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ORIGINAL ARTICLE

NOISE INDUCED HEARING LOSSIN HEAVY METAL INDUSTRIAL WORKERS

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ABSTRACT: INTRODUCTION: Today the world is facing with number of serious problems, which are challenging the humanity for its survival. "The present generation and the future generations have to solve at least three grave problems, namely, population, poverty and pollution if they have to survive". Pollution is of many types like sound pollution, air pollution, and noise pollution. Workers who are exposed to heavy noise at industries are at higher risk of getting severe health problems especially the hearing loss which can be prevented when necessary precautions are taken. **AIM:** The study consists of 'Noise Induced Hearing Loss' (NIHL) that may be present in the heavy metal industrial workers exposed to high levels of noise at the work place and compared with the control group and also to find out which frequencies are effected more. **SETTING:** The study was carried out in a nearby heavy metal industry, by taking different departments with varying noise range from (83-105 dB) are as follows: 1. Shells (90-92dB), 2. Press Shop (94-96 dB), 3. Cryogenic Production (85-86 dB), 4. Heat Exchangers (95-105dB), 5. Pressure Vessels (88-90 dB), 6. Tool Manufacturing Section (88-92 dB), 7. Welding (90-92 dB), (8). Training Section (87-88 dB), 9. Quality Control (83-85 dB), 10. Garage (86-88 dB). **MATERIALS & METHODS**: The study population included all 200 male subjects with 100 test group and 100 control group. All are subjected to thorough clinical examination, hearing tests in the department of physiology and pure tone audiometry at Visakhapatnam, from January 2014 to January 2015. The parameters studied were age, duration of exposure and years of service and intensity of exposure to noise. **STATISTICAL ANALYSIS:** In this study statistical analysis is Chi square analysis for estimation of p value which is <0.05. **RESULTS:** The case sheets analyzed were total 200. Test group which include100 and control group 100. Among test group almost all of them had some amount of noise induced hearing loss. Most common frequencies involved are between 4000HZ and 8000HZ with a notch. Subjects taken for study who are exposed to 85-105dB of noise for continuous 8 hours duration on any working day for several years of service are found to be affected. **CONCLUSION:** All heavy metal industrial workers need regular and complete clinical examination periodically. Effective measures should be taken to reduce the intensity of sound at the work place. Awareness about use of protective measures against high noise levels will be very useful.
KEYWORDS: Audiometry, Noise induced hearing loss, Sensory neural hearing loss, Decibels.

INTRODUCTION: Hearing loss in any person interferes with daily life activities like communicating with other people in the society. It will be disgusting both for the individual who is suffering with hearing loss and also to the family members and friends. It may lead to inferiority complex and stress in general. The quality of life will be poor. In industrial workers where there is lot of noise at their workplace proper hearing is essential for good communication and performance at job which can be prevented if sufficient care is taken both by the individual and the organization. Occupational noise induced hearing loss which is of sensorineural type is caused by exposure to high noise & is the most prevalent occupational health hazard workers facing today. Worldwide 16% disabling hearing loss in adults is attributed to occupational noise. Early recognition and treatment are must to prevent

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further damage to the ear[1]Workers should get awareness about harmful effects of noise on hearing by implementing compulsory education and regular training programs.

AIMS OF THE STUDY: To find out whether;

1. The test group subjects who are exposed to heavy noise have hearing loss are not.
2. To study whether the hearing loss is proportional to the duration of service.
3. Relation to the intensity of noise and hearing loss.
4. Which frequencies are more affected in the auditory range and compared with the control group having normal hearing ability.

MATERIALS AND METHODS: The study group involved test group subjects who are exposed to high noise above (85dB-105dB) for 8hrs duration at work place in a heavy metal industry and compared to a control group of similar ages and also work for similar duration but not exposed to high noise. Whole study included age groups between (35-55yrs), all were male subjects as there are no female workers. Duration of exposure to noise was categorized based on their years of service in the company into (10-15yrs, 16-20yrs, 21-25yrs, and 26-30yrs). Subjects were instructed to come on Monday after taking rest on Sunday to avoid temporary threshold shift, and were instructed not to listen high pitch music wearing headphones during the course of study. All the subjects have undergone thorough initial screening with watch test, verbal interrogation, Rinne's, and Weber's test with tuning fork of 256 Hz frequency followed by pure tone audiometry which is done to each ear separately. This is done by selecting the right ear or left ear option present in the computer connected to the audiometer by default. The whole procedure was followed in a sound proof room. Methods followed were simple, non-expensive, user friendly, and harmless to the subjects. The heavy metal industry was selected because it is close to our work place having an access, easy follow up, high noise level at the work place, more number of workers and with long duration of service. From each person Information was collected and provided in the form of case sheet. All the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation. Statistical method used to analyze data was Chi square analysis for estimation of p value <0.05 which is highly significant.

