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INDUSTRIAL NOISE EXPOSURE AND ITS EFFECTS ON BLOOD PRESSURE IN ADULT INDUSTRY WORKERS

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Abstract
Noise pollution has always been a prevalent case in industrial environment, yet there has never been a cohesive assertion on the actual effect of these noise exposures on the blood pressure. Many occupational studies have allied exposure to noise in working environment to a number of physiological and psychological responses like secretion of adrenaline and cortisol needed to adjust the body function but in-return may result to an increase in blood pressure. On the contrary, some researchers have emphatically disagreed with the findings by pointing-out that different individuals are likely to exhibit different noise excitations. This research was to investigate whether there is noise pollution in sawmills and also to examine if there is any significant blood pressure changes as a result of the noise pollution. The research was carried out in phases. In the first phase of the study, a sound level meter was used to determine the ambient noise levels in the sawmills. These measured noise levels were used to calculate workers exposure dosage. In the subsequent phase of the study, a structured health and life style questionnaire was used as exclusion criteria for the selection of the eventual subjects that was tested with automatic sphygmomanometer for blood pressure difference. The research population comprises a population of male and female(n=101) in the sawmill environment, who had been exposed to high level of noise from one year and above and whose activities are within the measured noise level distance. The blood pressure and pulse pressure was measured at regular two-minute intervals before, and after prolonged period of exposure to high (fluctuating) noise level. Result was analyzed by SPSS-17 package using student t-test. The subjects selected for control group were six volunteer students (male), aged 25-32 years and were exposed to high level of (fluctuating) noise, and later exposed to experimental conditions, without production of noise. The result of the study have established that noise pollution was prevalent in these sawmills, and has a significant effects on the blood pressure. However, these effects as regards to increase or decrease depends on some other un-captured factors since individual noise appraisal and societal appreciation of the activities generating the noise have also a notable effect on whether the effect would be tending towards a decrease or increase. In conclusion, the noise exposure dosage of these sawmill workers exceeds the permissible exposure limit as prescribed by the occupational safety and health administration. In addition, prolonged exposure to high (fluctuating) noise levels may be a possible influence on the blood pressure changes.

Key word: noise pollution, permissible exposure limit, blood pressure, Adult Workers.

Introduction
The increase in population in Nigeria has necessitated the growth of sawmill industries to meet with the ever demand of the growing population. These technological progresses are aimed to gain velocity in production and decrease the physical work burden of men but now have some negative effects by increasing health problems too. With increased mechanisation there is an increase in environmental pollution like noise which is detrimental to the health of the operators which services are paid for by their employer. Exposures to noise levels found in sawmills are likely to be the most intense and sustained of any experienced in daily living. In the sawmill industry people are generally subjected to noise of a varying nature. High noise levels, particularly those of short duration such as impulse or impact noise, are present in many Sawmill workshops and are capable of causing damage to health. In sawmill workshops noise levels can be expected to range between about 80 and 125dB (A). Some machines such as chain saws, chippers, hammered saw blades and those containing many welds together with power generating sets emit high noise levels. However, these relatively short duration exposures happen many times per shift and may therefore pose a serious hazard to hearing and other health related problems.Though noise pollution is a slow and imperceptible killer, very little efforts have been made to cushion its effects on humans. It is, along with other types of pollution has become a serious health hazard. Passchier-Vermeer (2000) reported noise exposue as a constituents of a health risk, by stating a sufficient scientific evidence that noise exposure can induce hearing impairement, hypertension, and ischemic heart disease, annoyance, sleep disturbance, and decrease school performance. But with a limited evidence on other effects such as changes in the immune system and birth defects. The effects of excessive noise could be so severe that either there is a permanent loss of memory or a psychiatric disorder (Bond, 1996). Thus,there are many adverse effects of excessive noise or sudden exposure to noise. The recognition of noise as a source of annoyance began in antiquity. Clearly, as purported by some researchers that noise may be the desired end or an inconsequential by-product of the desired end for one group (employers), and a thing of misery to another (the employees), a need for its control is pertinent. Though amplified music may give pleasure to many, the excessive noise of much modern-day industry probably gives pleasure to very few or none at all.The contemporary research developments has recognized and aligned noise as a serious health hazard,

Research Objectives
(i) Determining the ambient noise levels in sawmills.

