Original papers

Audiometry in Brass Workers

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Abstract

Objectives – To compare hearing impairment among brass workers with that of the general population.

Study Design – A cross sectional analytical design

Methodology – One hundred and seventy male brass workers and 170 controls from the general population were selected as subjects. The control group was matched for the age of the brass workers. A questionnaire was used to extract sociodemographic and relevant data related to hearing impairment. Pure tone audiometry was carried out in the order of 1000, 1500, 2000, 3000, 4000, 6000, 8000, 250, 500 and 1000 Hz for both ears. Noise levels were measured in 10 randomly selected brass workshops.

Results – The number of pairs included in the analysis was 154. Tinnitus and subjective hearing impairment were present in 1 (0.6%) and 18 (11.7%) respectively among brass workers while the respective figures in the control group were 3 (1.9%) and 13 (8.4%) the differences of which were not significant. Brass workers had ORR of 3 (95%CI of 1.6 –5.8) and 4.9 (95% CI = 2.3-10.4) for overall hearing impairment in the left and right ears respectively.

On multiple logistic regression, being a brass worker in all frequencies except 1000 Hz. and advancing age in the frequencies of 3000 to 6000 Hz. were found to be risk factors . The duration of service was found be a risk factor in the frequencies of 3000 and 4000 Hz when data pertaining to brass workers alone were analysed. The noise levels in the workshops ranged between 84 dB to 103 dB.

Conclusions – Brass workers were at a higher risk of hearing impairment due to the prevalent high noise levels. Cheap and effective preventive measures are recommended.

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Key Words - Noise induced hearing loss, Brass workers, Audiometry

Introduction

Manufacture of brassware is one of the leading small-scale industries in and around the historical village of Gadaladeniya, Sri Lanka. Adjoining most households are small workshops where scrap brass is turned out as objects of ornamental value. The steps involved in the manufacture of brassware range from smelting of scrap metal which is casted into different shapes as required which are welded together, fettled, engraved with designs and finally polished (1). Over the years this industry has become mechanized and the noise generated as a result could be heard miles away from those workshops.

Exposure to high noise levels has auditory as well as non-auditory effects (2). Impairment of hearing is the major auditory effect that results from exposure to high noise levels which might lead to incapacitation of the workers who are constantly exposed to noise over long periods of time (2).

Only few studies have been carried out to detect occupational hearing impairment (3,4,5) in this country. This study therefore, was carried out with the aim of comparing hearing impairment among brass workers with that of the general population.

Methodology

This study is a part of a research project carried out to determine different occupational health hazards experienced by brass workers in the year 1993 (6).

The subjects consisted of 170 male brass workers selected randomly as the study group and 170 males as controls matched for age selected from the general population (details refer citation no. 1). Relevant exclusion criteria for this component of the study were past exposure to sudden explosions, a history of ear discharge, ear surgery and congenital deafness. The controls selected were not engaged in occupations with constantly high noise levels. All subjects were requested to refrain from working on the day prior to audiometry.

A questionnaire was administered to extract relevant socio-demographic data and factors related to hearing impairment and other relevant occupational health hazards.

Audiometry was carried out using a manually operated audiometer (OB 40 – Madsen Electronics) in the village school during the vacation, in the morning when the surroundings were quiet. The sound pressure level varied between 25 dB and 35 dB when measured, which were below the limit of 40 dB that is recommended (7). Biological calibration of the audiometer was carried out prior to each session.

Table 1: Median hearing threshold levels (HTL) for the two ears in brass /control groups

Left Ear Median HTL - dB				Right Ear Median HTL - dB		
Pairs n	**Study**	**Control**	**Frequency Hertz**	**Control**	**Study**	**Pairs n**
154	20.0	20.0	250	20.0	25.9	154
154	20.0	20.0	500	20.0	25.0	154
154	20.0	15.0	1000	15.0	20.0	154
154	15.0	15.0	1500	15.0	20.0	154
154	15.0	15.0	2000	15.0	15.0	154
154	17.5	15.0	3000	15.0	20.0	154
154	25.0	15.0	4000	15.0	25.0	154
153	35.0	20.0	6000	20.0	32.5	153
152	25.0	15.0	8000	15..0	25.0	151

Each subject was examined for presence of ear discharge and wax, perforated eardrums, and collapse of external auditory meatus, throat infection and common cold before performing audiometry. The two ears were tested separately after giving clear instructions to the subjects.