Pure Tone Audiometry of Subjective Type (Model-Tam 25)

Tuning Fork with 256 Hz Frequency

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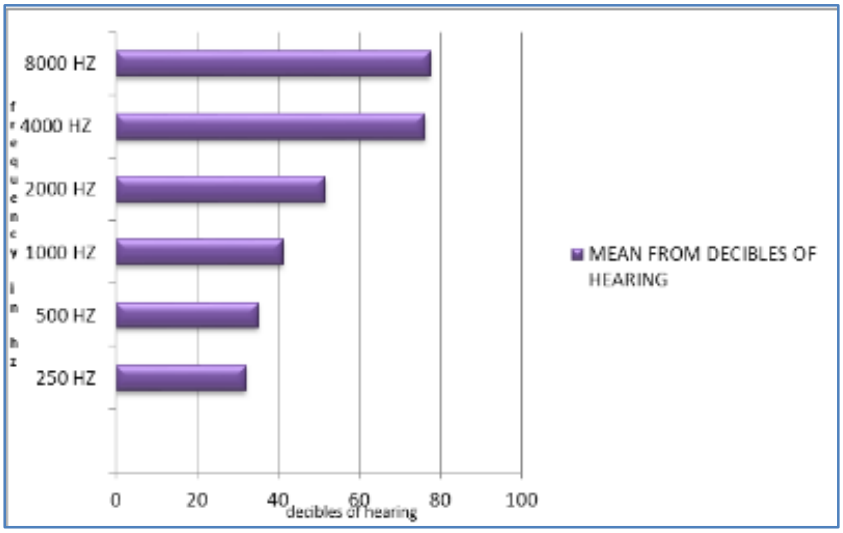
Frequency in(Hz)		Control (mean±S.D)	Cases (mean±S.D)	z-value	p value
250	Right	18.02±3.84	32.7±15.22	6.60	<0.001
	Left	17.54±4.32	31.5±13.37	7.02	<0.001
500	Right	19.6±4.29	35.9±16.30	6.83	<0.001
	Left	19.4±4.21	34.4±13.11	7.69	<0.001
1000	Right	18.94±4.77	44±19.97	8.62	<0.001
	Left	17.86±4.59	38.3±15.50	8.93	<0.001
2000	Right	17.92±3.46	53.5±23.88	10.42	<0.001
	Left	18.82±4.19	49.7±21.00	10.19	<0.001
4000	Right	19.6±3.84	78.4±20.93	19.53	<0.001
	Left	18.16±3.62	74±19.29	20.10	<0.001
8000	Right	20.02±5.31	78±22.85	17.47	<0.001
	Left	18.96±4.28	77±21.38	18.87	<0.001
Pure tone average	Right	18.81±3.31	44.43±18.81	9.48	<0.001
	Left	18.66±3.23	40.76±15.19	10.05	<0.001

Table 1: Statistical Comparison of Mean Threshold Intrensity Values between Test Group And Control Groups At Various Frequencies

Frequencies	250HZ	500HZ	1000HZ	2000HZ	4000HZ	8000HZ
MEAN±SD	32.1±12.62	35.15±13.29	41.15±16.14	51.6±19.99	76.2±17.90	77.5±19.38
P-VALUE	>0.001	>0.001	>0.001	>0.001	>0.001	>0.001

