduate Studies Signature Date
Ahmadu Bello University, Zaria

DEDICATION

This dissertation is dedicated to the glory of God, to my late mother, Prophetess Titilayo Adeola Owojori.

ACKNOWLEDGEMENTS

Glory and honour goes to our heavenly father for His grace, mercy and strength bestowed upon me in the course of this race.

I offer my sincere gratitude to my supervisors, Dr. I.M.K. Gadzama and Dr. G.J. Sow for their support throughout the time of this research. Without your candid and immeasurable advice, guidance and worthy directions, this thesis wouldn't have been written. I must say that one simply could not wish for better or friendlier supervisors.

It is with a sincere heart that I appreciate Prof. Aliyu Baba Nabegu of Kano State University of Science and Technology for helping with the sound level meter. I wish to acknowledge the help of Dr. M.O. Ibrahim of Faculty of Education, Ahmadu Bello University in validating the questionnaire.

More so, I acknowledge the Zaria Zonal Inspectorate of Education Office of Kaduna State Ministry of Education and the Kaduna State Universal Basic Education Board (SUBEB) for allowing me to visit the sampled schools. I am also indebted to the Principals, Teachers and Students of the Primary and Secondary Schools visited for their good cooperation.

To my wife Adeyoshola Owojori and my children Eniola and Princess Hephzibah, I am grateful for your support. I am grateful to the extended members of Owojori's family who supported me morally and financially, the entire council of elders of Holy Ghost Fire Assembly of Christ Anointed Evangelical Ministry, Iwo Osun State.

The man who believed in my career Prince Olugbenga Owojori, I say I am most grateful to you for your immense support for me in all my academic endeavours. May the good Lord watch over you to reap the fruit of whatever you have sown.

Lastly, I must acknowledge the contributions of my good and sincere friends, Joseph Aromeh, Bashir Malik, Yusuf Ismail, Samaila Benjamen, Anakobe Bashir, Egbugha Malachi, and Yisa Gana Abraham (all from ABU, Zaria), and Mfon (from University of Calabar).

ABSTRACT

This study measured the ambient noise levels in twenty schools (both primary and secondary) in Zaria to document the level of noise in the schools, variation that occur during the day and its effects on teaching and learning process. Noise levels (A-weighted decibels) were measured using Extech 407732 sound level meter. A total of 574 questionnaires were administered, which involved 419 students and 155 teachers, to assess occupational and teaching related outcome. These schools were chosen to cover heavy and light traffic roads, as well as those submerged into residential buildings. The questionnaires were validated by experts in the Faculty of Education and tested for its internal consistency using Cronbach alpha (0.848 for teachers and 0.700 for students). Manual traffic count was carried out around schools that identified traffic noise as their main source of noise exposure. The data obtained was used to compute Equivalent Continuous Level (Leq.), Noise Pollution Level (L_{NP}), Noise Climate (NC), and Percentile Noise Levels (L_{10}, L_{50}, L_{90}). The result shows that the indoor and outdoor noise levels in primary and secondary schools is high ranging between 71.5 - 95.9 dBA, 59.1 - 98.7 dBA (Indoor) and 75.5 - 93.1 dBA, 70.4 - 98.5 dBA (Outdoor) respectively. The traffic noise index (TNI) ranged between 64.3 - 122.7 dBA and 54.5 - 123.1 dBA for primary and secondary schools respectively. These values exceeded the World Health Organization (1980) and National Environmental Standards and Regulations Enforcement Agency (2007) noise level limit of 35 dBA and 55 dBA for indoor and outdoor noise levels in academic environment. At 95% confidence level, the mean of the paired samples are the same. There was no statistically significant change in the Leq. from morning to afternoon in the schools (P = 0.299 and 0.980). Similarly, there was no significant difference in the level of noise pollution in Primary and Secondary Schools (P = 0.895). There was no significant difference in the traffic, indoor, and outdoor noise levels. Over

94.2% of the teachers complained that noise affected their teaching and 92.6% of the students reported that noise affected their learning ability. They reported tiredness, lack of concentration, communication interference, voice masking, low speech intelligence among the major problems. About 55.5% reportedly said they are not aware of noise pollution. It was concluded that students and teachers in public schools in Zaria are exposed to high decibel of noise. This affects the process of teaching and learning. It was recommended that noise barriers should be installed into the buildings and overcrowding in classrooms should be avoided.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ABBREVIATIONS

ALHCZ – Al-Huda Huda College, Zaria

ANSI – American National Standards Institute

ARMZ – Abdul-Rahman Mora Primary School, Zaria

BAKZ – Bello Aliyu Primary School, Kofan-Doka, Zaria

BBAZ – Baba Ahmed Primary School, Zaria

BNL – Background Noise Level

BRCZ – Barewa College, Zaria

DAIZ – Dr. Abubakar Imam Primary School, Zaria

dB – Decibel

dB(A) – A-Weighted decibel

FEPA – Federal Environmental Protection Agency

FMOE – Federal Ministry of Environment

GGSSCZ – Government Girls Secondary School, Chindit, Zaria

GGSSDZ – Government Girls Secondary School, Dogon-Bauchi, Zaria

GGSSGZ – Government Girls Secondary School, Kofan-Gayan, Zaria

GGSSKZ – Government Girls Secondary School, Kongo, Zaria

GGSSPZ – Government Girls Secondary School, Pada, Zaria

GPS – Global Positioning System

GSSBZ – Government Secondary School, Bogari, Zaria

GSSTJZ – Government Secondary School, Tudun- Junkun, Zaria

ICBEN – International Commission on the Biological Effects of Noise

IEC – International Electro-technical Commission

L_{10} – Noise level that exceeds 10% of the time

L_{50} – Background noise level in the absence of nearby noise sources

L_{90} – Instantaneous noise level that exceeds 90% of the time

LAEQA - A-Weighted Equivalent Continuous Sound Level for Afternoon

LAEQM - A-Weighted Equivalent Continuous Sound Level for Morning

LAEQMA - A-Weighted Equivalent Continuous Sound Level for Morning and Afternoon

L_{AI} - Instantaneous A-weighted Noise Level

LAQE – A-Weighted Equivalent Continuous Sound Level

LEQ – Equivalent Continuous Sound Level

LNP – Noise Pollution Level

NC – Noise Climate

NESREA – National Environmental Standards and Regulations Enforcement Agency

NIHL – Noise-Induced Hearing Loss

NPC – National Population Commission

OSHA – Occupational Safety and Health Administration

RTS – Reception Threshold for Sentences

SADZ – Sani Adamu Primary School, Zaria

SAMZ – Sarki Musa Primary School, Zaria

SIASSZ – Sheikh Ibrahim Arab Special Secondary School, Zaria

SLM – Sound Level Meter

SPL – Sound Pressure Level

SPSS – Statistical Package for the Social Sciences

SSMZ – Sarki Sambo Primary School, Zaria

SSSKZ – Science Secondary School, Kufena, Zaria

TNI –	Traffic Noise Index
TOAZ –	Tsoho Abdullahi Primary School, Zaria
TWA –	Time Weighted Average
UNIZ –	U.B.E. Isan Nabawa Primary School, Zaria
US EPA –	United State Environmental Protection Agency
USA –	United State of America
WHO –	World Health Organization

GLOSSARY AND DEFINITIONS

Noise - Noise is an unwanted sound.

Sound - Sound is a form of energy emitted by vibrating body and on reaching the ear it causes the sensation of hearing through nerves.

Decibel - It is measurement unit of sound, represented by dB. It is a unit to measure the intensity of a sound or the power level of a sound signal by comparing it with a given level on a logarithmic scale. This is a logarithmic unit used to express the ratio of two values of a physical quantity.

Traffic Noise Index – This is the measure of annoyance responses to traffic noise which takes into account the traffic flow.

Noise Percentiles ($L_{10,\ 50,\ \&\ 90}$) -The sound levels exceeding 10%, 50%, and 90% of the total time intervals during a particular period and are designated as L_{10}, L_{50} and L_{90} respectively.

A-weighted Scale - It resembles the audible response of human ear. It is represented as dB (A).

Noise Pollution Level – This is the measure of noise level that gives the vibration in sound signal with a fluctuating noise.

Equivalent Sound Level (Leq.) – It is the constant noise level that expends the same amount of energy as the fluctuating level over the same period of time. It is the total energy response by the human ear and indicator of physiological disturbance to the human mechanism.

Noise Climate – This is the range over which the sound levels are fluctuating in an interval of time.

Reliability – Reliability is an index that estimates consistency of scores measured by the questionnaire.

Validity - This is the degree to which the questionnaire measures what it is supposed to measure.

SYMBOLS

dB –	Decibel
dB (A) –	A-Weighted decibel
L_{AI} -	Instantaneous A-weighted Noise Level
Leq. -	Equivalent Continuous Sound Energy
LNP -	Noise Pollution Level
M -	Meter
TNI -	Traffic Noise Index

CHAPTER ONE

1.0 INTRODUCTION

Noise is any undesired sound, either one that is intrinsically objectionable or one that interferes with other sounds that are being listened to (Encyclopedia Britannica, 2012). The extent to which noise is annoying depends on many factors such as the pitch irregularities, duration, rhythm and unexpectedness or whether the noise has any meaning for the particular observer (Ebeniro and Abumere, 1999). Noise become an unjustifiable interferences and imposition upon human health, comfort and quality of human life (Gorai and Pal, 2006).

Society has attempted to regulate noise since the early days of the Romans, who by decree prohibited the movement of chariots in the streets at night (Goines and Hagler, 2007). But it was not until the late 1960s that people started to protest against a specific highway or airport and claimed that citizens must be protected from the adverse impact of noise pollution followed by passage of nuisance lawsuits in different parts of the world (Yuhazri *et al*., 2010). Things changed rapidly in the United States as the Federal Government officially recognized noise as a pollutant and began to support noise research and regulation. Consequently, the National Environmental Policy Act (NEPA) in 1969 and the Noise Pollution and Abatement Act (more commonly called the Noise Control Act (NCA)) of 1972 came into existence (Firdaus and Ahmad, 2010). Afterward, various European countries such as The Netherlands (1979), France (1985), Spain (1993) and Denmark (1994), etc. formulated national laws governing noise.

Noise caused by traffic is the nuisance that is most often cited by roadside residents. School administrations and students living in the proximity of roadways will increasingly perceive noise problems (Avsar and Gonullu, 2001). The effect of environmental noise on growing children has become one of the most important problems, because the personality, mentality and physique of children are being formed particularly at this early age. According to the some of the studies, students' performance and behaviours can be changed both in high noisy ambience and quiet ambience (Sargent *et al.*, 1980). The higher outdoor noise causes the higher indoor noise in classrooms. Disturbance from the outdoor noise is increased in hot seasons in the classrooms, especially when the windowpanes are open (Avasr and Gonullu, 2005).

Environmental challenges vary considerably among schools around the world, across countries and within communities (World Health Organization, 2004). Nowadays, children experience a key part of their childhood in their school and it forms one of their principal social activities and setting (Alsubaie, 2014). The Ottawa Charter for Health Promotion stated that "health is created and lived by people within the settings of their everyday life; where they learn, work, play and live" (WHO, 1987). World Health Organization defines a health-promoting school as "one that constantly strengthens its capacity as healthy setting for living, learning and working" (WHO, 2014). The American Academy of Pediatrics defines a "healthful school environment" as "one that protects students and staff against immediate injury or disease and promotes activities and attitudes against known risk factors that might lead to future disease or disability" (America Academy of Pediatrics, 1993). The school environment encompasses the social, physical and biological factors. Learning in classrooms is mainly facilitated through verbal and auditory communication between teachers and students (Flexer and Long, 2003).

Zannin *et al*. (2012) said the long and arduous process of individual and collective education takes place primarily in classrooms. It is here that contact is established between teachers and students and between individual students and their peers. It is here that knowledge is transmitted in its most ancient form, i.e., through oral communication. The quality of this communication, and ultimately, of classroom education itself, is closely linked to the acoustic quality of the classroom. This acoustic quality can be characterized based on the reverberation time, speech transmission index, sound insulation, and the noise levels inside and outside the classroom (Zannin and Zwirtes, 2009). High noise levels in the classroom impair oral communication, causing students to become tired sooner more often, and this premature fatigue tends to have a negative effect on their cognitive skills (Hagen *et al*., 2002).

School is also an important microenvironment just like home and work place. The school is important for the cognitive, creative, and social development of children. Schools are therefore expected to ensure the best possible conditions for child's physical and intellectual development, including control of excess environmental noise (Ana *et al*., 2009).

Environmental pollution becomes more severe and widespread due to population growth, urbanization and industrialization in the cities (Ralte and Lalramnghinglova, 2013). There are many factors which cause the environment to be polluted and one of those undesired and unpleasant factor is 'noise' which affects the quality of life (Haq *et al*., 2014). Noise pollution is one of the major problems for developing countries. There is a need to control the noise exposure levels in sensitive areas as hospitals, schools, and kindergartens (Mitra, 2008; Oyedepo and Abdullahi, 2009; Noori and Zand, 2013; Amin *et al*., 2014; Marriscal-Rammires *et al*., 2014; Mukhola, 2014).

Noise as pollution is said to occur when the noise level is above the maximum permissible level for a given environment (WHO, 1980; FEPA, 1991). The most important measurement of noise is its loudness. This loudness depends on the physical sound pressure that is measured on the sensitivity of the human ear which in turn depends on the frequency of the sound (Levitt, 2001). Noise pollution has become an important environmental problem in that this problem has negative impacts on public health both physically and psychologically (Aparicio-Ramon *et al*., 1993; Yoshida *et al*., 1997; Buchta and Vos, 1998; Kura *et al*., 1999; Ali and Tamura, 2003; Stansfeld and Matheson, 2003).

There have been many attempts to reduce noise pollution in many countries (Arana and Garcia, 1998; Onuu, 2000; Zannin *et al*., 2002; Li *et al*., 2002; Morillas *et al*., 2002; Kumbur *et al*., 2003; Yilmaz and Ozer, 2005; Ozyonar and Peker, 2008; Pathak *et al*., 2008; Allen *et al*., 2009). Due to urbanization and industrialization, noise pollution has gained attention and as an environmental hazard rated third to air and water pollutions (Singh and Davar, 2004). Apart from the psychosocial effects of community noise, there is a growing concern about the impact of noise on public health, particularly regarding cardiovascular outcomes (Passchier-Vermeer and Passchier, 2000).

Recently, noise pollution has been of increasing concern worldwide, particularly in the urban centres (Banerjee *et al*., 2008; Ana *et al*., 2009; Goswami *et al*., 2011; Olayinka, 2013; Jamir *et al*., 2014). Many studies addressing the problem of noise pollution in educational institutes throughout the world have been conducted (Ana *et al*., 2009; Golmohammadi *et al*., 2010; Woolner and Hall, 2010; Debnath *et al*., 2012; Alsubaie, 2014). The auditory system of the teachers and students continuously analysing acoustic information, which is filtered and interpreted by different cortical and sub-cortical brain structures (WHO, 2009). Arousal of the autonomic nervous system and the endocrine system is associated with repeated temporal changes in biological responses. In the long run, chronic noise stress may affect the homeostasis of the organism due to dysregulation, incomplete adaptation and/or the physiological costs of the adaptation (Spreng, 2000).

Ikenberry (1974) has analysed some effects of noise pollution to school students and found that the students find it difficult to hear the teacher, lectures, classroom discussions, and other activities. Klatte *et al*. (2013) in their research work showed that students can perform better under quiet environments than under noisy ones. Debnath *et al*. (2012) stated that noise pollution produces multi-problems to the teaching-learning process and negatively affects the performance of both teachers and students.

Significant increase in the population of urban centres has been witnessed in Nigeria within the last decade. This increase has influenced the lifestyle of the citizenry contributing to the increase in noise pollution (Abel, 2015). Urbanization and industrialization have contributed greatly to noise pollution in recent time without adequate consideration of its effects in the future to come.

1.1 Statement of Research Problem

The noise problems of the modern industrial societies seem incomparable to the past given the larger sources of noise now present outdoors and indoors. Traffic noise is one of the main sources of environmental noise exposure in urban communities (WHO, 2001). Noise pollution has been recognized as one of the major threats confronting the world today. The WHO in 2005 revealed that noise is a dangerous agent which affects human health and the environment (Zanin *et al*., 2006). Noise pollution has become problematic yet an unnoticed form of pollution in most developing countries (Essandoh *et al*., 2011). In the recent years, transportation has created excessive noise pollution which is displeasing the activity or balance of human and animal life. Noise can damage physiological and psychological health of Human being (Bharanthan *et al*., 2007). Noise exposures have been linked to a range of non-auditory effects including annoyance, sleep disturbance, cardiovascular diseases, and impairment of cognitive performances in children (Basner *et al*., 2014). People in Nigeria do not pay significant attention to the seriousness of noise pollution and its dangerous environmental consequences (Anomohanran, 2013). In Nigeria, there is no legal frame work upon which noise pollution can be abated. Federal Environmental Protection Agency (FEPA) in Nigeria only provided daily noise exposure limits for workers in industry (i.e. 90 dB (A) for 8h exposure). In short, the Nigerian Government and her citizenry appear not to be conscious of the present and future impacts of noise induced health hazards in their environment. Unless and until measures are taken to control the level of noise, the ongoing urbanization and industrialization may complicate the problem so much that it becomes incurable (Olayinka, 2013).

The harmful effects of noise on human health and development have been underestimated for a relatively long time. The need for studies regarding urban noise pollution and its consequences on the environment has motivated various researchers on the problem in several countries (Zheng, 1996; Zeid *et al.*, 2000; Ugwuanyi *et al*., 2005; Armah *et al*., 2010; Thangadurai *et al*., 2015). But few research has been done to assess the level of noise pollution in primary and secondary schools that mostly do not have well designed architectural plans like the universities.

1.2 Justification

Although noise pollution is attracting attention of policy makers, but not much attention has been given to noise associated with educational institutions. However, several researches on noise pollution in higher institutes of learning have been conducted (Norlander *et al*., 2005;

Kang *et al*., 2011; Debnath *et al*., 2012; Ozer *et al*., 2014; Turumen *et al*., 2014; Sowah *et al*., 2014; Puglisi *et al*., 2015). This study, therefore, would be expected to bring to the fore, the status of noise pollution and its effects on teaching and learning process in the area of study. It will also set to the backdrop for further studies in order to identify some possible environmental problems that can affect students and their process of learning.

The data that was obtained on the level and effects of noise pollution will form a baseline for further studies and will provide regulatory agencies, State and Federal governments with valuable information on the promulgation of policies that will prevent indiscriminate build-ups of business centres around schools.

1.3 Aims:

The aim of this research is to assess the level of noise pollution and its effect on teaching and learning processes in primary and secondary schools in Zaria.

1.4 Research Objectives:

The objectives of this research are to determine the:

i. Level of noise in primary and secondary schools in Zaria.
ii. Difference between the equivalent continuous sound energy level (Leq.) in the morning and afternoon in primary and secondary schools in Zaria.
iii. Difference between the indoor, outdoor and traffic noise indices.
iv. Effect of noise pollution on teaching and learning in the schools.

1.5 Hypotheses

i. There is no significant difference in the level of noise pollution in primary and secondary schools in Zaria.

ii. There is no significant difference in the indoor morning and afternoon Leq. in primary and secondary schools in Zaria.

iii. There is no significant difference between indoor noise, outdoor noise and TNI across primary and secondary schools in Zaria.

iv. Noise pollution has no significant effect on teaching and learning process in the schools to be studied.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Definition of Noise

Noise is an unavoidable part of our daily lives and has increasingly become a major burden on the quality of lives. The word noise is concisely defined as unwanted sound that creates annoyance and interferes with conversation, disturbs sleep and teaching-learning process, reduce work efficiency, causing stress and challenge to public health (Debnath *et al*., 2012). Gorai and Pal (2006) considered noise as an unjustifiable interferences and imposition upon human health, comfort and qualitative human life. Noise is any undesired sound, either one that is intrinsically objectionable or one that interferes with other sounds that are being listened to (Encyclopedia Britannica, 2012). Ozdemir *et al*. (2014) defined noise as the level of sound, which exceeds the acceptable level and creates annoyance. Noise is derived from the Latin word "nausea" implying 'unwanted sound' or 'sound that is loud, unpleasant or unexpected'. According to Garg (2004), noise is transmitted usually through a medium such as air, when this noise reaches the ear, it may be perceived as desirable or undesirable. Okoro (2014) said it is the undesirable sound that is commonly referred to as noise. Anomohanran (2013) maintained that noise is an environmental pollutant that is increasing very rapidly as a result of increase in commercial, industrial and social activities. Noise can be described as sound without agreeable musical quality or as an unwanted or undesired sound (Abolarin, 2012).

2.2 Noise Pollution

Noise pollution is distinguished from other pollution categories due to its source and diffusion characteristics, which can adversely affect public health and environmental quality in the urban environment (Ozdemir *et al*., 2014). Noise can also be considered as environmental pollutant, a waste product generated in conjunction with various anthropogenic activities. Noise is any sound independent of loudness that can produce an undesired physiological or psychological effect in an individual and that may interfere with the social ends of an individual or group (Mahadi, 2012). These social ends include all of our activities - communication, work, rest, recreation and sleep. Noise Pollution has a significant impact on the quality of life and thus potentially on public health (Rauf *et al*., 2015). Noise that is perceived as a detriment to our quality of life due to its intensity, timing, duration and/or its source is defined as noise pollution (Onder and Akay, 2015). Noise is part of most activities and includes an almost unlimited range of sources from the singing of birds through to the hum of a power station. The response to noise by individuals can be as wide and as varied as the number of activities that produce it (Mahadi, 2012).

In modern life, many types of pollutions have been identified, one of them is noise pollution, which is the result of modern technology and urbanization of the cities (Daly and Zannetti, 2007). The World Health Organization in 2011 has reported seven categories of adverse health effects of noise pollution on humans which include hearing impairment, interference with spoken communication, sleep disturbances, cardiovascular disturbances, disturbances of mental health, impaired task performance, negative social behaviour and annoyance reactions (Goines and Haggler, 2007). Frequent exposure to high level of noise can cause severe stress on the auditory and nervous system (Subramani *et al*., 2012). It disturbs human being and causes an adverse effects on the mental and psychological well-being. Noise pollution is an act in which displeasing human or machine created sound that disrupts the activity of balance of human or animal life introduced to the environment. It can equally be described as an unwanted sound released into the environment without regard to the adverse effects it may have (Oyedepo, 2012).

2.3 Measurement of Noise

The measurement of noise is mostly done in decibel (dB). Noise is the result of fluctuations or oscillations in atmospheric pressure. These excite the ear mechanism and evoke the sensation of hearing. The human ear responds to changes in sound pressure over a very wide range (Hansen, 2001). The loudest sound pressure to which the human ear responds is ten million times greater than the softest. This large ratio is reduced to a more manageable size by the use of logarithms. The logarithms scale provides a more convenient way of comparing the sound pressure of one sound with another. To avoid a scale which is too compressed, a factor of 10 is introduced, giving rise to the decibel unit (Figure 2.1).

