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Prevalence of occupational noise induced hearing loss among wood and metal workers of Gakiriro, Kigali city

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ABSTRACT

Introduction: Occupational noise-induced hearing loss (ONIHL) is describeed as an acquired hearing deficiency caused by excessive workplace noise exposure. Little is known about cases of SNHL in our developing country where excessive noise working areas are more prominent.

Objectives: The study aims to assess the prevalence of noise-induced hearing loss among workers in the metal and wood manufacturing sector of Gakiriro, Kigali.

Methods: This was a cross-sectional and descriptive study conducted on 200 workers including wood and metal industrial workers. It's a The age, the noise intensity levels per each category of occupation, duration of exposure, and category of occupation and measurement of hearing loss were correlated.

Results: The overall prevalence of hearing induced was 36 % (72/200), and 35, 5 % (71/200) had NIHL. The mean age was 31.6 years with predominance of male workers. The age group between 30-39 years was more affected compared to other age groups. 99.5% of all participants were not protected during worktime. 47,7% had worked for 10 years and above with an average working time of 9 hours/day for five consecutive days. Noise level average assessed were 99.4dB (range 97-105 in woodworkers and 105.4dB 99-115 in metalworkers on regular daily basis for five consecutive days. Metal workers were more affected than wood workers.

Conclusion: Working in excessive noise workplaces could be a high risk for developing sensorineural hearing loss among young adults active in the wood and metal manufacturing enterprises. Lack of ear protection during working time and longer durations of exposure may increase the risk to develop ONIHL. Protective measures are needed for workers in these conditions and regular audiometric assessments should be conducted.

INTRODUCTION

Occupational noise-induced hearing loss (ONIHL) is described as an acquired hearing loss caused by excessive workplace noise exposure. Kurmis et al (2007) reported that approximately 37% of hearing loss among adults is attributed to excessive noise. This is an important cause of occupation-related morbidity worldwide [1].

Noise-induced hearing loss is characterized by high frequency hearing loss between 3 and 6 kHz on audiometric assessment. With continued exposure, a wider range of frequencies may be affected, thereby increasing human hearing impairment [2]. Noise-induced hearing loss is a work related disability that has a great effect on the employees' quality of life. People living with Noise Induced Hearing Loss (NIHL) have problems with communication, depression, poor performance, fear to lose their job, stigmatization and social isolation, to name but a few. Furthermore, this disability may impact employers if they are held responsible for the disability.

Two characteristics of NIHL have been established through various studies.
Normally, there is increasing hearing impairment with noise intensity and duration of exposure, such that more intense and longer duration noise exposures cause more severe impairment of hearing. Also, a susceptibility of an individual to noise-induced hearing loss is varying [3].

According to a World Health Organization report, 16% of disabling hearing loss in adults is attributable to occupational noise exposure. Since the 18th century, it has been recognized that NIHL is an occupational disease among copper workers who suffered hearing loss as a result of hammering on

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metal. In the 1800s, Fosbroke mentioned how black smiths were suffering from hearing impairment due to continued excessive noise exposure [3,4].

In 2000, 4.1 million disability adjusted life years were lost due to occupational NIHL [4]. Majority of these cases were found in developing countries. Social and economic burdens due to loss of hearing, including reduced earnings, limitations in career choice, stigmatization, abuse, and depression, all compounded by lack of access to appropriate healthcare facilities were also observed [5,6].

Occupational risk of NIHL in industries that expose workers to continuously high levels of noise is reported in the literature. Hong et al, reported that more than 30 million U.S workers were exposed to hazardous noise levels and nine million others were prone to other ototoxic agents [3]. According to Irwin et al, Hearing loss tends to be most rapid at 4 kHz during the first 10–15 years of noise exposure before spreading to surrounding frequencies.

In normal adults, human speech is heard between 0.25 and 6 kHz, with lower frequencies corresponding to vowels and higher frequencies representing consonants. Robinowitz and Robinson (2015) reported difficulty with a clarity of speech and words discrimination among people with NIHL [7,8].

There are wide consequences resulting from such a handicap which include impaired communication, social isolation, anxiety, and poorer job performance (9,10). On an audiogram, this is characterized by a dip or notch between 3 and 6 kHz with immediate recovery at 8 kHz [11].

METHODS

A cross-sectional and descriptive study of subjects aged between 18 and 50 years working in metal and wood manufacturing sector of Gakiriro, Kigali. The audiological tests were conducted at the audiology center of Rwanda Military Hospital. Subjects were enrolled from September 2014 up to January 2015.

All workers between 18 and 50 years working in the metal and wood manufacturing sector of Gakiriro-Kigali were recruited.

