

Original Research Article

Noise Induced Hearing Loss Among Sawmill Workers in a Sub-Saharan African Country

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Abstract: Introduction: Noise Induced Hearing Loss (NIHL) is a permanent sensorineural hearing loss (HL) which affects the quality of life of exposed individuals. **Aim:** To determine the prevalence of NIHL among sawmill workers at the Timber market and petty traders in Accra, Ghana, and to assess the difference in actual and self-reported HL among the sawmill workers. **Methods:** This was a comparative study of NIHL among sawmill workers at the Agbogbloshie Timber Market of Accra and petty traders whose work environment was situated remotely from the sawmill. Data was analysed using SPSS version 20.0. Demographic characteristics and pure tone audiometric testing of study participants were analysed and presented as mean±standard deviation, counts and percentages. Independent T-test was used in comparing pure tone hearing thresholds of sawmill workers and petty traders at various frequencies. **Results:** A total of 120 sawmill workers and 120 petty traders were studied. Sixty-four (53.3%) of the petty traders were females and all the sawmill workers were males. Mean age of the sawmill workers was 41.5±11.8 years. The prevalence of NIHL among the sawmill workers was 37.5% in the right ear and 43.3% in the left ear. Among the petty traders, the prevalence of NIHL was 12.5% in the right ear and 8.3% in the left ear. There was a statistically significant difference in NIHL between the sawmill workers and the petty traders (p-value = 0.0001). The prevalence of HL in the better ear for the sawmill workers and petty traders was 16.7% and 1.7% respectively. Sixty-nine (57.5%) sawmill workers self-reported HL compared to actual HL of 39 (32.5%) which showed a statistically significant difference (p-value = 0.011). **Conclusions:** The prevalence of NIHL among the sawmill workers was 37.5% and 43.3% in the right and left ears. There was a significant difference between actual and self-reported HL among the sawmill workers.

Keywords: Sawmill workers, Petty traders, Noise Induced Hearing Loss, Audiometric assessment, Hearing threshold.

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INTRODUCTION

Noise is an undesirable sound deemed to be unpleasant, loud or disruptive to hearing [1, 2]. Noise induced hearing loss (NIHL) is a permanent sensorineural hearing loss as a result of exposure to noise in excess of weighted average of 85dBA over a prolonged period [3]. It is usually bilateral and symmetrical [4], sensorineural, with “notching” of the audiogram at 3, 4, or 6 kHz and recovery at 8kHz [11, 5]. Hearing impairment characteristically affects higher frequencies (3 kHz, 4 kHz or 6 kHz) at the initial phase

and afterward the lower frequencies (0.5 kHz, 1 kHz or 2 kHz) [4].

Exposure to loud noise causes a gradual damage of the hair cells of the organ of corti and leads to a temporary or permanent shift in the hearing threshold. Noise induced hearing loss may be caused by one-time exposure to loud noise (acoustic trauma) or repeated exposures to noise at different levels of loudness over an extended period [6]. However intermittent exposures have been found to be less perilous since it allows the hair cells to have a sort of resting period [14].

The severity of NIHL is greatest after 10-15 years of unremitting or intermittent exposure. Individuals exposed to noise levels above 85dB are at more risk of developing NIHL than when the exposure is to sounds below this level [7]. Groups of people at risk of NIHL include stone quarry workers, food mill operators, sawmill workers, artillery men, ironsmiths, operators of grinding machines, workers in the power houses and highly mechanized industries etc [8].

Though this condition is irreversible, it is however preventable if noise management and hearing conservation programs are undertaken.

In Nepal, out of the 124 woodworkers (88 carpenters, 36 sawyers) studied, 31% of carpenters and 44% of sawyers had NIHL respectively [9]. Adhikari and Sahu assessed the prevalence of hearing loss among sawmill workers in West Bengal, India. They reported that 33.33% of the study population had hearing loss only in left ear, 38.89% had right sided hearing loss and 16.66% had bilateral impairment [10]. Abubakar *et al.*, reported in Kaduna, Nigeria, about 12.5% sawmillers having classical notch at the 4 kHz frequency. Among these, 7.69% were bilateral, 4.81% unilateral with 2.89% at the left and 1.92% at the right ear, respectively [11].