(ii) Assessing noise exposure dosage of workers working in sawmills.
(ii) Assessing the impact of these noise levels on blood pressure in the selected sawmill workers.

Justification For This Research

Work-related noise is a growing concern across Nigeria, as it directly affects workers not only in Sawmill industries but also in growth sectors such as services, education, entertainment, market places, bars and restaurants. The more recent data as reviewed by Spring (2004) has strengthened the evidence for an association between noise and adverse effect on blood pressure. Sabitoni (2006) study shows that on-the-job noise contributes to high blood pressure which, in turn, can cause heart disease or stroke. The new study, published in the Archives of Environmental Health, recorded noise levels at a Midwest auto assembly plant and correlated them with heart rate and blood pressure measurements among the autoworkers. The researchers found that blood pressure is affected by overall noise exposure while heart rate is affected by spikes in instantaneous loud noises. Systolic blood pressure rose two millimeters when average noise exposure rose ten (10) decibels or when the difference between average and maximum noise exposure increased by more than five decibels. A 13 decibel increase in average noise exposure produced a two-millimeter increase in diastolic blood pressure. These increases are worrisome because a long-term reduction of six millimeters in diastolic blood pressure has been associated with a 35-40 percent drop in strokes and a 20-25 percent reduction in coronary disease. In general, high blood pressure is associated with increased rates of stroke and heart disease. Although there have been extensive literatures on increases in blood pressure from exposure to occupational as well as environmental noise from people living near roads, airport, and Sawmills, the emphasis of this research would be a demonstration of association between chronic exposure to occupational noise and risk factor for high blood pressure among Sawmill workers in Nigeria.

Physiological Effects Of Noise Other Than Hearing Loss

Many occupational studies have suggested that individuals chronically exposed to continuous noise at levels of at least 85dB have higher blood pressure than those not exposed to noise (Zhao et al, 1991 and Lang et al, 1992). In effect the impact of noise on blood pressure is mediated through an intermediate psychological response such as noise annoyance, although this has not been convincingly proved (Lercher et al, 1993). The strongest evidence for the effect of noise on cardiovascular system comes from studies of blood pressure in occupational settings (Thompson 1996). Green et al, (1991) observed a significant increase in systolic and diastolic blood pressure in younger age group (25-44yrs) subjects exposed to more than 85dB noise as compared to decrease in systolic blood pressure and no effect on diastolic blood pressure in subjects aged 45-65yrs. Elise et al (2002) observed insignificant increase in blood pressure. In a study to observe the effect of exposure to short-term noise on systolic blood pressure and diastolic blood pressure Rashid et al, (2009) indicated that a short-term exposure to noise for 10 minutes produced a significant rise in blood pressure. Both systolic and diastolic blood increased but the rise in diastolic blood pressure was more than the rise in systolic blood pressure. However, Evan et al (2006) observed on blood pressure changes in children, on the basis of their study and previous scientific literature that, no unequivocal conclusions was drawn about the relationship between community noise and children's blood pressure.

Measurement Procedures

Three measurement positions were chosen during the field work, at the entrance (s), close to the noise source (s) (2 meters away from the noise source) and points within the workers working zone (10-12 meters away from the noise source(s)). Several noise measurements were taken at each of these positions in all the locations. The maximum and minimum noise levels at these positions was noted and averaged as the noise level at point or position. These noise levels were classified as was obtained during 8hour working shift and the average of the measurement positions were gotten as the noise level within the hourly intervals of the 8hour working shift. The hourly exposure duration C was gotten by summing working hours that have the same noise levels. In phase one, the ambient noise levels at each workstations were measured using sound-level meter and readings was taken in dBA. The recorded noise levels at different workstations were used in calculating workers exposure dosage. Workers exposure dosage was assessed using standard regulatory procedure: the Occupational safety and health administration (OSHA). Finally, in the second phase of the research the blood pressure of those exposed to these noise levels were measured using Automatic Sphygmomanometer.