A sound level meter type DT 1350A was used to measure noise levels in the wood and metal industries. Also, the average of duration of exposure in hours was calculated for the five consecutive working days. All participants were then surveyed using a questionnaire to collect their socio-demographic information, duration of exposure, and category of occupation.

Otoscopic examination and the initial screening audiometry were performed at the site of work in a free field from the noise source, using a GSI 18 screening audiometer. Thereafter, a diagnostic pure tone audiometry was conducted for bone and air conduction audiograms at Rwanda military hospital audiology center using a clinical audiometer, type GSI 61, with an updated certificate of calibration from H.A.S.S of South Africa.

Noise readings were taken from wood industry and metal industry, using a sound level meter DT1350 device (Gaotek Co., China).

Hearing impairment was defined as subjects having threshold levels of 26 dB and above according to World Health Organization standards. Participants who had hearing impairment at high frequencies: i.e: 3000-6000Hz with a specific notch at 4000 Hz were defined as having NIHL as per Dobie's criteria for NIHL.

Data entry and statistical analysises were performed using SPSS (version 16). Comparisons of variables were performed using chi-square test and the limit of significance was established at $P<0.05$.

Tools used for hearing assessment were not invasive and reassurance was given on data confidentiality. All participants consented for hearing assessment.

RESULTS

200 participants were recruited and underwent audiometrical screening. 92% of participants were males, reflecting a low number of females employed in hazardous noisy workplaces in Rwanda. (Table 1).

Table 1. *Age Distribution*

Age	Frequency	Percent
18-29	53	26.5%
30-39	130	65%
40-50	13	6.5%
>50	4	2%
Total	**200**	**100%**

The mean age was 31.6 years, and was similar in both occupational categories; the predominant age group was between 30-39 years (65%), and 4% were above 50 years, this may be due to superimposed presbyacousis on NIHL.

Table 2. *Exposure time (years) and Hearing Status*

Duration of exposure	HI	Normal
<12 months	2(28%)	5(72%)
1-5 years	11(23%)	38(77%)
6-10 years	16(33%)	33(67%)
11-15 years	22(40.7%)	32(59.3%)
16-20 years	15(47%)	17(53%)
21-30 years	4(57%)	3(43%)
31-40 years	2(100%)	0(0%)
Total	**72**	**128**

72(36%) had HI, where 71(35.5%) had NIHL. Among participants with NIHL,34.6% were aged between 30-39 years, This table shows that the progression of hearing loss as per increase of years of exposure (Table 2).

Metal workers were more affected by H.I (62%) compared to other occupation categories (P=0.002) (Table 3,4).

Table 3. *Hearing status per occupation category*

Occupation	HI	normal
Metalworker	23(62%)	14(38 %)
Woodworker	49(30%)	114(70%)
Total	**72(36%)**	**128(64%)**

Table 4. *NIHL and occupation category*

NIHL	Metalworker	Woodworker
No	15(40.5%)	114(88. %)
Yes	22(40. %)	49(30%)

The wood workshop noise levels ranged between 97-105dB on a daily basis for 5 consecutive days, with an average noise level of 99.4dB.Noise levels measured in metal workshop were 99-115dB on a daily basis for 5 consecutive days and the average was 105.4dB.The mean noise level exceeded 85dB at both workplaces (Table 5).

Table 5. *Noise levels in wood and metal industries*

Days	Noise levels/Metal industry	Noise levels/Wood industry
Day1	99dB	97dB
Day2	115dB	99.6dB
Day3	99.8dB	105dB
Day4	111.4dB	97.7dB
Day5	102dB	97.8dB
Average noise level	105.4dB	99.4dB

There was no significant statistical difference (P=0.7). Among all participants with high frequency notch at 4000 Hz, 32.6% were aged between 30-39 years, showing a high number of youth at high risk of NIHL.

Figure 1. shows that, 99.7% of metalworkers with NIHL and 97.2% of woodworkers with NIHL had a frequency notch at 3000-4000 Hz.

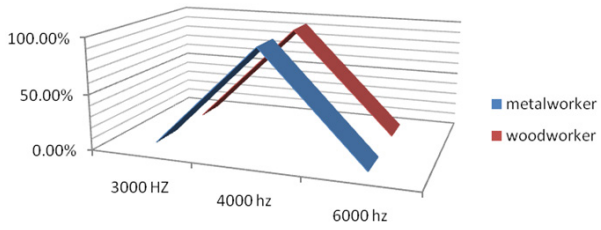

Figure 1. *Occupation category and HL frequency*

Among participants with hearing loss, the degree of severity was associated with the duration of exposure (P=0.002) (Figure 2).