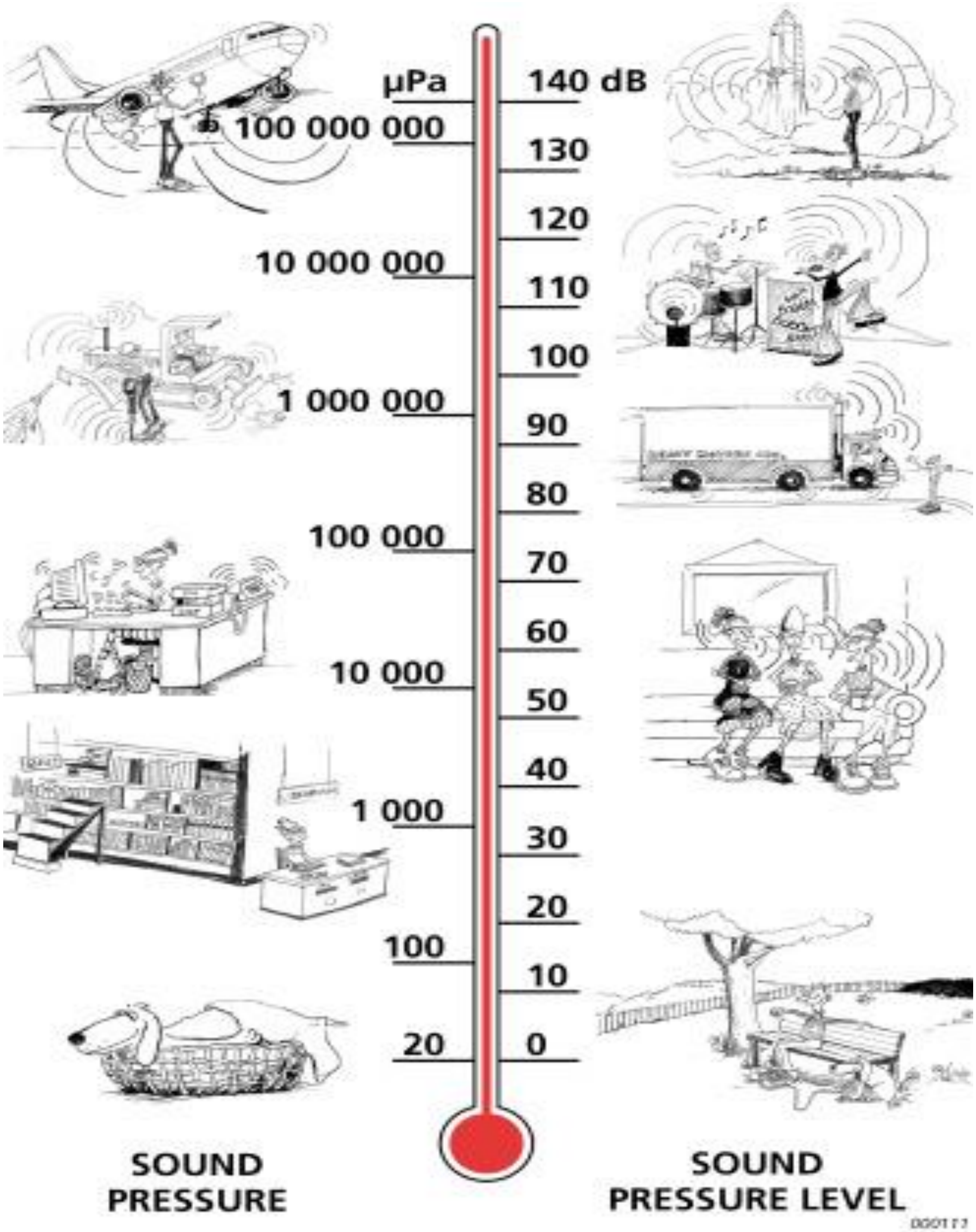


Figure 2.1: Pascal/Decibel comparison scale (Adapted from Bruel and Kjaer Sound and Vibration Measurement A/S 2001)

According to Ibrahim and Richard (2000), noise can also be measured using Pascal (Pa) but measurement in Pascal would produce quite unmanageable numbers (Figure 2.1). The decibel scale is simple and easy to use without involving long linear numbers. Decibel also gives a much better approximation of the response of human ear to loudness. Stumpf (1980) gave the formula for measuring dB as:

$$dB = 10\ Log\frac{I}{Io}$$

The unit of decibel is included with a weighting network (Pearsons and Bennett, 1974). This weighting network is used to differentiate sound based on its frequency. There are three categories of weighing system that is always used, i.e. A, B and C. The ‘A’ category discriminates against low frequencies. ‘B’ also discriminates against low frequencies but to a lesser extent, and ‘C’ is commonly used for higher level measurements. There is also a ‘D’ weighting but it is used to measure noise from airplanes.

Noise can also be measured by a SLM, which is an instrument designed to respond to sound approximately the same way the human ear does, and gives reproducible measurements of sound level.

The sound level meter according to Otutu (2011) consists of the following:

i. An electric conditioned microphone
ii. A display unit that displays the sound pressure level
iii. The power and range switch
iv. Response switch to adjust recording speed of the meter to either ‘slow or fast’
v. The functional switch for measuring sound level of acoustic material
vi. Unit calibration control
vii. Output jack that supplies AC signals and log converted DC signal for data processing

viii. The Battery cover

ix. The reset button used to reset level indicator

2.4 Permissible Noise Levels

In order to protect the health of the public, various standards have been designed by World Health Organization (Table 2.1(1999), Fig. 2.2 (2011)) and Federal Environmental Protection Agency (Table 2.2 (1991)).

2.5 Sources of Classroom Noise

The noise in a classroom is made up of external noise which is transmitted through the building envelope, plus internally generated noise, so that children in school may be exposed to noise from a wide variety of sources. External noise is likely to consist of a range of environmental noise including noise from transportation sources, industrial noise, plant noise and the noise of people outside the school. An additional source of noise which is reputed to cause significant disturbance to teaching is the noise of rain falling on lightweight school roofs (O'Neil, 2002). Oyedepo (2012) pointed out some sources of noise, which are Electricity generating plants, Vehicular traffic noise engine and pressure horns, Construction/industrial noise, Industrial/machinery noise, Noise from worship institutions, Household noise. Other sources of noise as pointed out by Abolarin (2012) are Aircraft noise, Noise from railroads, Noise from consumer products, Internal Combustion Engines (ICE).

Table 2.1: Guideline Values for Community Noise in Specific Environments

Specific Environment	Critical Health Effects	$L_{AEQ.}$ (dB)	Time Base (Hours)	L_{AMAX} (dB)
Outdoor living area	Serious annoyance	*55	16	
	Daytime and evening moderate annoyance	*50	16	
	Speech intelligibility and moderate annoyance	*35	16	
Dwelling, indoors, inside bedrooms	Daytime and evening sleep disturbance	*30	8	45
Outside bedrooms	Sleep disturbance, window open (outdoor value)	*45	8	60
School classrooms, and Pre-Schools, Indoors	Speech intelligibility, disturbance of information extraction, Message communication	*35	During Class	-
Pre-School bedrooms, Indoors	Sleep disturbance	*30	Sleeping time	45
School playground (outdoor)	Annoyance	*55		
Hospitals, wardrooms, indoors	Sleep disturbance, night time sleep disturbance	*30	8	40
Hospitals, treatment rooms, indoors	Daytime and evening Interference with rest and recovery	*30	16	-
Industrial, commercial shopping and traffic areas, indoors and outdoors	Hearing impairment	*70	24	110
Ceremonies, festivals and entertainment events	Hearing impairment	*100	4	110
Public addresses, indoor and outdoor	Hearing impairment	*85	1	110
Music through headphones	Hearing impairment	*85	1	110
Impulse sounds from toys, fireworks and firearms	Hearing impairment	-	-	140
Outdoors in parking and consolation	Disruption of tranquillity	-	-	-

(World Health Organization Noise Standard adapted from Guidelines for Community Noise WHO. 1999).

*Above this LAeq and period of exposure, the critical health effects will manifest.

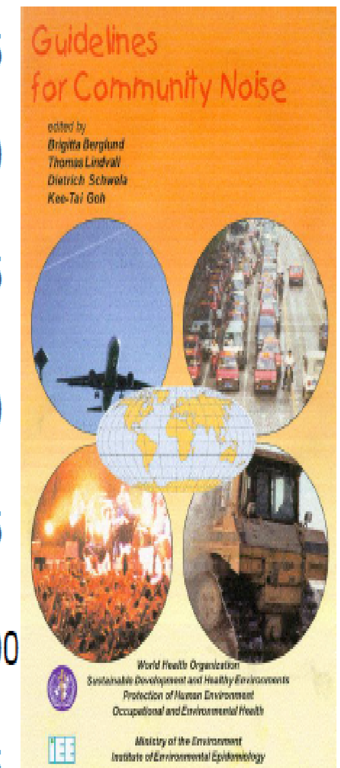
Table 2.2: Acceptable Sound Levels under different Situations

Situation	Acceptable Sound Level dB(A)
Working Environment (8 hours per day)	75
Bedroom inside at night	35
Indoor background level to ensure good speech intelligibility	45
Outdoor level at daytime	55
Outdoor level at night	45

Source: Adapted from FEPA (1991)

WHO Guidelines for Community Noise

Environment	Critical health effect	Recommended maximum sound level dB(A) L_{eq}
Outdoor living areas	Annoyance	50 - 55
Indoor dwellings	Speech intelligibility	35
Bedrooms	Sleep disturbance	30
School classrooms	Disturbance of communication	35
Industrial, commercial and traffic areas	Hearing impairment	70
Music through earphones	Hearing impairment	85
Ceremonies and entertainment	Hearing impairment	100
Occupational environment	Hearing impairment	85



World Health Organization
REGIONAL OFFICE FOR Europe

Quiet Please: The Future of EU Noise Policies
Brussels, 25 May 2011

Figure 2.2: WHO Guidelines for Community Noise (Adapted from Burden of Disease from Environmental Noise WHO, 2011)

2.6 Noise Descriptors

Several noise descriptors are used to interpret the measured decibel values. These noise parameters includes the following:

1. Noise Pollution Level: $L_{NP} = L_{eq} + K\sigma$

   Where

   K = Constant with a value of 2.56

   σ = the standard deviation of the acquired Leq_{values}. (Alao and Avwiri, 2010).

   OR

   L_{NP} = Leq. + ($L_{10} – L_{90}$) dB

   Where

   L_{10} = sound level exceeded 10% of observed time

   L_{90} = sound level exceeded 90% of observed time. (Obisung *et al*., 2013).

2. Equivalent Continuous Noise Level: This is used to describe fluctuating noise level. It is constant noise level that expends the same amount of energy as the fluctuating level over the same time period (Davis and Masten, 2004).

$$LAeq. = 10Log\frac{1}{T}\int_{0}^{T} 10\,L(t)/10$$

OR

$$LAeq. = 10Log\sum_{i=1}^{1=n} 10\,\frac{Li}{10}$$

Where

Li = the noise level in dB (A) of the ith sample

ti = fraction of total samples taken

n = the number of samples taken. (Obisung *et al*., 2013)

3. Noise Climate: $NC = L_{10} - L_{90}$

Where

L_{10} = the level of sound exceeding for 10% of the total time of measurement or Peak Noise level

L_{90} = the level of sound exceeding for 90% of total time of measurement or Background or Residual Noise Level

4. Noise Exposure Index: $NEI = \left(\frac{t1}{T1}\right) + \left(\frac{t2}{T2}\right) + \cdots + \left(\frac{tn}{Tn}\right)$ (Patil and Hunashal, 2012)

2.7 Effects of Noise

2.7.1 The Effects of Noise Pollution on Teaching and Learning

Ana *et al*. (2009) reported noise in school-day to be in a range of 68.3 – 84.7dB (A) in some secondary schools in Ibadan. The report showed that tiredness and lack of concentration are the most prevalent noise-related problems. According to them, over 60% of the respondents reported vehicular traffic as the major source of noise, and over 70% complained of being disturbed by noise. Shield and Dockrell (2008) have earlier found out that external noise has a significant negative impact upon performance, the effect being greater for the older children in schools. Chronic external noise exposure would impair concentration, general cognitive functioning, and particularly reading skills (Woolner *et al*., 2007). Increased noise from aircraft and traffic (within the 30 to 70dBA range) affected reading comprehension in children (Stansfeld *et al*., 2005). The researchers reported that for every 5dBA increase in ambient noise measured during daytime hours on the exterior surfaces of school buildings, grade-school aged children experienced a one to two months delay in reading comprehension.

According to Kang *et al*. (2011) the environmental noise levels of secondary schools have almost no significant relationships with the academic achievement indicators. However, Berglund *et al*. in WHO (1999) maintained that to be able to hear and understand spoken messages in the classrooms, the background sound level should not exceed 35dB (A) Laeq. during teaching sessions. For outdoor playgrounds, the sound level of noise from external sources should not exceed 55dB (A) $L_{Aeq.}$, the same value given for outdoors residential areas in daytime by WHO. According to Ibrahim and Richard (2000), 81% respondents agreed that noise pollution has a negative impact on study/work. These negative impacts caused by noise pollution in school include disturbance of study, hearing problem during classes, mental stress, difficult in doing discussions, health problem (headaches), and need to speak louder. Noise pollution have negative relationship between learning performance and noise levels (Shield and Dockrell, 2008). Noise pollution reduced learning capabilities (Woolner and Hall, 2010). Environmental noise may affect sleep, conversation, academic work in terms of reading and learning, and causes annoyance thus affecting task performance. Obot and Ibanga (2013) investigated noise pollution and found out that the noise pollution level in the University of Uyo is high and reaches a peak of 89.5dB(A) during the hours of 11am - 12noon. The noise emission level within the University has exceeded the maximum allowable noise level which ranges between 40dB(A) to 50dB(A) recommended for educational institutions (NIOSH, 1998) and could produce noise-pollution problems leading to annoyance, lack of concentration, interfering with communication and causing general stress, low productivity and increasing work absenteeism. Debnath *et al*. (2012) pointed out that environmental noise pollution in educational institutes produces multi-problems to teaching-learning process and negatively affects the performance of both teachers and students. Alsubaie (2014) found out that the indoor noise levels were significantly high since it exceeded the WHO (2011) guideline (35dBA). He suggested that the school authorities should adjust the adolescent's number to the classroom area to overcome the crowding that affect indoor noise and learning. Klatte *et al*. (2013) reviewed noise effects on cognitive performance in children and found that indoor noise and reverberation in classroom settings were associated with poor performance of the children in verbal tasks. They reported that the experimental studies addressing the impact of acute exposure showed negative effects on speech perception and listening comprehension. These effects are more pronounced in children as compared to adults. Children with language or attention disorders and second-language learners are still more impaired than age-matched controls. Noise-induced disruption was also found for non-auditory tasks, i.e., serial recall of visually presented lists and reading (Klatte *et al*., 2013). However, Bronzaft and McCarthy (1975) have earlier pointed out that a pause that teacher make during bursts of external noise leads effectively to a reduction in teaching time, sometimes estimating this loss to be as high as 11% of teaching time. Woolner and Hall (2010) concluded that noise over a given level does appear to have negative impact on learning, and that beneath these levels, noise may or may not be problematic, depending on the social, cultural and pedagogical expectations of the students and teachers. However, RANCH (2005) found that a chronic environmental stressor could impair cognitive development in children, specifically reading comprehension. Likewise, Smith *et al*. (1998) have found out in USA the evidence of voice fatigue as a particular health concern for teachers.

2.7.2 Age and Noise

According to Shield and Dockrell (2003), there has been a great deal of research in the past 30 years into the effects of noise on children's learning and performance at school. This has been mainly concerned with the primary school age range (5 to 11 years), and has included studies of the effects of chronic exposure to different kinds of environmental noise and of other kinds of classroom noise. Many of these studies have examined the effects of noise on children's cognitive processing in a range of tasks and on their academic performance at school. Lundquist *et al.* (2000) reported low correlation between sound level and standard of work; however, there was a significant relationship between annoyance and the effect of noise on school work.

Shield and Dockrell (2003) in comparing standardized assessment test scores with internal noise levels in 16 schools, found significant relationships between background (L_{A90}) levels in classrooms and test scores for several subjects. The result showed strongest association with noise was the English test of the older (age 11years) children, the relationship still held when the data was corrected for socio-economic factors. Nelson *et al.* (2002) argued that young children are ineffective listeners for speech in noisy condition until they reach adolescence, when they achieve levels of speech understanding similar to those of adults. Young children do not effectively listen and understand speech in reverberant conditions. Karsdorf and Klappach (1968), and Cohen *et al.* (1980) showed an increase in systolic and diastolic blood pressure in children exposed to very high road traffic noise levels or aircraft noise levels. The increase was assumed to be of a transient nature. Regecová and Kellerová (1995) observed significantly higher systolic and diastolic blood pressures among children 3 – 7 years of age in Kindergartens in noisy environments (> 60 dBA) compared to those among children in quieter environments. School children were examined during the years Munich airport moved from one location to another. The cross-sectional part of the study showed a marginally significant higher systolic blood pressure in children highly exposed at school. Children were matched on socioeconomic characteristics (Hygge *et al*., 1996). In the study, neuroendocrine indices of chronic stress (urinary cortisol levels and levels of epinephrine and norepinephrine) were also examined. Overnight resting levels of epinephrine and norepinephrine levels were significantly higher in children exposed to aircraft noise at the old Munich airport compared to control groups. There were no differences in cortisol levels. After the airport was moved, overnight resting levels of epinephrine and norepinephrine rose significantly among children living under the flight paths of the new airport. Again, no effects were observed on urinary cortisol levels (Evans *et al*., 1998). Donald *et al*. (2004) reported that young children aged five to eight had some difficulty understanding speech when the noise level reached 65dBA in many classrooms. However, at an intermediate level, kindergarten and grade 1 children had much difficulty than the older children. Klatte *et al*. (2013) concluded in his work on the harmful effect of noise on children's learning that children are much more impaired than adults by noise in tasks involving speech perception and listening comprehension. Concerning chronic effects, evidences indicate that enduring exposure to environmental noise may affect children's cognitive development.

2.7.3 Annoyance and Noise

According to the European Commission (2000), "annoyance is a term used to describe the negative feelings associated with noise". Lindvall and Radford (1973) insisted on its subjective aspects, defined annoyance as an "unpleasant feeling associated with an agent or condition that may affect an individual or group". Noise annoyance is a common effect of noise with high sound levels. Eysel-Gosepath *et al*. (2012) reported that annoyance in preschool is dependent on several additional parameters. The stress level is, for example, less for older teachers and full-time employees, which indicates that there is a subjective rating (Eysel-Gosepath *et al*., 2010). The study of Sjodin *et al*. (2012) pointed out that there was no significant correlation between the subjective noise annoyance and the objective noise measurement. The level of annoyance is not only influenced by the sound pressure level but also by its physical characteristics, such as the frequency spectrum, the duration of exposure, or tonal and impulse components (Mahendra and Venugopalachar, 2011). The sound with low frequencies are reported to cause stronger annoyance, especially when including impulse tones or vibrations (Leventhhall, 2004).

Environmental noise causes subjective discomfort which is assessed as reported noise annoyance (American National Standard Institute, 2000). Ali (2013) discovered a strong relationship between noise levels and percentage of highly annoyed respondents. He observed that 57% of the respondents said that noise obstructed their learning achievement. He reported that younger students were more annoyed than older ones. The respondents said that road traffic, railway noise, chatter in classroom and scrapping sound from tables and chairs were most annoying noise sources. Furthermore, Sato *et al*. (1999) discovered that there was a strong relationship between the maximum noise level and the extent of annoyance. Heinrich *et al*. (2013) concluded that children exposure to road traffic noise may be related to increased hyperactivity and more emotional symptom especially in children exposed to higher nocturnal noise.

Pronello and Camusso (2016) observed low correlation between annoyance and noise. They maintained that noise levels are, arguably, a useful indicator to examine annoyance, but it is not reliable enough to define the discomfort of the people, while the site characteristics could shed light on annoyance variability. Baker (2015) discovered that a high school football game presents continuous noise over a relatively short duration on a predictable schedule and was found to have a slight annoyance on its surrounding community, and the sound of a train horn which was unpredictable and could occur at any time was found to have a moderate level of annoyance. The use of generator as a result of power failure in Nigeria could produce moderate noise or noise which in turn could cause slight or very much annoyance (Chagok *et al*., 2013).

2.7.4 Noise and Communication Interference

The noise in the school environment affects the teaching and learning process. This process needs good verbal communication, especially at the beginning of school life, when children have not yet developed their hearing strategies, thus impairing the understanding of certain activities in the case of not being able to hear the full statement (Lourenco and Silveira, 2011). Communication interference is basically a masking process in which simultaneous, interfering noise renders speech incapable of being understood. The higher the level of the masking noise, and the more energy it contains at the most important speech frequencies, the greater will be the percentage of speech sounds that become indiscernible to the listener (WHO, 1999). Excessive noise impairs communication. It means we mostly communicate by speech. This speech interference results in a large number of personal disabilities, handicaps and behavioural changes, problem with concentration, fatigue, uncertainty, lack of self-confidence, irritation, misunderstanding, decreased working capacity, and problem in human relation (Lazarus, 1998). As the sound pressure level of an interfering noise increases, people automatically raise their voice to overcome the masking effect upon speech (increase of vocal effort). This imposes an additional strain on the speaker. Nevertheless, the interpretation required for compensating the masking effect of the interfering sounds, and for comprehending what was said, imposes an additional strain on the listener (WHO, 1999). Eniz (2004) argued that children who are in the process of acquiring vocabulary are the mostly affected, by not always understanding exactly what their teacher is saying. He maintained that the problems caused by noise in children and adolescent are decentralization, low productivity, and interference with communication and learning difficulties.

Noise in schools is considered as a harmful factor that affects the hearing organ of the pupils and teachers, and disturbs the speech reception and comprehension (Kreisman *et al*., 2010). In addition to the above findings, reports from Gilavand and Jamshidnezhad (2016) showed that noise pollution can cause poor concentration in schools, interfering with the conversation, drop off students in the courses and even reducing their grades. Ausgustynska *et al*. (2010) pointed out that poor acoustics in classrooms have an adverse influence on speech reception and make teaching and learning processes difficult. Lazarus (1990) earlier asserted that for complete sentence intelligibility in listeners with normal hearing, the signal-to-noise ratio (i.e. the difference between the speech level and the sound pressure level of the interfering noise) should be 15–18 dB(A) which implies that in smaller rooms, noise levels above 35 dBA interferes with the intelligibility of speech. Earlier recommendations suggested that sound pressure levels as high as 45 dBA would be acceptable (US EPA, 1974). For speech to be intelligible when listening to complicated messages (at school, listening to foreign languages, telephone conversation), it is recommended that the signal-to-noise ratio should be at least 15 dBA. Thus, with a speech level of 50 dBA, (at 1m distance, this level corresponds to a casual speech level of both women and men), the sound pressure level of interfering noise should not exceed 35 dBA.

2.7.5 Noise and Blood Pressure

Epidemiological studies on the relationship between transportation noise (particularly road traffic and aircraft noise) and cardiovascular effects have been carried out on adults and on children, focusing on mean blood pressure, hypertension and ischemic heart diseases as cardiovascular end-points. In 1999, the World Health Organization concluded that the available evidence suggests a weak association between long-term noise exposure above 67-70 dB (A) and hypertension. More recent studies have suggested that noise levels of 50 dB (A) at night may also increase the risk of myocardial infarction by chronically elevating cortical production. Stansfeld and Matheson (2003) studied non-auditory effects of noise on health and found out that noise exposure raises catecholamine secretion, and in children, chronic exposure is associated with increased blood pressure. In earlier research, Lang *et al*. (1992) suggested that individuals chronically exposed to continuous noise at levels of at least 85 dB have higher blood pressure than those not exposed to noise. In a prospective study carried out around Stockholm's major airport, subjects exposed to energy-average levels above 50 dB (A) had a significant relative risk of 1.19 (95% CI= 1.03 - 1.37) for the development of hypertension over 10-year follow-up period, compared with less exposed. The increase in risk per 10 dB (A) was 1.2 (95% CI = 1.03 - 1.40). The effect was particularly found in older people, which may reflect longer years of residence (Eriksson *et al*., 2007). Saeed (2010) examined the effects of noise pollution on arterial blood pressure and heart rate of school children and found strong positive correlation between sound pressure levels in the sample schools and blood pressure and heart pulse rate. In similar study, Abdelraziq *et al*.

(2003) found strong correlation between noise pollution and systolic and diastolic blood pressure, heart rate and hearing threshold. The mean systolic and diastolic blood pressure for the sexes are correlated positively with the noise pollution level. Generally, exposure to noise may lead to increased risk of hypertension, cardiovascular disease and impairment of cognitive performance in school children (Basner *et al*., 2014).

2.7.6 Noise and Headaches

Shahid and Bashir (2013) quoting Akansel and Senay (2008), Mclaren and Maxwell-Armstrong (2008), Orellanna and Vishaniac (2007), Monsen and Gustafsson (2005) said noise adversely affects the bodily function including cardiovascular system. It alters the rhythm of heart beat which makes the blood thicker and dilates blood vessels which not only makes the focusing of the eyes difficult but also causes headaches and irritability.

In a survey of causes and psychological effects of noise in some selected area of Kano conducted by Umar and Barde (2015), it was observed that 44% of the respondents exposed to noise suffered from headache. Pathak *et al*. (2008) indicated that 85% of the people they studied were disturbed by traffic noise, and 90% suffer headache, high blood pressure, dizziness and fatigue as a result of traffic noise. Chronic environmental noise causes a wide variety of adverse health effect, including sleep disturbance, annoyance, noise-induced hearing loss (NIHL), cardiovascular diseases, endocrine effects and increased incidence of diabetes (Raaschou-Nielsen *et al*., 2013).

2.7.7 Noise and Stress

A neuro- endocrinological definition of stress is that it is a state that threatens homeostatic or adaptable systems in the body (McEwen, 1998). Noise is considered a non-specific stressor that may cause adverse health effects in the long run. Epidemiological studies suggest a higher risk of cardiovascular diseases, including high blood pressure and myocardial infarction, in people chronically exposed to high levels of road or air traffic noise (WHO, 2011). Noise causes the release of stress hormones that can adversely affect health. Noise disturbs the homeostasis of the cardiovascular, endocrine and immune systems in the body to cope with the environmental or perceived demands of the individual. The imbalance between the demand and individual's resources to cope determines the individual's ability to deal with noise-induced stress. The body's ability to cope with overstimulation can lead to adverse stress reactions (Prasher, 2009). Noise-induced stress is contagious, impacting family members who eventually wind up at the nurses' station complaining about a variety of issues worsened by the extraneous noise. Those who work long shifts in noisy environments, day in and day out, have experiences similar to patients. Nurses report exhaustion, burnout, depression and irritability (Mazer, 2012).