The frequencies tested were in the order of 1000, 2000, 3000, 4000, 6000, 8000, 500 and 250 and 1000 Hertz (Hz), and the hearing threshold level (HTL) for each frequency was recorded in decibels (dB) Three measurements were taken at each frequency and the average of the lowest two values was considered as the final value. For determination of reliability, HTL at 1000Hz was repeated in all the subjects at the end of the whole procedure and on analysis the difference in the median values obtained was zero which indicates satisfactory reliability.

Table 2 : Impairment of hearing by frequency - Left Ear

Frequency Hertz	S-N C-N	S-A C-A	S-N C-A	S-A C-N	OR	95%CI	P value
250	101 (65.6%)	10 (6.5%)	14 (9.1%)	29 (18.8%)	**2.1**	**1.1-3.9**	**0.030**
500	97 (63.0%)	07 (4.5%)	13 (8.5%)	37 (24.0%)	**2.9**	**1.5-5.4**	**0.001**
1000	123 (79.9%)	4 (2.6%)	12 (7.8%)	15 (9.7%)	1.3	0.6-2.7	0.700
1500	128 (83.1%)	3 (1.9%)	9 (5.8%)	14 (9.1%)	1.6	0.7-3.6	0.405
2000	126 (81.8%)	3 (1.9%)	9 (5.8%)	16 (10.4%)	1.8	0.8-4.0	0.230
3000	106 (68.8%)	9 (5.8%)	11 (7.1%)	28 (18.2%)	**2.6**	**1.3-5.1**	**0.010**
4000	79 (51.3%)	16 (10.4%)	10 (6.5%)	49 (31.8%)	**4.9**	**2.5-9.7**	**0.000**
6000	49 (32.0%)	38 (24.8%)	8 (5.2%)	58 (37.9%)	**7.3**	**3.5-15.2**	**0.000**
8000	67 (44.1%)	21 (13.8%)	18 (11.8%)	46 (30.3%)	**2.6**	**1.5-4.4**	**0.001**

S – Study, C – Control, A – Abnormal, N – Normal, Cut off = 25 & > 25 dB for each frequency
Mc Nemar's test

The noise levels in 10 randomly selected workshops were measured using Bruel & Kjaer 2218 type precision sound level meter which conforms to the requirements of the American

Table 3 : Impairment Of Hearing By Frequency - Right Ear

Frequency Hertz	S-N C-N	S-A C-A	S-N C-A	S-A C-N	OR	95%CI	P value
250	88 (57.1%)	9 (5.8%)	14 (9.1%)	43 (27.9%)	**3.1**	**1.7-5.6**	**0.000**
500	82 (53.2%)	12 (7.8%)	18 (11.7%)	42 (27.3%)	**2.3**	**1.3-4.1**	**0.003**
1000	111 (72.1%)	6 (3.9%)	13 (8.4%)	24 (15.6%)	**1.9**	**0.9 - 3.6**	**0.100**
1500	117 (76.0%)	3 (1.9%)	11 (7.1%)	23 (14.9%)	2.1	1.0 - 4.3	0.592
2000	212 (78.6%)	4 (2.6%)	9 (5.8%)	20 (13.0%)	2.2	1.0-4.9	0.063
3000	102 (66.2%)	7 (4.5%)	11 (7.1%)	34 (22.1%)	**3.1**	**1.6-6.1**	**0.001**
4000	75 (48.7%)	19 (12.3%)	9 (5.8%)	51 (33.1%)	**5.7**	**2.8-11.5**	**0.000**
6000	47 (30.7%)	34 (22.2%)	8 (5.2%)	64 (41.8%)	**8.0**	**3.8-16.7**	**0.000**
8000	64 (42.4%)	19 (12.6%)	14 (9.3%)	54 (35.8%)	**3.9**	**2.1-6.9**	**0.000**

S – Study, C – Control, A – Abnormal, N – Normal

Cut off = 25 & > 25 dB for each frequency

Mc Nemar's test

Standards Association. The measurements were taken one metre away from the worker at the level of his head (8). For each location, measurements from four different directions were taken and the average was considered as the final value. A grand total of 360 measurements were taken which was representative of 90 locations.

