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NOISE-INDUCED HEARING IMPAIRMENT AS AN OCCUPATIONAL RISK FACTOR AMONG NIGERIAN TRADERS

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Summary: Noise pollution in workplaces poses serious health risks including that of cardiovascular disturbances and impairment of hearing. The objective of this study was to assess the effects of occupational noise on hearing among selected industrial workers in Benin City, Nigeria. Male and female workers (n=150) in sawmills, Food Processing industries and Marketers of recorded music who had been exposed to high levels of occupational noise for between 1-14years were evaluated. We determined the ambient noise levels in their workplaces to be over 90dB. We analyzed the air and bone conduction defects for both their left and right ears. The results showed that noise-induced hearing impairment was present in 100% of the workers exposed for a period of 14 years. By 4-8 years, 100% of sawmill workers had developed hearing impairment. In addition, air-conduction pathway in the right ear was affected more than the left ear. In general, male workers were more susceptible to noise induced hearing impairment. In a situation of low level of awareness and dearth of enforced noise control laws in many developing countries, noise pollution can pose severe hearing impairment and other health risks.

***Key Words**: Occupational noise, hearing, impairment, Nigerians.*

Introduction

Occupational noise remains a serious industrial disease (Sataloff and Sataloff, 1987). Evidence has accumulated that noise is a risk factor in sleep disturbance, cardiovascular dysfunction, speech interference and mental health distortion, including hearing impairment and balance disorder (Ylikoski, 1988; Satterfield, 2001). In some occupational groups, high noise levels can result in intolerable reactions and negatively impact on job satisfaction and performance (Burns, 1980). With repeated or prolonged exposure to noise levels in the order of greater than 80dB, hearing impairment may occur. (Harris 1979).

The process of impairment of hearing may be gradual but it can eventually result in the destruction of the hair cells of the organ of corti. Apart from high noise causing acoustic trauma, it can cause a temporary or permanent shift in hearing threshold (Harris, 1979). Such impairments may result in profound or total deafness. NIHI can be caused by one time exposure to noise as well as repeated exposure to noise at various levels of loudness over an extended period. The usual conversation is conducted at or less than 60dB. Exposure to a daily average noise level that is above 85dB is unsafe, because of damage to the hair cells.

Noise-induced hearing impairment (NIHI) is hardly a matter of public health concern in many developing countries such as Nigeria. There are few or poorly enforced noise – pollution control laws in many parts of the country. In the rapidly industrializing parts of the country, the occupational groups exposed to noise pollution are hardly aware of the health risks of the noise levels at their places of work. There are certainly no protective measures in use in these industries to reduce the impact of noise on the health of the workers. There is a definite critical level of noise and duration of exposure, which trigger the process of hearing impairment. These critical levels vary with age, genetic make-up, and previous exposure to loud noise.

The goal of this study was to determine the ambient noise levels in these industrial areas of Benin City, Nigeria. The objective was to assess the impact of these noise-levels on hearing in the selected occupational groups. We further related the onset of hearing impairment to the duration of exposure of the individuals to the noise. We hope that the findings will serve to inform the policy makers in Government and the industry to institute control and safety measures to protect their workers and to raise the level of awareness of these workers on the health risks of their work

environment and thus stimulate them to use protective gears.

Materials and Methods

Study Group

We selected 150 industry workers (98 males and 52 females) aged between 14 - 40 years who had spent a minimum of one year in either of three industrial areas. And are in no way provided with noise prevention aids. They were workers in Food Processing Industry, Sawmill and marketers of musical records. The workers carry out their business for a period of 8 - 10 hours daily and 6 -7 days in a week. We used a structured health and lifestyle questionnaire to elicit information from the workers. The information elicited from the questionnaire formed the basis of selection of the eventual 150 subjects. The exclusion criteria included:

(a) History of high blood pressure.
(b) History of treatment with ototoxic drugs including streptomycin.
(c) Smoking.
(d) Evidence of respiratory tract infection including common cold.
(e) History of past ear trauma/infection. The rationale for the long exclusion criteria was to minimize the influence of the many confounding factors in the development of hearing impairment.

A group of 30 staff and students of the University of Benin Teaching Hospital served as the control group. All the volunteers gave their written/informed consent. The postgraduate research committee of the medical school of University of Benin approved the study.

Determination of Ambient Noise

The ambient noise levels of the three industrial locations and the hospital were determined using a Noise Meter (Peters, UK). The ambient noise level was determined at four different times of the day namely: 9am, 12noon, 3pm, and 6pm. The mean of these determinations was calculated. The aim of the time-determinations was to ascertain if there were peak periods for noise levels in these places.