Noise is a non-specific stressor that arouses the autonomous nervous system and the endocrine system (Maschke *et al*., 2000; Babisch, 2002). Increased allostatic load is associated with various diseases, including ischemic heart disease (Sabbah *et al*., 2008). Classical biological risk factors have been shown to be elevated in subjects that were exposed to high levels of noise (Lercher and Kofler, 1993; Yoshida *et al*., 1997; Goto and Kaneko, 2002). Noise is one of the strongest work-related stress factors for teachers in nursery school (Losch and Schulze, 2016). In an interview with teachers concerning the negative working conditions and stress factors, 73% showed that noise is the strongest occupational risk (Khan *et al*., 2006). Some objective noise measurements in nursery schools showed maximum equivalent sound pressure levels over 8h (Leq8h) of up to 90 dB(A) for the supervision of children in playing sections (Kemp *et al*., 2013).

According to Seibt *et al*. (2004), Eysel-Gosepath *et al*. (2012), Sjodin *et al*. (2012), Sjodin *et al*. (2014), the average L_{eq8h} in nursery schools is in the range of medium intensity of 60-85dB which can trigger extra-auditory effects. The often-complained adverse health effects are increasing psychological strain of noise-induced stress, vocal load, masking, and higher frequency of errors (Basner *et al*., 2014).

2.7.8 Noise effects on behaviour

Noise pollution interferes with the ability to comprehend normal speech and may lead to a number of personal disabilities, handicaps and behavioural changes. These include problems with concentration, fatigue, uncertainty, lack of self-confidence, irritation, misunderstandings, decreased working capacity, disturbed interpersonal relationships and stress (Savale, 2014). It has been reported that performance of school growing children is poor in comprehension, when schools are in the busy/traffic area. Noise can cause irritation, which results in learning disabilities. The working performance of human will be affected as they will be losing their concentration. It affects the sleeping thereby inducing the people to become restless and lose concentration and presence of mind during their activities (Singh and Joshi, 2010).

Some behavioural effect of noise reported by Kjellberg (1990) include masking of auditory feedback or inner speech, distraction, arousal level and allocation of attention. The World Health Organization (1999) also pointed out that noise exerts negative social behaviour and annoyance reaction on individuals exposed to it. Annoyance is defined as a feeling of displeasure associated with any agent or condition believed by an individual to adversely affect him or her. These effects include changes in everyday behaviour (closing windows and doors to eliminate outside noises), changes in social behaviour (aggressiveness or disengagement), changes in social indicators (residential mobility, hospital admissions, drug consumption, and accident rates) and changes in mood (increased reports of depression). Noise above 80 dB is said to be consistently associated with decreased behaviour and increased aggressiveness.

2.8 Noise Exposure Limit

Sound waves travel from source to receiver through a variety of media (Dunn, 2015). Outdoors, they travel through the atmosphere and is influenced by wind turbulence and gradients, air temperature, ground reflections, etc. thus affecting the amplitude, the spectrum as well as the duration of the sound. For instance, the sound will be attenuated by air absorption, fog, rain or snow, barriers such as walls and buildings, and by ground effects. However, under certain circumstances, attenuation may not take place. Indoors, noise may travel through the air and the structure of the building and thus modified by the sound insulation of walls and windows, the reverberation time of the space, and the design and surface materials of the room (Daigle *et al*., 1986). In the EU countries about 40 % of the population are exposed to road traffic noise with an $L_{Aeq,T}$ exceeding 55 dB daytime and 20 % are exposed to levels exceeding 65 dB. Generally, about half of the EU citizens are estimated to live in zones which do not ensure acoustic comfort to residents. More than 30% are exposed at night to noise levels exceeding 55 dB L_{Aeq} which are disturbing to sleep.

The hearing loss is due to prolonged noise exposure which is generally associated with destruction of the hair cells of the inner ear. The severity of noise-induced hearing loss depends on both the location and the extent of damage in the organ of Corti, which, in turn, depends on the intensity and frequency of the sound exposure. The higher the frequency, the nearer the point of maximum displacement of the basilar membrane is to the base of the cochlea where the basilar membrane is narrowest. This point is shifted towards the apex of the cochlea as the sound frequency decreases. The maximum stimulation of cells occurs at the point of maximum displacement. A large part of the upper cochlea is responsive to low frequency stimulation and loss of hair cells can be extensive without significant loss in low frequency sensitivity. Noise may cause the destruction of the Corti organ by altering the cochlear blood flow which in turn may alter the metabolic status of the cells and the local temperature leading to damaged proteins (WHO, 1999).The Federal Government of Nigeria under sections 28 and 107 of the national environmental act Cap 153 on 21st March 2003 enacted the National Environment (Noise Standard and Control) Regulation, 2003 where the permissible limit of noise is defined (Table 2.4).

Table 2.3: Maximum Permissible Noise Levels for General Environment

Facility	Noise Limit dB (A) Leq.	
	Day	Night
A. Any building used as hospital, convalescence home, home for the aged, sanatorium and institutes of higher learning, conference rooms, public library, environmental or recreational sites.	45	35
B. Residential buildings	50	35
C. Mixed residential (with some commercial and entertainment)	55	45
D. Residential + industry or small-scale production + commerce	60	50
E. Industrial	70	60

Adapted from National Environmental Standards and Regulations Enforcement Agency (NESREA, 2007)

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

The study was conducted in Zaria, a prominent city in Kaduna State, Nigeria with 698,348 inhabitants according to the 2006 population and housing census (NPC, 2010). It is situated between latitude 11°06′40" N and longitude 7°43′23″E and covers a large area of land of about 300 km^2 at an altitude of 644 m above sea level. Zaria has approximately 200 academic settings comprising of public and private nursery, primary and secondary schools as well as high institutions of learning.

3.2 Study Design

This study was a descriptive cross-sectional survey involving field measurements of environmental noise levels at specific recorded geographical coordinates (WHO, 1999; Department of Environment, Park, Heritage and the Arts, 2008; Central Pollution Control Board, 2015). The overall study population include students in primary 5 and 6 (these are the two terminal classes in the primary school education system in Nigeria), Senior Secondary School Classes I and II, and their teachers. A combination of stratified and random sampling was employed in getting the appropriate sample population for the study. Data collection was conducted in 20 schools (9 Primary and 11 Secondary Schools) which were selected using systematic sampling within the study area. A total of 574 participants were included in the study, which involved 155 teachers and 419 students.

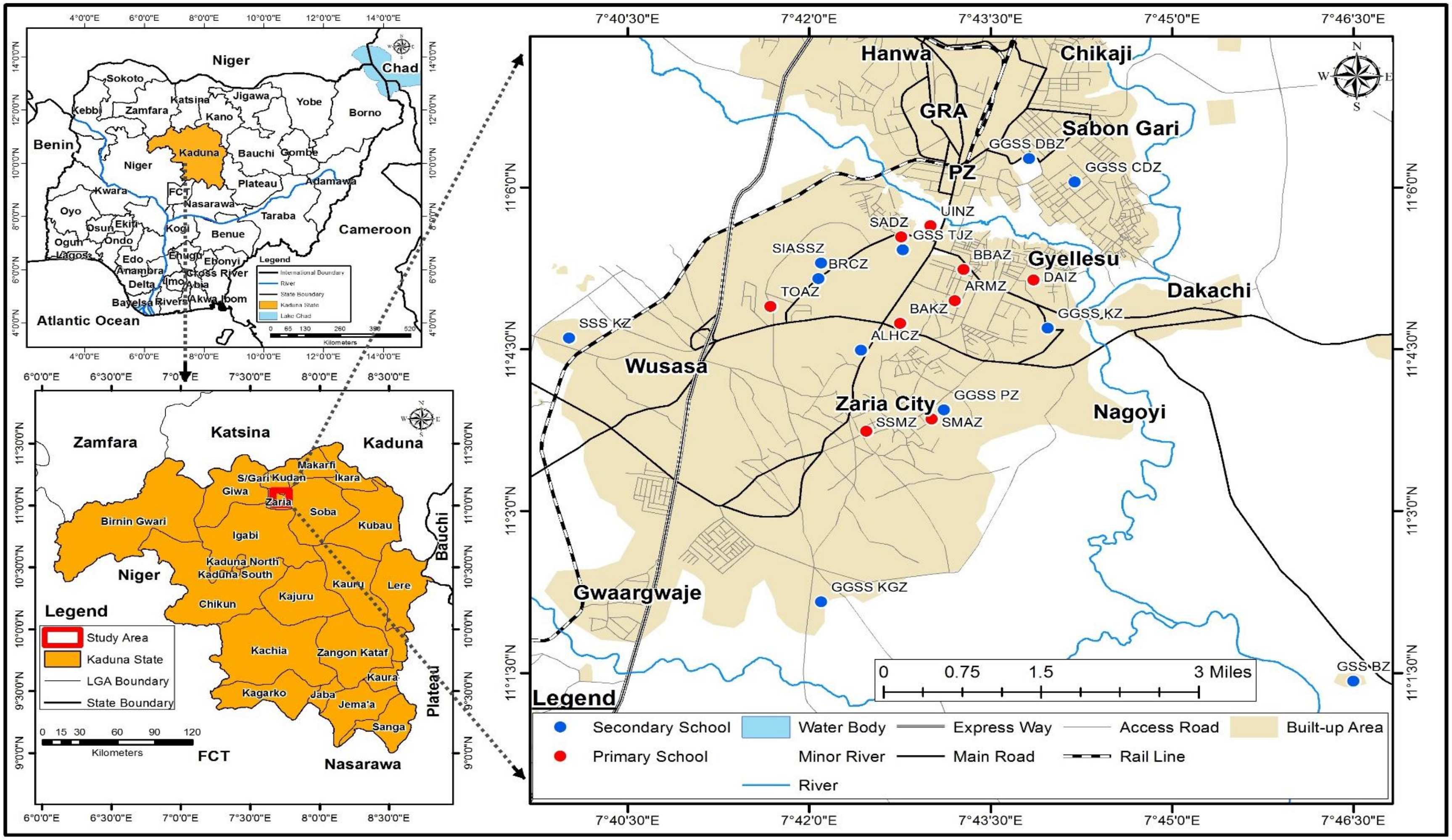


Figure 3.1: Map of Zaria showing the schools involved in the research

3.3 Criteria for School Selection

The schools used for this research were selected based on the following criteria:

a. Located along the road side.

   i. Along heavy traffic road.

   ii. Along light traffic road.

b. Submerged into residential buildings.

3.4 Assessment of Noise Levels

Two methods of assessment were used in carrying out this research, these methods include:

1. Objective assessment
2. Subjective assessment

3.5 Subjective Assessment - Data Collection on Environmental Issues

Structured questionnaires were administered to collect data related to environmental, health and learning related issues, with a focus on noise and its sources located outdoors and indoors. This was designed based on previous research in the USA including qualitative and quantitative measurement related to noise loudness and/ or frequency (Shendell *et al*., 2002). The questionnaire was also designed based on recommendations of Basner *et al*. (2015) for the International Commission on the Biological Effects of Noise (ICBEN) which prescribed the inclusion of annoyance level in the subjective response of the respondents.

The questionnaire contained both open and closed ended questions with three (3) sections.

- Section A - General information about the schools;
- Section B - Socio-demographic data on participants;
- Section C - Occupational and learning related features of the schools and classroom; noise pollution level, different noise sources and noise awareness.

The Questionnaire were self-administered.

3.6 Minimum Sample Size Calculation

The minimum sample size calculation was performed using Cochran (1977) sample size formula:

$$n = \frac{Z^2 P(1-P)}{d^2}$$

Where n = minimum sample size

Z = Statistics corresponding to the level of confidence (1.96)

P = Expected Prevalence (89% according to the report of Debnath *et al*., 2012)

d = Margin of Error (0.05)

3.7 Validity of the Questionnaire

The questionnaire's validity to measure the desired parameters was determined by experts' judgements in the Faculty of Education, Ahmadu Bello University, Zaria.

3.8 Reliability of the Questionnaire

To test the questionnaire for its reliability, a pre-test was carried out and the questionnaire was tested for its internal consistency using Cronbach's alpha in SPSS v20.

3.9 Objective Assessment: Quantification of Noise

The ambient noise monitoring was carried out using an EXTECH 407732 sound level meter. The monitoring and traffic density around the schools in the study area was carried out during the months of May to October, 2016. The noise level meter was set at the slow response mode with A-weighting (A-weighted decibels (dBA)). The measurement was conducted thrice per day,

- ✓ 6.30 A.M. – 7:10 A.M.

- ✓ 8.00 A.M. – 10:00 A.M.
- ✓ 10.00 A.M. – 10:30 A.M.
- ✓ 11:00 A.M. – 12:45 P.M.

Measurements were conducted at two points in the 40 classrooms. The Sound level meter was held at a height of 1.2 meters and 3 meters away from where the students sit. The data was recorded daily for a period of two school days. During each sampling of noise, ten (10) readings of sound pressure level (SPL) were recorded at an interval of 4 minutes in a period of 40 minutes which is equivalent to a lesson period in primary and secondary schools.

The meter was held at a position of 45^o in the midst of the students at a height of 1.2 meters which correspond to the average ear height of the students. Sound level measurements were made for 40 minutes in the middle of a lesson for each class. Immediately after the sound level measurements, students were asked to fill in the questionnaire (419 Students).

The L_{AI} (A-weighted instantaneous sound pressure level) measurements were recorded twice each day for two days per school. In each of the schools, measurements were conducted at six points per school involving two classrooms, two points on the corridor and two points on the playground.

From the readings, commonly used community noise assessment parameters like the exceedance percentiles L_{10}, L_{50}, and L_{90}, Constant equivalent noise level ($L_{Aeq.}$), Noise pollution level (L_{NP}), Traffic Noise Index (T_{NI}) and Noise Climax (NC) were computed. A hand-held, battery-powered factory calibrated global positioning system (Etrex Garmin) was used to determine the coordinates of the schools (Table 4.1). Traffic density (automobiles, vans, smaller and larger trucks, and buses) around the schools was also determined during the study period.

3.10 Traffic Monitoring:

Based on the responses of the population included in this study, the manual traffic assessment of automobiles around the schools was observed.

3.11 Data Analyses:

The A-weighted instantaneous sound pressure level obtained was used to compute various noise parameters which includes the following:

- Percentile Noise Levels (L_{10}, L_{50}, L_{90})
    - L_{10}: L_{10} is an indication that the upper end of the level range
    - L_{50}: constitutes the background level in the absence of nearby noise sources.
    - L_{90}: is the instantaneous noise level that exceeds 90% of the time.
- L_{Aeq}: is defined as the total energy response by the human ear and hence an indicator of physiological disturbance to the hearing mechanism.

$$LAeq. = 10 \text{Log} \frac{1}{T} \sum_{i=1}^{n} 10^{\frac{Li}{10}} * ti$$

- Noise Pollution Level (L_{NP}): this gives vibration in sound signal with a fluctuating noise.

$$L_{NP} = LAeq. + (L10 - L90)$$

OR

$$L_{NP} = LAeq. + KS$$

Where K = 2.56 and 'S' is the Standard deviation of the A-weighted Instantaneous Noise Level.

- Traffic Noise Index (TNI) = 4*(L_{10}-L_{90}) + L_{90} – 30dB (A)

(Essandoh and Armah, 2011).

The data from the completed questionnaires was analysed using SPSS statistical software package version 20. Descriptive statistics and t-test analysis were performed and the differences were considered significant at $p<0.05$. A One-way ANOVA was used to determine the differences between the indoor, outdoor and traffic noise levels.

CHAPTER FOUR

4.0. RESULTS

4.1. Schools and Noise Level

Table 4.1 shows the GPS locations of the sampled schools. The mean number of students per class ranged from 42 - 130. The highest and lowest were recorded in UNIZ and SSSKZ respectively. Among the sampled primary schools, UINZ and BAKZ recorded the largest classroom population while SMAZ and BBAZ had the smallest. Also, among the sampled secondary schools, SIASSZ had the largest classroom size while SSSKZ and GSSBZ had the smallest classroom size. The background noise level (BNL) quantified in the absence of the students in the classroom in the early hours of the day indicated that among the primary schools, ARMZ and UINZ had the highest noise pollution level (LNP) while DAIZ and BAKZ had the lowest LNP (Table 4.2). The BNL of the secondary schools revealed that ALHCZ and GSSTJ had the highest LNP while GGSSSCZ and GSSBZ were relatively lower (Table 4.3).

The continuous equivalent sound energy (L_{Aeq}) quantified on the playground is presented in Figures 4.1 and 4.2. Schools such as ARMZ, UINZ, SADZ, SSMZ and BBAZ had extremely higher values while DAIZ had the lowest (63.4 dBA). Among the secondary schools sampled, GGSSPZ was quantified to have the highest (76.6 dBA) while GSSBZ had the lowest (58.9 dBA). The values recorded were higher than the WHO standard of 35dBA. This study revealed that the noise pollution level (LNP) of the primary schools in the study area do not vary too much than the LNP in the secondary schools (Table 4.4).

Table 4.1: Sampled Schools in Zaria for noise level assessment with location and Mean Number of students per class (n)

S/N	School Acronym	GPS Coordinates	n
1.	ARMZ	N11º05.141′ E007º43.856′ 648m	60
2.	DAIZ	N11º04.948′ E007º43.207′ 621m	65
3.	BAKZ	N11º04.738′ E007º42.753′ 657m	124
4.	SSMZ	N11º03.762′ E007º42.473′ 636m	73
5.	SMAZ	N11º03.852′ E007º43.015′ 654m	50
6.	UINZ	N11º05.613′ E007º43.267′ 632m	130
7.	TOAZ	N11º04.895′ E007º41.682′ 661m	96
8.	BBAZ	N11º05.239′ E007º43.278′ 642m	50
9.	SADZ	N11º05.541′ E007º42.763′ 617m	70
10.	ALHCZ	N11º04.490′ E007º42.431′ 678m	74
11.	BRCZ	N11º05.152′ E007º42.078′ 633m	60
12.	SSSKZ	N11º04.604′ E007º40.017′ 588m	42
13.	GSSTJZ	N11º05.512′ E007º42.761′ 599m	77
14.	SIASSZ	N11º05.299′ E007º42.100′ 655m	100
15.	GSSBZ	N11º01.423′ E007º46.500′ 626m	43
16.	GGSSKGZ	N11º02.158′ E007º42.101′ 650m	84
17.	GGSSPZ	N11º03.880′ E007º43.029′ 655m	95
18.	GGSSDBZ	N11º06.265′ E007º43.819′ 604m	73
19.	GGSSCDZ	N11º06.050′ E007º44.198′ 658m	56
20.	GGSSKZ	N11º04.695′ E007º43.973′ 622m	62

Table 4.2: Background Noise Levels of the Sampled Primary Schools (dBA) in Zaria

S/N	Primary School	L_{10}	L_{50}	L_{90}	L_{Aeq}	L_{NP}	NC
1.	ARMZ	62.53	60.28	55.06	61.57	69.78	8.03
2.	DAIZ	40.47	38.00	35.53	38.40	43.35	4.95
3.	BAKZ	40.28	39.26	38.15	39.41	41.95	2.54
4.	SSMZ	49.98	45.26	43.15	46.16	53.51	7.25
5.	SMAZ	46.45	44.11	42.00	44.54	49.49	4.45
6.	UINZ	58.99	55.11	55.25	56.16	64.09	8.13
7.	TOAZ	45.95	42.53	37.57	43.81	52.31	8.40
8.	SADZ	50.32	46.75	42.74	47.84	55.76	7.39
9.	BBAZ	50.89	48.00	44.19	48.88	56.11	7.06

Keys: ARMZ - AbdulRahaman Primary School; DAIZ - Dr. Abubakr Imam Primary School; BAKZ - Bello Aliyu Primary School; SSMZ - Sarki Sambo Primary School; SMAZ - Sarki Musa Primary School; UINZ - U.B.E. Isan Nabawa Primary School; TOAZ - Tsoho Abdullahi Primary School; SADZ - Sani Adamu Primary School; BBAZ - Baba Ahmad Primary School.

Table 4.3: Background Noise Levels of Sampled Secondary Schools (dBA) in Zaria

S/N	Secondary School	L_{10}	L_{50}	L_{90}	L_{Aeq}	L_{NP}	NC
1.	ALHCZ	54.01	45.00	41.11	48.03	60.59	12.59
2.	SIASS	44.45	38.75	36.75	39.99	47.51	7.53
3.	GGSSPZ	48.01	45.00	41.82	45.71	52.03	6.32
4.	GGSSCZ	30.05	28.00	25.15	28.51	33.94	5.30
5.	GGSSKZ	46.95	44.53	43.53	44.74	48.17	3.47
6.	GGSSKGZ	46.43	43.11	38.86	44.69	55.07	10.31
7.	SSSKZ	38.85	33.50	30.10	34.86	43.64	8.70
8.	GSSTJZ	52.33	48.09	42.10	50.03	60.46	10.23
9.	GGSSDBZ	49.01	46.45	41.10	48.14	58.36	8.75
10.	GSSBZ	32.00	29.53	27.57	29.88	34.31	4.47
11.	BRCZ	51.93	45.76	43.62	46.89	55.16	8.15

Keys: ALHCZ - Al Huda Huda College; SIASS - Sheikh Ibrahim Arabic Special School; GGSSPZ - Government Girls' Secondary School Pada; GGSSCZ - Government Girls' Secondary School Chindit; GGSSKZ - Government Girls' Secondary School Kongo; GGSSKGZ - Government Girls' Secondary School kofar-Gayan; SSSKZ - Science Secondary School Kufena; GSSTJZ - Government Secondary School Tudun-Junkun; GGSSDBZ - Government Girls' Secondary School Dogon-Bauchi; GSSBZ - Government Secondary School Bogari; BRCZ - Barewa College.

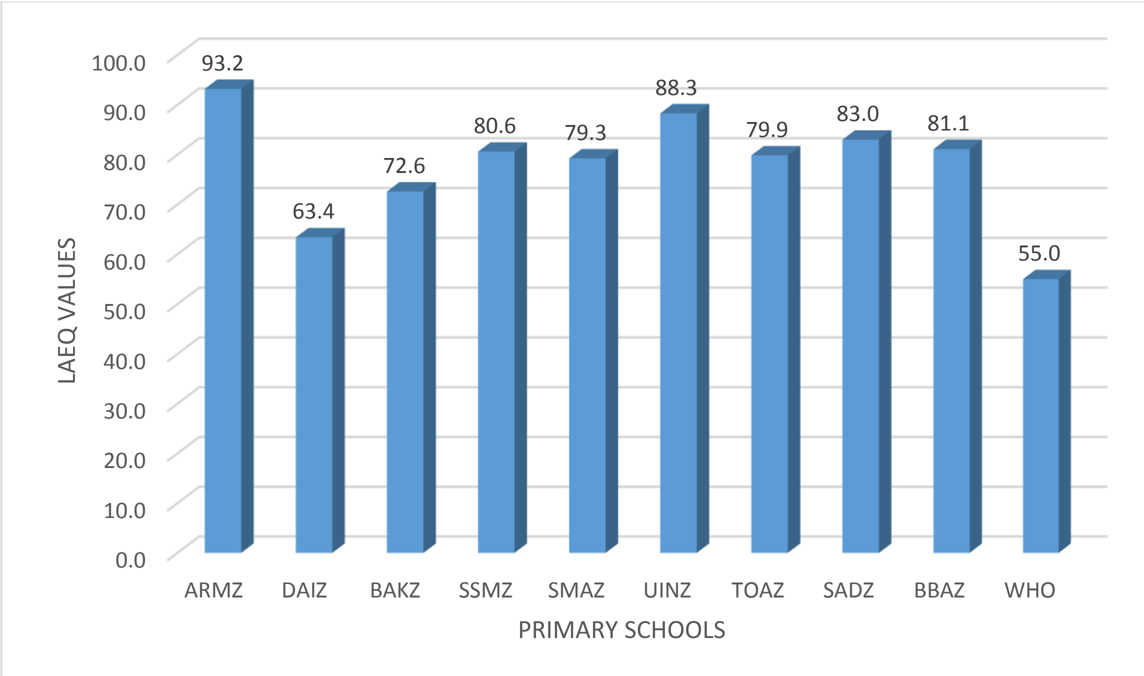


Figure 4.1: Playground Noise L_{Aeq} for Primary Schools in Zaria

Keys: ARMZ - AbdulRahaman Primary School; DAIZ - Dr. Abubakr Imam Primary School; BAKZ - Bello Aliyu Primary School; SSMZ - Sarki Sambo Primary School; SMAZ - Sarki Musa Primary School; UINZ - U.B.E. Isan Nabawa Primary School; TOAZ - Tsoho Abdullahi Primary School; SADZ - Sani Adamu Primary School; BBAZ - Baba Ahmad Primary School.