In Ghana, Boateng and Amedofu established a convincing relationship between the noise exposure levels, duration of exposure and development of occupational noise induced hearing loss among workers of sawmills and corn mills with about 20.0 % and 24.8 % of sawmill and corn mill workers having evidence of noise-induced hearing loss (NIHL) respectively [5, 12].

Sawmill workers process raw logs into timber, flooring, decking and other basic timber products. They carry out a range of manual tasks in the mill and operate several machineries to process timber. Enforcement of occupational health and safety policies are really inadequate and hence there is lack of safety regulation in the sawmill industry in Ghana. Consequently, workers in the sawmill industry are unprotected against excessive harmful noise at their workplace [13]. A few of the sawmill workers have complained about deterioration in their hearing to their employers. However, the difference in actual hearing loss and self-reported hearing loss among these sawmill workers is unknown. Information on the health risk of this population could support the need for preventive measures and the documentation of standard operative procedures at the mill. This paper reports the prevalence of NIHL among sawmill workers at the Agboghloshie Timber market in Accra compared with a group of petty traders in Accra.

METHODS

Study design and setting

This was a comparative study carried out among sawmill workers at the Agboghloshie Timber Market of Accra, Ghana and a control group of petty

traders whose work environment was situated remotely from the sawmill and were also associated with an acceptable environmental noise from human traffic and the usual market noise level. The Agboghloshie Timber Market is situated approximately 3 kilometres from the Agboghloshie Market and along the banks of the Korle-lagoon on the western side of the Odaw River in the central part of Accra, Ghana. They utilize machines and manual sawing and wood processing tools. The market is home to about 40,000 people who may live and work within the market.

Sampling Technique

A multi-stage sampling technique was used in selecting the sawmill workers. Each sawmill company at the timber market was designated as a single cluster. There were 85 sawmill companies at the market. At the first stage 30 clusters were selected by simple random sampling out of the 85 clusters. The simple random sampling was then conducted using random number generator in Microsoft Excel 2010 software with a sampling frame of all the sawmill clusters listed on Microsoft excel worksheet. A command was given for the randomisation of the list of clusters provided. The first 30 clusters that appeared on the list were selected for the second stage of sampling. The sampling frame of the companies was obtained from the Sawmill Workers' Association at the Agboghloshie Timber Market.

In the second stage, the selected clusters were visited and systematic sampling was used to select four sawmill workers at each of the 30 clusters to obtain the total sample size required. For each cluster, the total number of participants selected was divided by the number of sawmill workers in that cluster. The outcome (sampling interval) was used as a random starting point with which other members were also selected after the fixed sampling interval. This was done for all the companies until the sample size was obtained.

Sample size

The minimum sample size required for the study was 73 sawmill workers and 73 controls respectively using the formula $N = \frac{[P_1(1-P_1) + P_2(1-P_2)]}{(P_1-P_2)^2} \times f(\alpha, \beta)$ [14]. Where N is the sample size required for both groups, P_1 and P_2 are known proportions of noise induced hearing loss (NIHL) of the study group and the control group ($P_1 = 24.8\%$ and $P_2 = 4.8\%$) respectively from a previous study by Kitcher *et al.*, [3] $\alpha = 0.05$ the level of significance and $\beta =$ the power of the test, i.e. 90 % power and $f(\alpha, \beta) = 10.5$ (a constant). A total of 120 sawmill workers and 120 petty traders were however recruited for the study.

Study participants

All sawmill workers at the Agboghloshie Timber Market in Accra, aged 18 to 60 years were included in the study. The selected petty traders were about 200 meters away from the sawmill premises to ensure that they were not close to the sawmill to avoid

the impact of the noise from the sawmill on their hearing. Sawmill workers and petty traders with chronic discharging ear, previous ear surgery and previous history of head injury were excluded from the study. Informed consent was obtained from study participants before the commencement of data collection. Participants information provided were handled confidentially.