Table 2: Comparision between lower, mid, and higher frequencies of hearing loss



Graph 2: Comparision Between Lower, Mid, And Higher Frequencies Of Hearing Loss

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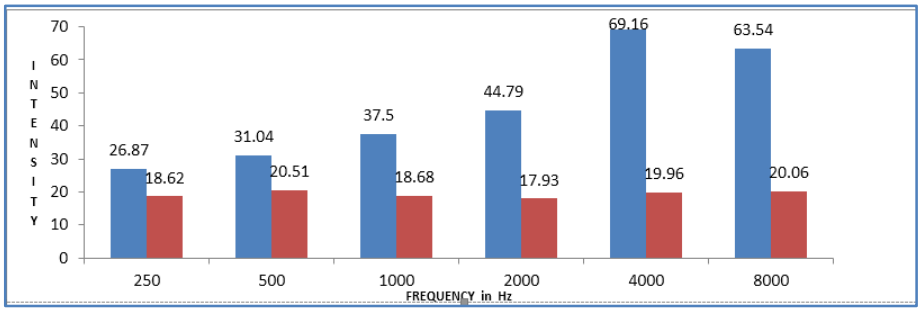
Frequency in(Hz)		Control group (35-45yr) (mean±S.D)	Test group (35-45yr) (mean±S.D)	z-value	p value
250	Right	18.62±4.10	26.87±11.40	3.37	<0.001
	Left	17.17±4.28	26.04±8.46	4.66	<0.001
500	Right	20.51±4.04	31.04±13.59	3.66	<0.001
	Left	18.79±4.27	28.12±6.39	6.10	<0.001
1000	Right	18.68±4.66	37.5±17.19	5.20	<0.001
	Left	17.24±4.71	30.41±8.45	6.80	<0.001
2000	Right	17.93±3.99	44.79±18.73	6.89	<0.001
	Left	18.58±3.48	39.79±15.07	6.74	<0.001
4000	Right	19.96±4.04	69.16±16.39	14.34	<0.001
	Left	18.13±3.75	61.45±13.30	15.44	<0.001
8000	Right	20.06±5.70	63.54±19.13	10.74	<0.001
	Left	17.72±4.34	61.66±15.58	13.39	<0.001

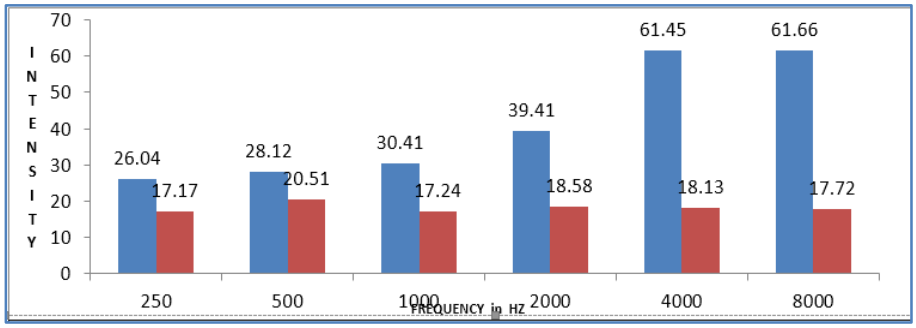
Table 3A: Comparison of hearing ability between the test group and control group of similar age (35-45 yrs)

Graph 3A: Comparison of Hearing Ability between the Right Ear of Test Group and Control Group of Similar Age (35-45Yrs).



Graph 3A

Graph 3B: Comparison of Hearing Ability between the Left Ears of Test Group and Control Group of Similar Age (35-45yrs).



