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Self Reported Hearing Impairments and Associated Risk Factors Among Metal and Woodwork Workers in Gondar Town, North West Ethiopia

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ABSTRACT

BACKGROUND: The global prevalence of occupational noise-induced hearing loss ranges between 16% and 24%. The wood and metalwork industries have recently expanded in Ethiopia. This study aims to determine the level of noise exposure and the prevalence of self-reported hearing impairments and associated risk factors among metal and woodworkers in Gondar town Ethiopia.

MATERIAL AND METHODS: An institutional-based cross-sectional study was conducted on 580 metal and woodwork workers from February10 to March 25/2020. The data were collected through an interviewer-led questioner and the noise level measurement. Multivariate Poisson regression models were used. *P*-values less than .05 and adjusted prevalence ratios with 95%CI were used to declare the presence and strength of an association respectively.

RESULT: The mean (SD) average noise exposure level in the wood and metalworking industries was 96.9 ± 3.5 dBA and 96.2 ± 4 dBA, respectively. The overall prevalence of self-reported hearing impairment was 20.7% [95%CI: (17.4-24)]. In an adjusted Poisson regression, listening to music with earphones for more than 2 hours per day (PR = 2.95, 95%CI: 1.32, 6.21) and listening to music at maximum volume (PR = 2.24, 95%CI: 1.05, 4.79) were associated with hearing impairments.

CONCLUSION: The majority of workers are exposed to noise levels that exceed OSHA's permissible exposure limit value. A hearing conservation program should be implemented to reduce noise exposure levels in the wood and metal work industries. Workers should be aware of the duration and volume of recreational noise exposure.

KEYWORDS: Hearing impairment, noise exposure, risk factor, listening to music

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Introduction

Hearing loss affects 1.3 billion people worldwide[1] and is the fourth leading cause of disability, with an estimated annual cost of more than 750 billion dollars.[2] In the United States, 22 to 30 million workers are potentially exposed to noise levels from both occupational and non-occupational sources.[2] According to a global hearing report, 1.1 billion young people are at risk of permanent hearing loss from listening to music at high volumes for extended periods of time.[3]

The metal and woodworking factories have a high level of noise exposure.[4-9] Occupational noise exposure has been documented since the 18th century when copper miners developed hearing loss as a result of noise from hammering on metal.[1,10] Hearing loss caused by work-related noise exposure is known as occupational noise-induced hearing loss (NIHL),[6,8,11] and its global prevalence is estimated to be 16% to 24%.[11,12] Occupational noise-induced hearing loss is the second-most common self-reported occupational injury or illness, accounting for 7% and 21% of all reported injuries or illnesses in developed and developing countries, respectively.[2,13] Over 4 million disability-adjusted life years (DALYs) are attributed to ONIHL.[14] Noise-induced hearing loss (NIHL) is the most common form of occupational disease in Malaysia, accounting for 78.1% of all diseases reported in Malaysian industries in 2013 and 2015.[15]

Approximately 600 million workers globally are exposed to occupational noise.[16] In the United States, the prevalence of workplace noise exposure was highest in mining (76%), followed by woodworking factories (55%).[11] All mean noise levels in all studied metalwork factories and 50% of studied woodwork industries in Saudi Arabia were higher than the standard level of 85 dBA.[6] The average noise level in Greek wood industries was found to be above the acceptable limit values.[17] In Nepal, 30.4% of metalworkers developed noise-induced hearing loss (NIHL),[18] and in the Southeast Asian furniture industry, 34.7% respondents experienced permanent threshold shifts.[8] Noise-induced hearing loss (NIHL) is 1 of the top 5 occupational illnesses in Zimbabwe, and the mining industry has a high prevalence of NIHL due to excessive noise levels.[19] 44% of study participants in Ghana's quarry industry had a hearing threshold greater than 25 dBA.[20]