The hearing threshold levels did not conform to a normal distribution and hence non-parametric analysis was resorted to. As the groups were matched, a matched analysis using McNemar's test was performed. Variation of HTLL (≤25 dB / >25dB) was assessed using multiple logistic regression where the independent variables considered were exposure status of brass worker and general population, side of ear (right / left) and 5 age categories (16- 20 years / 21- 25 years, 26-30 years, 31 –35 years and > 35years).

To determine the effect of duration of service, data pertaining only to brass workers were analysed using multiple logistic regression. The variables included were duration of service, side of ear and age categories as described previously for comparison with the control group. The cut-off for duration of service was considered as ≤ 5 versus > 5 exposed years which was computed taking into consideration the number of hours per day number of days per week and number of calendar years worked.

A probability of <0.05 was considered as significant while results are expressed as Odds Ratios (OR) with 95 % Confidence Intervals (95% CI).

Results

Of the initial 170 pairs 16 were excluded due to non-eligibility. Three subjects from the study and one from the control group were unable to respond to frequencies of 6000 or 8000 Hertz or both. Therefore, only 153 and 152 pairs for the left ear and 153 and 151 pairs for the right ear respectively were included for the frequencies of 6000 and 8000 Hertz. For the rest of the frequencies for both ears all 154 pairs were included.

The mean age was the same in the two groups, being 29.9 years, since both groups were matched. Fifty (32.5%) among the control group were unemployed.

In the study group 1 (0.6%) and 18 (11.7%) subjects respectively had tinnitus and subjective impairment of hearing while the respective values for the control group were 3 (1.9%) and 13 (8.4%) the differences of which were not statistically significant.

Table 4: Overall Impairment Of Hearing - Left Ear

		Control		Total
		> 25 dB	≤ 25 dB	
Study	>25 dB	11 (7.1%)	36 (23.4%)	47 (30.5%)
	≤25 dB	12 (7.8%)	95 (61.7%)	107 (69.5%)
Total		23 (14.9)	131 (85.1)	154 (100%)

McNemar's test: OR = 3; 95%CI – 1.6 – 5.8; Probability = 0.0009
Cut off - ≤ 25dB & > 25dB (average of HTLL at 1000, 2000, 3000 & 4000Hz for each subject)

The HTLs in the two groups for the two ears are shown in Table 1. The median values in the study group increased from 3000 Hz up to a maximum at 6000 Hz.in both ears. The respective values for left and right ears at 6000 Hz. were 35 and 32.5 dB. In the control group the median HTL did not exceed 25 dB in any of the frequencies while it was 20 dB in the frequencies of 250, 500 and 6000Hz and 15 dB in the rest of the frequencies for both ears.

Considering 25 dB as the cut-off point for each of the frequencies for the two ears separately, the proportions affected were tested using McNemar's test. Brass workers were at a significantly higher risk of hearing impairment at the frequencies of 250 and 500 Hz. and from 3000 – 8000 Hz for both left and right ears. (Tables 2 and 3).

For further analysis, those with an average HTL of more than 25 dB for frequencies of 1000, 2000, 3000 and 4000 Hz were considered as having impaired hearing (9). It was observed that the proportion of brass workers with hearing impairment was higher than that in the control group with ORs of 3 (95%CI of 1.6 –5.8) and 4.9 (95% CI = 2.3-10.4) for left and right ears respectively (Tables 4 & 5).

Thirty eight (24.7%) among the study group were affected in both ears according to the above classification and their mean age was 39 years. The mean ages of those affected in the left (47 – 30.5%) and the right (58 – 37.7%) ears were 37 and 36 years respectively. The age range for the above was 19 to 66 years. The mean years of service were 15 and 14 years for those affected in the left and right ears respectively with a range of 0.3 to 50 years.

On applying multiple logistic regression it was observed that the brass workers were at a higher risk of hearing impairment in relation to all the frequencies except at 1000 Hz. (Table 6).

