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Noise Induced Hearing Loss within the Rivers State University of Science and Technology, Port Harcourt, Nigeria

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ABSTRACT

The effect of Noise Induced Hearing Loss within the Rivers State University of Science & Technology, at certain locations were investigated. Micro-controlled Diagnostic Audiometer (Kamplex: KLC32), Portable sound meter (B173D), Human beings, Ear-plugs and Ear-muffs were employed in the investigation. Both right and left Air and Bone Conduction Pure Tone were measured on each subject. Results obtained showed that employees within the community are safe, so long as they are not exposed to more than 120 (dB) A for more than eight hours per day.

KEY WORDS: impairment, air conduction, bone conduction, audiogram, acoustic trauma, pure tone, threshold.

INTRODUCTION

Hearing plays an essential role in communication, speech and language development, and learning. Even a small amount of hearing loss can have profound, negative effects on speech, language comprehension, communication, classroom learning, and social development. Studies have shown that without proper intervention, children with mild to moderate hearing loss, on average, do not perform as well in school as children with no hearing loss. This gap in academic achievement widens as students progress through school, [1].

In United States of America, an estimated 12.5% of children and adolescents aged 6-19 years and 17% of adults aged 20-69 years have suffered permanent damage to their hearing from excessive exposure to noise, [2]. Every day, we experience sound in our environment, such as the sounds from television and radio, household appliances, and traffic. Normally we hear these sounds at safe levels that do not affect our hearing. However, when we are exposed to harmful noise (sounds that are too loud or loud sounds that last a long time) sensitive structures in our inner ear can be damaged; causing Noise Induced Hearing Loss (NIHL). These sensitive structures, called hair cells, are small sensory cells that convert sound energy into electrical signals that travel to the brain. Once damaged, our cells cannot grow back.

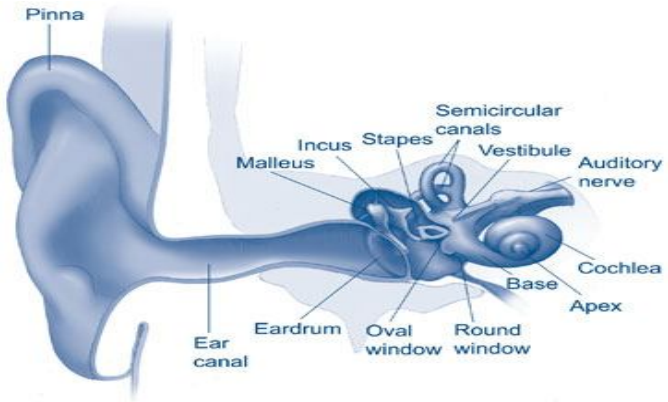

Fig. 1: The sound pathway

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NIHL occurs when too much sound intensity is transmitted into and through the auditory system. An acoustic signal from an energy source, such as a radio, enters into the external auditory canal, and is funneled through to the tympanic membrane. The tympanic membrane acts as an elastic diaphragm and drives the ossicular chain of the middle ear system into motion. Then the middle ear ossicles transfer mechanical energy to the cochlea by way of the stapes footplate hammering against the oval window of the cochlea. This hammering causes the fluid within the cochlea (perilymph and endolymph) to push against the stereocilia of the hair cells, which then transmit a signal to the central auditory system within the brain. When the ear is exposed to excessive sound levels or loud sounds over time, the overstimulation of the hair cells leads to heavy production of reactive oxygen species, leading to oxidative cell death. In animal experiments, antioxidant vitamins have been found to reduce hearing loss even when administered the day after noise exposure, [3]. Some of the abnormalities include metabolic exhaustion of the hair cells, structural changes and degeneration of structures within the hair cells, morphological changes of the cilia, ruptures of cell membranes, and complete degeneration and loss of hair cells, neural cells and supporting cells.