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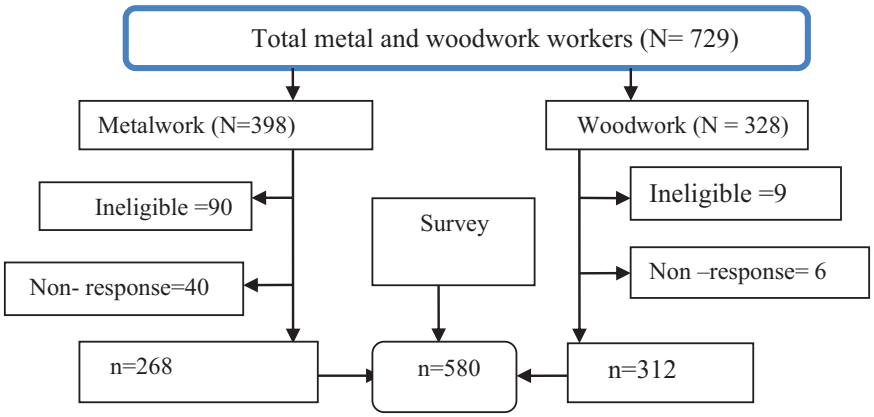


Figure 1. Schematic presentation of sampling procedure both metal and woodwork.

According to different research, factors which influence the occurrence of hearing impairments include loud sounds[2,21] with duration of exposure,[8,22] gender,[23] age,[18,24] use of hearing protective devices,[20] smoking, and alcohol.[18,24,25] Prior Noise exposure from garage (a repair shop for automotive vehicles), construction, armed services,[26,27] patient-related factors like family history of hearing loss, ear infection, and injury,[24,28] ototoxic medicines,[29] and vibration.[14,29,30]

Industrialization poses a public health risk throughout Sub-Saharan Africa, including Ethiopia.[18] Despite the fact that the number of metal and woodworking factories in Ethiopia is growing, the level of noise exposure remains unknown, particularly in the study area. This study is designed to determine the noise exposure level, the prevalence of self-reported hearing impairments, and associated risk factors among metal and woodworkers in Gondar town.

Materials and Methods

Study design, settings, and period

An institutional-based cross-sectional study was conducted on 580 metal and woodwork workers from February10 to March 25/2020 in Gondar town. Gondar is the capital city of the central Gondar zone in the Amhara regional state and one of Ethiopia's historical towns.

Source and study populations

All metal and woodworkers in Gondar town were the study's source population, and workers who had worked for at least 6 months were included.[31]

Sample size determination

The sample size was done for both first and second objectives. Assumptions for the first objective was 95%CI, 30.4% prevalence of hearing impairment among metalwork worker,[18] and 4% margin of error and for the second objective 95%CI, and power 80% and factors that have strong significant relation with hearing impairment.[16,23] After adding a 10% non-response rate, sample size for the first and second objectives was 599 and 644 respectively.

Sampling procedure

As the total sample size of this study is close to the entire target population, a survey sampling procedure Figure 1 was used to select study participants.

Data collection tool and procedure

An interviewer-led structured questionnaire was used to collect data on socio-demographic characteristics and risk factors such as current and previous occupational noise exposure, work experience, behavioral factors such as listening to music, drinking alcohol, using hearing protective devices, and patient-related factors such as a family history of hearing loss, ear infection, ear injury, and signs and symptoms of noise-induced hearing impairments. The level of workplace noise exposure was measured using a sound level meter (IEC 651, type II, Taiwan), which is recommended for field measurements due to its precision or provides a scale for noise level as perceived by the human ear.[32] Sound Pressure Level (SPL) measurements were taken at workers' head level over 15 minutes at one-minute intervals, and this noise level represented workers' exposure.[6] The average sound pressure level was calculated using the logarithmic formula shown below.

$$\text{Average LP} = \frac{10\log10\left[\begin{matrix}10^{LP1/10}+10^{LP2/10}\\ +10^{LP3/10}+.....10^{LP15/10}\end{matrix}\right]}{15}$$

Operational definitions. Hearing impairment was defined by using signs and symptoms of noise-induced hearing loss such as difficulty hearing when people speak, difficulty understanding conversation), tinnitus, and workers who showed at least one of these signs and symptoms were considered to have hearing impairments.[10,14,22,33]

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Ear infection: This was ascertained by the history of ear infection under the age of 18 years and in this regard certain viral infections in the inner ear destroy the cochlea, producing total deafness.[31]

Data quality control

To assure the quality of data, careful design, translation, and retranslation of the questionnaire were done. Pre-test was conduct on 5% of the sample population from other sites of similar industries. Two-day training was also given for data collectors. Proper categorization and coding of the data were done. Reliability of the questioner was assessed and its Cronbach's alpha value was .71.