Data collection

The first part involved the collection of participants' demographic data such as; age, sex, education, years in employment, and department at the sawmill. Medical history such as; history of Hypertension, Diabetes Mellitus and Sickle Cell Disease and data on self-reported hearing loss were also collected using a structured questionnaire. Participants who could not read or write were aided by the translation of the questionnaires in a vernacular (either Ga or Twi which are the predominant languages in the study areas) and then back translated to English to solicit responses from them.

The second part involved the measurement of environmental noise level at the various sawmill premises to determine the average noise level while the machines were in operation and when the machines were off. The noise level measurement was carried out at the stalls of the petty traders. The Larson Davis System 824 Type 1 sound level meter was used.

The third part of data collection comprised physical examination of the ear (otoscopy). A portable otoscope (YNR mini Fibre Optic Otoscope CE Approved) was used to visualize the external ear canal and the tympanic membrane to identify any obstruction from impacted wax, impacted foreign bodies, any discharge from ear infection (otitis externa or media) or any alteration of the tympanic membrane like a perforation or dullness from an otitis media with effusion.

The fourth part encompassed the use of a pure tone audiometer to assess the hearing threshold of each ear. This was done with a pure tone audiometer (Interacoustics Clinical Audiometer with Serial number: SN 0963836) and recorded on a proforma. Participants were instructed to wear earphones which was connected to the audiometer. Pure tones were then delivered to one ear at a time and participants were informed to signal whenever they heard a sound. This was done to test the air conduction of each ear. The minimum volume required to hear each tone was then plotted on an audiogram. A bone oscillator was placed against the mastoid bone of participants and sound impulse was delivered. The participants signalled when the impulse transmitted to the mastoid was heard. This tested the bone conduction of one ear at a time and was also plotted on an audiogram. Participants were tested individually in a sound-proof audiometric booth. Audiometric

assessment was conducted for 5 sawmill workers and 5 controls daily, from Monday to Saturday, until the total number to be sampled was obtained. These individuals were tested early morning before their work shift begun, about 14 hours following their most recent exposure to noise. This enabled some recovery from "hearing fatigue" as a result of abstinence from harmful noise. The pure tone audiometric testing was performed at the Hearing Assessment Centre of the Korle-Bu Teaching Hospital in Accra. This centre utilizes a sound-proof audiometric booth with an ambient noise level of about 30 dBA. This test site is near the Agbogbloshie Timber market and hence participants easily passed through the centre on their way to work and returned quickly after the test.

The hearing intensity in decibels (dB) was plotted against the sound frequency at frequencies of 500, 1000, 2000, 3000, 4000, 6000 and 8000 Hertz (Hz) on an audiogram. The Pure Tone Average (PTA) at frequencies of 500, 1000, 2000 and 4000 Hz was calculated for both sawmill workers and the petty traders and the values (pure tone average) was then classified using the World Health Organisation's (W.H.O) grades of hearing impairment to determine if there was any hearing impairment or otherwise [15]. The mean hearing thresholds at frequencies of 2000Hz, 3000Hz and 4000 Hz was also calculated for all participants to determine the degree of noise induced hearing impairment. The lower frequencies such as 250Hz, 500Hz and 1000Hz are characteristically resilient to noise induced hearing impairment [16]. The presence of an audiometric notch at 3000Hz, 4000Hz or 6000Hz was significant for NIHL.

Participants who were found to have noise induced hearing loss were informed, counseled and referred to the ENT unit of the Korle- Bu Teaching Hospital for specialist care.

Data Analysis

The data analysis was done using the IBM SPSS Statistics for Windows, Version 20.0 software. Demographic characteristics of study participants were analysed and presented as mean/standard deviation, counts and percentages. Chi square test and Fishers Exact Test were used in comparing proportions where necessary. An Independent sample *t*-test was used in comparing the pure tone hearing thresholds of sawmill workers to the petty traders at frequencies of 500, 1000, 2000, 3000, 4000, 6000 and 8000 Hertz (Hz). Prevalence of NIHL among the participants was determine by measuring the presence of NIHL, then dividing the number of people with NIHL by the number of people in whom it was measured. The outcome measure (prevalence) was expressed as a percentage (%). Percentage of actual and self-reported hearing loss among the sawmill workers were recorded. In all calculations, *p*-values less than 0.05 was taken as statistically significant.