Study Group

A structured health and lifestyle questionnaire was used to elicit information from the workers. The information that was elicited from the questionnaire was used for the basis of selection of the eventual subjects. Some exclusion criteria were considered and the rationale for the long exclusion criteria was to minimize the influence of the many confounding factors in the development of high blood pressure.

Sample Size Selection

Choosing an appropriate sample size is crucial to having a study that will provide statistically significant results. An appropriate sample size estimate was used in this study. In determining the appropriate sample size, this formula was used to calculate the sample sizes:

$$SS = P(1-P)(Z/E)^2 \text{ OR } SS = (Q)(Z/E)^2 \quad \ldots\ldots(1)$$

SS = Sample Size. **E** = is the margin of error and was chosen to be **9.8%, P** = Proportion of the population expected to display a significant blood pressure difference. **Q** = Proportion of the population expected not to display a significant blood pressure, **Z** = Confidence level needed (**Z-score**).

SS =? , E = 9.8%, P = .5, Q = .5 **SS =** $.5(.5)(1.96/.098)^2$ **= 100.** The survey was designed to capture **100** people from the population.

Area Measurements and Calculations

D_i = C_i/T_i = $(actual\ time\ of\ exposure\ i|calculated\ PEL\ time\ of\ noise\ levels\ i)$**… (2)**

Where **T_i** = $8/2\,(L-90)/5$ (**OSHA**) when using **PEL** dosage. The total exposure dose, D for the entire work shift was calculated by summing all partial doses **i………..1, 2, 3…n**

D = 100 $\sum_i^n 1\ C_i/T_i$ **= 100(**$\left\{\frac{c1}{T1}\right\}+\left\{\frac{C2}{T2}\right\}+\ldots\ldots\ldots+\left\{\frac{Cn}{Tn}\right\}$**)**

Where **D** = dose, total shift noise exposure as a percentage of **PEL**

C_i = time duration of exposure at noise level I that is **L_i** **N** = number of all noise levels observed

T_i = maximum **PEL** or **TLV** time at noise level I **PEL** = Permissible exposure limit

From the study it was shown that the workers were exposed to the following noise levels after series of measurements were taken at different shifts and the average level on each work shift was taken, we then have **94, 92,96,92,89,89,91,95** during **8**-hour shift of observation. This same exercise was repeated three times and the noise levels were **89, 92,91,89,87,92,89,91, 94,90,88,92,88,89,92,87** and **91, 95,96,88,95, 98, 96, 92 .**

TABLE 1

Noise level (dBA)	Exposure duration Ci (hour)	Ti = PEL (hour)
89	2	9.2
91	1	7.0
92	2	6.1
94	1	4.6
95	1	4.0
96	1	3.5

Note: **Ti** (**PEL**) values are standardized by the (**OSHA**)

Equation (2) **D_i** = C_i/T_i =$(actual\ time\ of\ exposure\ i|calculated\ PEL\ time\ of\ noise\ levels\ i)$

D = 100 $\sum_i^n 1\ C_i/T_i$ **= 100(**$\left\{\frac{c1}{T1}\right\}+\left\{\frac{C2}{T2}\right\}+\ldots\ldots\ldots+\left\{\frac{Cn}{Tn}\right\}$**)**

$$D = 100 \sum_{i=i}^{6} Ci/Ti = 100\,(1/9.2 + 1/7.0 + 2/6.1 + 1/4.6 + 1/4.0 + 1/3.5) = \mathbf{144\%}$$

Using this formula to other values, the workers exposure dosage **D** were **144%, 103%,105%, 186%** and this has shown that exposed workers are at risk since the calculated dosage exceed **100%** which is the permissible exposure limit(**PEL**).

