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Burden of Noise-Induced Hearing Loss in the Small-Scale Industrial Worker

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Abstract

Background: Noise-induced hearing loss (NIHL) remains a major occupational health concern, especially among workers in unregulated small-scale industrial settings. Prolonged exposure to loud machinery noise without adequate protective measures significantly increases the risk of hearing impairment. This study aimed to determine the prevalence of NIHL and identify related risk factors among workers in small-scale industries in Trichy.

Methods: A cross-sectional community-based study was carried out among 200 employees working for at least one year in weaving units, sawmills, printing presses, and lathe workshops. Participants were chosen through convenience sampling. Data were gathered using a pre-validated structured questionnaire, followed by ear examinations, tuning fork tests, and pure tone audiometry. Workplace noise levels were recorded using a sound level meter. Statistical analysis was done using SPSS version 26.0, applying chi-square tests to identify significant associations. A p-value below 0.05 was considered statistically significant.

Results: The study revealed an 18% prevalence of hearing loss. Significant associations were noted between hearing loss and working more than 8 hours per day ($p = 0.018$), and among workers aged 45 years or older ($p = 0.009$). Only 2% of participants used hearing protection. Frequently reported symptoms included headaches (15%), ear pain (12%), and tinnitus (9%). No statistically significant correlation was found between hearing loss and use of protective devices ($p = 1.000$), likely due to the very limited usage.

Conclusion: This study highlights a notable burden of occupational hearing loss among small-scale industry workers in Trichy. Extended work hours and increasing age emerged as major contributors. The extremely low use of hearing protection indicates an urgent need for awareness campaigns, routine hearing checks, and stricter enforcement of workplace safety norms to mitigate long-term auditory damage in this at-risk population.

Keywords: Noise-induced hearing loss, occupational noise exposure, small-scale industries, hearing protection

Introduction

Noise-Induced Hearing Loss (NIHL) remains a prominent occupational hazard worldwide, particularly affecting individuals working in environments with high levels of continuous or intermittent noise exposure [1]. Among these vulnerable groups, small-scale industrial workers are notably at risk due to poor occupational safety measures, limited awareness, and inadequate implementation of preventive strategies [2]. NIHL typically results from prolonged exposure to sound levels above 85 decibels (dB), leading to irreversible damage to the hair cells [3,4].

In many low- and middle-income countries, including India, small-scale industries play a major role in the economy and employ millions [5,6]. However, these sectors are often overlooked in terms of occupational

health surveillance. Workers in textile manufacturing, metal works, sawmills, construction, and weaving factories are frequently subjected to hazardous noise without proper protective equipment or regular hearing assessments [7-10]. The lack of structured occupational health policies in small-scale industries further exacerbates the risk [11].

Several regional and international studies have highlighted the alarming prevalence of NIHL in industrial environments. In Puducherry, India, a study among construction workers revealed a 13.2% prevalence of NIHL, with the most affected individuals being those with longer job durations and no use of ear protection [12,13,14]. A similar pattern was noted in West Bengal among textile workers, where noise levels exceeded 100 dB and contributed significantly to hearing threshold shifts [15,16]. Furthermore, studies from other countries mirror these findings. Research in Malaysia found that 42.7% of palm oil mill workers suffered from NIHL, while in Ethiopia, over 20% of industrial workers in metal and woodworking industries reported symptoms consistent with hearing impairment [17,18].

The public health burden of NIHL is not limited to hearing disability alone. Affected individuals often face reduced productivity, impaired communication, and diminished quality of life. Moreover, the economic implications include increased healthcare costs and loss of skilled labour due to premature disability [19]. Despite this, NIHL is largely preventable. Regular auditory screening, proper use of protection devices (HPDs), and enforcement of noise regulation standards can significantly reduce its prevalence [20].