Hearing Function Test: We determined the pure tone audiometric values of all the subjects at different sound frequencies range of 125 – 8000HZ. The clinical staff of ENT Surgery Department at the University of Benin Teaching Hospital performed the tests. The audiometry was by the Screening Audiometer (Amplaid A 132). A pure tone audiometry for both air conduction (AC) and bone conduction (BC) for the left ear (ACL/BCL) and the right ear (ACR/BCR) was determined.

Statistical Protocol

We employed a computer based statistical program Excel to analyze our results.

Results

Ambient Noise Level in the occupational locations

Noise induced hearing impairment occurred predominantly in the in higher frequency range of 300–6,000Hz, with largest effect observed at 4000Hz with increasing exposure time to environmental noise, nihi was also detected at lower frequencies of testing, more specifically at 2000Hz.

Table I: Some characteristics of the study population and their work locations.

Index	Range	Mean	Remarks
Age (years)	14-40	24+/-3	Generally young
Exposure period (years)	1-22	4+/-3	6-10hrs/day; 6-7days/week.
Ambient noise level in the industrial locations.	80-110dB	90+/-dB	Electro-acoustic work place had the highest ambient noise level
University	50-65dB	50+/-10dB	Control location. (university campus)

n = 150 [52 females and 98 males]; control group n=30.

Table II: Percent of industrial workers of three industrial groups who developed noise induced hearing impairment in the right ear over different exposure periods.

		ARC		
Exposure (yrs)	Food Processing	Sawmill	Marketers of recorded music	Total (n)
1 – 3	26.7	60	16	60
4 – 8	96.4	100	84.4	67
9 – 14	No subject	100	100	18
>14	No subject	100	No subject	5
		BCR		
1 –3	0	20	0	60
4 – 8	53.6	57.1	6.3	67
9 –14	No subject	80	46	18
>14	No subject	100	No subject	5

ACR = air conduction for the right ear BCR = b one conduction for the right ear

Table III: Percent of groups of industrial workers who developed noise-induced hearing impairment in the left ear over different exposure periods.

		ACL		
Exposure (yrs)	Food Processing	Sawmill	Marketers of recorded music	Total (n)
1 – 3	10	0	0	60
4 – 8	35.7	40	21.9	67
9 – 14	No subject	71.4	53.8	18
>14	No subject	75	0	5
		BCL		
1 –3	0	0	0	60
4 – 8	3.6	14.3	0	67
9 –14	No subject	0	0	18
>14	No subject	25	No subject	5

ACL = air conduction for the left ear BCL = bone conduction for the left ear

Table IV: Showing NIHI on the right and left ear at different period of exposure to loud noise for the male and female subjects.

	MALE			FEMALE			TOTAL		
Period of Exposure (years) for the Right Ear ACR	n	NIHI %	NI	n	NIHI	NI	N	NIHI	NI
1-3	44	31.8	68.2	16	6.3	93.8	60	25	75
4-8	35	94.3	5.7	32	87.5	12.5	67	91	9
9-14	15	100	0	3	100	0	18	100	0
>14	4	100	0	1	100	0	5	100	0
BCR									
0-3	44	2.3	97.7	16	0	100	60	2.3	97.7
4-8	35	54.3	45.7	32	6.3	93.8	67	54.3	45.7
9-14	15	66.7	33.3	3	0	100	18	66.7	33.3
>14	4	100	0	1	0	100	5	100	0

Table 1 describes the ambient noise levels in the study locations, the mean age of the subjects, and their noise exposure periods. The ambient noise levels in the three occupational locations was high with a range of 80 – 100dB relative to that of a University campus in the same city with a range of 50-65dB. The mean exposure period of our study population was 4±3 years. These workers normally put in an average of 6-10 hours/day for between 6-7days in a week. These results show that our study population (n=150; 98males and 52 females) was daily exposed to noise pollution. The healthy noise level is usually about 60dB (NIOSH, 1988). In particular, the ambient noise-level in the marketers of recorded music was the highest at 100dB and which remained so throughout the day. These individuals market recorded music which they play using loudspeakers.

Table II shows a distribution of the proportion of workers developing air or bone conduction impairments in their right ear over the different exposure periods. By 4-8 years of exposure, 100% of the Sawmill workers had developed determinable impairment. By the same period, over 84 % of the marketers of recorded music had developed air conduction impairment in the right ear, while about 94 % of food processors had the impairment. However, over a period of 9-14 years of exposure, all individuals in Sawmill and marketers of recorded music had developed air conduction impairment in the right ear (ACR impairment). However, for the exposure periods of 9-14 years and above 14 years, the number of subjects was small being 18 and 5 respectively. In comparison, bone conduction impairment was less frequent. By 4-8 years of exposure, just over 50% of the workers in sawmills had developed BCR impairment relative to a frequency of ACR impairment of over 90%.