Data management and analysis

The data was entered into the EPI Info version 7 software and exported to SPSS Version 20 software for further analysis. The mean, standard deviation (SD), and average mean noise exposure levels were computed as descriptive statistics. Multivariate Poisson regression models with robust variance were employed to estimate the prevalence ratios (PR) and corresponding 95% confidence intervals (CI).[34] To control for potential confounder variables, independent variables with *P*-values less than .25 in bivariable analysis were included in multivariate Poisson regression model. To declare the presence and strength of an association, *P*-values less than .05 and adjusted prevalence ratios with 95%CI were used.

Results

Socio-demographic characteristics of study participants

From a total of 626 eligible workers, 580 respondents with a response rate of 92.7% were fully participated in the study. The mean age of respondents was 26.32 (±7.32) years old. 53.8% of study participants worked in the woodwork industries, and nearly three-fourths (72%) were exposed to noise levels greater than 95dBA. Half of the participants (50.9%) had less than 3 years of work experience (Table 1).

Behavioral characteristics of study participants

More than three-quarters (80.9%) of study participants had music listening habits. Only 6.9% of respondents used hearing protection devices. The majority of respondents' reported a lack of provision and comfort issues as the main reasons for non-utilization of hearing protective devices respectively.

Comparative noise exposure level between wood and metalwork industries

The average noise exposure level in the wood and metalworking industries was 96.9 ± 3.5 dBA and 96.2 ± 4 dBA respectively. In the woodworking industry, the maximum noise level was 114 dBA (circular saw), and in the metalworking industry, the maximum noise level was 108 dBA (cutters and welding machines). There was a significant difference in sound level between the metal and woodworking industries (x2 = 15.1, *df* = 4, *P* = .005).

The prevalence of hearing impairment among the wood and metalwork industry

In this study, the overall prevalence of hearing impairment among wood and metalworkers was 20.7% [95%CI: 17.4%-24%]. Communication difficulties and tinnitus were reported by 32.9% and 26.4% of total study participants, respectively. Furthermore, 16.4% and 8.4% of workers reported difficulty hearing in the left and right ear without the use of a hearing aid, respectively.

Prevalence of hearing impairments in terms of industry. According to this study, the prevalence of hearing impairment was comparable among woodworker (20.8%) and metalworkers (20.5%). There is no statistically significant difference in hearing impairments between the wood and metalworking industries (x2 = 0.008, *df* = 1, *P*-value = .5) (Table 2).

Factors associated with hearing impairments

In adjusted Poisson regression analysis, listening to music at maximum volume and listening to music using earphones for more than 2 hours per day were significantly associated with hearing impairments. Wood and metalworkers who listen to music at maximum volume were 2.24 times more likely to have hearing impairments compared to workers who listen to music at lower volume (PR = 2.24; 95%CI: 1.05, 4.79), and workers who listen to music using earphones for more than 2 hours per day were 2.95 times more likely to have hearing impairments compared to their counterparts (PR = 2.95, 95%CI: 1.32, 6.21) (Table 3).