Unfortunately, the importance of hearing conservation remains low among small-scale industrial workers. Many workers are unaware that hearing damage may occur gradually and may not be immediately noticeable. Additionally, informal employment arrangements in these sectors often exclude workers from routine health checks or compensation for occupational illnesses [21,22].

Given this context, assessing the burden of NIHL in small-scale industries. A systematic evaluation of noise exposure levels, prevalence of hearing loss, and existing protective practices among these workers will aid in strengthening occupational health policies and promoting safer work environments.

Materials & Methods

This community-based cross-sectional study was conducted to assess the burden of noise-induced hearing loss (NIHL) among workers employed in small-scale industries in Trichy. The study population included both male and female workers who had been employed for at least one year in weaving units, sawmills, printing presses, and lathe industries. These industries were selected based on their prevalence and noise-generating potential.

The inclusion criteria for participation were workers aged 18 years and above with a minimum of one year of continuous employment in the selected industries and a willingness to participate after informed consent. Exclusion criteria included those with documented hearing loss before joining their current job, workers with other known causes of hearing loss such as cerumen impaction, chronic suppurative otitis media (CSOM), tympanic membrane abnormalities, or those unwilling to participate in the study.

The study was conducted between June 2023 and August 2024. Although an initial sample size of 786 was calculated based on a reported NIHL prevalence of 33.7% (Ruikar MM et al., Government Medical College, Nagpur), a final sample size of 200 was chosen for practicality and feasibility. Industries that permitted access for the study were first identified and enlisted. From these, eligible participants were selected using a convenience sampling method. Proportional representation was ensured, with a greater number of workers recruited from weaving units due to their higher density in the area.

Data collection was carried out using a structured and pretested interview schedule. The tool gathered sociodemographic information, work-related history such as type of industry, years of employment,

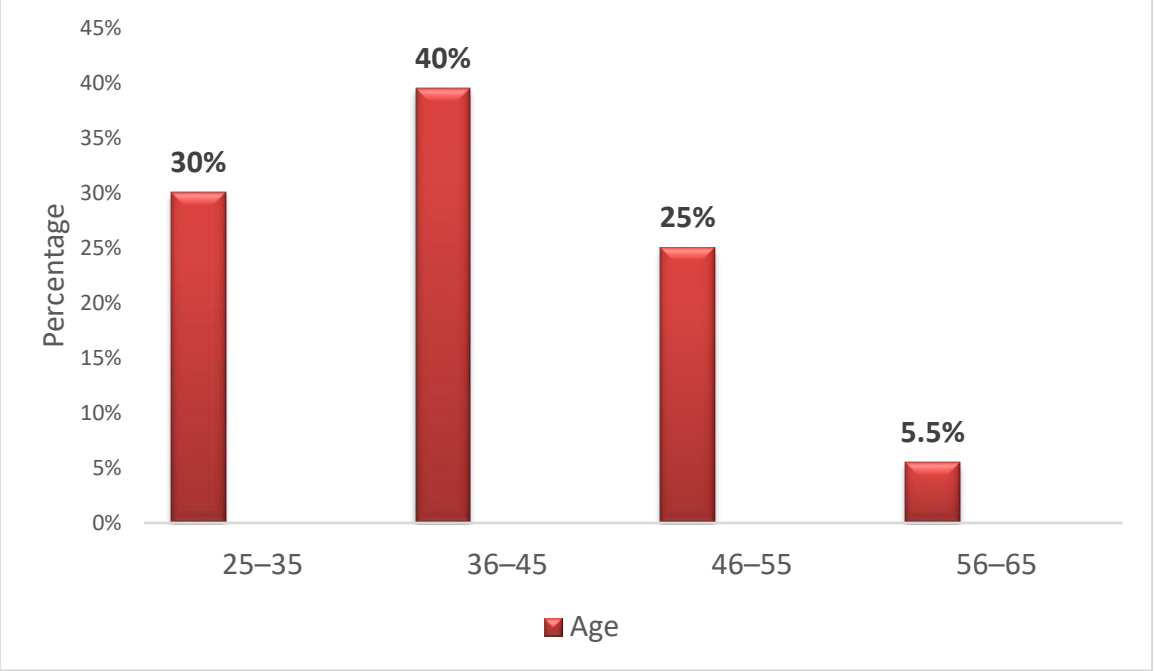
working hours per day, and use of hearing protective devices. It also included questions regarding symptoms of hearing loss, family history of hearing problems, and previous assessments for hearing impairment. The tool was validated through expert review and modified after a pilot study with 20 workers to ensure clarity and relevance.

