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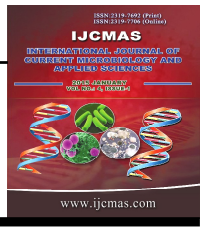

Original Research Article

Impact of noise on hearing and hypertension among workers in steel industry

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K e y w o r d s

Hearing impairment, Hypertension, occupational disease, noise monitoring, Audiometry, Permissible exposure limits (PEL)

A B S T R A C T

The impact of noise on workers' health in the steel industry in South India has been examined in the present study. The objectives of the present study were to study the prevalence of hypertension and hearing impairment in steel industry workers, relation between hypertension and hearing impairment with exposure. Of a total of 464 workers exposed to noise hazard Total 362 workers are examined in the study. There are five important production units in the industry viz., steel melting section (SMS), rolling mill section (RMS), power plant, blast furnace section (IMD) and administration department (AD). Workers who working in SMS, RMS, MBF and power plant, quality control etc formed a continuously exposed group (CEG) and workers of Administration section(AD) formed the intermittently exposed group (IEG). Workers were interviewed, examined and information was collected in a pre-tested pro-forma. Blood pressure was measured, and audiometric tests were done to assess hearing ability. It has been observed that the noise levels measured in SMS, RMS, MBF's &Power plant sections is more than PEL i.e. 8 hours, TWA 90 dBA specified in the state regulations. Workers were not using ear protection devices. Study indicate the prevalence of hearing impairment was significantly more in CEG (31.59%) as compared to IEG (16.36%). The co-relation between level of noise exposure and hearing impairment was found to be significant($r = 0.92$; $p < 0.001$). Positive relation between level of sound & hypertension was found ($r = 0.78$; $p < 0.05$). The results of present study indicate that hypertension & hearing impairment are common problem among workers exposed to high levels of occupational noise.

Introduction

Noise is one of the physical environmental factors affecting our health in today's world. Expsoure to continuous noise at a level higher than 85 dBA may lead to hearing loss. It is estimated worldwide 16% hearing disability is caused by occupational noise exposure (Nelson el at., 2005). Steel plant is considered as one of the nosiest industry in manufacturing sectors. The major source of noise in steel plant includes compressors, Blowers, Induced draught fans, conveyors, Pneumatic tools & equipments and the operations such as grinding, arcing, crushing, rolling, etc. Noise levels during

various operations in steel plants are high and generally form within the range of 84–120 dBA. The noise levels at steel plant operations without adequate engineering control were found to be 108–233 % above the PEL prescribed by State factory rules (PEL for 8 hrs TWA - 90 dBA). Thus the workers in steel industry are at high risk of NIHL.

Noise can not only cause hearing impairment (at long-term exposures of over 85 decibels dB), but it also acts as a causal factor for stress and raises systolic blood pressure(en.wikipedia.org). Studies reveal that prevalence of hypertension was found to be higher among workers exposed to high noise level. In India, the prevalence of hypertension was found to be 25.51% among workers exposed to high level of noise (Narlawar, 2006).

The present study, which was carried out in an integrated steel plant situated near Hospet is an attempt to study noise problems & their effect on hearing impairment & hypertension among steel workers.

The aim of the study is to determine potential hearing loss among the steel workers who are exposed to noise levels above 85 dBA This study also include to know association between noise level & hearing impairment and noise level & hypertension.

Materials and Methods

- **Study place**: –Integrated steel plant located near Hospet in Karnataka.
- **Study design**: – Cross sectional study.
- **Study period**: –December 2013 to April 2014.

Out of 464 employees exposed to noise hazard 362 workers participated in the study. Thus the response rate was 78.01 %. Written permission was obtained from the competent authority of the factory and cleared the study protocol.

For analysis and internal comparison production units such as Steel melting section (SMS), rolling mill section (RMS) and Power plant & Technical service were taken together as continuously exposed group (CEG), as workers were exposed to working environment continuously during their working hours. While administration division (AD) consisting of Stores, Finance, purchase, medical etc. were taken as intermittently exposed group (IEG) as workers visit the manufacturing units intermittently.

The factory works continuously round the clock in three shifts of eight hours each. Posting of worker in particular section was of permanent nature. The shifts of workers were changed on rotation every week. Protective devices like apron, shoes, helmets; goggles, hand gloves and masks were made available for workers in all sections.

All the workers who participated in this study were examined in the factory occupational health centre for medical checkup & audiometry tests with a prior appointment. Each worker was interviewed and examined. Information from employees with respect to noise problems was collected in a proforma designed for this purpose.

