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Orapuh Journal

ORIGINAL ARTICLE

Journal of Oral & Public Health

Factors leading to noise-induced hearing loss among workers in spinning mills in Salem District, Tamil Nadu, India

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ARTICLE INFO

Received: *19 March 2023*
Accepted: *19 April 2023*
Published: *05 May 2023*

Keywords:
Noise-induced hearing loss, spinning mills, increased noise level, hearing loss

Peer-Review: *Externally peer-reviewed*

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To cite:
Norman, P., Karthikeyan, E., Thirunaaukarasu, D., & Bavithra, J. (2023). Factors leading to noise-induced hearing loss among workers in spinning mills in Salem District, Tamil Nadu, India. *Orapuh Journal*, *4*(1), e1003. https://dx.doi.org/10.4314/orapj.v4i1.3

ISSN: *2644-3740*

Published by Orapuh, Inc. (info@orapuh.org)

Editor-in-Chief: V. E. Adamu, Ph.D., M.P.H., F.O.C.S. Professor (Associate), Engelhardt School of Global Health & Bioethics, Euclid University (Pôle Universitaire Euclide) – www.euclid.int

ABSTRACT

Introduction

Hearing loss has become a common feature above 40 years of age. It is more common in Industrial workers who are constantly exposed to loud sounds. With the number of industries rising daily, noise-induced hearing loss has become a constant threat to industrial workers. Salem is one of the districts with lots of spinning mills.

Purpose

This study was done to detect the factors leading to noise-induced hearing loss among workers in spinning mills in Salem District, Tamil Nadu, India.

Methods

Questionnaires containing questions on socio-demographic and work-related data were administered to 867 workers in spinning mills in Salem District. An Otolaryngologist screened their aural canal for wax, foreign bodies (which were removed if they persisted), and perforation in the tympanic membrane. Tuning fork tests and assessment of hearing by portable audiometry were done. The workplace's noise level was measured with a mini sound level meter (model-METRAVI SL – 4010). Data analysis was done using the Statistical Package for Social Sciences (SPSS).

Results

This study indicated that increased duration of work and Increased noise level in the workplaces, working more than ten years in a noisy environment, working more than 6 days a week, and working more than 8 hours a day were the factors associated with noise-induced hearing loss.

Conclusions

Noise Induced hearing loss is very common in workers working in mills. Adopting the protective measures provided and having regular hearing assessments to prevent hearing loss is indicated.

INTRODUCTION

Hard of hearing is not just a disease of old age. According to the World Health Organisation (WHO), a person who is not able to hear as well as someone with normal hearing with hearing thresholds of 25dB or better in both ears is said to have hearing loss. It has increased in the working population in the past few years. Hearing impairment, irrespective of the age of development, has devastating consequences for interpersonal communication, psychosocial well-being, and quality of life (Abraham, n.d.). Over 1.5 billion people worldwide suffer from hearing loss. Which could rise to 2.5 billion by 2050 (Atmaca, n.d.).

India is the second most populated country in the world. This posits that 6.5 percent of the Indian population has noise-induced hearing loss. Prolonged, cumulative exposure to loud noise levels (>85 dB) can damage the auditory system and induce a sensorineural type of hearing loss, usually bilateral, defined as noise-induced hearing loss (Chauhan, 2015). It is estimated that 16% of the disabling hearing loss in adults worldwide accounting for 4 million DALYs is attributable to occupational noise exposure (Davila, 2009). Noise-induced hearing loss is a serious problem in the working population. And with many companies on the rise, people tend to prefer working in such places where they have steady pay and health benefits. Continuous exposure to occupational noise may create physiological derangements of parameters about stress and anxiety in an individual's life

Age is the strongest predictor of hearing loss among adults aged 20-69 (Deafness and hearing loss, n.d.-a). WHO has stated that exposure to loud sounds or loud noises is the fourth reason for hearing loss (Deafness and Hearing loss, n.d.-b). People with hearing loss tend not to socialize with others. There is a high level of school dropouts, low chances of employment, and in those who are employed, low grades of employment when compared with their peers with proper hearing. Years of service in a noisy environment is another factor (Deafness and hearing loss, n.d.-a). Continuous exposure to loud noises can lead to permanent hearing loss. Studies have shown that the effect of hearing decreases as age rolls by. Hearing deficit manifests as the exposure crosses 5 years and on.