NIHL is therefore the consequence of overstimulation of the hair cells and supporting structures. Structural damage to hair cells (primarily the outer hair cells) will result in hearing loss that can be characterized by an attenuation and distortion of incoming auditory stimuli. Thus NIHL is a sensory neural type loss involving injury to the inner ear in which the sensitivity of the loss depends on the intensity and the frequency of the sound exposure. Data shows that there is considerable variation in human sensitivity with respect to hearing impairment, and therefore the hazardous nature of a "noisy environment" is described in terms of "damage risk". Physical ear discomfort to noise exposure starts from sound pressure levels of 80-100 decibels (dB). A continuous noise level of 85 dB can result in hearing damage as well as create various other negative effects on health [4]. NIHL occurs gradually and without pain. Often, by the time a person realizes that there is a hearing problem, it is too late to reverse its effects: permanent damage has occurred.

[5] studied the factors that constitute traffic noise and the effects of exposure to steady state noise and the impairment of hearing; while [6] in their study discovered that severe hearing impairment may also arise from intense sound produced as music in headphones. [7] concluded in their investigations that persons exposed to high level of noise (84-98 dB) for about three hours daily in working conditions run risk of noise-induced hearing loss in addition to cardiovascular disease and can develop hypertension five years earlier, under the same noise level. It is difficult to exclude unwanted signal into our auditory canal even when we are asleep, unlike our eyes which we can shut to exclude unwanted visual input, [8].

TYPES OF NIHL

Acoustic Trauma

NIHL caused by acoustic trauma refers to permanent cochlear damage from a one-time exposure to excessive sound pressure. This type normally results from exposure to high-intensity sounds such as explosions, gunfire, a large drum hit loudly, airplanes and firecrackers.

Gradually Developing NIHL

Gradually developing NIHL refers to permanent cochlear damage from repeated exposure to loud sounds over a period of time. Unlike NIHL from acoustic trauma, this form of NIHL does not occur from a single exposure to a high-intensity sound pressure level. Gradually developing NIHL can be caused by multiple exposures to any source of excessive volume, such as home and vehicle stereos, concerts, night clubs, industrial noise, and personal media players. The U. S. Department of Labour's Occupational Safety and Health Administration (OSHA) states that exposure to 85 dB (A) of noise, known as exposure action value, for more than eight hours per day can result in permanent hearing loss, [9]. Gradually developing NIHL results from the combination of the sound intensity and duration of exposure. Both NIHL caused by acoustic trauma and gradually developing NIHL can often be characterized by a specific pattern presented in audio logical findings. NIHL is generally observed to affect a person's hearing sensitivity in the higher frequencies, especially at 4000 Hz. 'Noise induced impairments are usually associated with a notch-shaped high-frequency sensorineural loss that is worst at 4000 Hz, although the notch occurs at 3000 or 6000 Hz as well [10]. The symptoms of NIHL are usually presented equally in both ears. Often a decline in hearing sensitivity will occur at frequencies other than at the typical 3000-6000 Hz range. Variations arise from differences in people's ear canal resonance, the frequency of the harmful acoustic signal, and the length of exposure

[11]. [12] Observed that NIHL usually occurs initially at high frequencies of 3000, 4000 or 6000 Hz, and then spreads to the low frequencies of 5000, 1000 or 2000 Hz.

Rivers State University of Science and Technology may be classified under community noise because of its complex nature since community noise (also called environmental, or residential or domestic noise) is defined as a noise emitted from all sources except noise at industrial work place. The main sources of noise within Rivers State University of Science and Technology include among others road and air traffic, construction, generators, ventilation systems, office machines, cement mixers, welding, hammering, boring, home appliances and neighbours. [13] Studied the effects of NIHL within the Port Harcourt Metropolis and observed that most workers at the Port Harcourt International Airport are affected by NIHL.

METHODOLOGY

The equipment employed in this research are, Micro-controlled Diagnostic Audiometer (Kamplex: KLC32), Portable Sound Meter (B173D), Human Beings and Ear-plugs and Ear-muffs.