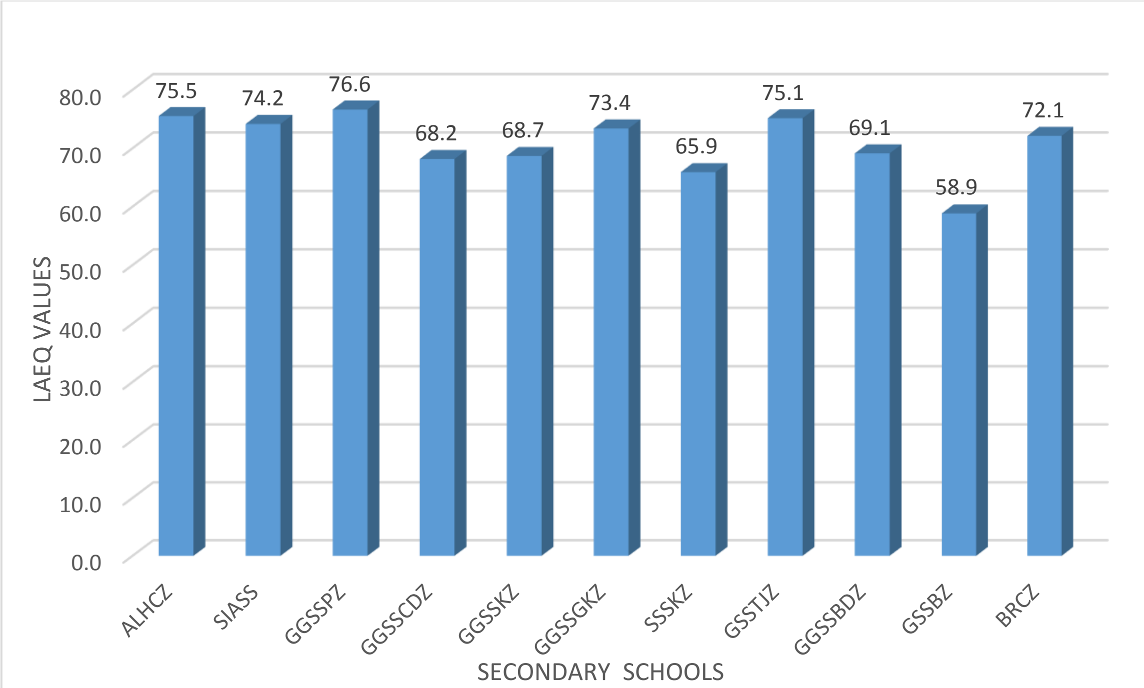


Figure 4.2: Playground Noise L_{Aeq} for Secondary Schools in Zaria

Keys: ALHCZ - Al Huda Huda College; SIASS - Sheikh Ibrahim Arabic Special School; GGSSPZ - Government Girls' Secondary School Pada; GGSSCZ - Government Girls' Secondary School Chindit; GGSSKZ - Government Girls' Secondary School Kongo; GGSSKGZ - Government Girls' Secondary School kofar-Gayan; SSSKZ - Science Secondary School Kufena; GSSTJZ - Government Secondary School Tudun-Junkun; GGSSDBZ - Government Girls' Secondary School Dogon-Bauchi; GSSBZ - Government Secondary School Bogari; BRCZ - Barewa College.

Table 4.4: Noise Levels in Some Primary and Secondary Schools in Zaria, Nigeria

Variables	N	Mean	SE	df	t-cal	P(Sig. 2-tailed)
Primary School	9	84.23	2.33			
				18	0.134	0.895
Secondary School	11	83.77	2.49			

4.2. The Equivalent Continuous Sound Energy ($L_{Aeq.}$)

The variation in the decibels of sound energy existing within the classroom from morning to afternoon was quantified. Among the primary schools, UINZ was observed to have the highest indoor $L_{Aeq.}$ in the morning (85.17 dBA) but becomes lower in the afternoon as seen in Figure 4.3. Schools such as ARMZ, DAIZ, SMAZ, TOAZ, SADZ, and BBAZ were of lowered indoor L_{Aeq} in the morning but increased in the afternoon. Among the primary schools, DAIZ had the lowest indoor L_{Aeq} in the morning (52.29 dBA) and increased in the afternoon (64.95 dBA). Among the secondary schools, GGSSDBZ had the highest indoor L_{Aeq} both in the morning and afternoon (77.81 and 85.87 dBA respectively) as seen in Figure 4.4. GSSBZ was quantified to have the lowest both in the morning and afternoon with 46.81 and 51.59 dBA respectively.

In all the primary schools sampled in the study, ARMZ had the highest outdoor L_{Aeq} in the morning (83.32 dBA) while DAIZ had the lowest (53.56 dBA). The outdoor L_{Aeq} in ARMZ increased in afternoon (86.66 dBA). In SSMZ, SMAZ, and UINZ, the outdoor L_{Aeq} were relatively the same both in the morning and afternoon (Fig. 4.5). Among the surveyed secondary schools presented in Figure 4.6, GGSSGKZ had the highest outdoor L_{Aeq} in the morning while GSSBZ had the lowest in the morning (57.16 dBA). On the other hand, SIASS had the highest in the afternoon (80.79 dBA) while GSSBZ has the lowest L_{Aeq} (50.65 dBA) in the afternoon.

The paired t-test carried out to test for significant difference between the $L_{Aeq.}$ morning and afternoon reveal no statistically significant change in the continuous equivalent sound energy from morning to afternoon. In the primary school, t (9) = -1.111, $p > 0.05$, indicating that there was no significant change in the L_{Aeq} from morning to afternoon. That is from 70.2922 ± 3.19 to 72.7611 ± 2.43 ($p < 0.05$) (Table 4.5). Also in the secondary schools, t (11) = -

0.026, $p > 0.05$ (Table 4.5) indicating that there was no statistically significant change in the L_{Aeq} from morning to afternoon from 66.6436 ± 2.50 to 66.6918 ± 2.56 ($p < 0.05$).

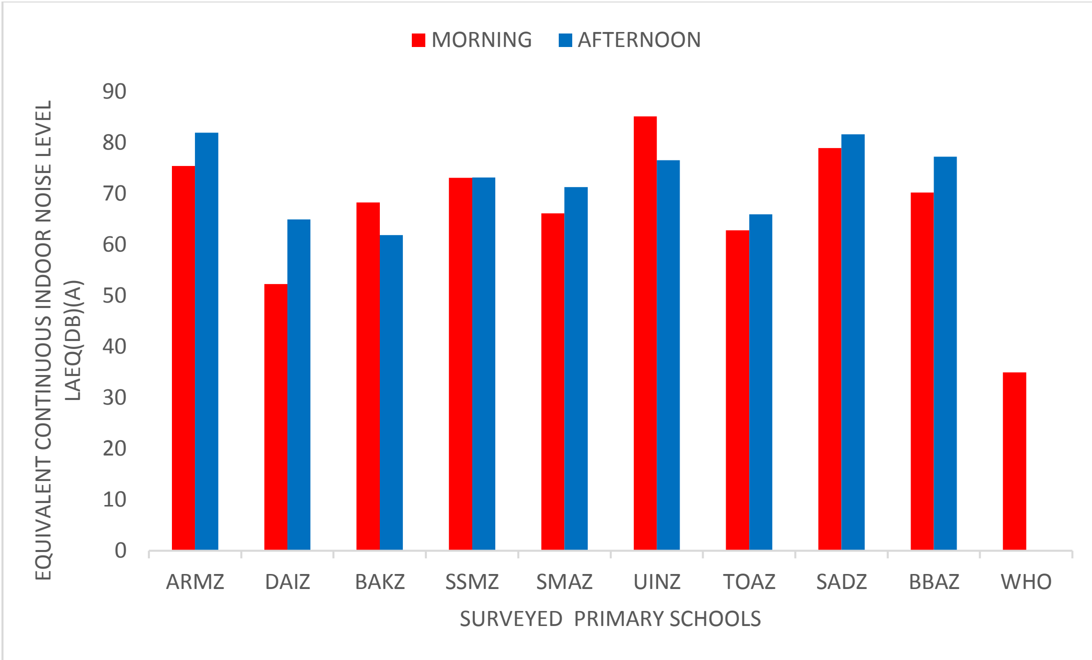


Figure 4.3: Variation of Indoor L_{AeqMA} with Sampled Primary Schools and Period of the day

Keys: ARMZ - AbdulRahaman Primary School; DAIZ - Dr. Abubakr Imam Primary School; BAKZ - Bello Aliyu Primary School; SSMZ - Sarki Sambo Primary School; SMAZ - Sarki Musa Primary School; UINZ - U.B.E. Isan Nabawa Primary School; TOAZ - Tsoho Abdullahi Primary School; SADZ - Sani Adamu Primary School; BBAZ - Baba Ahmad Primary School.

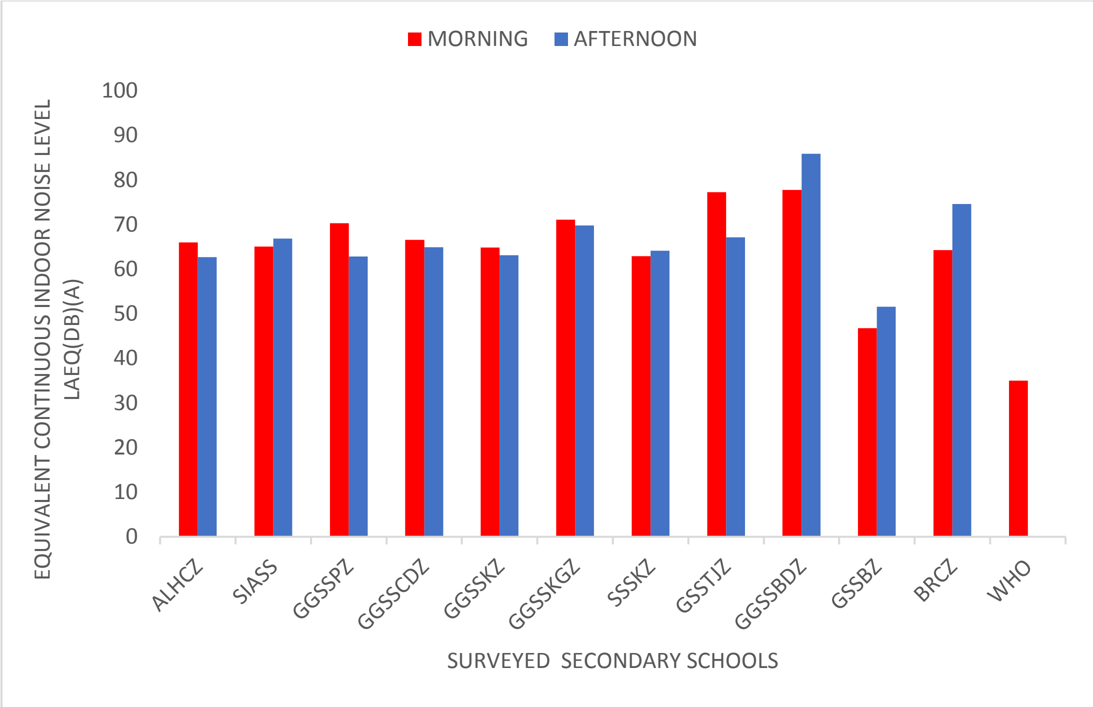


Figure 4.4: Variation of Indoor L_{AeqMA} with Selected Secondary Schools and Period of the day

Keys: ALHCZ - Al Huda Huda College; SIASS - Sheikh Ibrahim Arabic Special School; GGSSPZ - Government Girls' Secondary School Pada; GGSSCZ - Government Girls' Secondary School Chindit; GGSSKZ - Government Girls' Secondary School Kongo; GGSSKGZ - Government Girls' Secondary School kofar-Gayan; SSSKZ - Science Secondary School Kufena; GSSTJZ - Government Secondary School Tudun-Junkun; GGSSDBZ - Government Girls' Secondary School Dogon-Bauchi; GSSBZ - Government Secondary School Bogari; BRCZ - Barewa College.

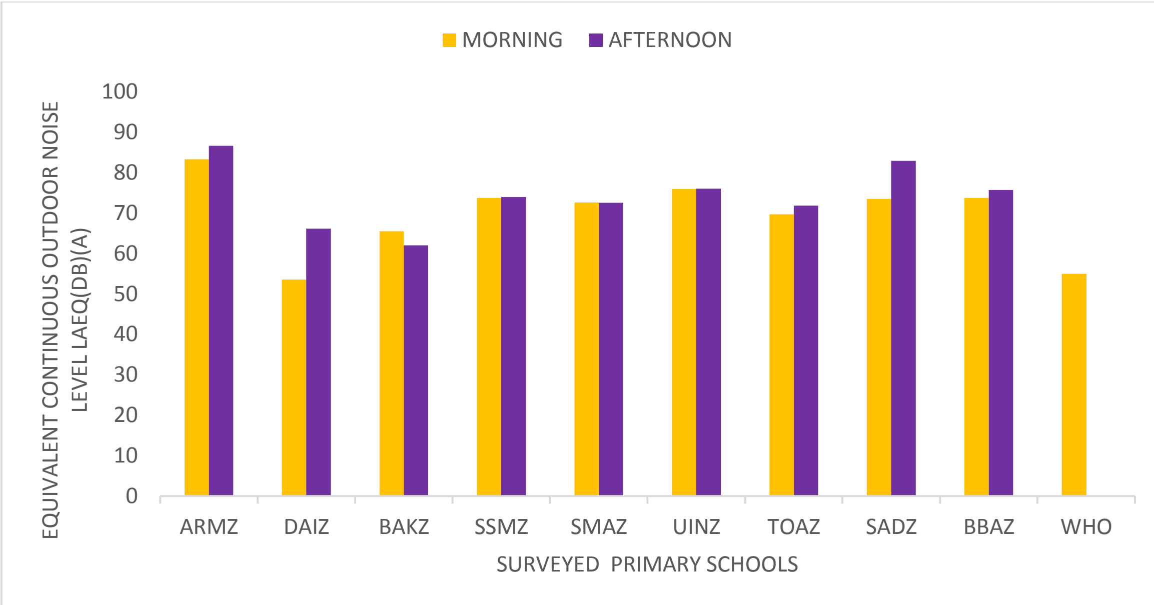


Figure 4.5: Variation of Outdoor L_{AeqMA} with Selected Primary Schools and Period of the day

Keys: ARMZ - AbdulRahaman Primary School; DAIZ - Dr. Abubakr Imam Primary School; BAKZ - Bello Aliyu Primary School; SSMZ - Sarki Sambo Primary School; SMAZ - Sarki Musa Primary School; UINZ - U.B.E. Isan Nabawa Primary School; TOAZ - Tsoho Abdullahi Primary School; SADZ - Sani Adamu Primary School; BBAZ - Baba Ahmad Primary School.

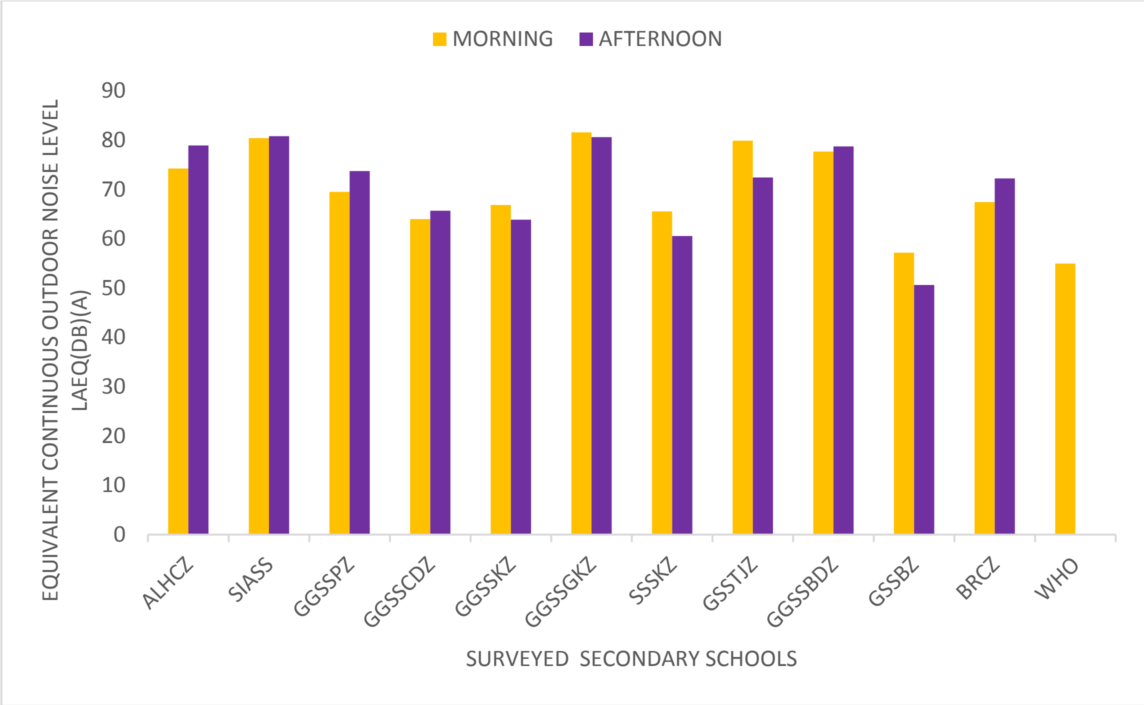


Figure 4.6: Variation of Outdoor L_{AeqMA} with Selected Secondary Schools and Period of the day

Keys: ALHCZ - Al Huda Huda College; SIASS - Sheikh Ibrahim Arabic Special School; GGSSPZ - Government Girls' Secondary School Pada; GGSSCZ - Government Girls' Secondary School Chindit; GGSSKZ - Government Girls' Secondary School Kongo; GGSSKGZ - Government Girls' Secondary School kofar-Gayan; SSSKZ - Science Secondary School Kufena; GSSTJZ - Government Secondary School Tudun-Junkun; GGSSDBZ - Government Girls' Secondary School Dogon-Bauchi; GSSBZ - Government Secondary School Bogari; BRCZ - Barewa College.

Table 4.5: Morning and Afternoon L_{Aeq} in Some Primary and Secondary Schools in Zaria, Nigeria

Schools	Pairs	N	Mean	SE	df	t-cal	P(Sig. 2-tailed)
	Morning L_{Aeq}	9	70.29	3.19			
					8	1.111	0.299
Primary	Afternoon L_{Aeq}	9	72.76	2.43			
Secondary	Morning L_{Aeq}	11	66.64	2.50			
					10	0.026	0.980
	Afternoon L_{Aeq}	11	66.69	2.56			

4.3. Difference Between Indoor, Outdoor and Traffic Noise Indices

The average traffic noise around the schools was assessed during the study. Among the primary schools, ARMZ was calculated to have TNI of 122.7 dBA, followed by SMAZ with an index of 109.6 dBA, and DAIZ was observed to have the least value of 64.3 dBA. Also among the secondary schools, SSSKZ was surprisingly observed to have the highest TNI of 123.1 dBA during the time of the study, though it was categorized among the less traffic school. During the study, SSSKZ was found to have high number of heavy trucks plighting the road in front of school which however increased the traffic noise of the area. BRCZ, SIASS, and GSSTJZ followed with 114.4, 107.1 and 104 dBA (Table 4.6). The impact of traffic noise was tested to check if there is any difference existing between the traffic noise, indoor and outdoor noise levels. The result of the analysis in Table 4.7 indicated that there was no significant difference statistically in the traffic, indoor, and outdoor noise levels in the primary and secondary schools.

Table 4.6: Average Traffic Noise Level around Sampled Schools (dBA) in Zaria, Nigeria

S/N	School	Average Traffic Noise Parameters						
		L_{10}	L_{50}	L_{90}	L_{EQ}	L_{NP}	TNI	NC
1.	ARMZ	83.3	70.8	67.7	74.5	92.6	122.7	14.3
2.	DAIZ	55.2	51.4	44.2	54.1	66.9	64.3	10.4
3.	BAKZ	72.4	66.0	62.2	69.9	81.1	81.8	12.6
4.	SSMZ	75.2	71.5	68.1	72.6	80.6	70.6	6.8
5.	SMAZ	71.9	64.5	58.6	68.1	83.7	109.6	13.5
6.	UINZ	80.1	72.6	69.1	74.7	86.0	88.6	11.1
7.	TOAZ	68.7	63.4	56.7	66.4	79.7	79.5	12.2
8.	SADZ	81.2	73.4	68.9	76.8	91.9	98.8	14.1
9.	BBAZ	73.5	66.4	62.5	68.9	81.7	86.5	10.9
10.	ALHCZ	75.9	73.5	68.3	74.7	83.5	74.0	8.1
11.	SIASS	73.4	63.8	56.7	68.8	88.0	109.1	20.0
12.	BRCZ	71.5	64.0	55.4	69.8	92.9	114.4	20.8
13.	GGSSPDZ	71.0	64.0	60.6	66.0	78.9	87.4	12.7
14.	GGSSCDZ	61.6	55.7	53.2	57.1	67.4	69.4	8.5
15.	GGSSKZ	65.3	62.6	58.8	63.4	70.3	56.2	5.9
16.	SSSKZ	74.3	58.1	51.8	67.1	91.3	123.1	24.5
17.	GSSTJZ	71.6	62.9	58.8	66.2	83.7	104.0	16.7
18.	GGSSDB	79.9	71.5	66.0	75.2	90.2	95.7	11.4
19.	GSSBZ	68.1	66.4	63.5	66.9	62.3	54.5	4.6
20.	GGSSKGZ	77.4	70.3	65.8	72.6	62.3	90.0	11.0

Table 4.7: Differences between the Noise Pollution Levels in and around the selected Schools in Zaria, Nigeria

Noise	Effects (Mean ± SE)
TNI	89.01±4.62[a]
IND	82.11±2.01[a]
OUT	84.97±1.84[a]
Average	85.36±1.80

Level of Significance = 0.05.

4.4. Effect of Noise Pollution on Teaching and Learning

Table 4.8 present the demographic result of the teachers surveyed in the course of the study. The entire 155(100%) teachers reported that their schools lack sound insulation or any other noise barrier. The most affected teachers were of age 31-40 years (34.2%) and 25-30years (21.60%). In the research study, 83(60%) were females while 62(40%) are males. The exposure period of the noise on the teachers and students was reported to be at least 5hours per day. In assessing the perception of teachers on the effects of noise on teaching process and the teacher, 92.3% of the teachers reported that external noise affects the concentration of the teachers in the delivery of lesson. 94.2% of the teachers also agree that noise affect teaching. Pointing out communication interference (93.5%) and voice masking (90.3%) as the major problem. In the same vein, 66.4% reported that road noise affect the process of delivering lesson, as the students quickly get tired (71%) (Table 4.9). However, the P-value of the chi-square is less than the alpha value ($p<0.05$), which means that the variables are dependent in the population and that there is a statistical relationship between the categorical variables.

The perception of the students' on the effect on learning was also assessed to determine its effects on the process. In the socio-demographic result, 99.3% of the students reported that their schools lack sound insulation. Largely, they fall between the age of 10-20 years, of which 46.3% are males and 53.7% were females, whereby 99.8% said they spent around 5hours in the school every day (Table 4.10). In Table 4.11, 92.6% of the respondents reported that noise reduces learning ability. These students pointed out that external noise affected their concentration (90.7%), causing their reading ability (94.5%) and listening ability (87.6%) to reduce. They reported speech intelligence (90.7%) and speech communication (90%) interference as some of the problems. However, 93.8% of the respondent believed that they will feel good and comfortable, if the noise is controlled (Table 4.11). Regarding the students' perception of noise pollution level and noise awareness (Table 4.15), 43% of the students considered the noise level of their school environments to be very annoying, 55.5% reportedly said they are not aware of noise pollution. 70.6% of the students also reported that the noise within and around the school environment is generated on daily basis, and 57.5% of them claimed that there have not been any effort to control noise. The percentage responses were subjected to Chi-square and this shows that $p<0.05$, inferring that the variables are dependent in the population and that there is a statistical relationship between the categorical variables.