Working for more than eight hours and five days a week are the other factors leading to noise-induced hearing loss (Deafness and hearing loss, n.d.-a). Working overtime i.e., more than the recommended hours or extra days leads to extra pay. So many people prefer to work extra hours as they get paid extra for the extra hours they work. Prolonged exposure leads to a temporary threshold shift (The hearing is impaired immediately after noise exposure but recovers after an interval of a few minutes to a few hours) which later becomes a permanent threshold shift (The hearing impairment is permanent and does not recover.)

South India has many textile industries. Salem is a district well-known for its handloom industry. There are many spinning mills in Salem (Haider, 1970). Many workers consult an otolaryngologist only after their hearing decreases. By then primary prevention has failed. Only a few workers consult a doctor, which is nothing but the tip of the iceberg. This study was conducted to determine the factors leading to noise-induced hearing loss in workers of such industries.

METHODS

This is a cross-sectional study. All the companies who agreed to participate in this study were questioned. All the workers - both male and female, who agreed to participate were included in the study. Workers with a history of conductive hearing loss, perforation in the tympanic membrane, and a history of hearing loss in the family and less than 2 years of experience in the field were excluded from this study. In a study by Rangar et al. (2014), the prevalence of hearing loss in textile mill employers was 33.7%. Taking that prevalence as 'index Prevalence', the sample size for this study was calculated to be 786. Of the 915 participants 9 refused to participate and 39 had less than 2 years of experience. So, 867 participants were studied.

Clearance was obtained from the Institutional Ethical Committee and permission to conduct the study was obtained from the owners of the corresponding industries after assuring them of the anonymous nature of the study. A structured interview schedule was designed. The schedule included questions on socio-demographic data like age, sex, education, type of industry, work experience, hours of work per day, weekly workdays, problems experienced because of noise in the work area, usage of any protective devices, history of hearing loss, previous history of hearing assessment, and level of performance.

The interview schedule design was discussed among the authors. A pilot study was conducted among 50 workers. The deficiencies were identified and rectified. Then, the Interview Schedule was finalized. The help of the Undergraduates of Karpaga Vinayaga Institute of Medical Sciences residing in Salem was sought. Before data collection, the post-graduates were oriented about the study and the questionnaire

After explaining the purpose of the study, and procedures and assuring anonymity to the participants, informed consent was obtained from each participant. After consent was obtained the pretested interview schedule was administered to the participants by the investigators.
Both ears of each participant were checked with an otoscope to identify other causes of hearing impairment like wax impaction and foreign body impaction in the external auditory canal, and injury to the tympanic membrane was also assessed by an Otorhinolaryngologist.

After clinical examination, the tuning fork tests were done by the Otorhinolaryngologist with a 512 Hertz tuning fork. The tuning fork tests that were done are (i) Rinnie Test, (ii) Weber Test, and (iii) Absolute Bone Conduction Test. All the workers with decreased absolute bone conduction tests were subjected to pure tone audiometry. Pure tone audiometry was done the next day using a portable device in a quiet room, giving a minimum of 12 hours of quiet time from work to eliminate the effects of noise-induced temporary threshold shift. The average of the hearing threshold levels at 500 Hertz, 1000 Hertz, 2000 Hertz, and 3000 Hertz were calculated in both ears and the level of hearing loss was assessed.

The workplace's noise level was measured with a mini sound level meter (model METRAVI SL – 4010). The noise level was tabulated in various areas of the working place and the average was calculated.