The Pure Tone Air-Conduction and Pure Tone Bone-Conduction methods adopted by [14] in measuring the extent of NIHL are also used in this study. The Pure Tone Air-Conduction Audiometry involves determining the minimum intensity of sound in the form of a pure tone which is audible. Each ear is tested separately. The threshold values obtained could be expressed, for example, as the actual values of the sound pressure level presented to the ear and measured preferably at the ear drum. The descending and ascending threshold of zero hearing which are techniques used to confirm that the person tested has reached his/her normal threshold of zero hearing were measured.

RESULTS AND DISCUSSION

Audiogram which is the graph of the subject's hearing sensitivity level usually show the elevation from normal sensitivity of hearing level rather than the actual hearing sensitivity level (threshold) of 85 dB.

Tables 1, 2 and 3 show Nigeria and International standards relative to the noise intensity levels of the noise sources respectively, while the main sources of noise and location within the Rivers State University of Science and Technology are shown in Figure 2.

Table 1: Standard noise exposure limit in Nigeria

S/N	Duration per day (hr)	Permissible Exposure Limit (dB)A
1.	8	90
2.	6	92
3.	4	95
4.	3	97
5.	2	100
6.	1.5	102
7.	1	105
8.	0.5	110
9.	0.25 or less	115

Table 2: United States Criteria on Noise Exposure Limit.

Common Sounds	Noise Level (dB)A	Effects
Boom cars	145	Beyond Threshold of pain 125 dB
Shot gun firing	130	
Rock Concept	110-140	Regular exposure more than 1 minute risk causes permanent loss
Thunder clap	120	
Stereo (over 100 watts)	110-115	
Chainsaw	110	
Jet fly over (100ft)	103	Not more than 15 minutes unprotected exposure.
Garbage truck	100	
Cement mixer	100	Recommended (90-100 dB)
Farm tractor	98	Very annoying at which hearing damage begins (hours)
Newspaper press	97	
Lawn mower	85-90	Annoying and interferes with conversation.
Food blender		
Average	80	

Table 3: European Criteria

S/N	Type room	Noise Level (dB)A
1.	Broadcasting Studio	20
2.	Concert Hall	25
3.	Legitimate Theatre	25
4.	Classroom, Music room, TV Studio	30
5.	Bedroom	30
6.	Courtroom	30
7.	Living room	35
8.	Library	35
9.	Cinema Hall, Hospital	35
10.	Church	35
11.	Private Office	45
12.	Restaurant	50
13.	General Office	60
14.	Workshop	70

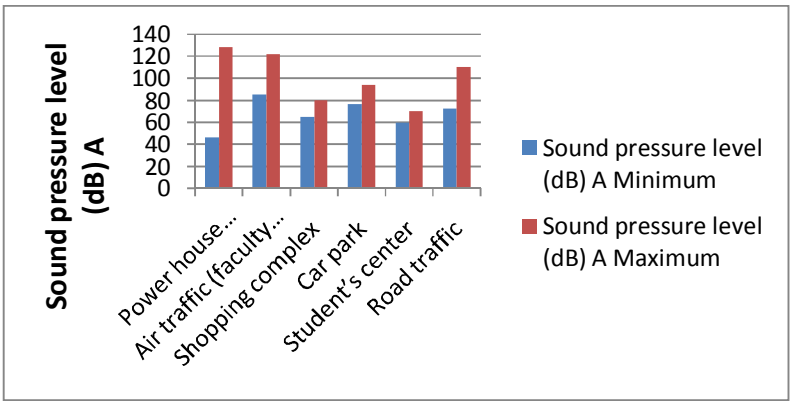

Figure 2: Main sources of noise in RSUST.