Table 4.8: Teachers' Socio-demography of the Sampled Schools

Variables	R1 (%)	R2 (%)	R3 (%)	R4 (%)	R5 (%)	Chi-square	P-value
Sound Insulation	0(0.00)	155(100)	-	-	-	-	-
Age	14(9.03)	49(31.60)	53(34.2)	31(20.00)	8(5.2)	52.45	0.00
Gender	62(40.00)	93(60.00)	-	-	-	73.02	0.00
Hours Spent/day	154(99.4)	1(0.6)	-	-	-	151.03	0.00
Noise Pollution Perception	41(26.5)	50(32.3)	56(36.1)	8(5.2)		35.48	0.00

N = 155 Keys: R1 = Provided/20-24years/Male/5hrs/Extremely Annoying

R2 = Not Provided/25-30years/Female/8hrs/Very Annoying

R3 = 31-40years/10hrs/Slightly Moderate

R4 = 41-50years/Not at all

R5 = 51-60years

Table 4.9: Effects of Noise Pollution on Teaching in Some Schools in Zaria, Nigeria

S/N	Variables	SA	A	IN	D	SD	Chi-square	P-value
1.	External Noise on Concentration	70(45.2)	73(47.1)	2(1.3)	8(5.2)	2(1.3)	177.29	0.00
2.	Teaching	59(38.1)	87(56.1)	7(4.5)	2(1.3)	-	131.53	0.00
3.	Communication Interference	69(44.5)	76(49.0)	1(0.6)	9(5.8)	-	119.04	0.00
4.	Reduced Social Interaction	30(19.4)	79(51.0)	19(12.3)	22(14.2)	5(3.2)	103.42	0.00
5.	Better Feeling	84(54.2)	66(42.6)	1(0.6)	3(1.9)	1(0.6)	213.48	0.00
6.	Comfort Level	55(35.5)	86(55.5)	9(5.8)	4(2.6)	1(0.6)	184.32	0.00
7.	Behaviour	31(20.0)	69(44.5)	17(11.0)	32(20.6)	6(3.9)	73.10	0.00
8.	Voice Masking	71(45.8)	69(44.5)	4(2.6)	10(6.5)	1(0.6)	164.97	0.00
9.	Road Noise	32(20.6)	71(45.8)	19(12.3)	26(16.8)	7(4.5)	75.68	0.00
10.	Tiredness	39(25.2)	71(45.8)	17(11.0)	22(14.2)	6(3.9)	82.77	0.00
11.	Learning Ability	59(38.1)	8(5.2)	8(5.2)	7(4.5)	4(2.6)	152.71	0.00

Table 4.10: Demographic Information on Students of the Sampled Schools in Zaria, Nigeria

Variables	R1 (%)	R2 (%)	R3 (%)	R4 (%)	Chi-square	P-value
Sound Insulation	3 (0.7)	416 (99.3)	-	-	407.09	0.00
Age	244 (58.2)	163 (38.9)	12 (2.9)	-	198.54	0.00
Gender	194 (46.3)	225 (53.7)	-	-	2.29	0.13
Hours Spent/day	418 (99.8)	1 (0.2)	-	-	415.01	0.00

N= 419 Keys: R1 = Provided/10-15years/Male/5hrs;

R2 = Not Provided/ 16-20years/Female/8hrs;

R3 = 21-25years/10hrs;

R4 = 10hrs

Table 4.11: Effects of Noise on Students Learning in Some Schools in Zaria

S/N	Variables	SA	A	IN	D	SD	Chi-square	P-value
1.	External Noise on Concentration	268(64.0)	112(26.7)	11(2.6)	19(4.5)	9(2.1)	594.50	0.00
2.	Behaviour	186(44.4)	201(48.0)	17(4.1)	12(2.9)	3(.07)	481.23	0.00
3.	Reading Ability	244(58.2)	152(36.3)	11(2.6)	7(1.7)	5(1.2)	569.48	0.00
4.	Listening Ability	238(56.8)	129(30.8)	8(1.9)	15(3.6)	29(6.9)	469.01	0.00
5.	Intermittent Noise	133(31.7)	174(41.5)	63(15.0)	31(7.4)	18(4.3)	216.07	0.00
6.	Road Noise	135(32.2)	167(39.9)	25(6.0)	61(14.6)	31(7.4)	194.62	0.00
7.	Stress	201(48.0)	173(41.3)	14(3.3)	24(5.7)	7(1.7)	430.06	0.00
8.	Social Interaction	166(39.6)	182(43.4)	36(8.6)	18(4.3)	17(4.1)	327.89	0.00
9.	Learning Ability	243(58.0)	145(34.6)	12(2.9)	12(2.9)	7(1.17)	540.56	0.00
10.	Speech Intelligence	195(46.5)	185(44.2)	16(3.8)	9(2.1)	14(3.3)	449.53	0.00
11.	Headache	226(53.9)	162(38.7)	14(3.3)	8(1.9)	9(2.1)	507.74	0.00
12.	Speech Communication	186(44.4)	191(45.6)	20(4.8)	14(3.3)	8(1.9)	437.05	0.00
13.	Conflicts	200(47.7)	177(42.2)	12(2.9)	15(3.6)	15(3.6)	439.27	0.00
14.	Control	285(68.0)	108(25.8)	12(2.9)	6(1.4)	8(1.9)	692.37	0.00

4.5 Mean Vehicular Density on Roads near the Selected Schools in Zaria, Nigeria

The entire students that participated in this study were asked to identify the sources of noise which they are exposed to and as such affected their learning process. Based on percentage responses, 36.5% of the students pointed out motorcycle, and 23.0% and 29.5% pointed out bus and vehicular horn respectively as sources of external noise. Likewise, 54.6% and 63.5% of the students identified noise from adjacent classes and classmates respectively as sources of internal noise as presented in Table 4.12. Among the students, 43.4% and 28.9% considered noise around their schools to be very annoying and extremely annoying respectively, and 55.6% claimed that they are not aware of noise pollution as seen in Table 4.13. In table 4.13, 70.6% of the students indicated that this noise is produced daily while 57.5% claimed that there have been no effort to control noise. Based on the responses of the participants involved in the study, nine (9) schools identified traffic as a major source of external noise, as such manual traffic count of various road-using machines (motorcycle, tricycle, cars, bus and trucks) was observed and presented in Figures 4.7 – 4.15. The manual traffic count revealed that the number of motorcycles plying the roads were more than that of cars and other vehicles during the study period (Fig. 4.7 – 4.15). Among the secondary schools, the highest number of motorcycles (bikes) were observed at ALHCZ (2746) as seen in Figure 4.11 while GGSSPZ had the least (602) as presented in Figure 4.12. Also in the sampled primary schools, ARMZ had the highest (1837) (Fig. 4.7) while SMAZ had the lowest (642) (Fig. 4.13).

Table 4.12: Overall Percentage of Identified Noise Sources in Some Schools in Zaria, Nigeria

S/N	Noise Source	Frequently Experienced	Moderately Experienced	Low Experienced	Rarely Experienced	Total %
1.	Mike	13.9	13.0	12.6	60.5	100
2.	Motorcycle	36.5	24.9	15.1	23.5	100
3.	Tricycle	16.7	18.9	25.8	38.6	100
4.	Bus	23.0	24.6	24.8	27.6	100
5.	Religious Activities	7.0	8.6	18.2	66.2	100
6.	Vehicular Horn	29.5	21.2	27.0	22.3	100
7.	Construction Activities	4.9	9.0	21.5	64.6	100
8.	Industrial Activities	5.7	10.4	14.2	69.7	100
9.	Peoples' Activities	20.7	25.7	19.9	33.7	100
10.	Adjacent Classes	54.6	25.9	11.7	7.8	100
11.	Classmates	63.5	19.8	9.2	7.5	100
12.	Others	17.8	22.4	15.5	44.3	100

Table 4.13: Students' Noise Pollution Level and Awareness in Selected Schools in Zaria

Variables	R1	R2	R3	R4	Chi-square	P-value
Noise Pollution Level	121(28.9)	182(43.4)	110(26.3)	6(1.4)	152.45	0.00
Noise Awareness	106(25.3)	80(19.1)	233(55.6)	-	95.98	0.00
Noise Production	296(70.6)	123(29.3)	-	-	314.90	0.00
Efforts to Control Noise	178(42.5)	241(57.5)	-	-	4.04	0.04

N = 419

Keys: R1 = Extremely Annoying/Highly Aware/Yes/Yes

R2 = Very Annoying/Relatively Aware/No/No

R3 = Slightly Moderate/Not Aware

R4 = Not at all

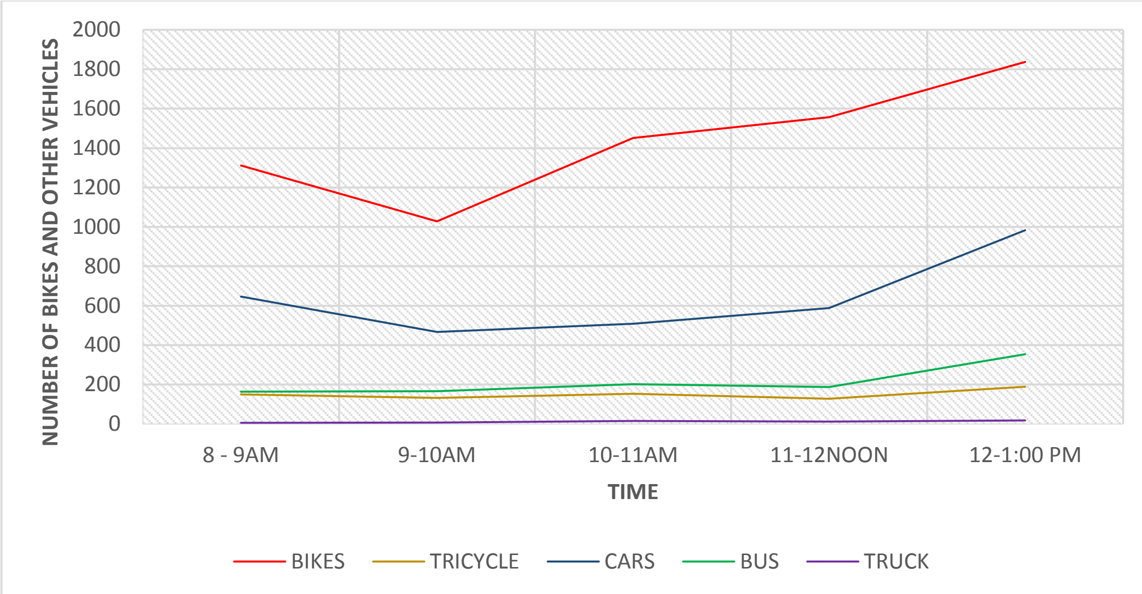


Figure 4.7: Mean Observed 2-day Traffic Density on the Main Road near AbdulRahman Mora Primary School by Hour during School Hours

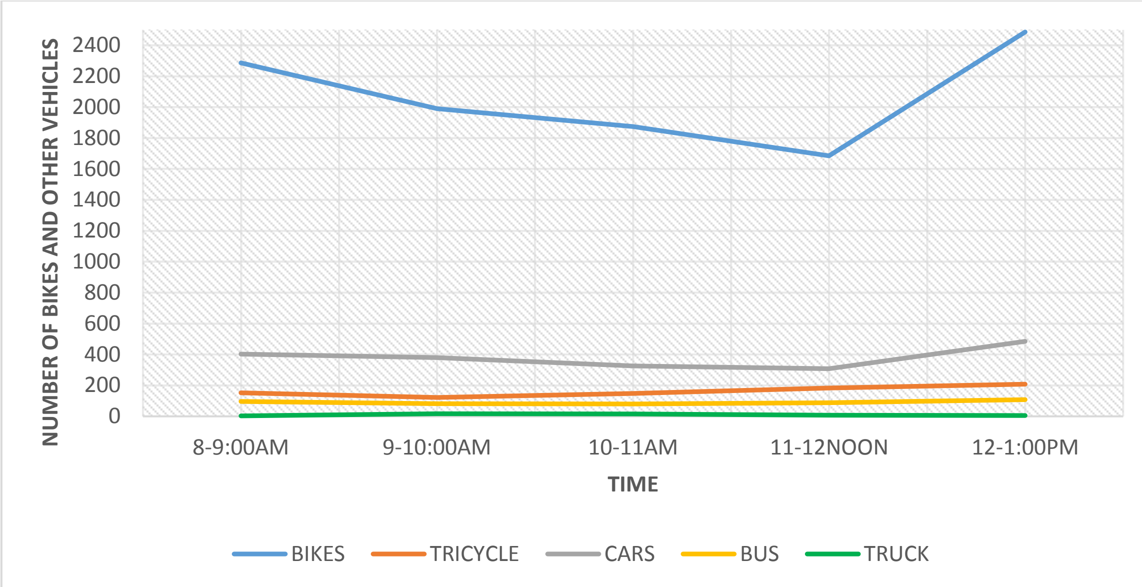


Figure 4.8: Mean Observed 2-day Traffic Density on the Main Road near Government Secondary School, Tudun-Junkun, Zaria, Nigeria, by Hour during School Hours

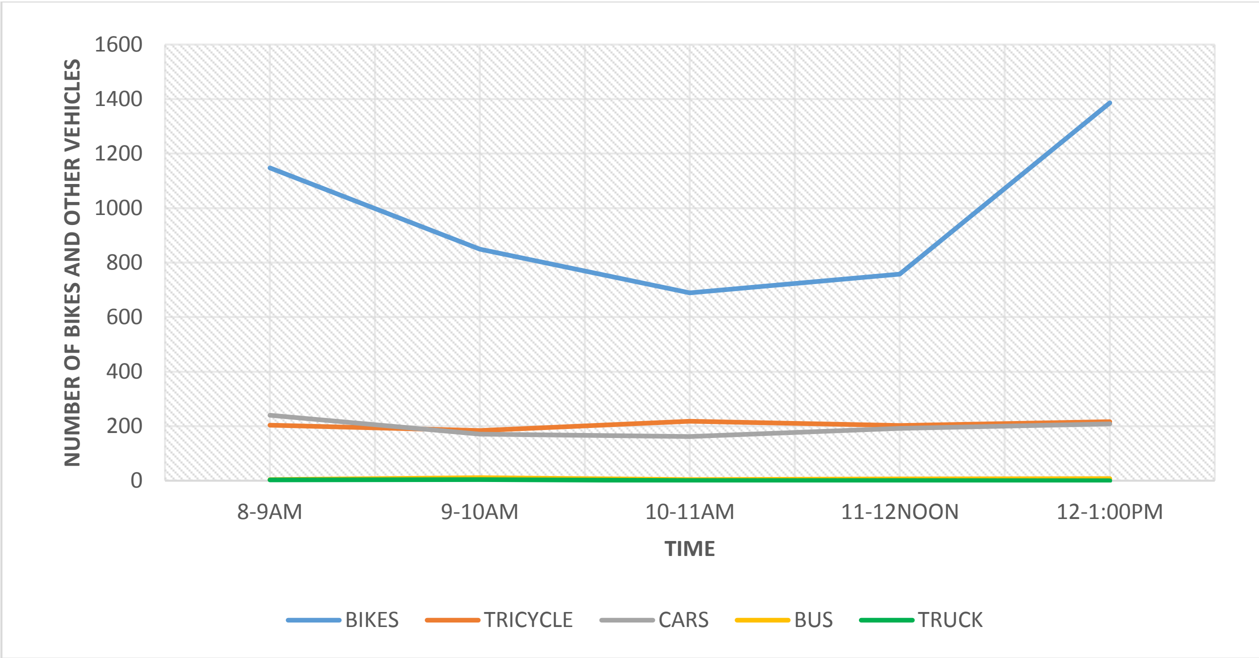


Figure 4.9: Mean Observed 2-day Traffic Density on the Main Road near U.B.E. Isan Nabawa Primary School Nigeria by Hour during School Hour

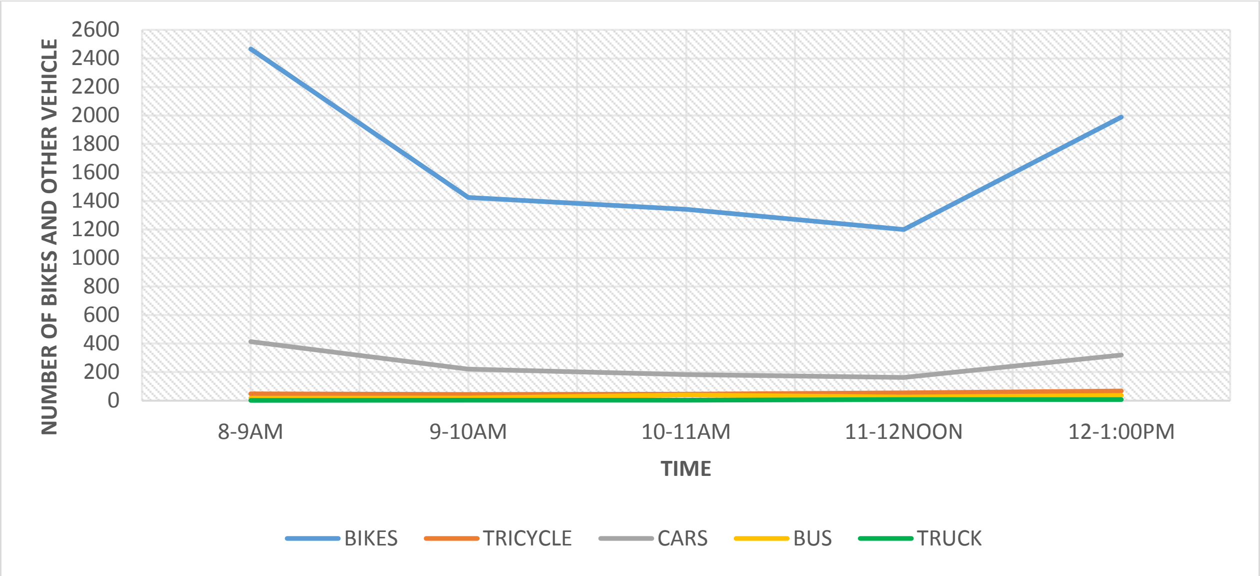


Figure 4.10: Mean Observed 2-day Traffic Density on the Main Road near Government Girls' secondary School Dogon-Bauchi, Zaria by Hour during School Hours

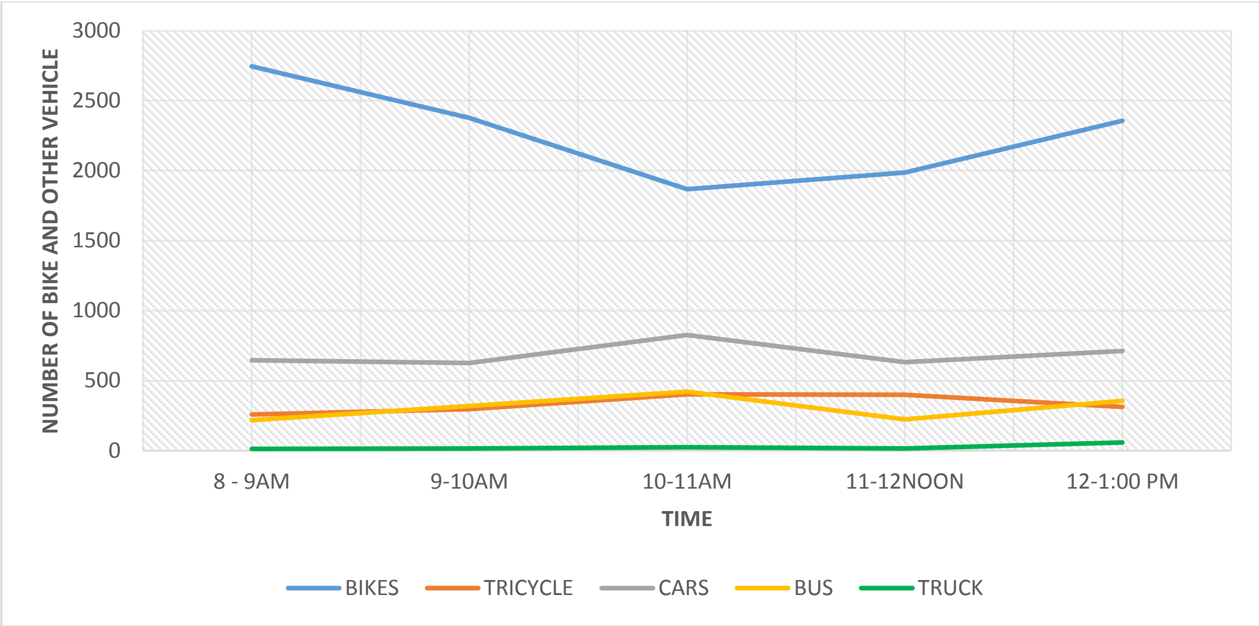


Figure 4.11: Mean Observed 2-day Traffic Density on the Main Road near Al-huda Huda College, Zaria by Hour during School Hours

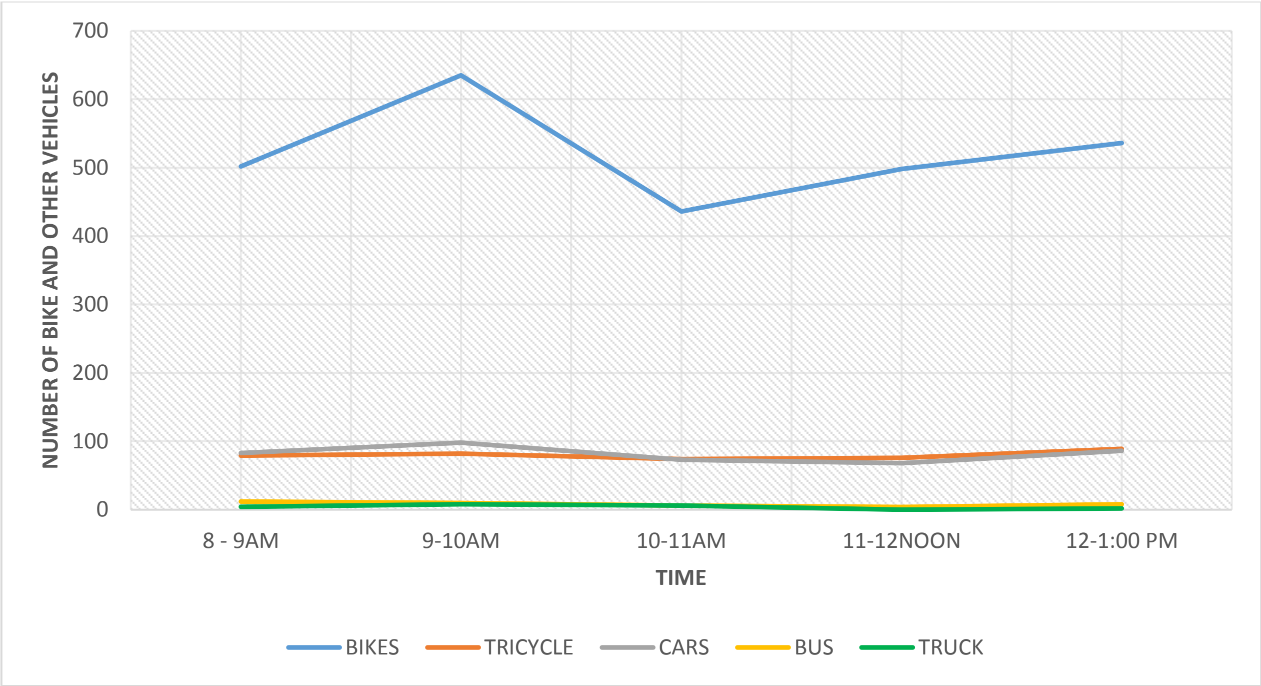


Figure 4.12: Mean Observed 2-day Traffic Density on the Main Road near Government Girls' Secondary School. Pada by Hour during School Hours

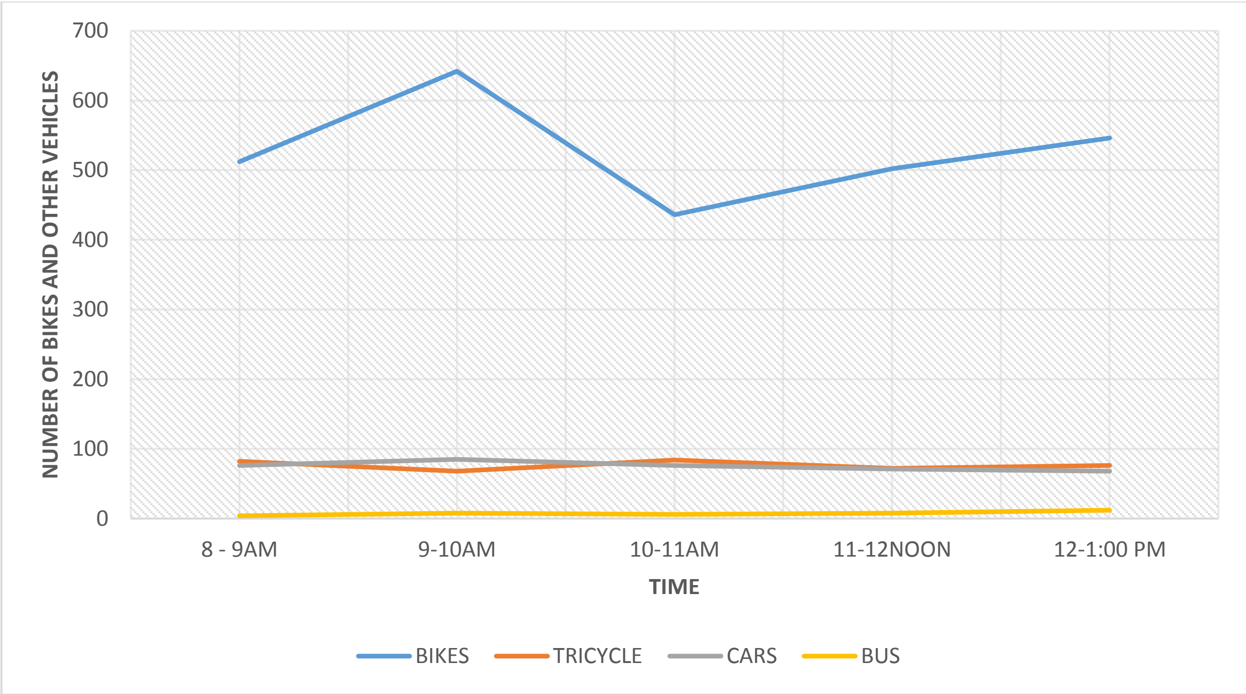


Figure 4.13: Mean Observed 2-day Traffic Density on the Main Road near Sarki Musa L.G.E.A. Primary School, Kwarbai, Zaria, by Hour during School Hours