Table 5: Overall Impairment Of Hearing - Right Ear

		Control		Total
		> 25 dB	≤ 25 dB	
Study	>25 dB	19 (12.3%)	39 (25.3%)	58 (37.7%)
	≤25 dB	8 (5.2%)	88 (57.1%)	96 (62.3%)
Total		27 (17.5)	127 (82.5)	154 (100%)

McNemar's test: OR – 4.9; 95%CI = 2.3 – 10.4 : Probability = < 0.0001
Cut off - =< 25 & > 25 dB (Average of 1000, 2000, 3000 & 4000 Hertz)

Both ears were at the same risk of hearing impairment except at 500 Hz where the right ear was at a marginally higher risk of being affected with a probability of 0.05 (Table 6). The risk of hearing impairment, in those above 35 years in comparison to those of 16-20 years of age was significantly higher in both groups, in all the frequencies. Those between 31 and 35 years had significant impairment from 3000 Hz. onwards while those between 25 and 30 years were affected significantly from 3000-6000 Hz (Table 6). A noteworthy feature was the consistent, significant increase in the risk of hearing impairment from 26 years onwards, at the frequencies typically affected by noise, namely 3000-6000 Hz.

Table 6 : Audiometry by exposure, side of ear and age categories – study and control groups

Variable		Hertz 250	500	1000	1500	2000	3000	4000	6000	8000
Exposure	OR	2.4	2.5	1.5	1.8	1.9	2.9	5.6	6.6	3.4
Reference General	CI	1.6-3.6	1.7-3.7	0.9-2.4	1.1-3.1	1.1-3.3	1.8-4.7	3.6-8.8	4.4-9.9	2.3-5.1
population	Prob	**0.00**	**0.00**	0.09	**0.03**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**
Side of the ear	OR	1.3	1.5	1.5	1.5	1.2	1.1	1.2	1.0	1.0
Reference Left ear	CI	0.9-1.9	1.0-2.2	0.9-2.4	0.9-2.1	0.7-2.1	0.7-1.7	0.8-1.8	0.7-1.4	0.7-1.5
	Prob	0.23	0.05	0.09	0.14	0.42	0.82	0.46	0.87	0.84
Age * 21–25years	OR	1.8	1.6	1.2	2.3	1.6	0.5	0.9	1.4	1.1
	CI	0.9-3.9	0.8-3.2	0.5-3.1	0.6-9.0	0.4-6.8	0.1-1.9	0.4-2.3	0.8-2.7	0.6-2.2
	Prob	0.11	0.19	0.73	0.25	0.54	0.27	0.86	0.28	0.68
Age* 26-30 years	OR	2.0	1.7	1.7	3.2	3.5	3.0	4.2	2.0	1.6
	CI	1.0-4.0	0.9-3.3	0.7-4.2	0.9-11.6	1.0-12.6	1.2-7.9	2.0-8.9	1.1-3.7	0.8-2.9
	Prob	0.07	0.13	0.24	0.08	0.06	**0.02**	**0.00**	**0.02**	0.16
Age* 31-35 years	OR	2.1	1.6	1.6	4.0	4.0	4.1	4.4	4.9	2.3
	CI	0.9-4.6	0.8-3.5	0.6-4.4	1.0-16.6	1.0-15.6	1.5-11.3	1.9-10.0	2.5-9.7	1.2-4.5
	Prob	0.08	0.22	0.35	0.05	0.05	**0.01**	**0.00**	**0.00**	**0.02**
Age* >35 years	OR	4.3	3.7	4.4	12.1	12.0	15.3	22.8	16.7	10.7
	CI	2.2-8.3	2.0-6.9	2.0-9.8	3.6-40.2	3.6-40.1	6.3-37.5	11-48	11-32	5.8-19.7
	Prob	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

OR – Odds Ratio; CI – 95% Confidence Interval; Prob - Probability
Total number of pairs 151 – 154; multiple logistic regression
*Refrence for Age – 16-20 years

On analysis of data pertaining only to the brass workers, those who had more than five exposed years of service were at a significantly higher risk of hearing impairment at 3000 and 4000Hz (Table 7) with ORs of 2.4 (95% CI; 1.1-5.3) and 3.1 (95%CI; 1.2-8.5) respectively. The two ears remained at equal risk of being affected as in the previous analysis. With regard to age, the risk of hearing impairment at the typical frequencies affected by noise (3000 –6000 Hz) remained significant with the increase in age from 26 years onwards (Table 7).

Of the 18 brass workers who had subjective impairment of hearing, only 7 (4.5%) had positive audiometric changes, while among the balance 136 who did not complain of hearing impairment, 54 (35%) had positive audiometric changes. The difference observed was not statistically significant.

