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Evaluation of Noise Pollution on Audio-Acuity among Sawmill Workers in Nnewi Metropolis, Anambra State, Nigeria

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Abstract- Noise pollution from occupation has gained ground in recent times, with its significant effect seen in auditory function. The study's aim is to determine the level of noise pollution and Audio Acuity among sawmill workers. A descriptive cross-sectional study was employed using a convenient sample technique and a sample size of 100, comprising 50 sawmill workers who work at Nnewi Sawmill and 50 students of the College of Health Sciences, Nnewi Campus. An amplivox-116 audiometer was used to ascertain the audio acuity and a noise meter to measure the noise level. Data obtained were subjected to SPSS version 25 (IBM, USA, 2018), and analyzed using independent t-test and Pearson correlation, and values were significant at $p<0.05$. The result of the study showed significance ($p<0.05$) between study groups and control for anthropometric variables.

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I. Introduction

Noise pollution is a significant issue affecting modern society, which has detrimental impact on the auditory system and other physiological parameters; however, noise-induced hearing loss is preventable; once acquired, hearing loss is permanent and irreversible (1). Noise is a sound or signal generated by random fluctuations or an unwanted part of an unpleasant signal to the ear (2). Noise exposure and its rate are different according to the personal and environmental features; but depend on individual characteristics such as age, work experience, race, and nutritional status (3,4). In addition, noise exposure can cause social and psychological problems (1,5), resulting in a negative impact on the physiological function of the auditory pathway and others systems. Exposure to high noise levels, especially at workplaces, has been a global concern as strong evidence links them with some high-ranking health challenges (6). Symptoms of short or long periods of noise exposure include auditory effects such as auditory fatigue and hearing loss, indirect non-auditory effects such as speech interference, annoyance, lowered mental peace, task performance, and several psychological changes (6–8).

The cochlea has a significant role in auditory transduction that takes place in the inner ear; which creates a tonotopic map by the chirality of the cochlea enabling interpretation of the vast amount of different sounds simultaneously through vibrations carried from the perilymph to the endolymph in the cochlear duct (9,10). Reports have shown that noise exposure above 85-decibels or a more extended period of exposure greater than eight hours results in cochlear damage and could affect the loss of hair cells in the cochlea. Although, hair loss in the cochlea results in the inability of afferent nerves stimulation, which brings about low differentiation of sound of distinct frequencies (10,11). Noise pollution of different sources causes Meniere disease, resulting from the dysregulation of aquaporin channels and osmotic disequilibrium involving the production of endolymph from perilymph through the Reissner membrane and stria-vascularis (11–13). One of the significant setbacks of occupational noise-induced hearing loss is the loss of auditory sensory cells in the cochlea (14). However, these hair cells cannot regenerate in mammals, and no diminution can occur. The only preference to preserve hearing loss is to abstain from the exposure to noise-induced hearing loss sources such as high sound above 90-decibels (15,16). The inability to understand speech in our everyday lives can have a severe social effect, a dominant characteristic of hearing loss. It could affect cognitive performance and decrease attention to tasks (4,17).

A report has shown that exposure to occupational noise for a more extended period (14-years) is known to cause hearing impairment; however,

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a period of 4-8 years among sawmill workers results in the development of hearing impairment (18). Exposure to prolonged or excessive noise results in a range of health problems such as anxiety, meagre concentration, decline productivity at office even in classrooms, communication difficulties and fatigue from lack of sleep, to more severe issues such as cardiovascular disease, cognitive impairment, tinnitus and hearing loss (4). Therefore, the study investigates and obtains evidence of the influence and consequences of exposure to sawmill noise on audio acuity.

II. Materials and Method

Study Design: A descriptive cross-sectional survey-experimental design, which involved the use of well-structured health and lifestyle questionnaire, a noise meter to check the level of the noise in the environment, an audiometer to test for the audio acuteness of the subjects.

Ethical Approval: An ethical approval consent was obtained from the Faculty of Basic Medical Science, College of Health Science, Nnewi Campus, with reference number NAU/CHS/NC/FMBS/376.

Data Collection and Technique: A convenient sampling method was employed in the subject selection of 100 participants, and they were within the ages of 18 to 45-years. A health and lifestyle questionnaire was administered to ascertain the volunteers' suitability for the research study; however, anthropometric variables of these individuals were determined using a stadiometer. A total of 100 subjects were employed, and the participants were assigned into groups of two as follows: Group A, which comprised of 50 individuals who worked at the Sawmill, formed the study group, and Group B comprised of 50 students of the college that made up the control group. A well-structured Health and Life Questionnaire containing information such as sex, age, history of hearing problem, duration of the noise exposure was administered before the commencement of the audio acuity test. Those with a history of hearing problems were exempted from this study.

Audio acuity assessment: The audiometer was used for this study. Instructions were given to the subjects concerning the test procedures, and were required to indicate whether they could hear or not hear a sound at different sound levels.

Data Analysis: Data was analyzed using SPSS version 25(IBM, USA, 2018), and data obtained was subjected to inferential statistics (Independent T-test and Pearson Correlation), and values were considered significant at $p<0.05$.