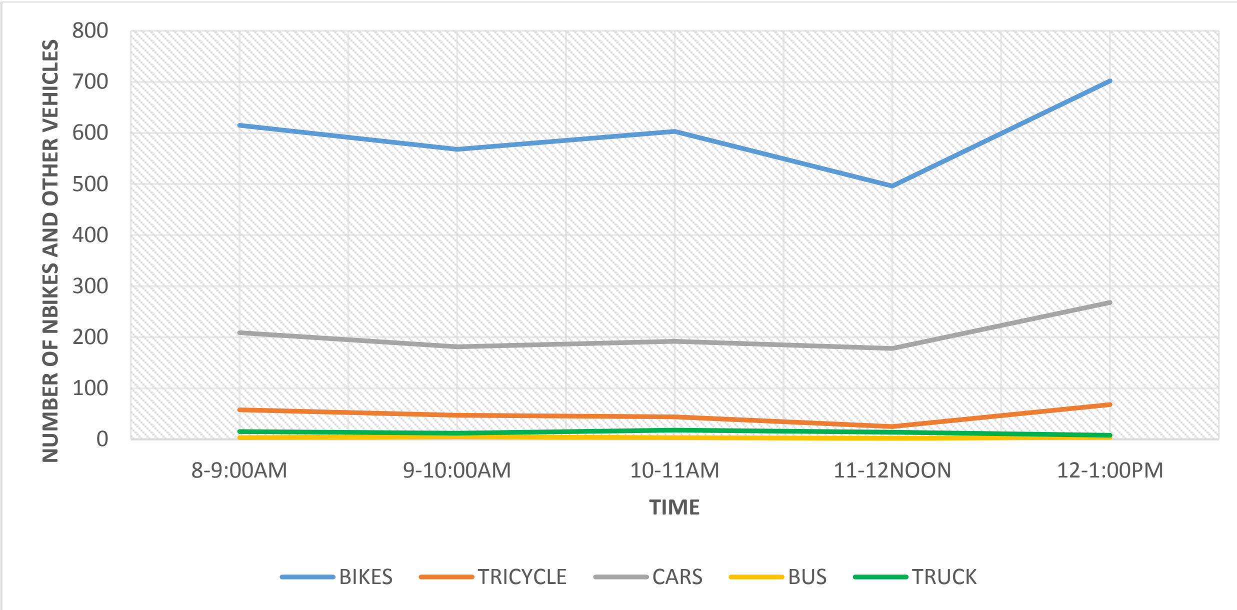


Figure 4.14: Mean Observed 2-day Traffic Density on the Main Road near Government Girls' Secondary School, Kongo, by Hour during School Hours

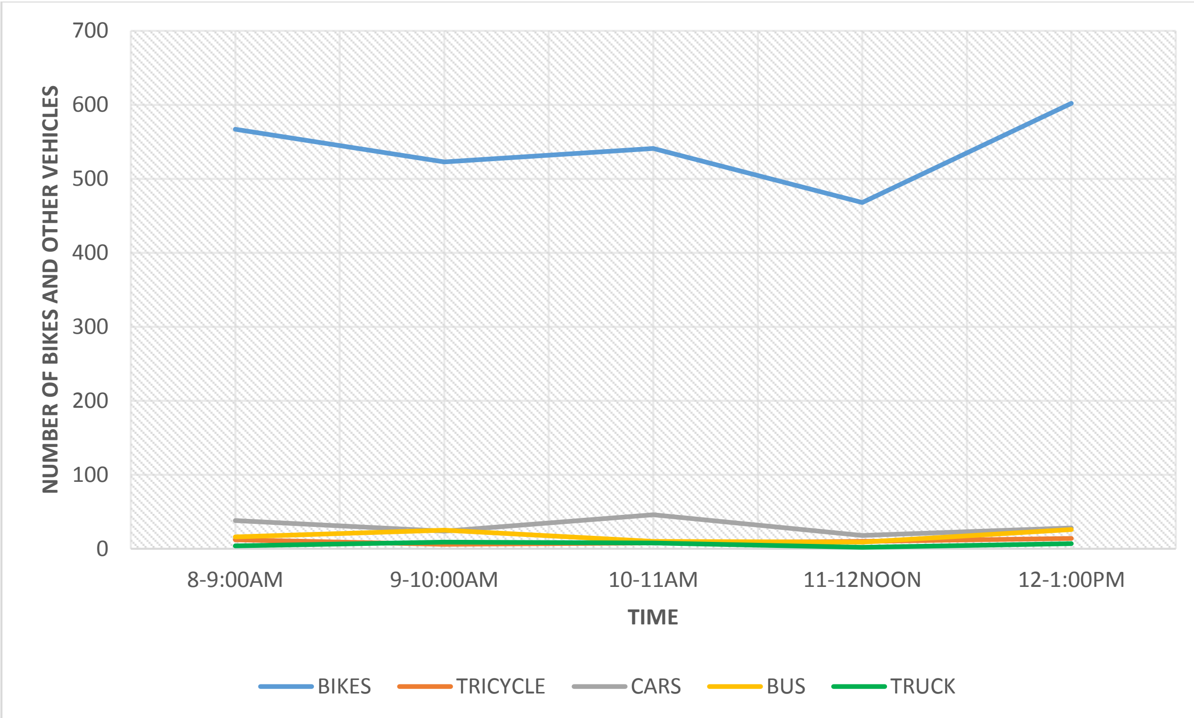


Figure 4.15: Mean Observed 2-day Traffic Density on the Main Road near Government Girls' secondary School. Kofar-Gayan by Hour during School Hours

CHAPTER FIVE

5.0. DISCUSSION

5.1. Noise Levels in Primary and Secondary Schools

It was observed in the course of the research that the surveyed schools are overcrowded, having average students per class of 50-100 which exceeded the national standard for classroom occupancy based on a Nigerian policy guideline – occupancy of ≤ 36 in six rows of six students in a floor area $\geq 19.4m^2$ with $\geq 2m$ between the teachers and front row (FMOE, 2005).

The background noise level (i.e. noise level in an unoccupied classroom) in all the visited classrooms were higher than the recommended standard. The Accredited Standard Committee (2002) affirmed that the BNL in an unoccupied classroom should not exceed 30 – 35 dBA. These high noise levels in the unoccupied classrooms could be attributed to the poor acoustic condition of the classrooms and their closeness to highway whereby traffic is continuous throughout the sampling period. These roads link Zaria to other cities such as Kaduna, Abuja, Funtua, Kano, Jos, etc. This ensures vehicular movement which starts in the early hours of working days thereby generating the high noise levels observed. The poor acoustic conditions of the classrooms will allow the passage of low intrusive noise. Wang and Ronsse (2010 and 2013) have earlier reported BNL values which exceeded the BNL recommendation of 35 dBA. Also, Pugh *et al*. (2006) reported noise levels in unoccupied classrooms that are above 30 dBA criterion recommended by the American Speech and Hearing Association (ASHA, 1995), and 35 dBA criterion recommended by American National Standard Institution (ANSI, 2002) for educational setting.

The continuous equivalent sound energy (L_{Aeq}.) on the playground in all the schools were higher than the standard of 55 dB (A) as seen Figures 4.1 and 4.2. These high L_{Aeq} on the playground can be attributed to three major factors which include; a very small land area to large population of students, these schools have no defined playground for the students as observed in ARMZ and UINZ, and they are very close to busy roads which increases the noise climate within the school environment. Dr. Abubakar Imam Primary School, Zaria (DAIZ) was observed to be 8.4 dBA higher than the WHO standard of 55 dBA which could be attributed to the fact that the school has a wide playground, far from the roadside and has sporting equipment which enable the students to spread out and engaged in different kinds of sport. Also among the secondary schools, GSSBZ was 3.9 dBA above standard which was mainly due to the fact that the students tend to go back into their homes during break-time, leaving few students on the playground within the School. Ana *et al.* (2009) have earlier reported mean noise levels of 68.3 dB (A) and 84.7 dB (A) outdoors in the playground. Alsubaie (2014) reported indoor noise levels that exceeded WHO (2011) standard.

The mean difference between the L_{NP} in both primary and secondary schools showed a slight difference. That the L_{NP} of primary schools in the study area did not vary too much from the L_{NP} in the secondary schools. Scientifically, it means that the variability in the two types of schools is not significantly different. This indicate that there is no statistically significant difference between the L_{NP} in both primary and secondary schools. This however implies that these pupils at the early stages of growth are exposed to high sound energy for about twelve (12) years of the early life. Frequent exposure to high level of noise can cause severe stress on the auditory and nervous system (Subramani *et al*., 2012).

5.2. Morning and Afternoon Continuous Equivalent Sound Energy

The study revealed varied L_{Aeq} across the schools during the periods of the day. Schools such as UINZ, BAKZ, SSMZ, SADZ, ALHCZ, GGSSPZ, GGSSCDZ, GGSSKZ, GGSSKGZ, and GSSTJZ were observed to have high indoor L_{Aeq} in the morning and fell slightly in the afternoon. These variations could be attributed mainly to the noise climate within Zaria urban community. DAIZ was located far from the road side, but submerged into residential buildings. The outdoor L_{Aeq} was observed to be approximately 2dB (A) lower than the standard in the morning but was 11.18 dB(A) higher than the standard in the afternoon, which was due to the effect of the generator used by the "Skill Acquisition Centre" built inside the school. This said centre trains members of the public in ICT, tailoring and shoe making. It starts its programme by 10:00 a.m. relying on the use of generator to power its computer systems. Chagok *et al*. (2013) reported that generator sound ranged between moderately noisy and noisy. All the schools surveyed were observed to have L_{Aeq} that exceeds the WHO standard of 35 dB (A) in the indoor of an academic classroom and 55 dB (A) recommended for the outdoor L_{Aeq} except DAIZ and GSSBZ that have approximately values lower than the standard in the morning and afternoon respectively. Mkoma *et al*. (2011) had reported the mean equivalent continuous noise level that ranged from 60.6 – 63.9 dBA for classroom, and 63.5 – 67.67.6 dBA for street side. These high indoor and outdoor L_{Aeq} could be attributed to factors such as closeness to busy road, less trees within the school which could have served as noise frequency breakers, several human activities going on around the schools such as carpentry works, motorcycle mechanical workshops, panel-beating workshops, recharge card selling points, as observed around GGSSDBZ and petrol station as observed around ARMZ. Chan *et al*. (2015) reported LAeq value that ranged from 67 to 70 dBA. The average maximum values of noise level reported by Bhosale *et al*. (2010) ranged from 81 – 86 dB

(A) and the minimum ranged from 74-78 dB (A). The total number of vehicles passing the road in unit time and the time of the day during which they pass (morning, afternoon and evening), may decide the session-wise intensity of noise levels. Bhosale *et al*. (2010) maintained that vehicular traffic is the significant contributor of the noise pollution in urban centres. However, the paired t-test carried out to test for significant difference between the $L_{Aeq.}$ morning and afternoon revealed no statistically significant change ($p > 0.05$) in the L_{Aeq} measurement from morning to afternoon. These educational institutions are exposed to very high LAeq which might cause nuisance to the students in addition to the adverse health effects (Balashanmugan *et al*., 2013).

This implies that in both primary and secondary schools, the students and staff are being hit by high sound energy continuously from morning to afternoon whether they are inside or outside the classroom. Chronic noise exposure has been identified as a problem that could impair concentration, general cognitive functioning, and particularly reading skills (Woolner *et al*., 2007).

5.3. Impact of Traffic Noise on Outdoor and Indoor Noise Level

The impact of traffic noise was analysed to check if there is any difference existing between the traffic noise, indoor and outdoor noise levels. The result of the analysis indicated no significant difference. It was however observed that the reasons for no significant difference existing between the noise levels could be attributed to factors such as high population of students within the classroom which is far above the recommendation of the Federal Ministry of Environment (FMOE, 2005). The congestion within the classroom and lack of acoustic properties such as sound absorber/insulation, could be considered as influencing factors within the classroom that contributed to the indoor noise levels.

This could also be attributed to lack of windows which allows the passage of intrusive noise from outside, coupled with the already congested classroom, as such increasing the level of noise inside the classroom to the situation outside. It is however reasonable to say that external noise impacted on the indoor noise in the schools surveyed for this research owing to some factors such as overpopulation of students within the classroom, lack of acoustic barriers (sound insulation). Shield and Dockrell (2004) earlier said that noise levels inside classrooms depend on the activities in which the children are engaged, and the number of children in the classroom also affect noise levels. The external noise influenced classroom noise levels only when children were engaged in the quietest classroom activities. Outdoor noise levels are influenced by traffic volume and congestion (Pritam *et al.,* 2014). The higher outdoor noise causes the higher indoor noise in classrooms. School buildings are often subjected to higher outdoor levels. Hence, intelligibility of lessons by students is decreased (Avsar and Gonullu, 2005). However, Golmohammadi *et al.* (2010) argued that outdoor district noise sources could not significantly affect indoor noise levels.

5.4. Effects of Noise on Teaching and Learning

The teachers indicated that these schools surveyed lack sound insulations, where 94.2% agreed that noise affect teaching process, indicating communication interferences and voice masking as some of the effects on noise. Noise pollution causes poor concentration in schools, interfering with the conversations (Gilavand and Jamshidnezhad, 2016). Likewise, 66.4% reported that road noise affect the process of delivering lesson. Essandoh and Armah (2011) had earlier reported that 82.1% of the respondents complained that noise from the audio music shops and traffic is a nuisance. Also, Debnath *et al*. (2012) reported that 89% of the respondents that was included their study agreed with noise pollution in the institutions and disturbed in the teaching-learning process Ana *et al*. (2009) also reported that 70% of the respondents complained of being disturbed by noise. About 92.6% of the students reported that noise reduces their learning ability, pointed out it that reduces their concentration, reading ability and listening ability among others. Bulunuz (2014) have earlier reported that over 90% of students are annoyed by noise in schools. The students also reported lack of acoustic materials within the classrooms. Sowah *et al*. (2014) reported that about 98% of schools in Teshie-Nimgua do not have acoustic materials to minimize noise levels. Regarding the students' perception of noise pollution level, noise awareness, 43% of the students considered the noise level of their school environment to be very annoying and 55% reportedly said they are not aware of noise pollution while 72.1% reported that road noise is a major source of noise. Augustynka *et al.* (2010) reported that 50% of the respondents considered noise as annoying and near 40% as very annoying or unbearable. Sowah *et al*. (2014) had earlier reported that near 80% of surveyed respondents' ranked constant traffic as number one source of noise. Also, among the respondents, 53.9% of the respondents reported that noise within the school causes them headache. Umar and Barde (2015) had earlier reported that 44% respondents exposed to noise suffered from headache.

5.5. Traffic Density around the Sampled Schools

The manual traffic count of various road-using machines (motorcycle, tricycles, cars, bus, and trucks) carried out around some schools revealed that the number of motorcycles plying the roads were more than that of cars and other vehicles during the study period (2016). The highest number of bikes was observed on the road in front of Al Huda Huda College inside Zaria City and the least was observed in Government Girls Secondary School, Pada, Zaria.

The result showed that the primary and major sources of external noise along these schools is the noise generated from traffic whereby highest percentage (%) of it is generated by the motorcycles, and internally the students are exposed to noise from adjacent classes and their classmates which could be attributed to congested classroom. Ana *et al.* (2009) reported that the source of external noise generated along Oba Akinbiyi High School, Ibadan was mainly from motor cars which was very high during 9-10:00AM and 12-1:00PM.

5.6. Biological Implication of High L_{AEQ} and Period of Exposure on Students and Teachers

In the course of the study, it was revealed that the overall noise pollution level (OL_{NP}) for the visited schools ranged between 73.9 - 97.0 dB (A) with an average exposure time of at least 5 hours per day. This high noise pollution is associated with high continuous sound energy ($L_{Aeq.}$) hitting the biological make-up of the individuals that are involved in the educational setting (students and staff). Extensive studies in the occupational settings and community levels have been linked with noise-induced cardiovascular effects. The prolonged exposure to occupational and /or environmental noise at sound levels above 60dB (A) can contribute to an increased risk for cardiovascular disease (Babisch, 2008). In a Swedish municipality partly affected by noise from a highway (20,000 vehicles/24hours) and a railway (200 trains/24hours), men who lived there for more than 10 years and were exposed to the highest level of noise (57-70 dB (A)) had a relative risk of hypertension almost three times that of the unexposed population (Odd Ratio (OR) = 2.9, 95%CI: 1.4-6.2) (Barregard *et al.*, 2009). In 2011, Sorensen *et al.* examined the relationship between exposure to road traffic noise and risk for stroke. They found a 0.26 mm Hg higher systolic blood pressure (95%CI: -0.11; 0.63) per 10dBA increase in 1-year mean road traffic noise levels, with strong associations in men (0.59 mm Hg (CI: 0.13; 1.05) per 10 dBA) and older participants (0.65mm Hg (0.08; 1.22) per 10 dBA. The exposure to railway noise above 60 dB associated with 8% higher risk for hypertension (95% CI: -2%; 19%, P= 0.11). There was a statistically significant interaction with age (P<0.001), with a strong association between road traffic noise and stroke among cases over 64.5years (IRR: 1.27; 95%CI: 1.13-1.43) and no association for those under 64.5 years (IRR: 1.02; 95%CI: 0.91-1.14). In a study among exposed subjects residing in Giliaquas in the vicinity of Elmas Airport in Sardinia, Italy showed an increased risk of long-lasting syndromal anxiety states (generalized anxiety disorder and anxiety disorder Not Otherwise Specified (NOS) which supports the hypothesis of a sustained central autonomic arousal due to chronic exposure to noise (Hardoy *et al.*, 2005). Babisch (2008) reported that road traffic noise was positively associated with increased risk of arterial hypertension in adults who live in areas with daytime average sound pressure level exceeding 65 dB (A). Evans *et al.* (2001) reported marginal and borderline significant effects of noise on elevated resting systolic blood pressure in fourth-grade children who were exposed to high noise level (>60dB) from road and railway noise. van Kempen *et al.* (2006) study reported significant association between daytime road traffic noise at schools and systolic blood pressure. Belojevic *et al*. (2008) reported that the prevalence of children with hypertensive values of blood pressure was 3.96% (13 children, 8 boys and 5 girls) with a higher prevalence in children from noisy residences (5.70%) compared to children from quiet residences (1.48%). Systolic pressure was significantly higher (5mmHg, on average) among children from noisy residences and kindergartens, compared to children from both quiet environments (p < 0.01). Heart rate was significantly higher (2beats/min on average) in children from noisy residences, compared to children from quiet residences (p<0.05). Multiple regression, after allowing for possible confounders, showed a significant correlation between noise exposure and children's systolic blood pressure (B=1.056; p = 0.009).

Prasher (2009) explained that noise causes a release of stress hormones that can adversely affect health. Noise disturbs the homeostasis of the cardiovascular, endocrine and immune systems in the body to cope with the perceived demands of the individuals. The imbalance between the demand and the individual's resources to cope determine the individual's ability to deal with noise-induced stress. The body's ability to cope with overstimulation can lead to adverse stress reactions. Evans *et al.* (2001) said the glucocorticoid hormone, cortisol, is the main secretory product of the neuroendocrine cascade and a valid indicator of stress. This cortisol profile normally shows a diurnal variation, high in the morning and low at night (Hofman, 2001). Several studies have shown elevated cortisol level in relation to noise. Spreng (2000) reported that after long-time stressful exposure, the ability to down-regulate cortisol may be inhibited. In models of noise, stress and disease, cortisol plays a key role in hypothalamic-pituitary-adrenal (HPA) axis activity. In an observational study, Ising *et al.* (2004) obtained salivary cortisol samples from 68 children who had had recent physician contact for bronchitis. They found that nighttime noise levels above 53dBA were associated with increased morning cortisol levels and were thought to lead, in the long term, to the aggravation of bronchitis in children. Reddy and Jherwar (2012) reported that the persons residing in some areas in India which are exposed to noise pollution show hypertension, irritation and sleeplessness and associated cardiac disorders while investigating the effects of noise pollution with relation to hypertension. Also, in a laboratory-based sleep study measuring salivary cortisol carried out by Waye *et al*. (2003), low frequency noise (40dB

(A), ≤125Hz) was associated with an attenuated cortisol response after waking. Cortisol levels had not yet peaked at 30 minutes post-waking, as it did in control ($N_{TOT} = 12$).

Conclusively, the World Health Organization (WHO) in 2011 identified some hazards of noise in her publication titled "Burden of Disease from Environmental Noise" which includes cardiovascular disease, cognitive impairment, sleep disturbance, tinnitus and annoyance. The auditory system is continuously analyzing acoustic information, which is filtered and interpreted by different cortical and sub-cortical brain structures. Arousal of the autonomic nervous system and the endocrine system is associated with repeated temporal changes in biological responses. In the long run, chronic noise stress may affect the homeostasis of the organism due to dysregulation, incomplete adaptation and/or the physiological costs of the adaptation (Spreng, 2000). Noise is considered a nonspecific stressor that may cause adverse health effects in the long run. Epidemiological studies suggest a higher risk of cardiovascular diseases, including high blood pressure and myocardial infarction, in people chronically exposed to high levels of road or air traffic noise (Clark and Stansfeld, 2007; Munzel *et al*., 2014; Munzel and Sorensen, 2017).

CHAPTER SIX

6.0 SUMMARY, CONCLUSIONS, RECOMMENDATIONS AND CONTRIBUTIONS TO KNOWLEDGE

6.1. Summary

From the study, the quantified noise levels (both indoor, outdoor, and traffic noise levels) were found to be higher than the recommended values of 35dBA and 55dBA prescribed by the World Health Organization for an academic environment. The noise levels in both primary and secondary schools were found not to be different as both were higher than the standard. The traffic noise measured in this study was found to cause increase in the outdoor and indoor noise levels in and around the classroom owing to their closeness to the main roads and the lack of acoustic materials within the classroom to absorb the sound waves. Tiredness, lack of concentration, communication interference, voice masking, and low speech intelligence are the major problems reported by both teachers and students. And noise was found to have negative impact on teaching and learning process. It is recommended that sound insulation system should be installed into the classroom buildings, plantation of trees and vegetation buffer zone should be included into the school design because trees can absorb 4 – 6 dB noise intensity depending on their characteristics since it is impossible to reduce the vehicle density.

6.2. Conclusions

i. Noise levels in primary and secondary schools were found to be significantly higher ranging from 71.5-95.9dBA; 59.1dBA-98.7dBA and 75.5-93.1dBA; 70.4-98.5dBA for indoor and outdoor respectively. The equivalent continuous sound energy (L_{Aeq})

in both primary and secondary schools from morning to afternoon does not differ significantly.

ii. Also, significant difference could not be established between the indoor, outdoor and traffic noise indices.

iii. Indoor and outdoor noise levels in the schools exceeds the WHO (2011) and NESREA (2007) standards of 35 and 55 dBA respectively.

iv. Noise have detrimental effects on teaching-learning process, and as such there is urgent need to control noise to avert the accumulated health effects.

6.3. Recommendations

The following measures should be taken to reduce noise pollution in the schools:

1. Sound insulation system should be installed into the classroom buildings and high fence using concrete walls which protect noise from outside should be built.
2. Government should be build more classes to enable the schools staff to be able to adjust the students' number to the classroom area to prevent the problem of overcrowding that affect the indoor noise and learning.
3. Schools should be aware of plantation of trees and vegetation buffer zone because trees can absorb 4 – 6 dB noise intensity depending on their characteristics. And since it is impossible to reduce the vehicle density, which increases in parallel with population growth, then the practice to reduce noise by using living plant barriers should be generalized. And in obtaining good results, caution should be observed with the properties of the plants.

4. The students and teachers should be made aware of the hazards and human health catastrophe associated with noise pollution as this would help in reducing noise levels.
5. Application of speed limits for vehicles near the schools situated to the road sides should be enforced.
6. Proper enforcement of already existing legislation to control noise pollution should be implemented.
7. Enforcement to ban the use of horns when passing the educational zones.

However, further research should be conducted on dose-response relationship with respect to cardiovascular diseases among the students and the teachers.

6.4. Contribution to Knowledge

Environmental challenges have become severe and widespread due to the geometric population growth, urbanization and industrialization. The noise problem of the present days has become a thing of great concern due to larger sources of it now present outdoors and indoors. Noise exposures have been linked to a range of non-auditory effects including annoyance, sleep disturbance, cardiovascular diseases and impairment of cognitive performance in children. It has been said to cause the arousal of the autonomic nervous system and the endocrine system which is associated with repeated temporal changes in biological responses, and in the long run, chronic noise stress may affect the homeostasis of the organisms due to dysregulation, incomplete adaptation and the physiological costs of the adaptation. Therefore, this study assessed the noise levels within and outside the classroom and its impacts on the processes of teaching and learning.