The overall noise levels measured in the 10 workshops ranged from 84 to 103 dB. The minimum level observed ranged from 84 to 95 dB while the maximum observed ranged from 98 to 103 dB in the 10 workshops.

Discussion

Described above is a cross-sectional analytical study which measures both exposure and outcome simultaneously thus hampering the ability to determine which occurred first.

Despite the exclusions due to non-response to the questionnaire, otological problems, and non-response to audiometry with respect to 6000 and 8000 Hz., a minimum of 151 pairs were left for the analysis. This number is more than the required sample size of 147 calculated for the audiometry component of the study.

Temporary threshold shift (TTS) is a factor that leads to errors in determining the degree of permanent hearing impairment. Although requested to refrain from working on the previous day of the survey, to achieve this, a doubt remains regarding compliance to it by all the subjects. A noise free period of 16 hours (5 o'clock previous evening – 9 o'clock the following morning) may still have been observed, even if they did work till the evening. Although the recommended minimum noise free period is 14 hours (7) there seems to be no definitive agreement on the optimum number of hours required to overcome the effect of TTS. Alberti (10) is of the opinion as quoted that "for practical purposes the amount of improvement in TTS after the first day or two could be ignored, since it is less than the confidence limits of the audiometry used in testing". In the present study, the effect of TTS if present is assumed to be the

Table 7 : Audiometry by exposed years, side of ear and age categories – study group

Variable		**Hertz**								
		250	**500**	**1000**	**1500**	**2000**	**3000**	**4000**	**6000**	**8000**
Service	OR	1.3	0.9	2.3	1.6	1.5	2.4	3.1	2.4	2.3
	CI	0.6-2.9	0.4-2.1	0.9-6.0	0.6-3.9	0.6-3.7	1.1-5.3	1.2-8.5	0.6-9.2	0.9-5.8
	Prob	0.54	0.83	0.08	0.32	0.35	**0.04**	**0.03**	0.20	0.08
Side of the ear	OR	1.5	1.4	1.7	1.7	1.3	1.2	1.2	1.1	1.2
Reference	CI	0.9-2.5	0.8-2.2	0.9-3.3	0.9-3.3	0.7-2.7	0.7-2.2	0.7-2.0	0.6-1.8	0.8-2.0
Left ear	Prob	0.10	0.22	0.08	0.13	0.39	0.54	0.50	0.79	0.37
Age* 21–25years	OR	2.7	2.1	1.4	3.6	1.9	0.6	1.2	2.2	1.3
	CI	1.1-6.4	0.9-4.7	0.5-4.0	0.7-18.1	0.3-11.0	0.1-3.8	0.5-3.1	1.1-4.7	0.6-2.9
	Prob	**0.03**	0.08	0.52	0.12	0.46	0.60	0.75	**0.04**	0.55
Age* 26-30 years	OR	1.6	1.5	1.0	3.0	3.0	3.9	3.8	2.9	2.1
	CI	0.7-3.8	0.7-3.4	0.4-2.9	0.6-14.9	0.6-14.9	1.1-14.5	1.6-9.0	1.4-6.0	1.0-4.5
	Prob	0.30	0.30	1.00	0.19	0.19	**0.04**	**0.00**	**0.00**	0.06
Age* 31-35 years	OR	1.7	1.1	0.7	3.7	4.6	6.9	4.7	4.2	3.4
	CI	0.6-4.6	0.4-2.9	0.2-2.6	0.7-20.2	0.9-24.0	1.8-26.6	1.8-12.2	1.8-10.2	1.4-8.2
	Prob	0.29	0.83	0.59	0.13	0.07	**0.01**	**0.00**	**0.00**	**0.01**
Age* >35 years	OR	2.4	3.2	1.4	8.0	9.2	17.1	13.0	14.9	6.3
	CI	1.0-5.9	0.8-4.7	0.5-4.1	1.7-38.6	1.9-43.4	4.7-62.3	5.0-33.5	5.3-41.8	2.7-14.9
	Prob	0.06	0.11	0.56	**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**

OR – Odds Ratio; CI – 95% Confidence Interval; Prob - Probability
Total number of pairs 151 – 154; Multiple logistic regression
*Refrence for Age – 16-20 years

Ideally audiometry ought to be conducted in a sound proof booth. However, due to practical problems, it was carried out in the field and maximum effort was made to simulate the ideal situation of a sound proof environment. The sound levels measured ranged from 25 to 35 dB. The recommended minimum acceptable background noise level for all the frequencies, of 40 dB for labour purposes (7), was fulfilled.