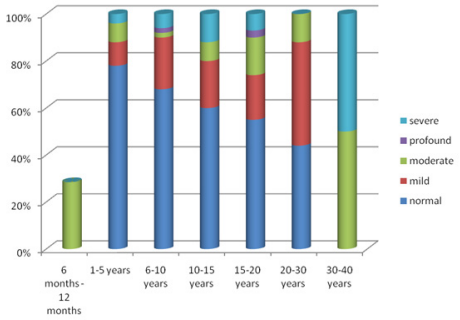

Figure 2. *Degree of hearing loss vs duration of exposure*

There is tendency to have more mild hearing impairment in woodworkers (57%). Metalworkers with moderate Hearing Loss (34%), severe Hearing Loss(26%) (P=0.009) (Figure 3).

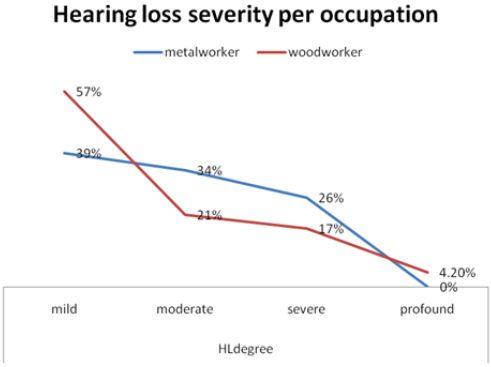

Figure 3. *Degree of hearing loss occupational category*

Metal and wood workers were compared on other possible contributing factors (age, duration of years of exposure). The only factor showing a statistically significant association with hearing impairement was occupational exposure (P=0.002), and this is explained by the high intensity of noise in metal workers on daily basis (99-115dB, with the average of 105.4dB).

Participants with 30-39 age group are 54% and 67% in metal and woodworkers respectively, but no significant statistical difference of age in both groups (P=0.2) (Table 6).

Table 6. *Age and Occupation*

Age	Occupation	
	Metalworker	**Woodworker**
18-29	11(29.7%	42(25.7%)
30-39	20(54%)	110(67.4%)
40-50	3(8.1%)	10(6.1%)
>50	3(7.8%)	1(0.6%)
Total	**37**	**163**

Source: Primary data, 2015

There is no significant statistical difference in the duration of exposure (years) in both categories of occupation (P=0.36) (Table 7).

Table 7. *Duration of exposure in years and occupation*

Duration years of exposure	Occupation	
	Metalworkers	Woodworkers
6 months - 12 months	0(0%)	3(1.8%)
1-5 years	7(18.9%)	44(26.9%)
6-10 years	5(13.5%)	44(26.9%)
10-15 years	12(32.4%)	45(27.6%)
15-20 years	5(13.5%)	26(15.9%)
20-30 years	6(16.2%)	1(0.6%)
30-40 years	2(5.4%)	0(0%)
Total	37	163

The table below also shows that 99.5% of workers in both wood and metal factories worked without ear protective devices.

Table 8. *Protection during worktime*

Protection	Frequency	Percent
No	199	99.5%
Yes	1	0.5%

DISCUSSION

Results from this study showed a high prevalence of HI and NIHL in the wood and metal industry workers of Gakiriro-Kigali. This is likely due to high noise levels identified since the mean sound level was of 99.4dB in woodworkers and mean of 105.4 dB in metal workers in the area. These findings showed similar results with a Kenyan study by C. Mburu et al [29] in metalworkers which found 35,2% of the workers with H.I from noise levels exposure ranging between 72.0dB to 113.8dB with a working time of more than 8hrs daily [19].

A review study conducted by David et al, in South Africa, showed also similar findings to our study [30].

Male workers were predominant in this study. And this could be due to the fact that males commonly tend to be involved in hazardous activities. The public health concern in this study is that these males were of a younger age group. This could be the result of several factors: according to National institute of statistics of Rwanda (NISR), majority of the Rwandan population is young. (50% of the total population is below 16 years) [31]. Another explaining factor could be young people migrating from rural areas to urban cities looking for jobs, mainly in small scale industries, making metal and wood factories their likelihood place employment.

Increased duration of exposure (<10 years) in the metal and wood industry was also reported by Kamalesh et al. [32]. This could also explain our overall HI prevalence in this study. Thus the duration of exposure could be a contributing factor to hearing impairment.

In a study conducted by Mburu et al. [19], it was reported that 97.1% of workers in metal industry were unprotected. In this study, a 99.5% proportion of all participants were also found not wearing ear protection devices.