III. Results

Table 1: Baseline Characteristics of Participants

Variables	Group	MEAN	±STD	P-value	T-value
Age (Years)	Control	22.04	±2.48	0.00*	-12.26
	Test Group	33.02	±5.82		
Weight (kg)	Control	67.48	±12.06	0.11	-1.63
	Test Group	71.02	±9.48		
Height (m)	Control	1.61	±0.11	0.35	-0.92
	Test Group	1.63	±0.07		
Body Mass Index (kg/m2)	Control	25.35	±3.49	0.16	-1.41
	Test Group	26.47	±4.43		

Table 1 results revealed Test group had a higher ($p<0.05$) significant age than control group. Furthermore, weight, height, and BMI showed a higher non-significance ($p>0.05$) between Test group than Control.

Table 2: Comparison of audio acuity and noise level among Study and Control group

Variables	Group	MEAN	±STD	P-value	T-value
Right Ear Audiometer (dB)	Control	8.98	±3.27	0.00*	-30.98
	Test Group	35.74	±5.15		
Left Ear Audiometer (dB)	Control	9.28	±3.20	0.00*	-31.02
	Test Group	35.72	±5.10		
Noise level (dB)	Control	43.00	±0.00	0.00*	0.15
	Test Group	100.00	±0.00		

Table 2 result showed that right and Left ear audiometric test and noise level revealed test group had a higher significance than control.

Table 3: Correlation between duration of work, age, and audio acuity of left and right ear audio-acuity among sawmill workers

		Right Ear Audio-acuity (dB)	Left Ear Audio-acuity (dB)	Age (Years)
Work duration	Pearson Correlation	0.827**	0.767**	0.475**
	p-value	0.000	0.000	0.000
	N	50	50	50

The result from table 3 revealed a significant correlation between work duration and right ear audio-acuity (rs=0.827; *p0.000*), left ear audio acuity (rs=0.767; *p=0.000*), and age (rs=0.475; *p=0.000*).

IV. Discussion

Noise is any unwanted or disturbing sound that is a persistent pollutant in modern society resulting from noise occurring from recreational, environmental, or occupational sources leading to noise-induced hearing loss, a common type of acquired hearing loss (19). However, noise exposure at moderate levels can induce a temporary shift in hearing thresholds. It is caused by reversible damage to the stereocilia of hair cells. However, exposure to loud noise leads to a permanent loss in hearing thresholds due to irreversible damage to cochlear hair cells (20,21). A report revealed that high-intensity noise above-recommended limits of 70dB could initiate some work-related health challenges, including noise-related ailments such as headaches and hearing impairments(7). Noise-Induced Hearing Loss is an irreversible but preventable disorder (22).

The current study findings showed a significant ($p<0.05$) difference between the audio acuity between the left and right ear between the study and control group; however, the mechanism of action results from the interference of louder noise greater than 100dB. The physiology for the loss of hearing impairment is attributed to an outer hair cell loss, reduced blood flow in the basal region, rupture of tight cell junctions, excitotoxicity of cranial nerve VIII fibers, cochlear synaptopathy, or loss of inner hair cells and cranial nerve VIII fibers (20,23), which result from persistent noise more significant than the standard threshold of noise. Further, our study's findings have an alignment with the findings of (24), who reported a significant difference ($p<0.05$) between the study group and control group of the audio acuity in both ears when compared. It indicates that prolonged exposure high level of noise above the standard threshold could affect the hearing acuity leading from mild to moderate hearing loss, resulting from a decreased sensitivity of hair cells situated in the inner ear. The study report of (25,26) is aligned with this study findings, revealing hearing loss on the right and left ears among the test groups.

The resulting study showed a significant correlation between the duration of work and age and audio acuity among sawmill workers. In addition, there is a significant association between ages and audio precision of both ears. The possible mechanism of action is associated with a shift in a progressive increase in auditory thresholds, mainly in the high-frequency range (27), which results in sensory loss, which affects sleep, concentration, mood, and quality of life as a minor annoyance (25,28). Another mechanism involved is excess stimulation of the hair cells when the ear is exposed to excessive sound levels or loud sounds over time. It leads generation of reactive oxygen species, such as superoxide and hydroxyl anion radicals, resulting in oxidative cell death (22,27). Our study has similarity with the report of (18), who revealed that noise-induced hearing impairment was correlated with work duration, which has significance. Jain *et al.* (22) report also aligned with our study result with hearing impairment increased to exposure of occupational noise ($p=0.000$). The report of (25,29)showed that workers with long years of service were positively associated with hearing loss, corroborated with our study findings. Furthermore, reports from (22,27,29,30) have alignment with our study report revealing a significant association between age and audio acuity of sawmill workers.

V. Conclusion and Recommendation

In conclusion, the study revealed that audiometric results of both left and right ear of sawmill workers compared to control had a significant increase, indicating hearing impairment. In addition, hearing loss is associated with age and work duration, which negatively affects the audio acuity of sawmill workers. Therefore, it is recommended that considering the results of the above experiments, noise above 100dB is detrimental and can result in hearing impairments. The use of ear muffs among the sawmill workers will help to minimize the intensity of the noise, thereby reducing the risk of hearing impairment.

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Conflict of interest

The authors have no competing interest.

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