Graph 3B

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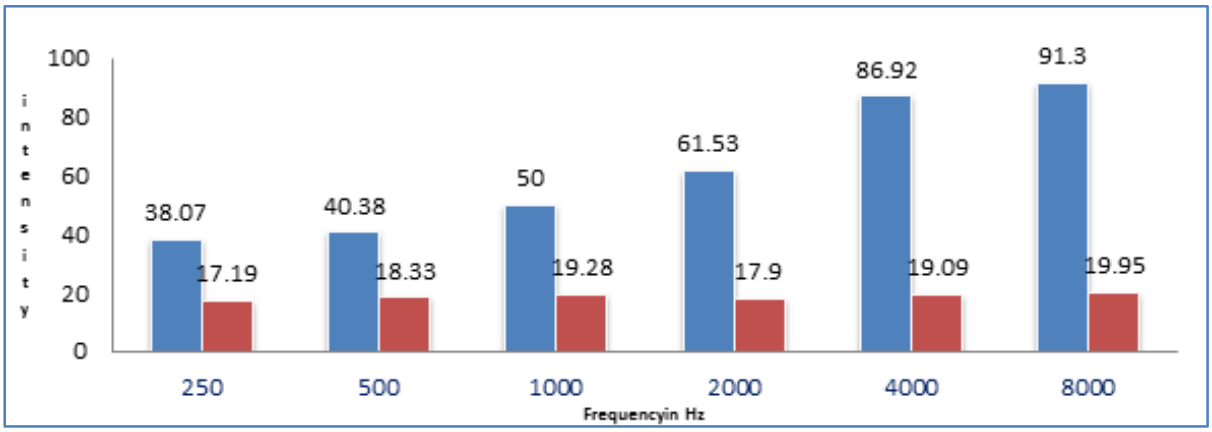
Frequency in(Hz)		Control group (46-55yr) (mean±S.D)	Test group (46-55yr) (mean±S.D)	z-value	p value
250	Right	17.19±3.38	38.07±16.49	6.29	<0.001
	Left	18.04±4.43	36.53±15.15	5.91	<0.001
500	Right	18.33±4.39	40.38±17.54	6.17	<0.001
	Left	20.23±4.08	40.19±15.06	6.46	<0.001
1000	Right	19.28±5.01	50±20.78	7.27	<0.001
	Left	18.71±4.38	45.57±17.04	7.72	<0.001
2000	Right	17.90±2.66	61.53±25.60	8.63	<0.001
	Left	19.14±5.08	58.84±21.78	8.99	<0.001
4000	Right	19.09±3.59	86.92±21.31	15.95	<0.001
	Left	18.19±3.53	85.57±16.63	20.10	<0.001
8000	Right	19.95±4.87	91.34±17.35	20.02	<0.001
	Left	20.66±3.6	91.15±15.44	22.50	<0.001
Pure tone average	Right	18.49±3.49	50.60±19.97	8.04	<0.001
	Left	19.33±3.07	48.16±16.02	8.97	<0.001

Table 3B: Comparison of Hearing Ability between the Right and Left Ears of Test Group and Control Group of Similar Age (46-55yrs)

Graph 3B: Comparison of Hearing Ability between the Right and Left Ears of Test Group and Control Group of Similar Age (46-55yrs).



Graph 3B

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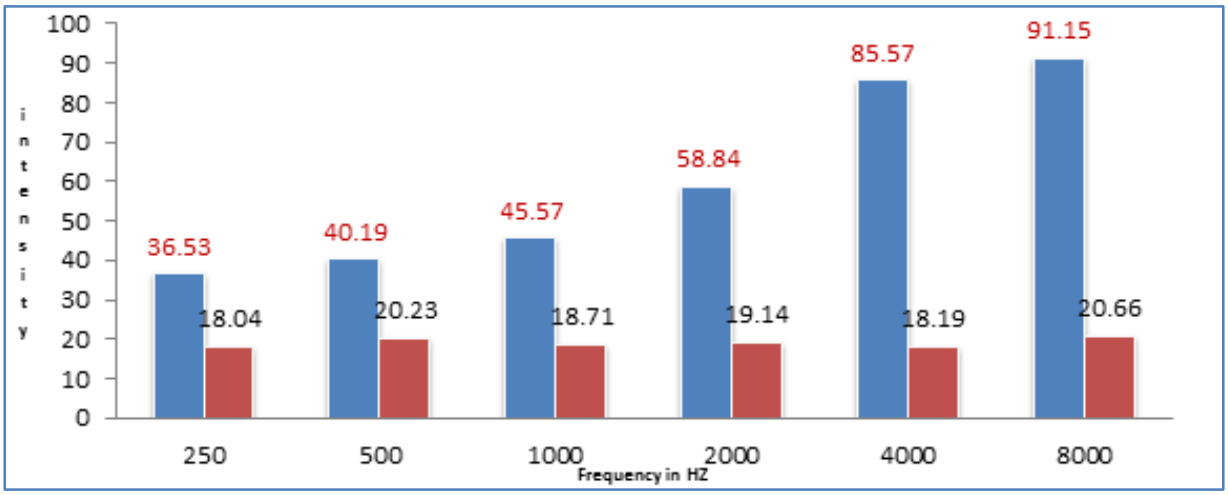
Graph 3B: Comparison of Hearing Ability between the Right and Left Ears of Test Group and Control Group of Similar Age (46-55yrs).