Ethical Consideration

Ethical approval was obtained from the Institutional Review Board of the Korle-Bu Teaching Hospital with approval number; KBTH-IRB 00088/2019. The study was done following the Helsinki Declaration for the conduct of scientific research. Consent for publication of the outcome of the study was obtained from all the participants.

RESULTS

Demographic characteristics of the sawmill workers and controls

A total of 120 sawmill workers and 120 petty traders were recruited for the study. Sixty-four (53.3%) of the petty traders were females and all the sawmill workers were males. The mean ages for the sawmill workers and petty traders were 41.5 ± 11.8 and 32.5 ± 10.4 years respectively. The age range of the sawmillers was 19 to 60 years and 21.0 to 60.0 years for the petty traders. Forty (16.7%) of the sawmillers were within the age group 41-50 years and sixty-three (26.2%) of the petty traders were within age 18 to 30 years. The mean years in employment was 16.9 ± 9.9 years and 6.5 ± 4.7 respectively. The years in employment range from 1.0 year to 35.0 years among the sawmillers and 1 to 30 years among the petty traders.

The average hours of work per day for both sawmill workers and the petty traders were 9.5 ± 0.5 hours and 9.8 ± 0.4 hours.

Both sawmill workers and petty traders had a day's rest per week. Fifty-nine (24.6%) of the sawmillers had Junior High School education and forty-two (17.5%) of the petty traders had primary school education.

Sixty-nine (57.5%) of the sawmill workers had noticed a change in their hearing ability. Eight (7.0%) of the sawmill workers had hypertension and 4 (3.0%) had Diabetes Mellitus.

There was a significant difference between the sawmill workers and the petty traders in terms of age, years in employment, gender and educational level (p -values = 0.001, 0.001, 0.001 and 0.028) Table 1.

Noise level measurement at the work stations of the sawmill workers and petty traders

The minimum noise level (68.5 dBA) at the sawmill was recorded at the storage/packing department while the maximum (106.2 dBA) was recorded at the sawing/cutting department. The equivalent continuous noise level at the sawmill ranged from 88.7 to 98.8 dBA. For the petty traders, the levels of 60.7 to 70 dBA were recorded Table 2.

Hearing threshold levels for worse and better ears of sawmill workers and petty traders

For the worse ear; seventy-seven (64.2%) sawmill workers and 106 (88.3%) controls had normal hearing. Mild hearing loss was seen among 35 (29.2%)

sawmill workers and 9 (7.5%) controls. Moderate hearing loss was seen among 8 (6.7%) sawmill workers and 1 (0.8%) control(s). Four (3.3%) of the controls had severe hearing loss and none of the sawmill workers had severe hearing loss. The prevalence of hearing loss in the worse ear for the sawmill workers was 35.9%. The prevalence of hearing loss in the worse ear for the controls was 11.6%. There was a statistically significant difference in hearing threshold levels between sawmill workers and controls for the worse ear ($p = 0.001$).

For the better ear; a total of 100 (83.3%) of the sawmill workers and 118 (98.3%) controls had normal hearing. Mild hearing loss was seen among 15 (12.5%) sawmill workers and 2 (1.7%) controls. Moderate hearing loss was seen among 5 (4.2%) sawmill workers. The prevalence of hearing loss in the better ear for the sawmill workers was 16.7%. The prevalence of hearing loss in the better ear for the controls was 1.7%. There was a statistically significant difference in hearing threshold levels between sawmill workers and control for the better ear ($p = 0.001$) Table 3.

Actual hearing loss and self-reported hearing loss among sawmill workers

Among the sawmill workers, 69 (57.5%) self-reported hearing loss. Actual hearing loss was found among 39 (32.5%) of the sawmill workers. There was a statistically significant difference between actual and self-reported hearing loss among the sawmill workers ($p = 0.011$) Table 4.