This study did not find an increasing rate of hearing impairment over progressing duration of exposure. This is different to the study findings by Kamalesh et al. [32] where increasing hearing loss was associated with duration of exposure with 90% of HI for an increased duration over 10 years, This may be due to the fact that workers have gradual progress of years of exposure on high intensity noise levels with no protection.

In this study majority of the study population didn't have HI despite being exposed to high noise levels in their workplaces. We think this may be due to the susceptibility differences for noise damage on cochlear outer hair cells and the variations in acoustic signal transmission by the external auditory canal [3,4].

In this study, we also found that metal workers were more affected with HI. In Nepal, Robinson et al. found a lower prevalence of HI in metal workers. This difference could be explained by the difference in duration exposure per day in both countries. In our setting, metal workers were continuously exposed to high levels of noise (105dB) for an average of 9 hours/day, while in Nepal, metal workers had scheduled power cuts off that varied between 4 to 6 hours with a noise level exposure of 86.1 to 103 dB [2], offering them some time period of noise relief during working time.

There was also high frequency hearing loss varying between 3000-4000 hz in 99.7% of metal workers and 97.2% of wood workers, a study done by Kumar et al(33), found that 48% of tractor drivers had high frequency hearing loss (3000-4000dB) with noise levels of 88-90dB, these disparities are likely to be due to high exposure noise levels in metal and wood workers (105.4dB and 99.4dB) .

In this study, 57% of woodworkers had mild hearing impairment whereby metal workers had 34% with moderate hearing loss and 26% had severe hearing loss. Omokhodion et al [33] in his study done in Nigerian mill enterprise found 49% of workers with mild hearing loss, and Nilson et al. [13] found 20.4% of shipbuilders with severe hearing loss. This is likely due to prolonged duration of exposure.

According to the WHO disability weighting system, which assigns a disability weight to each disease state [27], given that the average life expectancy of a Rwandan is 64years, this means that the average worker will live with this disability for 32.4 years. For our cohort of 200 workers, this totals 2,300.4 years of living with NIHL. The cost to prevent these years of disability is $668, which is extremely low.

The cost to prevent one year of NIHL is $0.29, or 240.7 Rwandese francs.

This study furthermore demonstrated that the intensity of noise levels in both categories of occupation was significantly correlated with hearing impairment (P=0.002), this is similar to Singh et al's study done in India, which showed a significant correlation (P=0.05) of hearing impairment with a high intensity of noise (34).

In conclusion, this study observed a high preverence of HI and NIHL among all participants according to the WHO acceptable standards within both the wood and metal industries.

However, there may be other unknown factors associated with this hearing handicap within our participants not explored in this study.

Working for more than 9 hours without protective measures were reported as NIHL main risk factors.

Health policymakers should raise the awareness of workers and employers on noise related damages. Employers should provide ear protection devices to their workers during worktime and ensure that workers have limited hours of exposure through working shifts.

There should be establishment and strengthening of legislations for hearing conservation programs. Morever, regular audiometric assessment should be also perfomered.

REFERENCES

[1] Kurmis AP, Apps SA. Occupationally-acquired noise-induced hearing loss : a senseless workplace hazard. 2007;20(2):127–36.

[2] Whittaker JD, Robinson T, Acharya a, Singh D, Smith M. Noise-induced hearing loss in small-scale metal industry in Nepal. J Laryngol Otol [Internet]. 2014;128(10):871–80. Available from: http://www.journals.cambridge.org/abstract_S0022215114001728

[3] Hong O, Kerr MJ, Poling GL, Dhar S. Understanding and preventing noise-induced hearing loss. Dis Mon [Internet]. Elsevier; 2013;59(4):110–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23507351

[4] Nelson DI, Nelson RY, Concha-Barrientos M, Fingerhut M. The global burden of occupational noise-induced hearing loss. Am J Ind Med. 2005;48(6):446–58.

[5] Olusanya BO, Neumann KJ, Saunders JE. The global burden of disabling hearing impairment: a call to action. Bull World Health Organ [Internet]. 2014;92(5):367–73. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4007124&tool=pmcentrez&rendertype=abstract

[6] WHO. Deafness and hearing loss [Internet]. Fact sheet N°300. 2013. p. 1–5. Available from: http://www.who.int/mediacentre/factsheets/fs300/en/

[7] Rabinowitz PM. Noise-induced hearing loss. Am Fam Physician. 2000;61(9):2749–56.