The intensity of noise from the power house and road traffic and sometimes from the shopping complex (particularly when PHCN is off) is observed to be high. Also the intensity of noise from aircraft (Agip helicopter) is observed to be outrageously high for the university community, especially at the premises of the Faculty of Science and main Library. The audiogram of one of the subject's tested is shown in Figures 3 and 4. The air traffic momentarily disrupts academic activities, because, for the period of flying, it causes temporary hearing loss. The subjects that operate the generator do not spend much time in the generator house and may not be exposed to serious ear damage, although they experience temporary hearing loss.

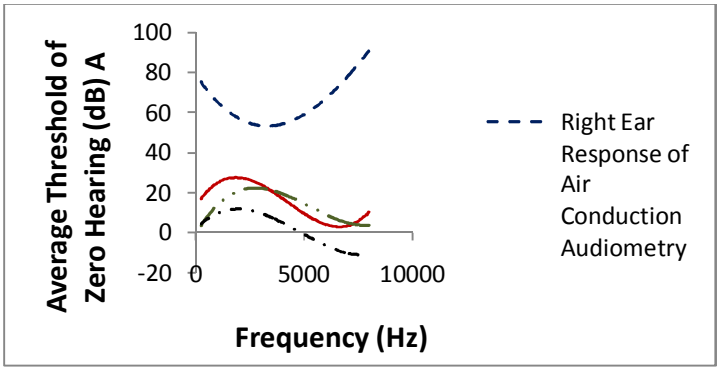

Fig. 3: Air and bone conduction relative sensitivity curves for test 1.

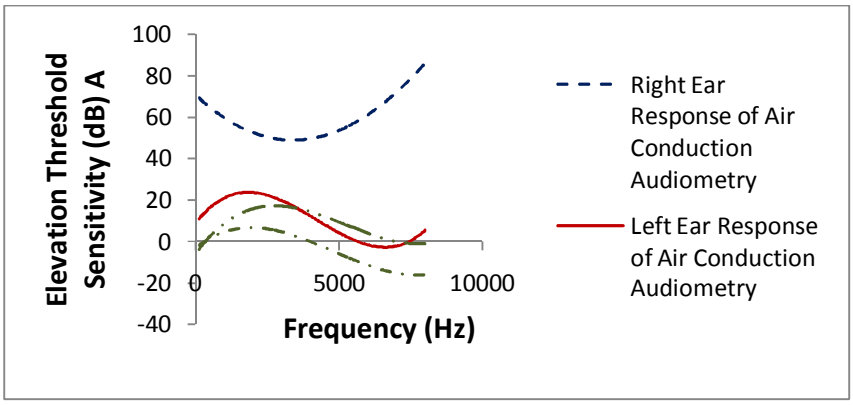

Fig. 4: Air and bone conduction relative sensitivity curves for test 2.

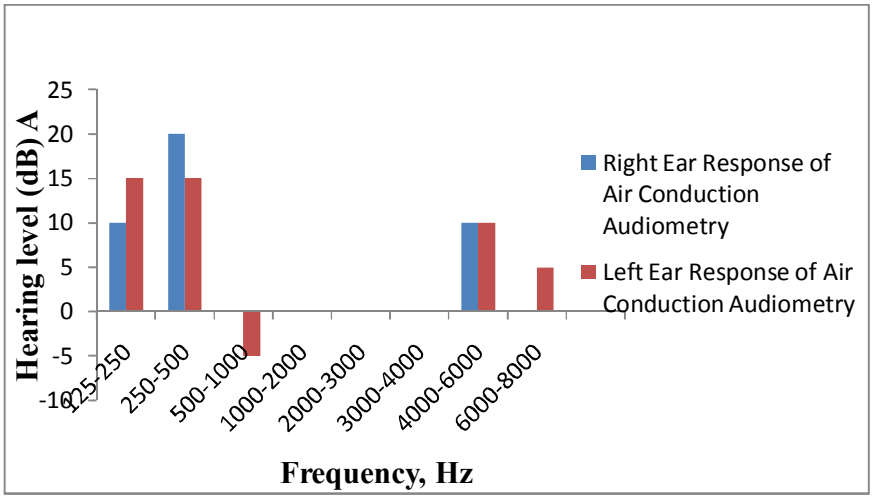

Fig. 5: Elevation Threshold Sensitivity Chart (Air Conduction)