1. The indoor and outdoor noise levels in primary and secondary schools were found to be higher during the study in 2016 than the WHO standards (Indoor: 71.5-95.9dBA; 59.1-98.7dBA, and Outdoor: 75.5-93.1dBA; 70.4-98.5dBA).
2. The noise levels of both primary and secondary schools surveyed were found to be high such that the students and teachers would be exposed to it for at least 5hours/day relatively for 12 years of their basic educational level.
3. Tiredness, lack of concentration, communication interference, voice masking and low speech intelligence were reported in this study to be among the problems the students and teachers faced due to high noise levels in the study area.

REFERENCES

Abdelraziq, I. R., Ali-Shtayeh, M .S. and Abdelraziq, H. R. (2003). Effects of noise pollution on blood pressure, heart rate and hearing threshold in School children. *Journal of Applied Science*, *3*(10), 717 - 723.

Abel, A. A. (2015). Urban noise pollution in Nigeria cities: Imperatives for abatement. *British Journal of Applied Science and Technology*, *10*(6), 1-9.

Abolarin, T. S. (2012). Identification of major noise donors, a sure way to abating way. *Proceeding of International Conference on Clean Technology and Engineering Management (ICCEM),* 13 - 20.

Accredited Standards Committee S12, Noise. (2002). *American national standard: Acoustical performance criteria, design requirements, and guidelines for schools (ANSI S12.60-2002)*. Melville, NY: Acoustical Society of America.

Akansel, N. and Senay, K. (2008). Effect of intensive care unit noise on patient: A study on coronary artery bypass graft surgery patients. *Journal of Clinical Nursing, 17*(12), 1581-1590.

Alao, A. A. and Avwiri, G. O. (2010). Noise levels associated with selected oil and gas installations in Ogab/Egbema/ Ndoni local government areas of Rivers State, Nigeria. *Journal of Environmental Issues and Agriculture in Developing Countries*, *2*(2 and 3), 42-47.

Ali, S. A. A. (2013). Study effects of school noise on learning achievement and annoyance in Assiut City, Egypt. *Applied Acoustics, 74(*4), 602 - 606.

Ali, S. A. and Tamura, A. (2003). Road traffic noise levels, restrictions and annoyance in greater Cario, Egypt. *Applied Acoustics, 64*(8), 815-823.

Allen, R. W., Davies, H., Cohen, M. A., Mallach, G., Kaufman, J. D. and Adar, S. D. (2009). The spatial relationship between traffic-generated air pollution and noise in 2 US cities. *Environmental Research*, *109*, 334 - 342.

Alsubaie, A. S. R. (2014). Indoor noise pollution in elementary schools of eastern province, Saudi Arabia. *Journal of Research in Environmental Science and Toxicology*, *3(*2), 25 - 29.

American Academy of Paediatrics. (1993). *Committee on School Health. School Health: Policy and Practice*, (5th ed.). Pp. 87-92. Available Online: http://pediatrics.aappublications.org/cont... Accessed on November 22nd, 2015.

American National Standards Institute. (2002). *American national standard acoustical performances criteria, design, requirements, and guidelines for schools* (ANSI Standard 12.60-2002). New York, NY: Author.

American Speech-Language-Hearing Association (ASHA). (1995). Position statement and guidelines for acoustics in educational setting. *ASHA, 37*(Suppl. 14), 15-19. Retrieved from www.asha.org/uploadFiles/elearning/jss/6173/6173Article4.pdf

Amin, N., Skider, I., Zafor, N. A. and Chowdhury, M. A. I. (2014). Assessment of noise pollution of two vulnerable sites of Sylhet City, Bangladesh. *International Journal of Water Resources and Environmental Engineering*, *6*(1), 112 - 120.

Ana, G.R.E.E., Shendell, D.G., Brown, G.E. and Sridhar, M.K.C. (2009). Assessment of noise and associated health impacts at selected secondary schools in Ibadan, Nigeria. *Journal of Environmental and Public Health*, 1-6.

Anomohanran, O. (2013). Evaluation of environmental noise pollution in Abuja, the capital city of Nigeria. *International Journal of Research and Reviews in Applied Sciences, 14*(2), 470-476.

Anomohanran, O. and Osemeikhian, J. E. A. (2006). Day and night noise pollution study in some major towns in Delta State, Nigeria. *Ghana Journal of Science, 46*, 47-54.

Aparicio-Ramon, D. V., Suarez-Varela, M. M. M., Garcia, A. G., Gonzales, A. L., Ruano, L., Sanchez, A. M. and Caraco, E. F. (1993). Subjective annoyance caused by environmental noise. *Journal of Environmental Pathology, Toxicology and Oncology*, *12*(4), 237-243.

Arana, M. and Garcia, A. (1998). A social survey on the effects of environmental noise on the residents of Pamplona, Spain. *Applied Acoustics*, *53*(4), 245-253.

Armah, F. A., Odoi, J. O., Yawson, D. O., Yengoh, G. T., Afrifa, E. K. A. and Pappoe, A. N. M. (2010). Mapping of noise risk zones derived from religious activities and perceptions in residential neighborhoods in the Cape Coast metropolis, Ghana. *Journal of Environmental Hazards: Human and Policy Dimensions*, *9*(4), 358-368.

Aslam, M. J. Aslam, M. A. and Batool, A. (2008). Effect of noise pollution on hearing of public transport drivers in Lahore City. *Pakistan Journal of Medicine Science, 24*(1), 142-146.

Augustynska, D., Kaczmarska, A., Mikulski, W. and Radosz, J. (2010). Assessment of teachers' exposure to noise in selected primary schools. *Archives of Acoustics, 3*(4), 521-542.

Avsar, Y. and Gonullu, M. T. (2001). Outdoor noise level at Yildiz Technical University, Istanbul, Turkey. *Journal of the Canadian Acoustical Association*, 29–37.

Avsar, Y. and Gonullu, M. T. (2005). Determination of safe distance between roadway and school buildings to get acceptable school outdoor noise level using noise barriers. *Buildings and Environment, 40*, 1255-1260.

Babisch, W. (2002). The noise/Stress concept, risk assessment and research needs. *Noise and Health, 4*(16), 1-11.

Babisch, W. (2008). Transportation noise and cardiovascular risk: updated review and synthesis of epidemiology studies indicate that the evidence has increased. *Noise and Health, 8*, 1-29.

Baker, A. A. (2015). *Investigation of community annoyance as invoked by a high school stadium and a train horn proximal to residentially zoned homes.* (Master's thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia). Retrieved from https://vtechworks.lib.vt.edu/handle/10919/54568

Balashanmugan, P., Ramanathan, A. R., Nehrukumar, V. and Balasubramaniyan, K. (2013). Assessment of noise pollution in Chidambaram Town. *International Journal of Research in Engineering and Technology, 2*(10), 85-93.

Banerjee, D., Chakraborty, S. K., Bhattacharya, S. and Gangopadhyay, A. (2008). Evaluation and Analysis of Road Traffic Noise in Asansol: An Industrial Town of Eastern India. *International Journal of Environmental Research and Public Health, 5*, 165-171.

Barregard, L., Bonde, E. and Ohrstrom, E. (2009). Risk of hypertension from exposure to road traffic noise in a population-based sample. *Occupational and Environmental Medicine, 66*(6), 410-415.

Basner, M., Babisch, W., Davis, A., Brink, M., Clark, C., Janssen, S. and Stansfeld, S. (2014). Auditory and non-auditory effects of noise on health. *The Lancet. Vol. 383*(9925), 1325-1332.

Basner, M., Brink, M., Bristow, A., Kiluizeneer, Y., Finegold, L., Hong, J., ….. and Sorqust, P. (2015). ICBEN review of research on the biological effects of noise 2011-2014. *Noise and Health, 17*(75), 57-82.

Belojevic, G., Jakovljevic, B., Stojanov, V., Paunovic, K. and Ilic, J. (2008). Urban traffic noise and blood pressure and heart rate in pre-school children. *Environmental International, 34*(2), 226–231.

Bharanthan, T., Glodan, D., Ramesh, A., Vardhini, B., Baccash, E., Kiselev, P. and Goldenberg, G. (2007). What do pattern of noise in a teaching hospital and nursing home suggest?. *Noise Health, 9*(35), 31-34.

Bhosale, B. J., Late, A., Nalawade, P. M., Chavan, S. P. and Mule, M. B. (2010). Studies on assessment of traffic noise in Aurangabad city, India. *Noise and Health, 12*(48), 195-198.

Bronzaft, A. L. and McCarthy, D. P. (1975). The effect of elevated train noise on reading Ability. *Environment and Behavior*, 7(4), 517-527.

Buchta, E. and Vos, J. A. (1998). Field survey on the annoyance caused by sound from large firearms and road traffic. *The Journal of the Acoustical Society of America, 104*(5), 2890-2902.

Bulunuz, N. (2014). Noise pollution in Turkish elementary schools: evaluation in noise pollution awareness and sensitivity training. *International Journal of Environmental and Science Education, 9*, 215 – 234.

Central Pollution Control Board. (2015). *Protocol for ambient noise level monitoring.* CPCB, 1-5. Available from c*pcb.nic.in/upload/NewItems/NewItem_213_Protocol_for_NoiseMonitoring.pdf*

Chagok, N. M. D., Told, J. Z., Domtau, L. D., Fom, T. P. and Ngadda, Y. H. (2013). Sound pressure level, noisiness and perceived noise level of some commonly used Generators in Pankshin Metropolis of Plateau State, Nigeria. *Civil and Engineering, 3*(9), 45-52.

Chan, M. K. K., Li, C. M., Ma, P. M. E., Yiu, E. M. L. and Bradley McPherson. (2015). Noise levels in an urban Asian school environment. *Noise and Health, 17*(74), 48-55.

Clark, C. and Stansfeld, A. S. (2007). The effect of transportation noise on health and cognitive development: a review of recent evidence. International Journal of comparative Psychology, 20, 145-158.

Cochran, G. W. (1977). Sampling techniques (3rd Ed.). New York: John Wiley and Sons. 448p.

Cohen, S., Evans, G. W., Krantz, D. S. and Stokols, D. (1980). Physiological, motivational, and cognitive effects of aircraft noise on children: Moving from the laboratory to the field. *American Psychologist, 35*(3), 231-243.

Daly, A. and Zannetti, P. (2007). An introduction to air pollution: Definitions, classifications, and history. *Arab School for Science and Technology (ASST).*

Davis, M. L. and Masten, S. J. (2004). *Principles of environmental engineering and science.* McGraw-Hill. 52-60.

Debnath, D., Nath, S. K. and Barthakur, N. K. (2012). Environmental noise pollution in educational institutes of Nagaon town, Assam, India. *Global Journal of Science Frontier Research Environment and Earth Sciences, 12*(1), 1-5.

Donald, J. G., Garry, K., Karen, Y. and William, H. E. (2004). Speech intelligibility of young school-aged children in the presence of real-life classroom noise. *Journal of the America Academy of Audiology*, *15*(7), 508-517.

Dunn, R. A. (2015). Ocean acoustic reverberation tomography. *Journal of the Acoustical Society of America*, *138*, 3458–3469.

Ebeniro, J. O. and Abumere, O. E. (1999). Environmental noise assessment of industrial plant. *Nigeria Journal of Physics*, *11*, 97-105.

Egbugha, M. C., Obisung, E. O. and Egbugha, A. C. (2016). Building acoustic: Measurement and analysis of sound levels in new arts theatre, faculty of arts auditorium and University of Calabar conference hall. *Innovative Systems Design and Engineering*, *7*(4), 1-9.

Encyclopaedia Britannica. (2012). *Encyclopaedia Britannica Ultimate Reference Suite.* Chicago: Encyclopaedia Britannica.

Eniz A. de O. (2004). *Poluição Sonora em Escolas do Distrito Federal.* (M. Sc. Thesis, Universidade Católica de Brasília, Brasília). Available Online: http://www.bdtd.ucb.br:8443/jspui/bitstream/12... Accessed January 16th, 2016.

Environment Division (2008). *Noise measurement procedures manual*. (2nd Ed.). Department of Environment, Parks, Heritage and the Arts. Available from *epa.tas.gov.au/documents/noise_measurement_procedures_manual_2008.pdf*

Eriksson, C., Rosenlund, M., Pershagen, G., Hilding, A., Ostenson, C. and Bluhm, G. (2007). Aircraft noise and incidence of hypertension. *Epidemiology*, *18*, 716–721.

Essandoh, P. K. and Armah, F. A. (2011). Determination of ambient noise levels in the main commercial area of cape coast, Ghana. *Research Journal of Environmental and Earth Sciences*, *3*(6), 637-644.

Essandoh, P. K., Armah, F. A., Afrifa, E. K. A. and Pappoe, A. N. M. (2011). Determination of ambient noise levels and perception of residents in hall at the University of Cape Coast, Ghana. *Environment and Natural Resources Research*, *1*(1), 181-188.

European Commission. (2000). European commission position paper on EU noise indicators" 92-828-8953-X Office for official Publications of the European Communities, Luxemberg.

Evans, G. W., Bullinger, M. and Hygge, S. (1998). Chronic noise exposure and physiological response: a prospective study of children living under environmental stress. *Psychological Science*, *9*(1), 75-77.

Evans, G. W., Lercher, P., Meis, M., Ising, H. and Kofler, W. (2001). Community noise exposure and stress in children. *Journal of Acoustical Society of America*, *109*(3), 1023-1027.

Eysel-Gosepath, K., Daut, T., Pinger, A., Lehmacher, W. and Erren, T. (2012). Effects of noise in primary schools on health facets in German teachers. *Noise and Health*, *14*, 129–134.

Eysel-Gosepath, K., Pape, H. G., Erren, T., Thinschmidt, M., Lehmacher, W. and Piekarski, C. (2010). Sound levels in nursery schools. *HNO*, *58*(10), 1013–1020.

Federal Environmental Protection Agency (FEPA). (1991). *Guidelines and Standard for Environmental Pollution Control in Nigeria*. Abuja: Nigeria.

Federal Ministry of Environment. (2005). Policy Guideline on School Sanitation. Retrieved (September 20th, 2016) from http://tsaftarmuhalli.blogspot.com/2011/12...

Firdaus, G. and Ahmad, A. (2010). Noise pollution and human health: A case study of municipal corporation of Delhi. *Indoor and Built Environment, 19*(6), 648-656.

Flexer, C. and Long, S. (2003). Sound-field Amplification: Preliminary Information Regarding Special Education Referrals. *Communication Disorders Quarterly, 25(1)*, 29-34. doi: 10.1177/15257401030250010501

Garg, S.K. (2004). *Environmental Engineering (Vol. 2)*. New Delhi: Khana Publishers.

Gilavand, A. and Jamshidnezhad, A. (2016). The effects of noise in educational institutions on learning and academic achievement of elementary students in Ahvaz, South West of Iran. *International Journal of Pediatrics*, *4*(3), 1453-63.

Goines, L.R.N. and Hagler, L. M. D. (2007). Noise pollution: A modern plague. *Southern Medicinal Journal*, *100*(3), 287-294.

Golmohammadi, R., Ghorbani, F., Mahjub, H. and Daneshmeh, Z. (2010). Study of school noise in the capital city of Tehran-Iran. *Iran Journal of Environmental Health, Science and Engineering*, *7*(4), 365-370.

Gorai, A. K. and Pal, A. K. (2006). Noise and its impact on human being: A review. *Journal of Environmental Science and Engineering, 48*(4), 253-260.

Goswami, S., Nayak, S. K., Pradhan, A. C. and Dey, S. K. (2011). A study on traffic noise of two campuses of University, Balasore, India. *Journal of Environmental Biology, 32*(1), 105-109.

Goto, K. and Kaneko, T. (2002). Distribution of blood pressure data from people living near an airport. *Journal of Sound and Vibration*, *250*(1), 145–149.

Hagen, M., Huber, L. and Kahlert, J. (2002). Acoustic school design. *Forum Acusticum Sevilla*. Pp. 1-7.

Hansen, C. H. and Sehrndt, C. H. (2001). Fundamentals of acoustics. *Occupational Exposure to Noise: Evaluation, Prevention and Control. World Health Organization*.

Hansen, C.H. (2001). Fundamentals of Acoustics. In: B. Goelzer, C. H. Hansen, and G. A. Sehrndt (Eds.). *Occupational exposure to noise: evaluation, prevention and control*. World Health Organisation, pp. 23–52.

Haq, I., Hussain, T., Farooq, H. and Ahmad, M. R. (2014). Evaluation of the traffic noise pollution at some busiest sites of Faisalabad city, Pakistan. *Academic Research International, 5,* 23-26.

Hardoy, M. C., Carta, M. G., Marci, A. R., Carbone, F., Cadeddu, M., Koress, V.… and Carpiniello, B. (2005). Exposure to aircraft noise and risk of psychiatric disorder: The Elmas survey. *Social Psychiatry and Psychiatric Epidemiology*, *40*(1), 24-26.

Heinrich, J., Tiesler, C. M. T., Brik, M., Thiering, E., Kohlbock, G., Koletzko, S., … and Babisch, W. (2013). Exposure to road traffic noise and children's behavioural problems and sleep disturbance: Results from the GINIplus and LISAplus studies. *Environmental Research*, *123*, 1-8.

Hofman, L. F. (2001). Human saliva as a diagnostic specimen. *Journal of Nutrition, 131*(5), 1621s-1625s.

Hygge, S., Evans, G. and Bullinger, M. (1996). The Munich airport noise study: cognitive effects on children from before to after the changeover of airports. In: *Proceedings of Inter-Noise 96,* Aug. 1996, St. Albans, UK: Institute of Acoustics.

Ibrahim, Z. H. and Richard, H. K. (2000). Noise pollution at school environment in residential area. *Jurnal Kejuruteraan Awam (Journal of Civil Engineering), 12*(2), 47-62.

Ikenberrgy, L. D. (1974). School noise and its control. *Journal of Environmental Health, 36*(5), 493-499.

Ising, H., Lange-Asschenfeldt, H., Moriske, H. J., Born, J. and Eilts, M. (2004). Low frequency noise and stress: Bronchitis and cortisol in children exposed chronically to traffic noise and exhaust fumes. *Noise and Health, 6*(23), 21-28.

Jaiswal, P.S. and Jaiswal, N. (2003). *Environmental Law,* Second Ed., p.327.

Jamir, L., Nongkynrch, B. and Gupta, S. K. (2014). Community noise pollution in Urban India: Need for public health action. *Indian Journal of Community Medicine, 39*, 8-12.

Jarup, L., Babisch, W., Houthuijs, D., Pershegen, G., Katsouyanni, K., Cadum, E., …… and Vigna-Taliante, F. (2008). Hypertension and Exposure to Noise near Airports: the HYENA Study. *Environmental Health Perspectives, 116*(3): p. 329.

Kang, J., Xie, H. and Tompsett, R. (2011). The impacts of environmental noise on the academic of secondary school students in greater London. *Applied Acoustics 72*(8), 551-555.

Karsdorf, G. and Klappach, H. (1968). The influence of traffic noise on the health and performance of secondary school students in a large city. *Zeitschrift fur die Gesamte Hygiene, 14*, 52 - 54.

Kemp, A. A. T., Delecrode, C. R., Guida, H. L., Ribeiro, A. K. and Cardoso, A. C. V. (2013). Sound pressure level in a municipal preschool. *International Archives of Otorhinolaryngol*ogy, *17*(02), 196–201.

Khan, A., Thinschmidt, M. and Seibt, R. (2006). Workplace health promotion for nursery school teachers. *Prävention und Gesundheitsforderung, 1*(2), 88–93.

Kjellberg, A. (1990). Subjective, behavioral and psychophysiological effects of noise. *Scandinavian Journal of Work, Environment and Health, Vol. 16,* (Supplement 1), 29-38.

Klatte, M., Bergstrom, K. and Lachmann, T. (2013). Does noise affect learning? A short review on noise effects on cognitive performance in children. *Frontiers in Psychology, Vol. 4*, Article 578, 1-6.

Kreisman, B. M., Mazevski, A. G., Schum, D. J. and Sockalingam, R. (2010). Improvements in speech understanding with wireless binaural broadband digital hearing instruments in adults with sensorineural hearing loss. *Trends in Amplification, 14*(1), 3-11.

Kumar, R., Kumar, N., Kumar, D., Pawar, M. and Chauhan, A. (2010). Assessment of noise level status in different areas of Moradabad city. *Report and Opinion, 2*(5), 59-61.

Kumbur, H., Ozsoy, H. D. and Ozer, Z. (2003). Investigation of noise levels in sensitive zones around the city of Mersin 1998-2002. *Ekoloji 13*(49), 25-30.

Kura, S., Moritomo, M. and Maekava, Z. I. (1999). Transportation noise annoyance: A simulated environment study for road, railway and aircraft noises, part 1: Overall annoyance. *Journal of Sound and Vibration, 220*(2), 251- 278.

Lang, T. H., Fouriaud, C. and Jacquinet-Salord, M. C. (1992). Length of occupational noise exposure and blood pressure. *International Archives of Occupational and Environmental Health, 63*(6), 369-372.

Lazarus, H. (1990). New methods for describing and assessing direct speech communication under disturbing conditions. *Environmental International 16,* 373-392.

Lazarus, H. (1998). Noise and communication: the present state. In N. L. Carter and R. F. S. Job (Eds.), *Noise as a Public Health Problem. Noise Effects, 1,* 157-162.

Lercher, P. and Kofler, W. (1993). Adaptive behavior to road traffic noise, blood pressure and cholesterol. In: M. Vallet, (Ed.). *Noise and Man'93. Proceedings of the 6th International Congress on Noise as a Public Health Problem, Nice, 1993.* Arcueil Cedex, Institut National de Recherche sur les Transports et leur Sécurité, 465–468.

Lercher, P., Stansfeld, S. A. and Thompson, S. J. (1998). Non-auditory health effects of Noise: Review of the 1993-1998 in *Proceedings of the 7th International Congress on Noise as a Public Health Problem (Noise Effects' 98),* N. L. Carter and R.F.S. Job, (Eds.), vol. 1, pp. 213-220, Syndey, Australia.

Leventhall, H. (2004). Low frequency noise and annoyance. *Noise and Health*, *6,* 59–72.

Levitt, H. (2001). Noise reduction in hearing aid. *Journal of Rehabilitation Research and Development*, *38(*1), p.111.

Li, B., Tao, S. and Dawson, R. W. (2002). Evaluation and analysis of traffic noise from the main urban roads in Beijing. *Applied Acoustics, 63*(10), 1137-1142.

Lindvall, T. and Radford, T.P. (1973). Measurement of annoyance due to exposure to environmental factors. *Environmental Research*, *6*, 1-36.

Losch, D. and Schulze, J. (2016). Stressfaktoren in kindertagesstätten. *Zentralblatt fur Arbeitsmedizin*, *66*(3), 147–152.

Lourenço, G. M. S. and Silveira, D. D. (2011). Educação ambiental, desenvolvendo atividades para minimizar o ruído na Escola. *Revista Eletrónica em Gestão, Educação e Tecnologia Ambiental (4),* 546–557.

Lundquist, P., Holmberg, K. and Landstrom U. (2000). Annoyance and effects on work from environmental noise at school, *Noise and Health*, *(2)*8, 39-46.

Mahadi, M. (2012). Noise pollution and its effect on students of some selected educational institutes of Dhaka metropolitan city. (Unpublished MS thesis, Bangladesh Agricultural University, Mymensigh). Retrieved from http://dspace.bau.edu.bd/bitstream/123456789/995/1/ENVSC-244%20DEC-2012.pdf

Mahendra, P. K. and Venugopalachar, S. (2011). The possible influence of noise frequency components on the health of exposed industrial workers—A review. *Noise and Health*, *13,* 16–25.

Mariscal-Ramires, J. A., Fernandes-Prieto, J. A., Canada-Bago, J. and Gadeo-Martos, M. A. (2014). A new algorithm to monitor noise pollution adapted to resource constrained devices. *Multimedia Tools and Applications, 70*, 1-15.

Maschke, C., Rupp, T. and Hecht, K. (2000). The influence of stressors on biochemical reactions – A review of present scientific findings with noise. *International Journal of Hygiene and Environmental Health, 203*, 45-53.

Mazer, S. E. (2012). Creating a culture of safety: Reducing hospital noise. *Biomedical Instrumentation and Technology*, *46*(5), 350-355.

McEwen, B. S. (1998). Stress, adaptation, and diseases. Allostasis and allostatic load. *Annals New York Academy of Sciences*, 37-44.

Mclaren, E. and Maxwell-Armstrong, C. (2008). Noise pollution on an acute surgical ward. *Journal of Annals of Royal College of Surgeons of England, 90*(2), 136-139.

Mitra, A. (2008). Diabetes and stress: A review. *Studies on Ethno-Medicine*, *2*(2), 131-135.

Mkoma, L. G., Kiumbu, H. F. and Gaganija, M. S. (2011). Noise pollution in school environment in Mwanza city, Tanzania. *Tanzania Journal of Natural and Applied Sciences*, *2*(2), 373-381.

Monsen, M. G. and Gustafsson, U. M. E. (2005). Noise and sleep disturbance factors before and after implementation of a behavioural modification programme. *Journal of Intensive and Critical Care Nursing, 21*(4), 208-219.