Discussion

According to this study, the prevalence of hearing impairment was comparable among metal and woodwork workers. The overall prevalence of self-reported hearing impairment was 20.7% [95%CI: 17.4%-24%]. This finding is consistent with studies conducted in the United States woodwork industry (20.86%),[23] Ethiopia's metalwork industry (22%),[35] and the South Thailand sawmill industry (22.8%).[36] This similarity could be attributed to similar methods used (cross-sectional and retrospective cross-sectional in the case of the US) and worker characteristics. However, the findings of this study are lower than those of previous studies in Rwanda's wood and metalwork industries (36%),[5] and Nepal's woodwork industry (31%).[8] This difference could be attributed to differences in methods used (audiogram tests in Rwanda may have increased the prevalence), operational definition of hearing impairments, use of hearing protective devices (0.5% in Rwanda and 6.6% in

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Table 1. Socio-demographic characteristics of wood and metalwork workers in Gondar Town (n = 580).

VARIABLES	CATEGORY	FREQUENCY	PERCENT
Sex	Male	543	93.6
	Female	37	6.4
Age	15-24	265	46.2
	25-34	234	40.3
	35-44	59	10.2
	>44	22	3.8
Religion	Orthodox Christian	476	82.1
	Muslim	96	16.2
	Protestant	6	1
	Others	2	0.3
Marital status	Single	432	74.5
	Married	148	25.5
Educational level	Primary education	115	19.8
	Secondary education	304	52.4
	Diploma and certificate	138	23.8
	Degree and above	23	4
Work experience in current occupation (y)	1-3	295	50.9
	4-8	190	32.8
	9-12	63	10.3
	>12	32	5.5
Types of occupation	Woodwork	312	53.8
	Metalwork	268	46.2
Noise exposure level	<95 dBA	162	27.9
	95.0-99.0 dBA	276	47.6
	99.00-100 dBA	52	9
	>100 dBA	90	15.5

Others; 7th day Adventist, Hawariyawi.

Table 2. Noise-induced hearing impairment and work categories.

HEARING IMPAIRMENT	WORK CATEGORIES			*P*-VALUE
	WOODWORK	METALWORK	TOTAL	
No	247 (79.2%)	213 (79.5%)	460 (79.3%)	>.05
Yes	65 (20.8%)	55 (20.5%)	120 (20.7)	

our study), and duration of exposure or work experience, as well as worker characteristics. This finding, on the other hand, is higher than that of a study conducted in Brazil Metalworking Company (15.9%),[37] and this difference could be attributed to high noise exposure levels and a lack of enforcement of occupational health and safety regulations in Ethiopia.

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Table 3. Prevalence ratios of factors associated with self reported hearing impairments among wood and metalwork workers in Gondar town, northwest Ethiopia (n = 580).

VARIABLES	PREVALENCE RATIO (PR)	95%CI		*P*-VALUE
		LOWER	UPPER	
Intercept	0.07	0.015	0.32	.001
Educational level				
Primary education	1.25	0.25	6.21	.78
Secondary education	1.57	0.78	3.17	.2
Diploma and certificate	0.83	0.46	1.5	.53
Degree and above	1			
Monthly salary				
<1500	0.49	0.23	1.65	.07
1500-2000	0.82	0.44	1.53	.54
2001-3200	0.67	0.34	1.34	.26
>3200	1			
Noise exposure level				
<95 dBA	1			
95.0-99 dBA	1.0.4	0.48	2.63	.7
99.0-100 dBA	1.13	0.48	23	.9
>100 dBA	0.85	0.36	2.03	.7
Use of ear protective device				
No	2.07	0.52	8.31	.302
Yes	1			
Volume of music listening				
Quite	1			
Moderate	1.76	0.94	3.31	.08
Maximum volume	2.24	1.05	4.79	.037
Duration of using earphone to listen music				
<-2 h	1			
>2 h	2.95	1.32	6.21	.008
Involve in dance concert				
Yes	1.49	0.82	2.74	.19
No	1			
Ear infection under age of 18				
Yes	1.93	0.97	3.83	.06
No	1			

1 = Reference group, Model fittest (*P* = .82).