Blood pressure measurement

Blood pressure was measured in supine position by using BP Digital monitor HEM-7113 of Omron make as per manufacturer's guidelines. The OMRON HEM-7113 is a fully automatic blood pressure monitor

operating on the oscillometric principle. It measures Blood pressure & pulse rate & shows the result digitally.

Accuracy: Pressure: + 3mm Hg.

After a brief period of rest for 5 minutes interval, Blood pressure was measured in a quiet private room in sitting posture. The centre of the cuff was at heart level and three measurements were taken at 5 minutes intervals. The systolic & Diastolic blood pressures were recorded and the average of three readings was used for data analysis.

Hypertension was defined according to the 7th report of JNC (Joint National committee on prevention, detection, evaluation & treatment of high blood pressure) as systolic blood pressure > 130mm Hg and Diastolic blood pressure >80mm Hg.

Determination of noise level at workplace

Actual noise levels in this plant have been measured and their maximum and minimum values are taken for 3 minutes and the average reading was recorded. These details are given in Table 2. The details of sound level meter used for this study are given below:

- Model No: TES -1350
- Make: TES Electrical electronics corp.
- Range: 35 dB to 130 dB. Frequencies between 31.5 Hz to 8 kHz.
- Weighting scale: A&C
- Accuracy: + 2.0 dB.

Results have been recorded by holding the instrument at a height of 1.5m from ground in working environment of the workers in order to determine the noise levels to which the workers are ex- posed.

Audiometric assessment

Audiometric test was conducted for 362 employees and hearing loss was assessed by audiometry test.

The Audiometer model Proton Sx-3, was used which is self-recording type and confirmed to ANSI standard. It was calibrated biologically & acoustically at regular intervals. The audiometer operator was a certified audio technician.

The workers were tested at the start of work shifts to minimize temporary threshold shift effects. The workers tested had not worn hearing protectors. The tests were conducted for workers who are exposed to continuous noise in the production shops and also for control group employees working in administration department having minimal occupational noise exposure.

The workers tested were divided into five age groups 18–20, 21–30, 31–40, 41–50, 51–60 years.

A hearing level (HL) was recorded as the average of audiometric threshold at 500, 1000 and 2000 Hertz. Hearing impairment was considered to have occurred when the hearing level (HL) was exceeded 25 dBA.

Hearing impairment criteria

The prevalence of hearing loss was determined based on hearing threshold levels with a low fence of 25 dBA at the pure tone audiometric test frequencies of 500, 1000 & 2000 Hz (NIOSH, 1990).

The criteria prescribed for determination of hearing impairment from various professional bodies are:-

a. National insurance commission: 50 dB hearing loss averaged through 1, 2 and 3 kHz in the ear which hears best.
b. American academy of ophthalmologists

&otolaryngologists 25 dB hearing loss averaged through 0, 5, 1 and 2 kHz in both ears.

c. British association of ophthalmologists: 40dB hearing loss averaged through 1, 2 and 3 kHz in both ears.

The hearing impairment criteria and classification suggested by Mr. Wendy, pallant is considered in this study because it considers hearing loss from the threshold hearing level of 26 dB – 40 dB as mild hearing loss. This helps to take corrective measures in the early stages of hearing loss. Based on hearing threshold level, the degrees of hearing loss are classified as below (Wendy Pallant, 2001).

a. **Normal hearing (0–25 dB**): At this level hearing is within normal limits.
b. **Mild hearing loss (26–40dB)**: At this level, patients feel difficulty in suppressing background noise. Patients within this degree of loss may not hear soft speech.
c. **Moderate hearing loss (41–55 dB)**: Patients with this degree of loss have trouble hearing some conversational speech.
d. Moderate –severe hearing loss (56–70 dB): With this degree of loss patients do not hear most conversational level speech.
e. Speech hearing loss (71–90 dB): Severe hearing loss may affect voice quality.
f. **Profound hearing loss (> 90 dB):** with profound hearing loss (deafness), speech and language deteriorate.

The dip or notch at 4 KHz or 6 KHz is a symptom of noise induced hearing loss.

Statistical analysis

Data from completed questionnaire were entered in Microsoft excel spread sheets & analyzed with the help of MINITAB statistical software package. X^2 test & coefficient of co-relation were used for statistical tests. Frequency distribution tables & percentage were used to summarize study data in tabular formats.

Results and Discussion

Table 1 depicts section wise distribution of Noise level. It is observed that Noise level was more than permissible limit in SMS, RMS and MBF's& power plant sections. Hearing impairment and hypertension was found to be significantly more in these areas.