All study participants underwent a clinical ear examination performed by a qualified ENT specialist using an otoscope to rule out external and middle ear pathologies. This was followed by tuning fork tests (Rinne, Weber, and Absolute Bone Conduction) using a 512 Hz tuning fork. Workers with suspected hearing impairment based on these tests were referred for pure tone audiometry (PTA), which was conducted using the TRIVENI TAM–25 audiometer at a certified hearing aid center in Trichy. Audiometric testing was done 16 hours after cessation of noise exposure to eliminate temporary threshold shifts. Hearing thresholds were assessed at 500 Hz, 1000 Hz, 2000 Hz, and 3000 Hz, and the average threshold level was used to determine the degree of hearing loss.

In addition, noise levels in the various industrial workplaces were measured using the METRAVI SL– 4010 mini sound level meters. Multiple readings were taken at each location during regular working hours, and the average noise level was recorded. The collected data were compiled using Microsoft Excel and subsequently analyzed with SPSS software version 26.0. Descriptive statistics were employed to present the data summaries, while chi-square tests were utilized to assess relationships between variables. A p-value below 0.05 was regarded as indicative of statistical significance.

Results

Figure 1: Age Distribution of Workers (n = 200)



The majority of workers were in the 36 to 45-year age group, followed by those aged 25–35. Workers above 55 years made up a small proportion of the workforce.

Table 1: Sex Distribution of Workers

Sex	Adjusted Count	Percentage
Male	150	75.0%
Female	50	25.0%

The workforce was predominantly male, reflecting gender patterns in small-scale industrial employment.

Table 2: Literacy Status of Workers

Literacy Level	Adjusted Count	Percentage
Illiterate	23	11.5%
Primary school	52	26.0%
Secondary school	105	52.5%
College	20	10.0%

The majority of participants (52.5%) had a secondary school education, followed by 26% with primary school education. Only 10% had attended college, while 11.5% were illiterate. This shows that most individuals had basic to moderate levels of education.

Table 3: Work Hours per Day

Work Hours	Adjusted Count	Percentage
≤ 8 Hours	111	55.5%
> 8 Hours	89	44.5%

A significant portion of the workers (almost 45%) were working for more than 8 hours per day, possibly increasing their exposure risk.

Table 4: Symptoms Related to Hearing and Noise Exposure

Symptom	Adjusted Count	Percentage
Headache	30	15.0%
Ear pain	24	12.0%
Tinnitus	18	9.0%
Giddiness	3	1.5%
Pain and headache	3	1.5%
Pain & tinnitus	2	1.0%
Giddiness & headache	2	1.0%
Pain & giddiness	0	0.0%

The most common symptom was headache (15%), followed by ear pain (12%) and tinnitus (9%). Less frequent symptoms included combinations such as pain and headache (1.5%), pain & tinnitus (1%), and giddiness & headache (1%). Giddiness alone was reported by 1.5% of participants, and no cases of combined pain & giddiness were observed.

Table 5: Use of Protective Hearing Devices

Use of Protective Devices	Adjusted Count	Percentage
Yes	4	2.0%
No	196	98.0%

Only a very small proportion of workers used hearing protection, pointing to poor awareness or accessibility to protective measures.

