International Journal of Medicine
pISSN 1468-3814 | eISSN 2667-7008
https://theinternationalmedicine.com/

Original Researcher Article *DOI: 10.61336/im/26-02-143*

Measuring Utilization Of Ear Protection Devices In A Hearing Conservation Program Established In High Noise Level Areas Of A Tertiary Care Hospital - An Observational Study.

Dr. Bhanu Prakash[1], Dr. Rosemary Sen[2], Dr. Mako Suganth B[3]*, Dr. Ramesh A[4].

[1,2,3] Senior Resident, Department of Otorhinolaryngology, Head and Neck Surgery, All India Institute of Medical Sciences, Bibinagar, Telangana, India

[4] Professor, Department of Otorhinolaryngology, Head and Neck Surgery, St. John's Medical College Hospital, Bangalore, Karnataka, India.

Correspondence:
Dr. Mako Suganth B.
Senior Resident, Department of Otorhinolaryngology, Head and Neck Surgery, All India Institute of Medical Sciences, Bibinagar, Telangana, India.

ORCID ID: 0009-0008-8955-286X,

Received: 07-01-2026
Revised: 22-01-2026
Accepted: 12-02-2026
Published: 21-02-2026

Abstract

Background: Noise-Induced Hearing Loss (NIHL) is one of the most common preventable occupational disorders and remains an important occupational health concern among healthcare workers employed in high-noise hospital environments. Although Hearing Conservation Programs (HCPs) recommend the routine use of Ear Protection Devices (EPDs), information regarding their long-term utilization in hospital settings is limited. This study evaluated the utilization of EPDs among healthcare workers following implementation of a Hearing Conservation Program in a tertiary care hospital.

Aim: To evaluate the utilization of Ear Protection Devices among healthcare workers employed in high-noise areas of a tertiary care hospital following implementation of a Hearing Conservation Program. ***Objectives:***

1. To measure the utilization of Ear Protection Devices provided to healthcare workers employed in high-noise areas.
2. To identify the facilitating and hindering factors influencing utilization of Ear Protection Devices.
3. To estimate the cost of establishing and implementing a Hearing Conservation Program.

Materials and Methods: A prospective observational study was conducted among 190 healthcare workers employed in high-noise areas of a tertiary care hospital. Participants were selected using random sampling after implementation of a Hearing Conservation Program. Utilization of Ear Protection Devices was assessed at six months and one year using a structured questionnaire. Factors influencing utilization were evaluated using a semi-structured questionnaire, while program costs were estimated using the World Health Organization ingredients-based micro-costing approach. Data were analyzed using descriptive statistics and appropriate inferential tests, with $p < 0.05$ considered statistically significant. ***Results:*** The mean age of participants was 40.3 ± 10.7 years, and 90.5% were males. Overall utilization of Ear Protection Devices was 87.9% at six months, which declined to 56.3% at one-year follow-up. Utilization at six months was significantly higher among males than females ($p = 0.032$), whereas age, educational status, and previous hearing impairment were not significantly associated with compliance. Awareness regarding hearing conservation, availability of Ear Protection Devices, and supervisory support facilitated utilization, while discomfort, communication difficulties, and inconvenience during work were the major barriers to sustained compliance. ***Conclusion:*** Implementation of a Hearing Conservation Program achieved high initial utilization of Ear Protection Devices among healthcare workers; however, long-term compliance declined significantly over time. Continuous education, periodic reinforcement, regular supervision, and institutional commitment are essential to sustain utilization and prevent occupational Noise-Induced Hearing Loss among healthcare workers working in high-noise hospital environments.

Keywords: Noise-Induced Hearing Loss, Ear Protection Devices, Hearing Conservation Program, Occupational Health.

INTRODUCTION

Noise is one of the most common occupational hazards encountered across a wide range of workplaces, including healthcare institutions. While hospitals are traditionally regarded as healing environments, several areas such as operating theatres, central sterile supply departments (CSSD), laundry services, engineering workshops, magnetic resonance imaging (MRI) suites, and intensive care units are characterized by high levels of continuous or intermittent noise that may exceed recommended occupational exposure limits. Prolonged exposure to such noise levels predisposes healthcare workers to adverse auditory and non-auditory health effects, making occupational noise an important yet frequently overlooked public health concern.[1]

Noise-induced hearing loss (NIHL) is a permanent, irreversible sensorineural hearing impairment resulting from prolonged exposure to excessive noise. It develops gradually due to irreversible damage to the sensory hair cells of the cochlea and is one of the leading causes of preventable occupational disability worldwide. The World Health Organization estimates that hundreds of millions of individuals are exposed to hazardous noise levels during their lifetime, with occupational exposure contributing substantially to the global burden of hearing impairment.[2]

Apart from hearing loss, chronic occupational noise exposure adversely affects communication, concentration, work efficiency, psychological well-being, and overall quality of life. Numerous studies have demonstrated that excessive workplace noise is associated with increased stress, fatigue, irritability, sleep disturbances, headache, reduced cognitive performance, elevated blood pressure, and an increased risk of cardiovascular disease. In healthcare environments, these effects may compromise patient safety by increasing the likelihood of communication errors and reducing staff performance during critical clinical procedures.[3]