Table 2 shows the age composition of the subjects working in steel factory. Among 362 workers participated in the study 64 were contract employees. Out of 362 participants 307 employees are working in manufacturing units exposed to noise and 55 employees were selected from administration, stores, finance, medical etc. as control group who visit manufacturing sections intermittently.

Audiometric test reports

The test reports of audiometry for 362 employees both from study & control group studied in detail.

Table 3 gives Audiometric test reports of 362 employees indicating hearing impairment of workers among continuously exposed group (CEG) & intermittently exposed group (IEG) workers. The degrees of hearing loss are classified into six groups as Normal, Mild, Moderate, and Moderate to severe, speech hearing loss & profound hearing loss (deafness). It is found nearly 70% of workers have normal hearing and about 30% of employees have mild to severe hearing loss. There are no cases of speech

hearing loss & profound hearing loss (deafness) noticed during Audiometry tests.

Table 3 indicates hearing impairment among workers in CEG is (35.83 %) which is much more than the hearing impairment i.e.16.36 % among IEG employees. This indicates a positive relationship between noise exposure & hearing impairment.

Table 4 shows age wise distribution of workers and association between hearing impairment and duration of exposure. As the age group increases, the workers are more experienced and their exposure to noise is long. The hearing impairment was found very high i.e. 39.39 % among workers in the age group of 51–60 whereas hearing impairment was found very less i.e. 21.96% in the age group of 21–30. This clearly indicates the prevalence of hearing impairment was directly associated with duration of exposure.

Table 5 shows section wise distribution of workers & association between hypertension& duration of exposure. It is observed that hypertension among employees of all age groups was in the narrow range of 33.33%–33.14%. In this study no positive relationship was found between the age group of employees i.e. exposure and hypertension. It was also observed that prevalence of hypertension was more among workers of CEG (35.5%) as compared to workers of IEG (21.81%).

Table 6 shows association between hearing impairment & hypertension. It was observed that out of 106 workers with hearing impairment, 68 workers have hypertension. This works out 64.15% whereas out of 256 workers with normal hearing, 53 workers have hypertension. This works out 20.70%. This clearly indicates there is positive association between hearing impairment and hypertension. This association was found to be statistically significant (x^2 =61.65, $p< 0.05$)

Table 7 shows association between level of sound and noise related health problems like hypertension & hearing loss. It was observed that hypertension & hearing loss were more common in production & maintenance sections having high levels of noise viz., Blast furnaces, Steel making section, Rolling mills, Power plant, and Technical service as compared to Administration section where level of sound was low. From the study it is found that the correlation between level of sound and hearing impairment was found to be significant ($r = 0.92$; $p< 0.01$; $t = 6.05$). Further it is found that the correlation between level of sound & hypertension found to be statistically significant ($r = 0.78$; $p< 0.005$, $t = 3.28$)

Noise hazard is increasingly being recognized as a physical factor in the environment that is injurious to many aspects of health& safety. Noise is an environmental problem in industrialized societies. Occupational noise is a widespread risk factor, with a strong evidence base linking it to important health outcome i.e. hearing loss & hypertension. Many research scientists in the world have observed a significant rise in blood pressure in response to noise (Herbold *et al.,* 1989; Mahmood *et al.,* 2007; Mollar, 1980; Berendra Yadav *et al.,* 2013).

It was found that occupational noise induced hearing loss was most frequent among all occupational diseases. The prevalence rate of NIHL as per central labour institute study is 15.2%. In our study the prevalence rate of hearing loss was 35.5%. This may be due to high noise generation equipments (Compressors, pneumatic grinders,

conveyors, Induced draught fans etc.) and the process like rolling, grinding, crushing, drilling and arcing in LRF's employed in steel plant.

Talbot stated that subjects with a severe noise related hearing loss <65 dB HL averaged over 3.4 and 6 KHz had a greater likelihood of hypertension and suggested that this could be the result of long term noise exposure (Talbott *et al.,* 1985). In a study conducted by Narlawar (2006), it is found that the prevalence of hypertension was found to be 25.51% among workers exposed to high level of noise. Whereas in our study the prevalence of hypertension was found as high as 33.42% among workers exposed to high noise level. This may be due to combined effect of heat & noise at many places in steel industry.

In the present study, the data related to body mass index, smoke and alcohol intake were not collected. Increased number of participants in such study would give more accurate results. Nevertheless, results of the present study indicate that hypertension and hearing loss are significantly associated with duration of exposure of noise. Both noise-induced health problems (hypertension & noise impairment) were common in CEG workers as compared to IEG workers. Also it was found that hypertension was more common in workers with hearing impairment. CEG workers working in SMS, RMS and MBF's & power plant sections are exposed to higher noise level than permissible limit of noise.