Table III shows the percent distribution of the groups of workers who developed air or bone conduction impairment in the left ear (ACL or BCL impairment). There was a gradual but steady increase in the frequency of either impairments but as was for ACR, air conduction was affected more in all the groups. Also, by 4-8 years of exposure, over 70 % of the sawmill workers had developed ACL impairment compared to just over 50% of the electro-acoustic workers

Sex differences in the development of hearing impairment

Table IV shows the distribution of male and female workers who developed air or bone conduction hearing impairment in the right ear over the exposure periods. By 4-8 years of exposure, 94 % of the male subjects (n=35) had determinable air conduction hearing impairment in the right ear (ACR impairment). In contrast only about 87% of their female counterparts (n=32) had ACR impairment. The same trend occurred for bone conduction hearing impairment (BCR impairment). The sex-difference trend was maintained in the three different noise sources (Marchie, 2002). It would thus appear that males were more susceptible to developing noise induced hearing impairment. However, the results are not statistically significant but they raise salient questions on sex differences in the onset or severity of noise induced hearing impairment.

Discussion

In this study, we describe the level of noise pollution in selected industrial locations in Benin City Nigeria. The average ambient noise level in Sawmills, Electro-acoustic market, and food processing industrial areas was determined to be above 90dB (Table I). This noise level is well above the healthy noise level of 60dB. It is noteworthy that the local government of Benin City has no or poorly enforced regulations on noise pollution. In addition, the workers in these locations do not use any protective gears nor were they well aware of the possible health risks of noise pollution. Occupational noise poses important health risks, and is one of the biggest industrial diseases (Sataloff & Sataloff, 1987). The dearth of regulatory measures against emission of loud noise and lack of protective gears by the workers increase the health risk posed by loud noise on them.

Our results of hearing-impairment test on 150 of such industrial workers show that within 4-8 years of exposure, over 90% of the workers had developed temporary or permanent shift in their hearing threshold (Tables II and III). By 14 years or over, all the evaluated workers had developed hearing impairment. Sawmill workers appear to develop impairment in their left and right ears faster than any other group of workers (Table II and III). By 1-3 years of exposure to noise 60% of Sawmillers has developed ACR nihi compare to only 16%, and 27% of recorded music marketers and food processing respectively. There is a clear association between length of exposure to noise level and the development of impairment for all categories of industry workers exposed to noise in this study.

There was an interesting asymmetry in hearing impairment for the left and right ears. Table II shows that whereas air conduction in the right ear (ACR) was impaired in over 90% of food processors who had been exposed to noise for 4-8 years, less than 40% of them had air- conduction- hearing impairment for the left ear (ACL) as in table III. The same trend is observable for bone-conduction hearing impairment in the right ear compared to the left ear (BCR vs. BCL). In a related study on the Israeli Defense Force (IDF), Sallerfield et al (2000) reported hearing impairment asymmetry among the soldiers but which affected the left ear more at a rate of 82%. This difference relative to our finding can be explained by the positioning of the weapons by these soldiers. We are uncertain of the possible reasons for this in our study.

It is yet uncertain which of the two ears is more susceptible to damage by noise, but persistent stimulation of any ear and firing of the hair cells can lead to wear, tear and adaptive changes. Sensorineural damage results more often from noise pollution compared with bone conduction (Satterfield, 2001). This partly explains our finding of lower frequency of hearing impairment for bone conduction. Table IV shows a slight sex difference in the frequency of hearing impairment for the different exposure groups but this finding is not significant. Whereas the number of the female subjects was smaller than the males, by 1-3 years of exposure, 31.8% of the male subjects had ACR impairment compared to only 6.3% of our female subjects developing it. The onset of impairment appears faster in the males than the females exposed to same noise source. We are uncertain of the basis of this difference. It is yet uncertain if there are sex differences in the development of hearing impairment. Evidently, more studies would be required to establish this trend. McFadden (1999) had also reported a sex differences in the onset of hearing impairment inn chinchillas.

From our study, the critical exposure period to noise appears to be between 4-5 years. By 9-14 years, 100% of our study population had developed detectable impairment, which suggests a gradual but steady development of impairment. Age is a notable factor in nihi development. Older subjects above 40 years are reportedly at greater risk (NIOSH, 1988). Our subjects were generally young with a mean age of 24 $\pm$ 3 (table I).

Nihi occurred mostly at the higher frequency range of 3000 – 6000Hz, with largest effect observed at 4000Hz. With increasing exposure time to noise nihi was also seen at lower frequencies such as 2000Hz. Our observation agrees with similar work done by Sataloff (1983).

In conclusion, loud noise from industries certainly endangers the health of workers. Beyond the impairment of hearing, loud noise affects several physiologic processes of the body including mental well being. Hearing impairment similarly has its many psycho-physiological consequences. The various levels of government in many developing countries will need to put policies in place to protect different occupational groups including the motorcyclist popularly called 'Okada' operators who commonly present with a variety of occupational health problems (Orisakwe *et al*) to our growing industry workers who are occupationally exposed to loud noise.

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