Pure tone averages at 2000Hz, 3000Hz, and 4000Hz for both sawmill workers and petty traders (NIHL)

For the right ear; 75 (62.5%) and 105 (87.5%) of the sawmill workers and controls had normal hearing. Mild hearing loss was seen among 35 (29.2%) sawmill workers and 11 (9.2%) controls. Moderate hearing loss was seen among 7 (5.8%) sawmill workers and none for controls. Three (2.5%) of the sawmill workers and 4 (3.3%) controls had severe hearing loss. The prevalence of NIHL for the right ear for the sawmill workers was 37.5%. The prevalence of NIHL for the right ear for the controls was 12.5%. There was a statistically significant difference between the hearing threshold for NIHL for the right ear of the sawmill workers and control ($p = 0.001$).

For the left ear; 68 (56.7%) and 110 (91.7%) of the sawmill workers and controls had normal hearing. Mild hearing loss was seen among 37 (30.8%) sawmill workers and 10 (8.3%) controls. Moderate hearing loss was seen among 12 (10.0%) sawmill workers and none for controls. Three (2.5%) of the sawmill workers had severe hearing loss. The prevalence of NIHL for the left ear for the sawmill workers was 43.3%. The prevalence of NIHL for the left ear for the controls was 8.3%. There was a statistically significant difference between the hearing threshold for NIHL for the left ear between the sawmill workers and control ($p = 0.001$) Table 5.

Hearing thresholds and departments at the sawmill

At the sawing/cutting department; 54 (45.0 %) sawmill workers had a normal pure tone average. Twenty-nine (24.2%) had mild hearing loss and 6 (5.0%) had moderate hearing loss. None had severe hearing loss. Total with hearing loss at the sawing/cutting department was 35 (29.2%).

For the sawmill workers at the planer mill/design/moulding; 7 (5.8%) had normal pure tone average, 4 (3.3%) had mild hearing loss and 2 (1.7%) had moderate hearing loss. A total of 6 (5.0 %) sawmill workers had hearing loss at the planer mill/design/moulding.

For the packing/storage department; 16 (13.3%) of the sawmill workers had normal pure tone average. Two (1.7%) of the sawmill workers had a mild hearing loss. None had moderate hearing loss and a total of 2 (1.7%) had hearing loss. An overall total of 43 (35.8%) sawmill workers had hearing loss Table 6.

Audiometric notch distribution in the right and left ears

Thirteen (10.8 %) sawmill workers and 6 (5.0 %) petty traders had a notch at 3kHz. Twelve (10.0 %) sawmill workers and 1 (0.8) petty trader had a notch at 4kHz. At the 6kHz, 9 (7.5 %) sawmill workers and 8 (6.7 %) petty traders had a notch. There was a significant difference between sawmill workers and petty traders at 3kHz and 4kHz notches (*p*-values = 0.031 and 0.003 respectively).

Eight (6.7 %) sawmill workers and 15 (12.5 %) petty traders had a notch at 3kHz. Twenty-five (20.8 %) sawmill workers and 1 (0.8 %) petty trader had a notch at 4kHz. At the 6kHz; 5 (4.2 %) sawmill workers and 12 (10.0 %) petty traders had a notch. There was a significant difference between sawmill workers and petty traders at the 4kHz notch (*p* = 0.001) Table 7.

Table 1: Demographic characteristics of sawmill workers and petty traders

Characteristics	Sawmill workers N (%)	Petty traders N (%)	Total N (%)	P-value
Age (years):				
18-30	28 (11.7)	63 (26.2)	91 (37.9)	0.001*
31-40	21 (8.8)	25 (10.4)	46 (19.2)	
41-50	40 (16.7)	26 (10.8)	66 (27.5)	
51-60	31 (12.9)	6 (2.5)	37 (15.4)	
Years in employment:				
<10	30 (12.5)	102 (42.5)	132 (55.0)	0.001*
10-19	43 (17.9)	15 (6.1)	58 (24.2)	
20-29	27 (11.2)	2 (0.8)	29 (12.0)	
30-39	20 (8.3)	1 (0.4)	21 (8.7)	
Gender:				
male	120 (50.0)	56 (23.3)	176 (73.3)	0.001*
Female	-	64 (26.7)	64 (26.7)	
Total	120 (50.0)	120 (50.0)	240 (100.0)	
Education:				
Primary	27 (11.2)	42 (17.5)	69 (28.7)	0.028*
JHS	59 (24.6)	38 (15.8)	97(40.4)	
SHS	20 (8.3)	27 (11.2)	47 (19.5)	
Vocational/technical	12 (5.0)	13 (5.4)	25 (10.4)	
Tertiary	2 (0.8)	-	2 (0.8)	
Department at the sawmill:				
Sawing/cutting	89 (71.2)		89 (71.2)	
Planer mill/design/moulding	13 (10.4)		13 (10.4)	
Packing/storage	18 (14.4)		18 (14.4)	
Noticed change in hearing ability	69 (57.5)		69 (57.5)	
Hypertension	8 (6.7)		8 (6.7)	
Diabetes Mellitus	4 (3.3)		4 (3.3)	