Testing of audiometry is recommended to begin at 1000 Hz. since it is perceptually the most familiar frequency out of all pure tones (9).

same in both groups which would minimize any bias that is bound to occur as a result.

The well-accepted fact that hearing thresholds do not conform to a normal distribution despite transformation was the feature in the present study (11). However, there are studies which have considered audiometry data as normally distributed and described the threshold levels as the mean (12,13,14).

Overall comparison of the median threshold values indicate that the right ear is the worst affected, where all the frequencies are concerned, while in the left 6000 Hz had the highest median threshold value. Despite these differences the two ears were found to be affected to the same degree in the multiple logistic regression models except at 500 Hz with a borderline probability of 0.05 (Table 6). Individual susceptibility is said to vary between ears and this may explain the above difference. However, what is usually described is a bilateral affection which is symmetrical (15).

The frequencies that were affected were the higher ones, typically affected by noise and also the lower ones which are important in discriminating speech for both the ears. When measuring the risk by frequency, the worst affected frequency was the 6000 Hz for both the ears. However the characteristically affected frequency described, 4000 Hz (15), was not so affected in the present study.

The confounding effect of age, on hearing thresholds is evident in this study as well. There was a significant increase in the risk for both ears with increase in the age, for both groups, involving the frequencies, typically affected by noise. However this effect was significantly more for the study group and may be accounted for by the occupational noise exposure.

A significant association between the duration of service and loss of hearing at the frequencies of 3000 and 4000 Hz. indicated a dose response relationship, which is relevant in confirming noise as a risk factor for hearing impairment. Several cross sectional studies (16) have failed to determine a significant dose response relationship and this may be attributed merely to the study design, in which one cannot determine precisely the duration of exposure, unlike in a follow up study. Yerg, Sataloff et al. (16), has attributed this to the fact that age and duration of service were correlated in their study. Healthy worker effect also may play a role in explaining the lack of a dose response relationship. The brass workers who remain in the industry may be the ones who are less susceptible to the noise hazard while the others affected, may have already left.

These results compare in general with those of the other studies conducted in Sri Lanka (3,4,5) except the presence of a 4000 Hz dip which was not a characteristic feature in the present study.

Exposure to noise was quantified by conducting environmental noise measurements. The recommended noise levels for most countries is 85 dB (A) for an 8 hour shift and for 90 dB (A) for a 4 hour shift. The noise levels measured in the brass workshops exceeded these specified levels. Some employees work throughout the week, except during lunch and the tea break, thus exceeding the number of specified hours of exposure.

Energy in speech is contained within the low frequency ranges while the information required to understand speech is said to reside in the higher frequencies (10,17). Hearing impairment affecting 4000 Hz due to noise, progresses at a steady rate for about 10 years, after which it slows down while it gradually spreads to the other frequencies. Involvement of the lower frequencies of 1 kHz and below may take about 30 years. Subjects begin to complain only when 2-3 KHz are involved, the initial symptom being inability to discriminate speech in crowded places (10). With the spread of the loss further to the lower frequencies only, hearing impairment becomes apparent. The fact that 35% of subjects who had hearing impairment by audiometry were not actually aware of it, is proof of the above feature.

The study findings indicate that brass workers are affected with hearing impairment directly as a consequence of their occupation. Noise should be reduced at the point of origin which is the ideal. In the event of this not being feasible the next available option is to protect the workers by providing them with necessary protective gear. The former requires sophisticated costly engineering techniques which a small enterprise may not be able to afford. Hence, provision of protective gear may be the only option left, as limiting working hours which is the other choice might reduce the earning capacity of workers as their wages are based on the number of articles turned out or the hours worked per day.

According to Melnick (7) dry cotton reduces sound by 10 to 12 dB at 3000 and 4000 Hz. Even though the reduction of noise is minimal, use of cotton wool may be a positive step towards training workers in the use of much more effective earplugs and muffs as a preventive measure.

In conclusion, brass workers were found to have a significant hearing impairment in comparison to the general population. We recommend the use of cheap and effective preventive measures to protect the workers from the hazard of loud noise.

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