[8] Robinson T, Whittaker J, Acharya A, Singh D, Smith M. Prevalence of noise-induced hearing loss among woodworkers in Nepal: a pilot study. Int J Occup Environ Health [Internet]. 2015;21(1):14–22. Available from: http://www.maneyonline.com/doi/abs/10.1179/2049396714Y.0000000084

[9] De Weese, DD SW. Evaluation of hearing.Textbook of otolaryngology.6th.St louis.MO:Mosby:1982 [Internet]. OMS; 1982. Available from: http://www.who.int/quantifying_ehimpacts/national/en

[10] Hétu R, Riverin L, Lalande N, Getty L, St-Cyr C. Qualitative analysis of the handicap associated with occupational hearing loss. Br J Audiol. 1988;22(4):251–64.

[11] Irwin J. Noise-induced hearing loss and the 4 kHz dip. Occup Med (Lond). 1994;44(4):222–3.

[12] Yaremchuk K, Dickson L, Burk K, Shivapuja BG. Noise level analysis of commercially available toys. Int J Pediatr Otorhinolaryngol. 1997;41(2):187–97.

[13] Nilsson R, Liden G SA. Noise exposure and hearing impairement in shipbuilding industry. Scand audiol 6. 1977;59–68.

[14] Dobie RA. Prevention of noise-induced hearing loss. Arch Otolaryngol Head Neck Surg. 1995;121(4):385–91.

[15] Presser S, Couper MP, Lessler JT, Martin E, Rothgeb JM, Bureau USC, et al. METHODS FOR TESTING AND EVALUATING SURVEY QUESTIONS University of Maryland University of Michigan U . S . Census Bureau Office for National Statistics University of Michigan. Public Opin. 2004;68(1):109–30.

[16] Ognyanova D, Maier CB, Wismar M, Girasek E, Busse R. Mobility of health professionals pre and post 2004 and 2007 EU enlargements: Evidence from the EU project PROMeTHEUS. Health Policy. 2012. p. 122–32.

[17] Osibogun A, Igweze IA, Adeniran LO. Noise-induced hearing loss among textile workers in Lagos metropolis. Niger Postgrad Med J. 2000;7(3):104–11.

[18] Hessel PA, Sluis-Cremer GK. Hearing loss in white South African goldminers. S Afr Med J. 1987;71(6):364–7.

[19] C.Mburu J kiman. Evaluation of Occupational Noise exposure among workers in metal fabricating sector in Kamukunji Kenya. Kenya,kamukunji; 2005. p. 1.

[20] Humes LE, Joellenbeck LM, Durch JS. NOISE AND MILITARY SERVICE Implications for Hearing Loss and Tinnitus. Noise Mil Serv Implic Hear loss tinnitus. the National Academy of Sciences; 2006;399.

[21] Tornabene S V., Sato K, Pham L, Billings P, Keithley EM. Immune cell recruitment following acoustic trauma. Hear Res. 2006;222(1-2):115–24.

[22] Fuente A, Hickson L. Noise-induced hearing loss in Asia. Int J Audiol. 2011;50 Suppl 1(84):S3–10.

[23] Basner M, Babisch W, Davis A, Brink M, Clark C, Janssen S, et al. Auditory and non-auditory effects of noise on health. The Lancet. Elsevier Limited; 2014. p. 1325–32.

[24] Hansen CH, Alberti PW, Johnson DL, Samir NY. Occupational Exposure to Noise Evaluation, Prevention and Control. Int Immunol [Internet]. 2014;26(6):NP. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24849260

[25] Hong O. Hearing loss among operating engineers in American construction industry. Int Arch Occup Environ Health. 2005;78(7):565–74.

[26] Irwin J. Noise-induced hearing loss and the 4 kHz dip. 1994;222–3.

[27] Mathers C, Smith A. Global burden of hearing loss in the year 2000 [Internet]. 2000. Available from: http://www.who.int/healthinfo/statistics/bod_hearingloss.pdf

[28] Dobie RA. A method for allocation of hearing handicap. Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery. 1990. p. 733–9.

[29] C.Mburu J kiman. NIHL KENYA. Kenya, kamukunji; 2005.

[30] McBride DI. Noise-induced hearing loss and hearing conservation in mining. Occup Med (Lond). 2004;54(5):290–6.

[31] NISR. 2012 Population and Housing Census Report. Kigali; 2012.

[32] Dube K, Ingale S, Ingale L. Hearing impairment among workers exposed to excessive levels of noise in ginning industries. Noise and Health. 2011. p. 348.

[33] FO Omokhodion, Adeosun A A FA. Hearing impairement among mill workers in small scale enterprises in south west nigeria. Noise Heal. 2007;1463–741.

[34] Singh LP, Bhardwaj A, Kumar DK. Prevalence of permanent hearing threshold shift among workers of Indian iron and steel small and medium enterprises: a study. Noise Health [Internet]. 2012;14(58):119–28. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22718110