JHS, Junior High School; SHS, Senior High School. *, significant *P*-values.

Table 2: Noise level measurement at the work stations of the sawmill workers and petty traders

Departments	Average noise level at the premises of sawmill workers and controls (dBA)		
	Minimum noise level (dBA)	Maximum noise level (dBA)	LEQ
Sawmill:			
Sawing/cutting	92.1	106.2	92.5
Planer mill/Moulding/Design	78.1	99.3	98.8
Storage/packing	68.5	90.0	88.7
Petty traders:	60.7	70.0	66.0

LEQ = Equivalent Continuous level.

Table 3: Hearing threshold level for worse and better ears of sawmill workers and petty traders

Hearing Threshold Level (dBHL)	Worse Ear			Better Ear		
	Sawmill Workers N (%)	Petty traders N (%)	P-value	Sawmill Workers N (%)	Petty traders N (%)	P-value
Normal (<=25 dB)	77 (64.2)	106 (88.3)	0.001*	100 (83.3)	118 (98.3)	0.001*
Mild Hearing Loss (26-40 dB)	35 (29.2)	9 (7.5)		15 (12.5)	2 (1.7)	
Moderate Hearing Loss (41-60dB)	8 (6.7)	1 (0.8)		5 (4.2)	-	
Severe Hearing Loss (61-80dB)	-	4 (3.3)		-	-	
Total	120 (100.0)	120 (100.0)		120 (100.0)	120 (100.0)	
Prevalence of Hearing loss	43 (35.9)	14 (11.6)		20 (16.7)	2 (1.7)	

*, significant P-values.

Table 4: Actual hearing loss and self-reported hearing loss among sawmill workers

Actual Hearing loss	Self-reported hearing loss		Total N (%)	P-value
	Yes N (%)	No N (%)		
Yes	29 (24.2)	10 (8.3)	39 (32.5)	0.011*
No	40 (33.3)	41 (34.2)	81 (67.5)	
Total	69 (57.5)	51 (42.5)	120 (100.0)	

*, significant P-values.

Table 5: Pure tone averages at 2000Hz, 3000Hz and 4000Hz for both sawmill workers and petty traders for the right and left ears (NIHL)

Hearing assessment NIHL	Right ear			Left ear		
	Sawmill Workers N (%)	Petty traders N (%)	P-value	Sawmill Workers N (%)	Petty traders N (%)	P-value
Normal (< =25 dB)	75 (62.5)	105 (87.5)		68 (56.7)	110 (91.7)	
Mild hearing loss (26-41 dB)	35 (29.2)	11 (9.2)		37 (30.8)	10 (8.3)	
Moderate hearing loss (41-60 dB)	7 (5.8)	-		12 (10.0)	-	
Severe Hearing loss (61-80 dB)	3 (2.5)	4 (3.3)		3 (2.5)	-	
Total	120 (100.0)	120 (100.0)		120 (100.0)	120 (100.0)	
Total with NIHL hearing loss	45 (37.5)	15 (12.5)	0.001*	52 (43.3)	10 (8.3)	0.001*

NIHL, Noise Induced Hearing Loss. *, significant P-values.