Numbers and codes were assigned to each variable, data entry was done in an Excel spreadsheet. Data were then transformed into the SPSS (Statistical Package for Social Sciences) software. Descriptive statistics were used to present the data. Chi-square analysis was used to compare the baseline demographic variables. P-value < 0.05 was considered statistically significant.

RESULTS

Age distribution of workers

In this study majority of the workers (39.56%) belonged to the age group 36 to 45 years. None of the workers was below the age of 25 years and above the age of 65 years.

Sex-wise distribution of workers

Among the 867 workers, 75.10% were males while 24.9% were females.

Prevalence of noise-induced hearing loss

A typical noise-induced hearing loss is a sensory neural type involving injury to the inner ear. It is bilateral and symmetrical, usually affecting the higher frequencies (3k, 4k, or 6k Hertz) and then spreading to the lower frequencies (0.5k, 1k, or 2kHertz) (Hapsari, 2021). Noise Induced Hearing Loss is usually a high-frequency sensorineural hearing loss (SNHL). Sensorineural hearing loss usually occurs when the nerves transmitting sound to the brain are damaged because of trauma or disease. Hence based on the audiogram findings the workers with SNHL were termed to have noise-induced hearing loss.

Noise-induced hearing loss was assessed by pure tone audiometry

The workers with SNHL (revealed by tuning fork test, ABC), subjected to pure tone audiometry confirmed the prevalence of noise-induced hearing loss to be 32.1%.

Among the participants, most of the workers had mild sensorineural hearing loss (69.06%) **(Table 1)**.

Table 1:
Degree of sensorineural hearing loss

DEGREE OF HEARING LOSS	NUMBER OF WORKERS	PERCENTAGE %
Mild SNHL	192	69.06%
Moderate SNHL	63	22.67%
Moderately severe SNHL	12	4.31%
Severe SNHL	11	3.96%
Profound SNHL	0	0.0%
TOTAL	278	100%

Association between Age and Noise Induced Hearing Loss

As the age increased the prevalence of noise-induced hearing loss increased and the prevalence among different age groups differed significantly **(Table 2)**.

Table 2:
Relationship between age and noise-induced hearing loss

AGE IN YEARS	NOISE-INDUCED HEARING LOSS ABSENT	NOISE-INDUCED HEARING LOSS PRESENT	TOTAL
25 – 35	206(78.6%)	56(21.4%)	262(100%)
36 – 45	251(73.2%)	92(26.8%)	343(100%)
46 – 55	116(53.7%)	100(46.3%)	216(100%)
56 - 65	16(34.8%)	30(65.2%)	46(100%)
TOTAL	589(67.9%)	278(32.1%)	867(100%)
Chi square = 61.37	df = 3	p value < 0.001.	

Sex distribution in participants with noise-induced hearing loss

The prevalence of noise-induced hearing loss was more in males than in females and the difference was statistically significant **(p<0.05) (Table: 3)**.

Table 3:
Sex distribution in participants with noise-induced hearing loss

SEX	NOISE-INDUCED HEARING LOSS ABSENT	NOISE-INDUCED HEARING LOSS PRESENT	Total
Male	424(65.1%)	227(34.9%)	651(100%)
Female	165(76.4%)	51(23.6%)	216(100%)
Total	589(67.9%)	278(32.1%)	867(100%)
Chi square = 9.437	df = 1	p value is 0.002	

Relation between Literacy status and noise-induced hearing loss

There was no significant relationship between the Literacy status of the participants and hearing loss **(p>0.05) (Table 4)**.

Table 4:
Relation between Literacy status and noise-induced hearing loss

LITERACY STATUS	NOISE-INDUCED HEARING LOSS ABSENT	NOISE-INDUCED HEARING LOSS PRESENT	TOTAL
Illiterate	66(66.0%)	34(34.0%)	100(100%)
Primary school	139(61.8%)	86(38.2%)	225(100%)
Secondary school	318(70.0%)	136(30.0%)	454(100%)
College	66(75.0%)	22(25.0%)	88(100%)
Total	589(67.9%)	278(32.1%)	867(100%)
Chi square = 7.031	df = 3	p value is 0.071	

Duration of work and noise-induced hearing loss

In this study, the prevalence of noise-induced hearing loss was more among workers with work experience of more than 10 years which was statistically significant **(p<0.05)** (**Table 5)**.