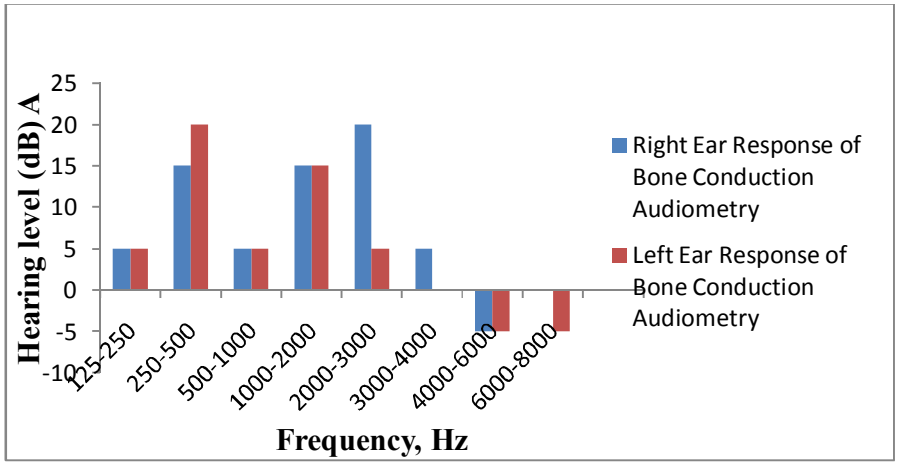

Fig. 6: Elevation Threshold Sensitivity Chart (Bone Conduction).

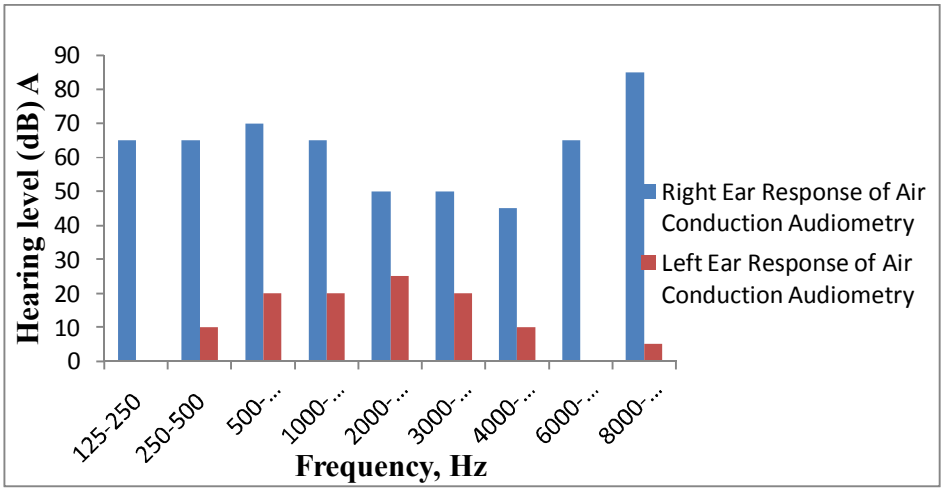

Fig. 7: Elevation Threshold Sensitivity Chart (Air Conduction)