Table 6: Hearing thresholds and departments at the sawmill

Hearing Impairment	Sawmill departments			
	Sawing/cutting N (%)	Planer mill/design/moulding N (%)	Packing/storage N (%)	Total N (%)
Normal pure tune average (< =25dB)	54 (45.0)	7 (5.8)	16 (13.3)	77 (64.2)
Mild hearing loss (26-41 dB)	29 (24.2)	4 (3.3)	2 (1.7)	35 (29.2)
Moderate hearing loss (41-60 dB)	6 (5.0)	2 (1.7)	-	8 (6.7)
Total	89 (74.2)	13 (10.8)	18 (15.0)	120 (100.0)
Total with hearing loss	35 (29.2)	6 (5.0)	2 (1.7)	43 (35.8)

Table 7: Audiometric notch distribution in the right and left ears

Type of notch	Right ear			Left ear		
	Sawmill workers N (%)	Petty traders N (%)	P-value	Sawmill workers N (%)	Petty traders N (%)	P-value
3kHz	13 (10.8)	6 (5.0)	0.031*	8 (6.7)	15 (12.5)	0.239
4kHz	12 (10.0)	1 (0.8)	0.003*	25 (20.8)	1 (0.8)	0.001*
6kHz	9 (7.5)	8 (6.7)	1.000	5 (4.2)	12 (10.0)	0.129

*, significant P-values.

DISCUSSION

This study demonstrates that at the Agboghloshie timber market in Accra, sawmill workers were all males irrespective of the various sawmilling activities. The Controls (petty traders) for this study were made up of males and females with females being the majority with a percentage of 53.3%. Petty trading in the country unlike sawmill operations is a trade dominated by females. This observation is similar to findings of other researchers who reported that the sawmilling industry is made of predominantly males [9-11, 17]. Kitcher *et al.*, [3] also reported that more females were conventionally involved in small scale trading also known as petty trading at the markets. This finding may be due to the socio-cultural practices in most African countries and other developing countries around the world, which discourages females from engaging in professions or trades which require operation of machinery.

Sawmill workers and controls work for long hours in a day to maximize productivity. As such, both sawmill workers and controls worked averagely 9.7 hours in a day. The prolonged periods (hours per day and years in employment) of exposure to different levels of noise at the timber market may have caused NIHL among sawmill workers and control since the effect of NIHL is greatest after 10 to 15 years of intermittent or unremitting exposure to noise above the tolerable limit of 85dB. Boateng and Amedofu [12] established a convincing relationship between the noise exposure levels, duration of exposure and development of occupational noise induced hearing loss among workers of sawmills in the country. Jabbari *et al.*, [13] in their study revealed that an 8-hour work shift and work experience were significant contributing factors for developing NIHL among sawmill workers and that the progressive worsening of NIHL could be predictable with increase in the work experience. Prolonged exposure may not just cause NIHL among the sawmill workers but also amid residents living in close proximity to sawmills and individuals with businesses in the same environment.

In the study by Abubakar *et al.*, [11] approximately 27.5% worked for more than 8 hours a day. This indicates that majority of the workers worked under 8 hours in a day. This observation is contrary to the work duration of respondents in this study who worked not less than 9 hours in a day; thus, the effects of prolonged exposure to hazardous workplace noise will be more pronounced among the subjects of this study.

This study noted a prevalence of sensorineural hearing loss of 16.7% in the better hearing ear of the sawmill workers and 1.7% prevalence of SNHL in the better hearing ear of petty traders thus confirming that sawmill workers at the Agboghloshie timber market have significantly more sensorineural hearing loss relative to the petty traders. The significant difference ($p=0.001$) in

sensorineural hearing loss between the sawmill workers and petty traders together with the significant presence of 4 kHz audiometric notch in both left and right ears (20.8% and 10% respectively) among the sawmill workers than petty traders (0.8 % for both ears) strongly indicated that the hearing loss of the sawmill workers may likely be ascribed to NIHL. This is in support of the assertions in a similar study by Kitcher *et al.*, [3].

An audiometric notch at 4 kHz is considered to be the classical sign of NIHL. The presence of this notch was significantly higher among the sawmill workers (37 ears) than the petty traders (two ears). This is an indication that sawmill workers are exposed to high noise levels than the petty traders. Although notches were identified at 3 kHz and 6 kHz, they were equally spread among the sawmill workers and petty traders. This supports the assertion by some authors that a notch at these frequencies may be of limited importance in diagnosing NIHL [18].