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In this study, 16% and 8.4% of study participants reported difficulty hearing in the left and right ear without the use of a hearing aid, respectively. According to this finding, the left ear is more affected than the right ear, and this result is supported by various studies, such as Iran,[38] the Swedish wood processing industry,[39] New York,[40] Iran,[41] the United States of Louisiana,[42] and air force pilots.[43] This similarity could be due to noise shielding in one ear, unequal recovery after severe noise exposure, and unequal sensitivity of the ears and direction of noise exposure.[44]

In this study, listening to music with earphones was significantly associated with hearing impairments, and workers who listened to music with earphones more than 2 hours per day were 2.95 times more likely to have hearing impairments compared to their counterparts. This finding is consistent with a study in Singapore, where 1 in every 6 young people is at risk of developing leisure NIHL from music delivered via earphones,[45] and in Taiwan, listening music through headphones for 3 hours at maximum level showed transient shifts of 10 and 30 dB and returned to normal within 24 hours and can cause of noise-induced hearing impairments.[46] Workers who listened to music at maximum volume were 2.24 times more likely to have hearing impairments than workers who listened to music at low volume. This finding is consistent with a study that found that exposure to loud leisure noise is associated with hearing loss and tinnitus, with the risk increasing as noise exposure increases,[47] and another study done among young people found that listening too loudly for an extended period of time on personal listening devices (PLDs) such as CDs, iPods, and other MP3 players is a potential contributor to NIHL.[48]

In this study, one of the variables of interest was noise exposure level in the wood and metalwork industries, but found insignificant factors for noise-induced hearing impairments. This finding is consistent with the findings of a study conducted in Ethiopia's metalworking industry.[35] However, in other studies, the noise level was identified as a significant risk factor for NIHL.[16,49,50] This disparity could be attributed to a young labor force with limited work experience. According to the findings of this study, nearly three-fourths (72%) of respondents were exposed to average noise levels greater than 95 dBA, which is above the OSHA permissible exposure limit value for 8 hours of working time.[51] Similar findings were found in Rwanda's wood (99.4 dBA) and metalwork (105.4 dBA) industries, where 99.5% of all participants were not protected during work time.[5] Based on OSHA, workers exposed to noise exposures equal or exceed an 8-hour TWA of 85 dBA must be in a hearing conservation program comprised of exposure monitoring, audiometric testing, hearing protection, employee training, and record keeping.[52] This research found that workers are exposed to high average noise levels for an extended period of time (8 hours), despite the country having exposure limits to continuous noise at 90, 92, 95, 95, 97, 100, 102, 105, 110, 115 dBA to a period of 8, 6, 4, 3, 2, 1 and 12, 1, 12, 1/4, hours, respectively.[53]

Limitation of the Study

The in ability to use a noise dosimeter to measure personal noise exposure levels.

There is no audiogram test to assess the level of hearing loss.

There is no control group for comparisons.

Conclusion

This study found that the prevalence of hearing impairment is comparable in the metal and woodwork industries, but the woodwork industry has a higher noise exposure level, and the majorities (72%) of employees in both industries are exposed to noise levels above the OSHA permissible exposure limit value. Listening to music with earphones for more than 2 hours per day, as well as listening to music at maximum volume, were found to be significant risk factors for hearing impairment. As a result, a hearing conservation program must be implemented in the woodworking and metalworking industries, and workers must be aware of the duration and volume of recreational noise exposure.

Future research

Future research should include a noise dosimeter, an audiogram test, and a control group.

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Author Contributions

Eshetu Abera conceived of the study and contributed to its design, data collection, data analysis, results interpretation, and manuscript writing. Dr. Walelegn worked on, commented on, and edited the statistical output interpretation. Mr. Sintayehu Daba contributed to data analysis, commented on and edited statistical output interpretation, wrote up the manuscript, and all authors approved the submitted version of the manuscript.

Availability of Data and Materials

All data generated for this study are included in this article. The data are also available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

The Ethical Review Committee of the Institute of Public Health, College of Medicine and Health Sciences, University of

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Gondar, evaluated the ethical issue of this research and approved it as ethically sound research by the Rf No IPH/837/06/2020 and date 13/06/2020, and participants were informed about the purpose of the study, the importance of their participation, and their right to withdraw at any time, and written consent was obtained from each participant during data collection

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