Table 5:
Years of work and noise-induced hearing loss

YEARS OF WORK	NOISE-INDUCED HEARING LOSS ABSENT	NOISE-INDUCED HEARING LOSS PRESENT	TOTAL
≤ 10 YEARS	456(82.9%)	94(17.1%)	550(100%)
> 10 YEARS	133(42.0%)	184(58.0%)	317(100%)
TOTAL	589(67.9%)	278(32.1%)	867(100%)
Chi-square = 154.83	df = 1	p value < 0.001.	

Working all through the week

The prevalence of noise-induced hearing loss was more among workers working all through the week and was statistically significant **(p<0.05) (Table 6)**.

Table 6:
Days of work and hearing loss

DAYS OF WORK/WEEK	NOISE-INDUCED HEARING LOSS ABSENT	NOISE-INDUCED HEARING LOSS PRESENT	TOTAL
≤ 6 days	533(69.3%)	236(30.7%)	769(100%)
7 days	56(57.1%)	42(42.9%)	98(100%)
Total	589(67.9%)	278(32.1%)	867(100%)
Chi-square = 5.908	df = 1	p-value is 0.015	

Working more than 8 hours a day and noise-induced hearing loss

Increased hours of work were significantly associated with an increased prevalence of noise-induced hearing loss **(p<0.05) (Table 7)**.

Table 7:
Hours of work in a day and noise-induced hearing loss

HOURS OF WORK/DAY	NOISE-INDUCED HEARING LOSS ABSENT	NOISE-INDUCED HEARING LOSS PRESENT	TOTAL
≤ 8 HOURS	370(76.8%)	112(23.2%)	482(100%)
> 8 HOURS	219(56.9%)	166(43.1%)	385(100%)
TOTAL	589(67.9%)	278(32.1%)	867(100%)
Chi square = 38.834	df = 1	p value < 0.001	

Periodic ENT assessment and noise-induced hearing loss

The prevalence of noise-induced hearing loss did not show any significant relationship with periodic hearing assessment **(p>0.05)**.

Relationship between noise level in the workplace and noise-induced hearing loss

The prevalence of Noise Induced Hearing Loss was more in workers working at a noise level of more than 90 dB. It is statistically significant**(p<0.05) (Table 8)**.

Table 8:
Increased Noise levels in the workplace and noise-induced hearing loss

THE NOISE LEVEL IN THE WORKPLACE	NOISE-INDUCED HEARING LOSS ABSENT	NOISE-INDUCED HEARING LOSS PRESENT	TOTAL
91 dB and above	457(63.3%)	265(36.7%)	722(100%)
≤ 90 db	132(91.0%)	13(9.0%)	145(100%)
total	589(67.9%)	278(32.1%)	867(100%)
Chi-square =42.650	df = 1	p-value < 0.001	

Factors associated with noise-induced hearing loss

Increased duration of work and increased noise levels in the workplace were determined to be the most common factors associated with noise-induced hearing loss **(Table 9)**.

Table 9:
Factors Associated with Noise-Induced Hearing Loss

FACTORS CAUSING NOISE-INDUCED HEARING LOSS	PERCENTAGE % (N = 278)
More than 10 years of working	184(58.0%)
Working all through the week	42(42.9%)
Working more than 8 hours a day	166(43.1%)
Increased noise level of more than 90 decibels	265(36.7%)

DISCUSSION

Occupational hearing loss is a major problem in people working in industries, Armed forces, ships, aircraft, etc. (Lie et al., 2016). All the participants were between the age group of 25 years and 65 years. This proves the fact that child labor was not witnessed in any of the industries where this study was conducted. Adolescents, i.e., people 18 years and below cannot be enrolled in any hazardous occupation according to Child Labour (Prohibition and Regulation) Amendment Bill 2016 (Nandi & Dhatrak, 2008).