Workers feed back

According to Feedback obtained from the workers through questionnaire, it is noticed that workers are disturbed from noise problem in their workplace.

- Workers have sleep disturbance from noise problem.
- Workers have the problem of nervousness.
- Workers have complained of ringing in the ear & hearing problem.
- Most of the workers do not have periodical hearing tests.
- It is noticed during field study that only 35% of employees were found using ear protection equipments. Workers complained of discomfort in using earplug & other PPE's. But as already indicated, noise hazard being a major problem in Blast Furnace, Rolling Mills, steel Making shops and Power plant sections in Steel industry, the use of ear protection devices is found very essential.

It has been observed that the noise levels in the Steel industry are much above the noise level of 90 dBA which is PEL for 8 hours TWA as per State Factories rules.

Table.1 Distribution of Noise level in different Sections

Section	Noise level in dB	Average reading
Rolling Mill Section (RMS)	84-120	**102**
Steel Melting section (SMS)	80-102	**91**
Blast furnaces	82-108	**95**
Sinter plants	84-115	**99**
Power plant	77-103	**90**
Machine Shop (MS)	86-97	**91**
Administrative Department (AD)	46-52	**49**

Table.2 Age Composition of workers

Age in Years	No. of persons	%
18-20	02	**0.55**
21-30	105	**29.00**
31-40	140	**36.67**
41-50	82	**22.65**
51-60	33	**9.11**
Total	362	**100%**

The participants are from all age group, but the maximum number of workers was in the age group of 31–40 years i.e. 36.67%.

Table.3 Audiometry results: Section wise hearing impairment details among exposed & control group employees

	Workers exposed to Noise (study group)						**Control group**	
Sr.No	**Hearing level**	**Degrees of hearing loss**	**MBF n=111**	**SMS n=77**	**RMS n=69**	**Power plant, QAD, Civil, Utility etc n=50**	**Horticulture, Admn., Finance etc. n=55**	**Total**
01	0 – 25 dB	Normal	73(65.76)	53(68.83)	45(65.21)	37(74.0)	46(83.63)	254
02	26- 40 dB	Mild	32(28.82)	22(28.57)	16(23.18)	11(22.0)	08(14.54)	89
03	41- 55 dB	Moderate	05(4.50)	01(1.29)	06(8.69)	02(4.0)	01(1.81)	15
04	56- 70 dB	Moderate - severe	01(0.90)	01(1.29)	02(2.89)	Nil	Nil	04
05	71- 90 dB	Speech hearing loss	Nil	Nil	Nil	Nil	Nil	Nil
06	> 90 dB	Profound hearing loss (deafness)	Nil	Nil	Nil	Nil	Nil	Nil

- SMS – Steel making shop
- RMS – Rolling mill division.
- MBF's – Mini blast furnaces
- Technical services- Civil, Power plant, Quality assurance department, utility etc.
- Administration Department – Stores, Finance, security, Medical etc.
- Data in cells represent number of subjects with hearing loss.
- Figures in parenthesis show percentage of 'n'

Table.4 Association between age group & hearing impairment

Age group	SMS n= 77	MBF's n= 111	RMS n=69	Technical services n= 50	Administration department n=55	Total
18-20	Nil	Nil	Nil	Nil	Nil	Nil
21-30	09(6.49)	16(14.41)	07(10.14)	02(4.0)	01(1.81)	**35**
31-40	11(9.09)	17(15.31)	09(14.49)	08(16.0)	02(3.63)	**47**
41-50	04(2.59)	9(8.10)	08(11.59)	02(4.0)	05(9.09)	**28**
51-60	3(3.89)	Nil	02(2.89)	02(4.0)	04(7.27)	**11**
Total	**27**	**42**	**26**	**14**	**12**	**121**

- Data in cells represent number of subjects with hearing impairment
- Figures in parenthesis show percentage of 'n'

Table.5 Section wise association between age group & hypertension

	Workers exposed to noise				Control group			
Age group	**Normal n= 197**	**Mild n= 94**	**Moderate n= 14**	**Severe n= 2**	**Normal n=42**	**Mild n=11**	**Moderate n=2**	**Total**
18-20	02(1.01)	Nil	Nil	Nil	Nil	Nil	Nil	**02**
21-30	74(37.56)	17(18.08)	05(35.7)	Nil	08(19.04)	01(9.09%)	Nil	**105**
31-40	67(34.01)	53(56.38)	06(42.85)	Nil	10(23.80)	03(27.27)	01(50.0)	**140**
41-50	41(20.81)	16(17.02)	03(21.42)	01	17(40.07)	04(36.36)	Nil	**82**
51-60	13(6.59)	08(8.51)	Nil	01	07(16.66)	03(27.27)	01(50.0)	**33**
								362

- SMS – Steel making shop, RMS – Rolling mill division,MBF's – Mini blast furnaces
- Technical services- Civil, Power plant, Quality assurance department, utility etc.
- Administration Department – Stores, Finance, security, Medical etc.
- Data in cells represent number of workers with hypertension.
- Figures in parenthesis show percentage of 'n'

Table.6 Association between hearing impairment & hypertension.