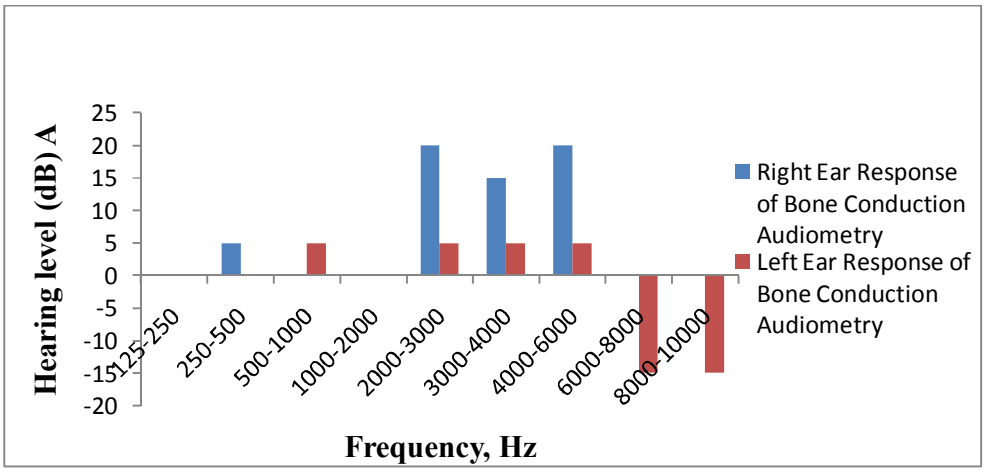

Fig. 8: Elevation Threshold Sensitivity Chart (Bone Conduction)

Noise from most of the sources within the Rivers State University Science and Technology Community is not harmful as can be seen from Table 2. Noise from shopping complex, road traffic, students' center and car park cause temporary threshold shift. This is a short term effect as its name indicates. The effect is reversible and is dependent on individual susceptibility, age and heredity. Noise from the generator house and faculty of science due to air traffic is outstrageous and may cause Permanent threshold if the subject is exposed for a longer period of time. This Permanent threshold shift causes acoustic trauma, tinnitus, and disorder in speech communication, to mention but a few. Results obtained as observed from the figures and compared to Table 1 are not dangerous.

CONCLUTIONS AND RECOMMENDATIONS

Acoustics is the Physics of sound, and sound is defined as any pressure variation that can be heard by the human ear at 20Hz to 20 kHz. This study is carried out under acoustic component known as audiology which covers the acoustic spectrum. In the study of NIHL within the university community, several locations were chosen. The procedural steps taken were the determination of Noise Intensity Levels of noise sources, Figure 2, and the Noise Survey questionnaires and then the audiometric measurements of individuals exposed to the noise sources, Figures 5-8). There are five platforms of audiometry- Air and Bone conduction audiometries, Speech audiometry, Monographic audiometry and Noise Exposure Calculation audiometry. However, the two platforms of audiometry used in this study are Air and Bone conduction audiometries. The audiograms and statistical bar chart representations can be used to identify individual's hearing status, whether normal, partially or permanently

impaired. The statistical bar charts also show the threshold sensitivity elevation at 1 kHz specifically and the sensitivity threshold level of the NIHL for all the audiometric frequencies (125 Hz-8 kHz).

It is highly recommended that the Occupational Safety and Health Administration (OSHA) standards described for occupational noise exposure in articles 1910.95 and 1926.52 which states that an employer must implement hearing conservation programs for employees if the noise level of the workplace is equal to or above 85 (dB) A for an average eight-hour time period, (Gelfand, 2001). OSHA also states that 'exposure to impulsive or impact noise should not exceed 140 dB sound pressure level.

Clinical examination by the usual ontology method is a basic part of any hearing examination, since the audiometric measurement is only part of the examination. The adiometry can be grossly misleading without the clinical examination. For example, the ear may be obstructed by wax, or the person could be suffering from cold, both of which would throw doubt on the reliability of the audiogram.

Noise regulations at workplace are very essential. Employers have a duty to protect their employees hearing, by informing them of how to protect their hearing, by marking any 'Ear Protection" zones, by providing them with ear protection (Ear plugs and ear muffs).

Employees at generator house, shopping complex and those who found themselves within the premises of the Main library and Faculty of Science should be required to wear hearing protection, particularly if they will be exposed to more than the stipulated eight-hour period.

It is also recommended that raising public awareness through education and information, monitoring and modeling of soudscapes, involving sufficient noise experts, initiation of research will go a long way in reducing the hazards of noise.

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