Graph 3B

Frequency In(Hz)		GROUP-A 85-95dbl (mean±S.D)	GROUP-B 95-105dbl (mean±S.D)	z-value	p value
250	Right	26.87±11.40	38.07±16.49	2.81	<0.005
	Left	26.04±8.46	36.53±15.15	3.05	<0.001
500	Right	31.04±13.59	40.38±17.54	2.11	<0.05
	Left	28.12±6.39	40.19±15.06	3.73	<0.001
1000	Right	37.5±17.19	50±20.78	2.32	<0.05
	Left	30.41±8.45	45.57±17.04	4.02	<0.001
2000	Right	44.79±18.73	61.53±25.60	2.65	<0.005
	Left	39.79±15.07	58.84±21.78	3.61	<0.001
4000	Right	69.16±16.39	86.92±21.31	3.31	<0.001
	Left	61.45±13.30	85.57±16.63	5.68	<0.001
8000	Right	63.54±19.13	91.34±17.35	5.36	<0.001
	Left	61.66±15.58	91.15±15.44	6.71	<0.001
Pure tone average	Right	37.75±15.18	50.60±19.97	2.57	<0.005
	Left	32.73±9.12	48.16±16.02	4.22	<0.001

Table 4: Comparison of Mean Threshold Intensity Values between Groups A 85-95 Db And Group b 95-105 Db Of Sound Exposure Among The Test Group Subjects At Various Frequencies

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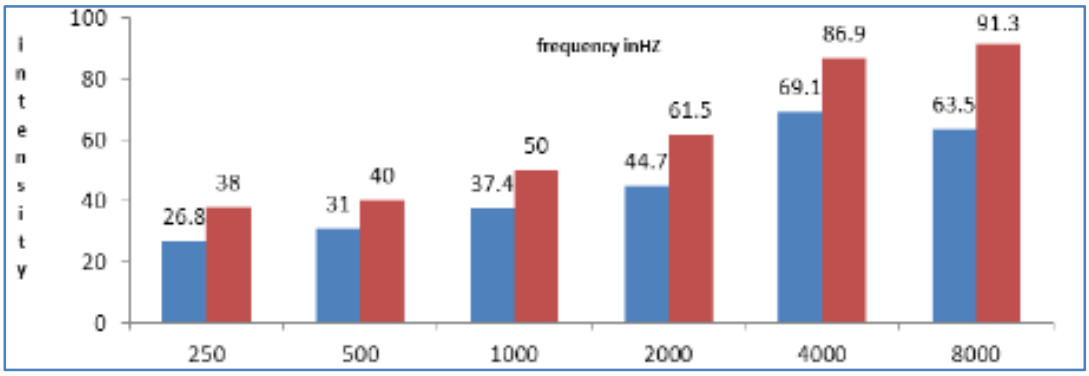
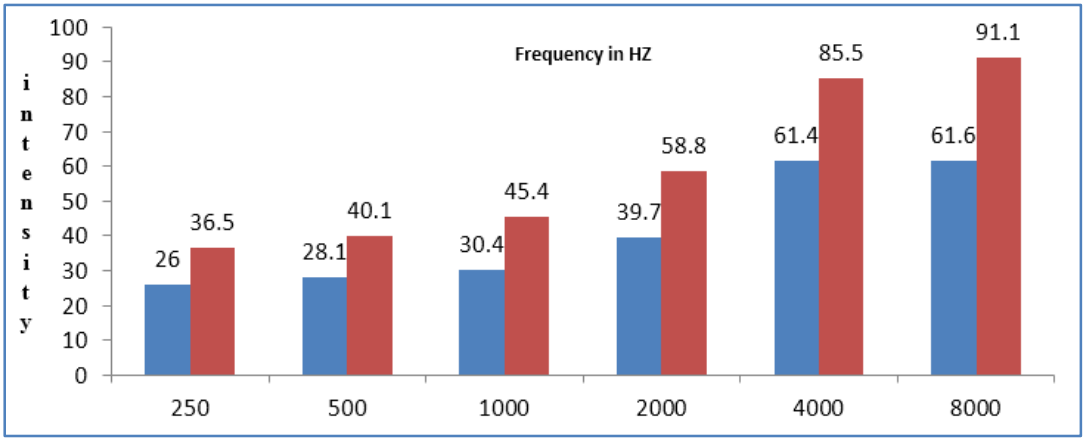
Graph 4: Right Ear Comparison of Mean Threshold Intensity Values of Right Ear of Test Group subjects between Group A (85-95) And Group (95-105 Db) At Various Frequencies.