Table 6: Association Between Work Hours and Hearing Loss

Work Hours	Hearing Loss (Yes)	Hearing Loss (No)	p-value
≤ 8 Hours	11	100	0.018
> 8 Hours	25	64	
Total	36	164	

There was a statistically significant association between longer work hours (>8 hours) and the prevalence of hearing loss ($p < 0.05$).

Table 7: Association Between Age Group and Hearing Loss

Age Group	Hearing Loss (Yes)	Hearing Loss (No)	p-value

< 45 Years	18	121	0.009
≥ 45 Years	18	43	
Total	36	164	

Hearing loss was significantly higher among workers aged 45 years and above ($p < 0.01$), indicating age-related vulnerability to occupational noise exposure.

Table 8: Association Between Use of Protective Devices and Hearing Loss

Use of Protective Device	Hearing Loss (Yes)	Hearing Loss (No)	p-value
Yes	1	3	1.000
No	35	161	
Total	36	164	

There was no significant association between the use of protective devices and hearing loss in this sample. However, the extremely low usage of protection (only 4 individuals) may limit the validity of this comparison.

Discussion

This study assessed the prevalence and risk factors associated with noise-induced hearing loss (NIHL) among 200 small-scale industrial workers employed in weaving units, sawmills, printing presses, and lathe workshops in and around Kanchipuram. The findings demonstrate a significant occupational health burden, with 18% of the workers showing evidence of hearing loss, a pattern that aligns with global occupational health concerns in unregulated work environments.

The proportion of workers affected by NIHL in this study is comparable to that reported by Rahman et al [23] in a study conducted among palm oil mill workers in Malaysia, where the prevalence was found to be 17.8%. Similarly, Sinha et al [24] documented a prevalence of 13.2% among construction workers in Puducherry, India, indicating a consistent trend of hearing impairment in noisy occupational settings, especially where hearing conservation programs are absent or poorly enforced.

A notable correlation was identified between extended working hours and the presence of hearing loss ($p = 0.018$). This aligns with findings from Mirza et al [25], who demonstrated that exposure to industrial noise for more than eight hours daily significantly elevated the risk of hearing impairment. In the current study, 44.5% of workers reported daily work durations exceeding eight hours, potentially amplifying their overall noise exposure and associated health risks.

Age also played a critical role in the development of hearing loss. Workers aged 45 years and above had significantly higher rates of NIHL ($p = 0.009$), which supports findings by Mlynski et al [26] in Tanzanian iron and steel workers, where age and duration of exposure were key determinants of auditory impairment. This relationship could be attributed to age-related cochlear degeneration in combination with chronic occupational exposure.

Interestingly, although the use of hearing protection was extremely limited—only 2% of workers reported using any form of protective device—there was no statistically significant difference in hearing loss between users and non-users ($p = 1.000$). This result, while unexpected, is likely due to the small number of workers using protection, which restricts the power of the analysis. A study in Ethiopia by Mulatu et al [27] also highlighted low compliance with hearing protection among industrial workers, attributing it to lack of awareness, discomfort, and limited access.

The presence of symptoms such as headache, ear pain, and tinnitus in a considerable number of participants further underscores the health impact of occupational noise exposure. Similar patterns were observed by Thapa et al [28] in Nepalese woodworkers, where tinnitus and headache were among the most frequently reported symptoms.

Overall, our findings reflect the need for stronger enforcement of occupational safety measures, including mandatory use of hearing protective devices, periodic auditory screening, and health education. Special attention must be given to workers in unorganized sectors who are often neglected in policy interventions. Future research should also explore longitudinal outcomes to better understand the progression of NIHL and the effectiveness of preventive strategies.

Conclusion

This study found that 18% of small-scale industrial workers in had noise-induced hearing loss (NIHL). Significant associations were observed between NIHL and longer work hours, as well as older age, indicating the cumulative effect of noise exposure over time. These findings highlight the urgent need for regular hearing assessments, mandatory use of protective devices, and stronger enforcement of occupational safety measures to prevent NIHL in vulnerable industrial populations.

Conflict of Interest: Nil

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