Sawmill workers had a higher prevalence of hearing impairment than the petty traders because of their level of noise exposure coupled with the possibility of non-compliance with the use of personal protective gears when working. Most of the petty traders peddled at the timber market and are not exposed to the noise at the timber market constantly for longer periods. A few petty traders are permanently stationed near the timber market but at a safe distance from the sawmill operations. The higher prevalence of impairment among sawmill workers than the petty traders was also highlighted in the study by Kitcher *et al.*, [3] in Ghana. Their study reported that 24 (23.76%) mill workers and 8 (7.7%) petty traders had hearing loss.

It is important to note that the prevalence of hearing loss was high among sawmill workers in the sawing/cutting department than the planer mill/design/moulding and the packing/storage departments. This brings to the fore the different levels of noise produced by these departments. The highest noise level produced by the sawing/cutting department was 106.2 dBA accounting for 29.2 % of the prevalence of hearing loss among sawmill workers at that department. The sawing/cutting department is responsible for the cutting and planning of woods at the Agboghloshie timber market. The department operated four machines namely; band saws, planers, riving knife and table saw machines. These machines are mostly operated simultaneously for longer hours.

The prevalence of hearing loss was higher among sawmill workers with the planer mill/design/moulding department compared to the sawmill workers with the packing/storage department. The prevalence of hearing loss among sawmill workers with the design department and packing department were 5% and 1.7% respectively. This prevalence was attributed to the activities of these departments. The

design department is responsible for the moulding, design and planning of woods into various wood artefacts such as beds and furniture. The department uses the lathe and spinning machines for its activities. The maximum noise level produced by the department due to the use of these machines was 99.3 dBA. The packing department is responsible for the sales and storage of woods at the Agboghoshie timber market. This department does not use any form of machines or equipment in carrying out its activities. As a result, the maximum noise produced at the department was 90 dBA which was relatively low compared to the noise produced by the design department.

Furthermore, the sawing department had the highest prevalence of NIHL as a result of the noise emanating from the machines used at the department. It is worth noting that the noise levels at the sawing/cutting department range from 92.1dBA to 106.2 dBA which exceeds the permissible noise level of 85 dBA.

Among the departments at the sawmill, hearing loss was least prevalent among the workers at the packing/storage department. This may be attributed to the fact that equivalent continuous noise levels were lower at this department as compared to the others (88.7 dBA as against 92.5 dBA and 98.8 dBA).

A similar study by Chauhan [19], revealed 34.2 % NIHL among workers in the steel rolling mill industry in Nairobi. His study also established the duration of employment and age as risk factors for developing occupational noise induced hearing loss. This is in conformity with the finding in the present study of the prevalence of hearing loss identified based on the number of years in employment of sawmill workers at the Agboghoshie timber market. A hearing conservation program will prevent the beginning of occupational hearing loss among the sawmill workers. It will also preserve and protect the remaining hearing of those who already have hearing loss and will equip workers with the knowledge and hearing protection devices necessary to protect them.

Future research in this regard should consider the use of High Frequency Pure Tone Audiometry, Otoacoustic emissions test or Auditory Brainstem Response test in order to detect the presence of hearing loss in higher frequencies that may not be apparent on the regular pure tone audiogram.

The lack of equipment and time constraint could not allow for the use of high frequency pure tone audiometry (measures hearing intensities beyond 8 kHz) and Otoacoustic emissions test in identifying hearing loss in this study.

No enquiry was made about previous employment, recreational noise exposure and use of ototoxic medication which could have an impact on an

individual's susceptibility to NIHL. Though all sawmill workers were males, gender match could not be done for the controls, because the small-scale trading industry consist predominantly of females.

CONCLUSIONS

The prevalence of NIHL among the sawmill workers was 37.5% in the right ear and 43.3% in the left ear. Among the petty traders, the prevalence of NIHL was 12.5% in the right ear and 8.3% in the left ear. A significant difference between actual and self-reported HL among the sawmill workers was observed.

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