Graph 4

Graph 4: Comparison of Mean Threshold Intensity Values of Left Ear of Test Group Subjects between Group A (85 95) Db and Group B 95-105 Db at Various Frequencies.



Graph 4

FREQUENCY	SERVICE IN YEARS			
	10-15YRS	16-20YRS	21-25YRS	26-30YRS
250HZ	24.38	28.84	35.19	42.05
500HZ	27.85	31.56	35.19	42.05
1000HZ	30.57	37.90	39.77	57.07
2000HZ	36.11	49.54	49.43	72.68
4000HZ	60.93	70.45	75.88	98.29
8000HZ	56.5	72.76	81.92	102.07

Table 5: Comparison of MEAN hearing loss between the test group subjects in years of service ranging from (10-30yrs) with exposure to heavy noise

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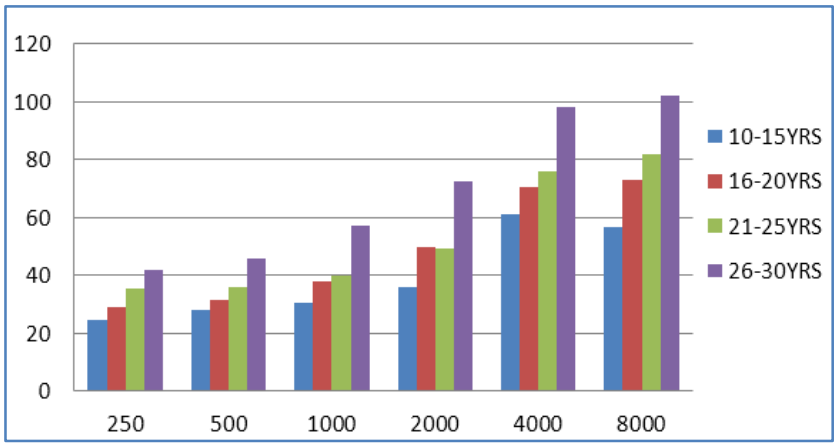
Graph 5: Comparison of hearing loss between the test group subjects in years of service ranging from (10-30yrs) with exposure to heavy noise.

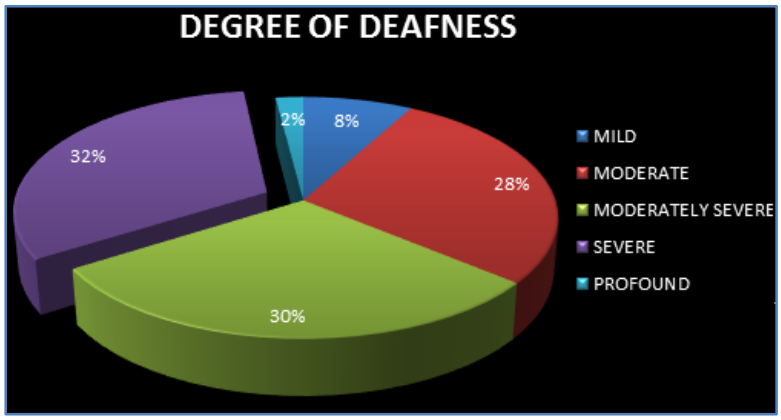


Graph 5

Graded degree of deafness	Number of subjects in test group (n=100)	Percentage
Mild	8	8%
Moderate	28	28%
Moderately severe	30	30%
Severe	32	32%
Profound	2	2%

Table 6(TG): Graded degree of deafness in 100 test group subjects

GRAPH 6: Graph showing that out of 100 test group subjects in our study ,as per W.H.O grading of deafness, 32% are with severe degree of deafness, 30% are with moderately severe, 28% are with moderate degree of deafness, 8% are with mild degree of deafness and two subjects are with profound degree of deafness.