RESULTS ON THE BLOOD PRESSURE MEASUREMENTS (AT A BACKGROUND NOISE LEVEL AND AT PROLONGED EXPOSURE AT AN ELEVATED NOISE LEVEL).

T ABLE 2. Number of subjects in whom blood pressure was affected by noise

				CONTROL EXPERIMENT			
Parameters	**increase**	**Decrease**	**No effect**	**parameters**	**Increase**	**Decrease**	**No effect**
Systolic blood pressure	**30 29.70%**	**67 66.34%**	4 3.96%	**Systolic blood pressure**	**4 66.66%**	**1 16.67%**	**1 16.67%**
Diastolic blood pressure	**30 29.70%**	**66 65.35%**	**5 4.95%**	**Diastolic blood pressure**	**4 66.67%**	**2 33.33%**	**-**
Pulse pressure	**47 46.53%**	**49 48.51%**	**5 4.95%**	**Pulse pressure**	**1 16.67%**	**5 83.33%**	**-**

Discussions on Statistical Results

- The mean systolic blood pressure of the test group on a paired sample statistics at a background noise level is greater than the systolic blood pressure at elevated noise level on a prolonged exposure, taking the difference of the sample means, the difference is by **3.723 (mmHg).**
- The mean of the diastolic blood pressure reading of the test group on a paired sample statistics at background noise level is greater than the mean of the diastolic blood pressure at elevated noise level on a prolonged exposure, taking the difference of the sample means, the difference is by **2.52 (mmHg).**
- The mean of the pulse pressure measurements on a paired sample statistics taken at a background noise level, taking the difference of the sample means, the difference is by **1.02**

The analyzed result on the findings has statistically shown that prolonged exposure to high (fluctuating) noise level has significant effects on the blood pressure. Analysis of the data showed that the systolic blood pressure, diastolic blood pressure, pulse pressure increased in **29.70%, 29.70%, 46.53%,** decreased in **66.34%, 65.53%** and **48.51%** of the total subjects. The control experiment has shown by statistics that prolonged exposure to high (fluctuating) noise level has significant effects on the blood pressure. It has shown the systolic blood pressure, diastolic blood pressure, Pulse pressure increased in **66.66%, 66.67%,** and **16.67%,** respectively decreased in **16.67%, 33.33%,** and **83.33%** of the total control subjects. This has also shown that different individuals are likely to exhibit differently to different noise excitations, as opined by Passchier-Vermeer (2000), that individual and societal appreciation of the activities generating the noise may result to adaptation.

Research Limitations

1. Due to budgetary constraints, the survey was designed to capture only hundred people from the sawmill environment, thereby making the margin of error to be **9.8** percent. For that reason, a **95%** confidence interval for the percentage that has shown a significance difference in their blood pressure was (**50%-9.8%) to (50%-9.8%)** suggesting that in a large sawmill environment, the level of significant change in the blood pressure due to noise exposure could acceptably range from **40.2%** to **59.85%** and this statistically implies considerable uncertainty about whether a majority of the population will actually show a significant blood pressure change.
2. Difficulties was encountered during the questionnaire administration, some of the exposed workers failed to fill the questionnaire and some that filled the questionnaire and was found eligible for the test absconded from the blood pressure measurement.

Conclusions

It is generally believed that how noise affects people depends on a complex mix of factors like: the nature of the noise, including its volume, tone, predictability and also on the individual appreciation of the activities generating the noise.

Inferences drawn from the study has shown that:

1. Sawmill workers spend a minimum of eight hours a day in this noisy environment.
2. Noise levels measured in these sawmills exceed the permissible exposure limit.
3. The noisy equipments are poorly placed within sawmills facility.
4. The sawmill workers do not use ear protector gadget.
5. Workers raise their voice very often when the machines are working in other to communicate with each other.

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