Morillas, J. M. B., Escobar, V. G., Sierra, J. A. M., Gomez, R. V. and Carmona, J. T. (2002). An environmental noise study in the city of Caceres, Spain. *Applied Acoustics, 63*(10), 1061-1070.

Mukhola, M. S. (2014). Street-food vending: Training directed at better food handling and associated environmental issues. *Anthropologist, 17*, 251-258.

Münzel, T. and Sorenson, M. (2017). Noise pollution and arterial hypertension. European Cardiology Review, 12(1),

Münzel, T., Gori, T., Babisch, W. and Basner, M. (2014). Cardiovascular effects of environmental noise exposure. *European Heart Journal*, ***35***, 829–36.

Nelson, P. B., Soli, S. D. and Seltz, A. M. A. (2002). *Acoustical Barriers to Learning.* NY: Acoustical Society of America. Pp. 1-12.

NIOSH (1998). *Criteria for a recommended standard: occupational noise exposure. Revised criteria*. Cincinnati, OH, National Institute for Occupational Safety and Health

Noori, K. and Zand, F. (2013). An investigation of traffic noise pollution effects of citizens' general and mental health (Case study: Kermanshah City). *Journal of Novel Applied Sciences, 2*, 344-349.

Norlander, T., Moas, L. and Archer, T. (2005). Noise and stress in primary and secondary children: Noise reduction and increased concentration ability through a short but regular exercise and relaxation program. *School effectiveness and school improvement, 16*(1), 91-99.

NPC (2010). 2006 population and housing census priority table volume 7. National population commission. Abuja: Nigeria. Available from *www.population.gov.ng/images/Vol_7_educational_attainment.pdf*

O'Neill, D. (2002). Experience of using building bulletin 87: does Building Bulletin 93 resolve all the difficulties? Presented at School Acoustics meeting, Institute of Acoustics, October 15 2002.

Obisung, E. O., Akpan, A. O. and Asuquo, U. E. (2013). Aircraft noise nuisance in Nigeria; a social and acoustical survey. *International Journal of Engineering Research and Applications, 3*(1), 680-692.

Obot, O. W. and Ibanga, S. M. (2013). Investigation of noise pollution in the university. *International Journal of Engineering Research and Technology, 2*(8), 1375-1385.

Okoro, R. C. (2014). Survey and analysis of noise by generating plants in some parts of the University of Calabar, Calabar, Cross River State Nigeria. *International Journal of Research in Agriculture and Food Sciences, 1*(3), 8-15.

Olayinka, O. S. (2013). Effective noise control measures and sustainable development in Nigeria. *World Journal of Environmental Engineering, 1*(1), 5-15.

Onder, S. and Akay, A. (2015). Reduction of traffic noise pollution effects by using vegetation, Turkey's sample. *Journal of Engineering and Economic Development, 2*(2), 23-35.

Onuu, M. U. (2000). Road traffic noise in Nigeria. Measurements, analysis and evaluation of nuisance. *Journal of Sound and Vibration, 233*(4), 391-405.

Orellana D, Vishniac B (2007). Noise in the adult emergency department of John Hopkins Hospital. *Journal of the Acoustical Society of America, 121*(4), 1996-1999.

Otutu, O. S. (2011). Investigation of environmental noise within campus 2, Delta State University, Abraka, Nigeria. *International Journal of Research and Reviews in Applied Sciences**,** 6*(2), 223-229.

Oyedepo, O. S. and Abdullahi, A. S. (2009). A comparative study of noise pollution levels in some selected areas in Ibria metropolis, Nigeria. *Environmental Monitoring and Assessment*, *120*, 499-525.

Oyedepo, S.O. (2012). Noise pollution in urban areas: The neglected dimensions. *Environmental Research Journal*, *61*(4), 259-271.

Ozdemir, B., Bayramoglu, E. and Demirel, O. (2014). Noise pollution and human health in Trabzon parks. *Ethno Medicine, 8*(2), 127-134.

Ozer, S., Zengin, M. and Yilmaz, H. (2014). Determination of the noise pollution on University (Education) campuses: a case study of Ataturk University. *Ekoloji Dergisi, 23*(90), 49-54.

Ozyonar, F. and Peker, F. (2008). Investigation of the environmental noise pollution in Sivas city centre. *Ekoloji, 18*(69), 75-80.

Passchier-Vermeer, W. and Passchier, W. F. (2000). Noise exposure and public health. *Environmental Health Perspectives 108* (Suppl. 1), 123-131.

Pathak, V., Tripathi, D. B. and Mishra, K. V. (2008). Dynamics of traffic noise in a Tropical city Varanasi and its abatement through vegetation. *Environmental Monitoring and Assessment, Vol.146,* 67-75.

Patil, Y. B. and Hunashal, R. B. (2012). Assessment of noise pollution indices in the city of Kolhapur, India. *Procedia- Social and Behavioral Sciences, 37,* 448-457

Pearsons, K. S. and Bennett, R. L. (1974). Handbook of noise ratings.

Prasher, D. (2009). Is there evidence that environmental noise is immunotoxic? *Noise and Health*, *11*(44), 151-155.

Pritam, U., Pandey, G. and Singh, S. P. (2014). Assessment of outdoor and indoor noise pollution in commercial areas of Gorakhpur city. *International Journal of Engineering Research and Technology, 312,* 777-783.

Pronello, C. and Camusso, C. (2016). A study of relationship between traffic noise and annoyance for different urban site typologies. *Transportation Research Part D, 44,* 122-133.

Pugh, K. C., Miura, C. A. and Asahara, L. L. (2006). Noise levels among first, second, and third grade elementary school classrooms in Hawaii. *Journal of Educational Audiology, 13,* 32-38.

Puglisi, G. E., Cantor-Cutira, L. C., Pavese, L., Castellana, A., Bona, M., Fasolis, V., ….. and Astolfi, A. (2015). Acosutic comfort in high-school classrooms for students and teachers. *Energy Procedia, 78,* 3096-3101.

Raaschou-Nielsen, O., Overvad, K., Sorensen, M., Andersen, Z.J., Nordsborg, R. B., Becker, T. and Tjonneland, A. (2013). Long-term exposure to road traffic noise and incident diabetes: A cohort study. *Environmental Health Perspectives, 121*(2), 217-222.

Ralte, L. and Lalramnghinglova, H. (2013). Assessment on different levels of noise pollution in Aizawl City, Mizoram, India. *Science Vision, 13,* 157-161.

RANCH (2005). Aircraft and road traffic noise and children's cognition and health; a cross-national study. *The Lancet, 365,* 1942-1949.

Rauf, K. M., Hossieni, H., Ahmad, S. S., Ali, H. and Kawa, H. (2015). Study of the improvement of noise pollution in University of Sulaimani in both new and old campus. *Journal of Pollution Effects and Control, 3,* 143.

Reddy, P. B. and Jherwar, S. (2012). Effects of noise pollution with relation to hypertension. *Trends in Life Sciences 1*(2), 30-33.

Regecová, V. and Kellerová, E, (1995). Effects of urban noise pollution on blood pressure and heart rate in pre-school children. *Journal of Hypertension, 13*(4), 405-12.

Sabbah, W., Watt, R. G., Sheiham, A. and Tsakos. (2008). Effects of allostastic load on the social gradient in ischaemic heart disease and periodontal disease: Evidence from the third national health and nutrition examination survey. *Journal of Epidemiology and Community Health, 62*, 415-420.

Saeed, A. M. R. (2010). The effects of noise pollution on arterial blood pressure and heart pulse rate schools children at Jennin city. (Doctoral Dissertation, An-Najah National University). Retrieved from https://scholar.najah.edu/.../effect_of_noise_pollution_on_arterial_blood_pressure_pu...

Sargent, J. W., Gidman, M. I., Humphreys, M. A. and Utley, W. A. (1980). The disturbance caused to school teachers by noise. *Journal of Sound and Vibration, 70*(4), 557–572.

Sato, T., Yano, T., Bjorkman, M. and Rylander, R. (1999). Road traffic noise annoyance in relation to average noise level number of events and maximum noise level. *Journal of Sound and Vibration*, *223*(5), 775-784.

Savale, P. A. (2014). Effects of noise pollution on human being: Its prevention and control. *Journal of Environmental Research and Development, 8*(4), 1026-1036.

Seibt, R., Dutschke, D., Thinschmidt, M. and Khan, A. (2004). Netzwerk für gesunde Beschäftigte in kindertagesstätten—Projektkonzept, Umsetzung und erste Befunde. *Arbeit, 13*(3), 312–319.

Shahid, M. A. and Bashir, H. (2013). Psychological and physiological effects of noise pollution on the residents of major cities of Punjab (Pakistan). *Peak Journal of Physical and Environmental Science Research*, *Vol.1*(4), 41-50.

Shendell, D. G., Di Bartolomeo, D., Fisk, W. J., Hodgson, A. T., Hotchi, T., Lee, S., .… and Apte, M. G. (2002). *"Final methodology for a field study of indoor environmental quality and energy efficiency in new re-locatable classrooms in northern California,"* Tech. Rep. LBNL-51101, E.O. Lawrence Berkeley National Laboratory, Berkeley, California, USA.

Shield, B. M. and Dockrell, J. E. (2003). The effects of noise on children at school: A review. *Building Acoustics*, *10*, 97-116.

Shield, B. M. and Dockrell, J. E. (2004). External and internal noise surveys of London primary schools. *Journal of Acoustical Society of America, 115,* 730-738.

Shield, B. M. and Dockrell, J. E. (2008). The effects of environmental and classroom noise on the academic attainments of primary school children. *Journal of Acoustic Society of America*, *123*, 133–44.

Silva, L. T., Oliveira, S. I. and Silva, J. F. (2016). The impacts of urban noise on primary schools. Perceptive evaluation and objective assessment. *Applied Acoustics, 106*, 2-9.

Singh, D. and Joshi, B. D. (2010). Study of the noise pollution for three consecutive years during deepawali festival in Meerut City, Uttar Pradesh, *New York Science Journal*, *3*(6), 40-42.

Singh, N. and Davar, S. C. (2004). Noise pollution: Sources, effects, and control. *Journal of Human Ecology*, *16*(3), 181-187.

Sjodin, F., Kjellberg, A., Knutsson, A., Kjellberg, A. and Landstrom, U. (2012). Noise and stress effects on pre-school personnel. *Noise and Health 14*(59), 166 – 178.

Sjodin, F., Kjellberg, A., Knutsson, A., Landstrom, U. and Lindberg, L. (2014). Measures against pre-school noise and its adverse effects on the personnel: An intervention study. *International Archives of Occupational Environmental Health*, *87*, 95 –110.

Smith, E., Lemke, J., Taylor, M., Kirchner, H. L. and Hoffman, H. (1998). Frequency of voice problems among teachers and other occupations. *Journal of Voice. 12,*(4**),** 480-488.

Sorenson, M., Hvidberg, M., Hoffman, B., Anderse, Z. J., Nordsborg, R. B., Lillehind, K. G., …, and Raaschou-Nelson, O. (2011). Exposure to road traffic and railway noise and association with blood pressure and self-reported hypertension: A cohort study. *Environmental Health*, *10*(92), 1-11.

Sowah, R. A., Alfred, Y. A., Carboo, D. and Adaboh, R. K. (2014). Noise pollution in Teshie-Nungua schools. *Journal of Natural Sciences Research 4*(21), 90 – 98.

Spreng, M. (2000). Central nervous system activation by Noise. *Noise and Health*, *2*(7), 49-57.

Stansfeld, S. A. and Matheson, M. P. (2003). Noise pollution: Non-auditory effects on health. *British Medical Bulletin*, *68*, 243-257.

Stansfeld, S. A., Berglund, B., Clark, C., Lopez-Barrio, Fischer, P., Ohrstrom, E., … and Berry, B. F. (2005). Aircraft and road traffic noise and children's cognition and health: A cross-national study. *The Lancet*, *365*, 1942-49.

Stumpf, F. B. (1980). *Analytical Acoustics.* Michigan: Ann Arbor Science Publisher. *14*(2), 57-62.

Subramani, T., Kavitha, M. and Sivaraj, K. P. (2012). Modeling of traffic noise pollution. *International Journal of Engineering Research and Applications*, *2,* 3175-3182.

Thangadurai, N., Ravichandran, C. and Meena, K. (2015). Environmental noise pollution in Salem, Tamilnadu, India. *I Control Pollution, 2004.*

Turunen, M., Toyinbo, O., Putus, T., Nevalainen, A., Shaughnessy, R. and Haverinen-Shaughnessy, U. (2014). Indoor environmental quality in school buildings, and the health and wellbeing of students. *International Journal of Hygiene and Environmental Health, 217*(7), 733-739.

Ugwuanyi, J. U., Ahemen, I. and Agbendeh, A. A. (2005). Assessment of environmental noise pollution in Makurdi metropolis, Nigeria. *Zuma Journal of Pure and Applied Sciences*, *6*(2), 134-138.

Umar, A. H. and Barde, A. (2015). A survey of causes and psychological effects of noise in some selected areas of Kano metropolis. *International Journal of Scientific Research, 4(11)*, 287- 290.

US EPA (1974). *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety.* Report EPA 550/9-74.004, US Environmental Protection Agency, Washington DC, USA. Accessed from www.rosemonteis.us/../usepa-1974 on May 22nd, 2016.

Van Kempen, E., van Kamp, I., Fischer, P., Davies, H., Houthuijs, D., Stellato, R., .. and Stansfeld, S. (2006). Noise exposure and children's blood pressure and heart rate: The RANCH Project. *Occupational and Environmental Medicine, 63,* 632-639.

Wang, L. M. and Ronsse, L. M. (2010). Effects of noise from building mechanical systems on elementary school student achievement. *ASHARE Transactions, 116,* (2), 347-354.

Wang, L. M. and Ronsse, L. M. (2013). Relationships between unoccupied classroom acoustical conditions and elementary student achievement measured in eastern Nebraska. *Journal of Acoustical Society of America, 133*(3), 1480-1495.

Waye, K. P., Clow, A., Edwards, S., Hucklebridge, F. and Rylander, R. (2003). Effects of nighttime low frequency noise on the cortisol response to awakening and subjective sleep quality. *Life Sciences*, *72*(8), 863-875.

WHO (1987). *The Ottawa Charter for Health Promotion. Health Promotion International*. Accessed from http://www.who.int/ ../en/ on July 08, 2016.

WHO (2001). *Noise in Schools*. Geneva.

WHO (2004). *The Physical School Environment, an Essential Component of a Health-Promoting School* (WHO/PHE and WHO/NPH). Available Online: www.who.int/school_youth_health/med... (accessed on March 3rd, 2016).

WHO (2009). *Night noise guidelines for Europe*. Available from www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf

WHO (2011). *Burden of Disease from Environmental Noise – Quantification of Healthy Life Years Lost in Europe.* Copenhagen: WHO Regional Office for Europe. Available Online: http://www.euro.who.int/../e94888.pdf (accessed on January 16th, 2016).

WHO (2014). *School and Youth Health. What is a Health Promoting School?* Available Online: http://www.google.com.ng/search?q=WHO.%20(2014).%20School%20and%20Youth%20Health.%20What%20is%20a%20Health%20promoting%20school&clientAction=534.click&clientAction=534.click&client=ISO-8859-1&hl=en (Accessed on 5th December, 2015).

Woolner, P. and Hall, E. (2010). Noise in schools: A holistic approach to the issue. *International Journal of Environmental Research and Public Health*, *7,* 3255-3269.

Woolner, P., Hall, E., Higgins, S., McCaughey, C. and Wall, K. (2007). A sound foundation? What we know about the impact of environments on learning and the implications for building schools for the future. *Oxford Review Education, 33*(1), 47–70.

World Health Organization (1980). *International Standard/Acceptable Levels.* Nigeria.

World Health Organization (1999). *Guidelines for Community Noise.* WHO, Geneva. Available Online: http://whqlibdoc.who.int/hq/1999/a68672.pdf accessed on November 23rd, 2015.

Yılmaz, H. and Ozer, S. (2005). Evaluation and analysis of environmental noise pollution in the city of Erzurum, Turkey. *International Journal of Environment and Pollution*, *23* (4), 438-448.

Yoshida, T., Osada, Y., Kawaguchi, T, Hoshiyama, Y., Yoshida, K. and Yamamoto, K. (1997). Effects of road traffic noise on inhabitants of Tokyo. *Journal of Sound and Vibration, 205*(4), 517-522.

Yuhazri, M. Y., Kamarul, A. M., Haeryip Sihambing, J. A. R., Haider, M. M., Toibah, A. R., Rahimah, A. H. and Tajul, A. A. (2010). The potential of agriculture waste material for noise insulator application toward green design and material. *International Journal of Civil and Environmental Engineering 10*(5), 13-18.

Zannin, P. H. T. and Zwirtes, D. P. Z. (2009). Evaluation of the acoustics performance of classrooms in public schools. *Applied Acoustics, 70,* 626-635.

Zannin, P. H. T., Diniz, F. B. and Barbosa, W. A. (2002). Environmental noise pollution in the city of Curitiba, Brazil. *Applied Acoustics, 63,* 351-358.

Zannin, P. H. T., Ferreria, A. M. C. and Szeremetta, B. (2006). Evaluation of noise pollution in urban parks. *Environment Monitoring Assessment, 118,* 423-433.

Zannin, P. H. T., Zwirtes, D. P. Z. and Passero, C. R. M. (2012). Assessment of acoustics quality in classrooms based on measurements, perception and noise control. In S. Daniela (Ed.), *Noise Control, Reduction and Cancellation Solutions in Engineering.* ISBN: 978-953-307-918-9, InTech, Available from http://www.intechopen.com/books/noise-control-reduction-and-cancellation-solutions-in-engineering/assessment-of-acoustics-qualtiy-in-classrooms-based-on-measurements-perception-and-noise-control

Zeid, Q., She, M. and Abdel-Razia, I. R. (2000). Measurement of the noise pollution in the community of Araba. *Acoustica*, *86*, 376-378.

Zheng, X. (1996). Study on personal noise exposure in China. *Applied Acoustics*, *48*, 59-70.

APPENDICES

Appendix I: Questionnaire for Teachers

SCHOOL OF POSTGRADUATE STUDIES
AHMADU BELLO UNIVERSITY, ZARIA
FACULTY OF LIFE SCIENCE
DEPARTMENT OF BIOLOGY

ASSESSMENT OF THE LEVEL AND EFFECTS OF ENVIRONMENTAL NOISE POLLUTION QUESTIONNAIRE FOR TEACHERS (ALEEN-PQT)

Dear Sir/Ma,

It is an honour to have you participating in this research. This questionnaire is not designed to implicate you, but it is designed to improve the health of teachers and teaching profession. This research aimed at quantifying the level of noise in and around the school, and assess its effect on teaching.

SECTION A: GENERAL INFORMATION ABOUT THE SCHOOL

- Name of the School: ……………………………………………………………..
- Average Number of Students/class: ……………………………………………..
- Sound insulation on doors/windows assessed by physical survey:

Provided [ ]   Not Provided [ ]

SECTION B: SOCIO-DEMOGRAPHIC DATA OF PARTICIPANTS

- Age (Years): 20-24 [ ]   25-30 [ ]   31-40 [ ]   41-50[ ]   51-60[ ]
- Gender Male [ ]   Female [ ]
- Length of hours spent/day: 5hrs [ ]   8hrs [ ]   10hrs [ ]

SECTION C:

Part A: Occupational and teaching related features of the schools and classroom

S/N	Statements with reference to noise	SA	A	IN	D	SD
1.	External noise affects concentration during delivering lectures					
2.	Noise affects teaching					
3.	High noise causes interference in communication between students and teachers					
4.	High noise causes reduction in social interaction					
5.	Teachers' feel better if noise level is reduced in the class					
6.	Noisy environment reduces comfort level					
7.	Behaviour is affected by noise					
8.	Due to high noise, teacher experiences voice masking					
9.	Teachers' concentration is affected by road noise					
10.	High noise causes school children to be tired					
11.	Students' learning ability is affected by noise					

SA: Strongly Agree; IN: Indifferent; SD: Strongly disagree; A: Agree; D: Disagree

Part B: Noise Pollution Level

- ❖ Please specify, what do you think about noise pollution of this area?

Extremely Annoying [ ] Very Annoying [ ] Slightly Moderate [ ] Not at all [ ]

- ❖ What would be your suggestion in improving the situation?

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

THANK YOU FOR YOUR UNDERSTANDING AND COOPERATION

Appendix II: Questionnaire for Students

SCHOOL OF POSTGRADUATE STUDIES
AHMADU BELLO UNIVERSITY, ZARIA
FACULTY OF LIFE SCIENCES
DEPARTMENT OF BIOLOGY

ASSESSMENT OF THE LEVEL AND EFFECTS OF ENVIRONMENTAL NOISE POLLUTION QUESTIONNAIRE FOR STUDENTS (ALEEN-PQS)

Dear Student,

It is worthy to let you know that this questionnaire is not to implicate you, but it is a research which puts your health and academic growth into consideration. This research is aimed at quantifying the level of noise and its effect on learning.

SECTION A: GENERAL INFORMATION ABOUT THE SCHOOL

- Name of the School: ……………………………………………………………………
- Average Number of Students/class: …………………………………………………
- Sound Insulation on Doors/Windows Assessed by physical survey:

Provided [ ]   Not Provided [ ]

SECTION B: SOCIO-DEMOGRAPHIC DATA ON PARTICIPANTS

- Age(Years):   10-15 [ ]   16-20 [ ]   21-25 [ ]
- Gender: Male [ ]   Female [ ]
- Length of hours spent/day: 5hrs [ ]   8hrs [ ]   10hrs [ ]

SECTION C: LEARNING RELATED FEATURES OF THE CLASSROOM

S/N	Statement with reference to noise	SA	A	IN	D	SD
1.	External noise affects concentration					
2.	High noise causes negative effect on behavior					
3.	High noise affects reading ability					
4.	High noise decreases student's listening ability					
5.	Students are disturbed by intermittent noise					
6.	Students are affected by road noise					
7.	Students feel stressed due to high noise					
8.	High noise reduces social interaction and enjoyment					
9.	Noise reduces students learning ability					
10.	High noise interferes with speech intelligence					
11.	Students experience headache due to exposure to noise					
12.	Speech communication is affected by noise					
13.	Noise causes conflicts with classmates					
14.	Students will feel good if noise is controlled					

KEYS: SA: Strongly Agree; A: Agree; IN: Indifference D: Disagree SD: Strongly Disagree

- NOISE POLLUTION LEVEL:

Please specify, what do you think about noise pollution of this area??

Extremely Annoying [ ] Very Annoying [ ] Slightly Moderate [ ] Not at all [ ]

EXPOSURE TO DIFFERENT NOISE SOURCES:

Please point out different types of noise experiences

S/N	Noise creating sources	Frequently experienced	Moderately experienced	Low experienced	Rarely experienced
1.	Microphone				
2.	Motorcycle				
3.	Truck				
4.	Bus				
5.	By religious activity				
6.	Vehicular horn				
7.	Construction activities				
8.	Industrial Activity				
9.	Peoples activity				
10.	From Adjacent classrooms				
11.	Classmates				
12.	Others				

- Noise Awareness

1. How aware are you of noise pollution around you?

   Highly Aware { } Relatively Aware { } Not Aware { }
2. Is the noise produced on daily basis?

   Yes { } No { }
3. Have there been efforts to control noise?

   Yes { } No { }
4. If Yes, by who?
   - School management { } Government { } NGO { }

THANK YOU FOR YOUR COOPERATION

Appendix III: List of Sampled Schools used for this study

SAMPLED SECONDARY SCHOOLS

i. Alhuda Huda College (ALHCZ).
ii. Barewa College (BRCZ).
iii. Science Secondary School (SSSKZ).
iv. Government Secondary School (GSSTJZ).
v. Sheikh Ibrahim Arabic Special Secondary School (SIASSZ).
vi. Government Secondary School Bogari (GSSBZ).
vii. Government Girls Secondary School Kofan-Gayan (GGSSGZ).
viii. Government Girls Secondary School Pada (GGSSPZ).
ix. Government Girls Secondary School Dogo Bauchi (GGSSDZ).
x. Government Girls Secondary School Chindit (GGSSCZ).
xi. Government Girls Secondary School Kongo (GGSSKZ).

SAMPLED PRIMARY SCHOOLS

i. Abdulrahman Mora L.G.E.A. Primary School (ARMZ).
ii. Sarki Sambo L.G.E.A. Primary School (SSMZ).
iii. Baba Ahmed L.G.E.A. Primary School (BBAZ).
iv. Sani Adamu L.G.E.A. Primary School (SADZ).
v. Sarki Mu’sa L.G.E.A. Primary School (SMAZ).
vi. Bello Aliyu L.G.E.A. Primary School (BAKZ).
vii. Dr. Abubakar Imam L.G.E.A. Primary School (DAIZ).
viii. Isan Nabawa U.B.E. Primary School (UINZ).
ix. Tsoho Abdulahi L.G.E.A. Primary School (TOAZ).