Graph 6

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DISCUSSION: The word noise is derived from the Latin word "nausea" meaning impulsive, unwanted, unpleasant, or loud unexpected sound.[2] In spite of various preventive measures to reduce the effect of noise, it is one of the most prevalent occupational health hazard.[3] "Hearing loss is the single largest disability in any given population. Worldwide 16% of the disabling hearing loss is attributed to occupational noise".[4] Occupational noise induced hearing loss is a major problem in the workers serving in industries, armed forces, aircrafts, ships, heavy mechanical transports, weaponry and aviation industries where there is continuous exposure to noisy environment.[5],[6] The casual association between occupational noise exposure and hearing loss is well‐documented. It has many adverse effects such as elevated blood pressure, agitation, disorientation, headache, reduced performance, sleeping difficulties, annoyance, stress, tinnitus, and last but not the least permanent irreversible sensory neural hearing loss (SNHL). In noise induced hearing loss there is shearing force on stereo cilia of the hair cell lining the basilar membrane of cochlea; leading on to wear and tear of delicate inner ear structures.[6] There are many hypothesis that include mechanical injury from basilar membrane motion, metabolic exhaustion, activity induced ischemia and ionic poisoning from breaks in cell membrane.[7]

The present study group comprised of 200 subjects and all are males because of non-availability of female workers. Test group comprises 100 Subjects working in a heavy metal industry, who were exposed to high noise levels and control group includes 100 subjects from nearby quarters who were not exposed to work place noise. Age group of both test and control groups range between 35 to 55 years. Both test and control groups were subjected to a thorough inquiry into the present, past and family history related to hearing problems. General examination was done judiciously to all the subjects, to eliminate all other causes of hearing loss. Clinical examination including hearing tests like Watch test and Tuning fork test (Rinnes test, Weber's test) were performed to all the subjects. To evaluate frequency of hearing Loss, pure tone audiometry of subjective type was done by using Audiometer of (Model tam-25). All the working group subjects were examined after giving rest for 16 hrs from Noise Exposure to eliminate the effects of "Temporary Threshold Shift" (TTS) and the entire control group subjects were examined after a full night rest.

After evaluation of the findings of the study the following results were obtained:

1. There is definite hearing loss in almost all the subjects among the study group when compared with control group. The observation in table 1 clearly supports the statement. All the 100 subjects had hearing loss in various frequencies. This observation coincides with the earlier observations made by Rupender K. Ranga, et al.[8]
2. From our observations we found that Hearing loss found in all the test group subjects is of bilaterally symmetrical sensory neural type which coincides with study carried by wallhagen et al., from our observation in table 1.
3. In our study hearing loss is seen in almost all frequencies (250-8000hz) but maximum hearing loss is seen in mid-frequencies and higher frequencies ranging from (4000-8000hz), with a characteristic notch at 4000hz.[8][9] With the observations we got from the table 2, graph 2. These observations differ from the other observations made by others.
4. The next finding is the duration of exposure to noise with reference to their service is proportional to the hearing loss. The observations in table 5 in our study the maximum hearing loss is observed between 45-55yrs of age group. Our study was done in a heavy metal industry consisting of welding tool, manufacturing, heat exchangers, press shop, and cryogen production

branches of heavy metal industry whereas Pathak and Ranga et al, study[8] which is done in a heavy industry, reported that there is maximum percentage of hearing loss was found between 36-40 years and 46-50 years it differs from our study in this aspect.

5. From our observations table 4, graph 4, we found that continuous exposure to heavy noise ranging from (85dB-105dB) for a period of continues 8hrs a day between (10yrs to 30yrs) of service caused hearing loss.
6. In comparison to W.H.O grading of hearing loss, from table 6, graph 6 in our study we got out of 100 test group subjects 32% are with severe degree of deafness, 30% are with moderately severe, 28% are with moderate degree of deafness, 8% are with mild degree of deafness and 2% are with profound degree of deafness.
7. From our observations table 5, we found that with continuous exposure to heavy noise for longer duration of service (10yrs-30yrs) causes reduced hearing ability.

CONCLUSION: All heavy metal industrial workers need regular & complete clinical examination periodically. Effective measures should be taken to reduce the intensity of sound at the work place. Awareness about use of protective measures against high noise levels will be very useful.

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