Hearing impairment	Hypertensive	Non-hypertensive	Total
Present	68(64.15)	38(35.84)	**106(29.28)**
Absent	53(20.70)	203(79.29)	256(70.71)
Total	**121(33.42)**	**241(66.57)**	**362**

Figures in parenthesis show percentage

X^2 = 61.65; P = < 0.05

Table.7 Association between level of sound and noise induced hypertension & hearing impairment in each section

Section	Noise level in dB	No. of persons with hypertension	No. of workers with hearing impairment
Rolling Mill Section (RMS)	102	27(39.13)	24(34.78)
Blast furnaces & Sinter plants	95	42(37.83)	36(32.43)
Steel Melting section (SMS)	93	26(33.76)	24(31.16)
Power plant, utility, civil, QAD	90	14(28.0)	13(26.0)
Control group(Admn, Finance, security, stores etc)	49	12(21.81)	09(16.36)

- Figures in parenthesis denote percentage.
- Hearing impairment **r =** 0.92 , p< 0.01, t = 6.05
- Hypertension r = 0. 78 , p<0.05, t = 3.28

The results show that noise causes hypertension and hearing impairment in exposed workers. So effective actions should be taken to prevent or minimize the effects of noise at workplaces. Efforts should be made to control the noise at the source, to minimize the transmission of noise by providing barrier and to protect the workers from noise hazard. There should be permanent arrangements for regular measurements of noise levels at Steel factory and education regarding noise control should be given prime importance. The problem of noise should be taken into consideration during design, planning & selection of machineries in the industry. Plant engineers should arrange the work schedule for workers according to the level of noise in workplaces. New workers who will work at noisy workplaces should be subjected to hearing and illness tests periodically. Suitable PPE's such as ear muff & ear plug should be provided for the workers and should be trained on regular usage of personal protective equipments. Employers and workers should help each other in combating noise problem and its effects on workers' health.

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References

Berendra Yadav, Sangeeta Singhal, S.F., Hashmi, Mohammad Muzammil, Ajay K. Singh. 2013. Effects of workplace noise on hearing and cardiovascular system. *Nat. J. Med. Allied Sci.,* 2(1): 41–48

Herbold, M., Hense, H.W., Keil, U. 1989. Effects of road traffic noise on prevalence of hypertension in men. *Soz Praventivmed,* 34(1): 19–23.

Mahmood, R., Ghulam, J.H., Alam, S., Safi, A.J., Salahuddin, Amin-ul-Haq. 2007. Effect of 90 decibel noise of 4000 Hertz on blood pressure in young adults. *Noise Pollut.*, 4: 1–4.

Mollar, A.R. 1980. Noise as a health hazard. In: Maxy Rossenau Public health and preventive medicine, 11th edn. Appleton Century Crofts, New York, Pp. 790–9

Narlawar, U.W., Bhooshan G. Surjuse, Sushama S. Thakre. 2006.

Hypertension and hearing impairment in workers of Iron and Steel industry. *Indian J. Physiol. Pharmacol.*, 50(1) : 60–66

Nelson, D.I., Nelson, R.Y., Concha-Barrientos, M., Marilyn Fingerhut, 2005. The global burden of occupational noise-induced hearing loss. *Am. J. Ind. Med.*, 48(6): 446–458.

NIOSH (1990). A practical guide to effective hearing conservation programs in the workplace. Cincinnati, Ohio: National Institute for Occupational Safety and Health. (DHHS (NIOSH) publication no. 90-120).

Talbott, E., Helmkamo, J., Matthews, K., Kuller, L., Cottington, E., Redmond, G. 1985. Occupational noise exposure. Noise induced hearing loss and the epidemiology of high blood pressure. *Am. J. Epidemiol.*, 21: 505–514.

Wendy Pallant, 2001. Deafness information sources and organisations concerning deafness. Levels of hearing loss. http://www.schooltrain.info/deaf_studies/audiology2/levels.htm.