The female workforce is way lesser when compared with the males. This could be because males in India are mostly the breadwinners in the family.

In this study, the prevalence of hearing loss was 32.1%. In a study conducted in Tanzania by Abraham et al., the prevalence of noise-induced hearing loss among textile workers was 58.5% (Ologe et al., 2005). Another study by Caldart et al plots the prevalence of noise-induced hearing loss to be 28.3% (Owen, 1995). A study conducted by Ranga et al in India showed a 39% prevalence of occupational noise-induced hearing loss in industrial workers (Ranga, 2014). In a study by Imran Sheikh, Occupational noise-induced hearing loss among the local industrial population in Kashmir: a lifestyle study, the prevalence was calculated to be 31% which almost coincides with this study (Sheikh, 2018). Of the 32.1% suffering from noise-induced hearing loss, the majority had mild sensorineural hearing loss.

Noise-induced hearing loss was seen more in the age group of 56 yrs-65yrs followed by 46yrs- 55 yrs. This proves that as age progresses the chance of getting noise-induced hearing loss when exposed to a noisy environment also increases. This was also seen in the study conducted by (Ologe et al., 2005) and (Ranga, 2014).

Noise-induced hearing loss was seen more in males when compared to female workers which could be to the fact that the male participants are way higher than the females.
There was no significant association between the Literacy status of the participants and hearing loss. Hence awareness must be given to both literates and illiterates alike. Every worker in the industry must be periodically exposed to health education about the hazards of noise-induced hearing loss.

People working more than ten years in a noisy environment had more prevalence of noise-induced hearing loss. The same was interpreted in other studies (Ologe et al., 2005; Ranga, 2014).

Another factor that leads to noise-induced hearing loss is working more than 6 days a week and more than 8 hours a day. The same was observed in other studies conducted in Bangladesh and Turkey (Sheikh, 2018 & Stucken, 2014).

This study demonstrated no relationship between periodic ENT assessment and noise-induced hearing loss. This could be because only 7 participants went for an ENT check and they were not suffering from noise-induced hearing loss. It is a well-known fact that undergoing regular ENT screening in such situations is mandatory. But very few participants opted to get their hearing screened in this study. The same has been reported internationally in various studies that though there is awareness about Noise-induced hearing loss and the availability of methods of prevention only a few opt for them (Arquivosdeorl (n.d.); Zare, 2017).

This study shows that there is a relationship between increased exposure to sound levels of more than 90 decibels and noise-induced hearing loss. A study conducted by Ghotbi, M. (Hearing loss among Fasa sugar factory workers,

Fars Province, Iran) adds more light to this finding (Zare et al., 2017).

This study shows that chronic exposure to loud sounds, working more than 8 hours a day in a noisy environment, working more than 6 days a week, and exposure to increased noise levels of more than 90 decibels are the factors leading to noise Induced hearing loss.

CONCLUSIONS

Noise Induced hearing loss is very common in workers working in mills. Adopting the protective measures provided and having regular hearing assessments to prevent hearing loss is better. Prevention is always better than cure.

RECOMMENDATIONS

The measures that could be taken to prevent such hearing loss can be

1. Practical hearing conservation programs
2. Strict rules for workers to use protective equipment
3. Regular training and observing the use of protective gear provided
4. Periodic otologic screening for all workers
5. Regular work rotation
6. Regular rest from work depending on the level of sound exposure

Acknowledgment: The authors would like to acknowledge the interns who participated in the study for their help and consideration.

Ethical Approval: Clearance was obtained from the KVIMS Institutional Ethical Committee and permission to conduct the study was obtained from the owners of the corresponding industries.

Conflicts of Interest: None declared.

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