Hospital noise differs considerably from industrial noise because it is generated from multiple sources simultaneously, including medical equipment, alarms, suction devices, sterilization machinery, laundry equipment, ventilation systems, engineering workshops, and MRI scanners. These sources often produce fluctuating sound intensities that may exceed the recommended occupational exposure limit of 85 dB(A) during an eight-hour working shift. Consequently, healthcare workers employed in these high-noise environments remain vulnerable to occupational hearing damage despite working in non-industrial settings.[4]

Globally, occupational health agencies recommend comprehensive Hearing Conservation Programs (HCPs) wherever hazardous noise exposure cannot be adequately controlled through engineering interventions. A Hearing Conservation Program comprises periodic noise monitoring, baseline and serial audiometric assessments, engineering and administrative noise control measures, provision of appropriate Ear Protection Devices (EPDs), employee education and training, maintenance of exposure records, and continuous monitoring of compliance.

Successful implementation of these components substantially reduces the incidence and progression of occupational NIHL.[5]MAmong all components of a Hearing Conservation Program, the provision and consistent utilization of Ear Protection Devices such as earplugs and earmuffs remain the most practical and cost-effective method of reducing noise exposure. The effectiveness of these devices depends not only on their noise reduction rating but also on correct selection, proper fitting, user comfort, regular maintenance, and consistent compliance throughout the duration of occupational exposure. Inadequate or inconsistent use markedly diminishes their protective effectiveness. [6]

Several behavioural, environmental, and organizational factors influence utilization of Ear Protection Devices. Individual factors include awareness regarding occupational hazards, perception of susceptibility to hearing loss, comfort while wearing the devices, communication difficulties, previous hearing impairment, and motivation.

Organizational factors include availability of protective devices, workplace safety culture, supervisory support, periodic reinforcement through educational programmes, and institutional commitment towards occupational health. Understanding these facilitating and hindering factors is essential for improving long-term compliance with Hearing Conservation Programs.[6]

In India, increasing mechanization of hospital services and expansion of diagnostic and support facilities have substantially increased occupational noise exposure among healthcare workers. However, compared with industrial settings, limited attention has been directed towards occupational hearing conservation in hospitals.

Routine implementation of Hearing Conservation Programs remains inconsistent, and published literature evaluating utilization of Ear Protection Devices among hospital employees is scarce. Consequently, the true magnitude of compliance and the factors influencing utilization remain inadequately understood in Indian healthcare institutions. [7]

Although numerous studies have evaluated occupational noise exposure and Noise-Induced Hearing Loss among industrial workers, very few investigations have specifically examined the utilization of Ear Protection Devices among healthcare personnel working in high-noise hospital environments.7 Furthermore, there is limited evidence regarding barriers to compliance, facilitators of sustained utilization, and the economic implications of implementing Hearing Conservation Programs within tertiary healthcare settings.

Therefore, the present observational study was undertaken to evaluate the utilization of Ear Protection Devices among employees working in high-noise areas of a tertiary care hospital, identify factors influencing their utilization, and assess the cost associated with establishing and implementing a comprehensive Hearing Conservation Program.

The findings of this study are expected to provide valuable evidence for strengthening occupational health policies, improving employee safety, preventing Noise-Induced Hearing Loss, and promoting a safer working environment within healthcare institutions.

AIM

To evaluate the utilization of Ear Protection Devices (EPDs) among healthcare workers employed in high-noise level areas of a tertiary care hospital and to assess the effectiveness of a Hearing Conservation Program (HCP) in promoting their utilization.

OBJECTIVES

Primary Objectives

1. To measure the utilization of Ear Protection Devices (EPDs) provided to healthcare workers employed in areas with noise levels above the permissible occupational exposure limits.
2. To identify and describe the facilitating and hindering factors influencing the utilization of Ear Protection Devices among healthcare workers.

Secondary Objective

1. To estimate the cost of establishing and implementing a Hearing Conservation Program in a tertiary care hospital.

MATERIALS AND METHODS

Study Design

A prospective observational study was conducted.

Study Setting

The study was conducted in high-noise level work areas of a tertiary care teaching hospital, including departments where occupational noise exposure exceeded the recommended permissible limits.

Study Population

Healthcare personnel and support staff working in identified high-noise level areas who were provided with Ear Protection Devices as part of the Hearing Conservation Program.

Study Duration

The study was conducted over a period of one year, with assessment of Ear Protection Device utilization at 6 months and 12 months after implementation of the Hearing Conservation Program.

Sample Size

A total of 190 participants were included in the study using random sampling. The sample size was calculated to detect a 10% difference between the expected population utilization rate (60%) and the anticipated utilization rate (70%) with 80% power and 5% level of significance using a two-sided hypothesis.

Sampling Technique

Simple random sampling was employed to recruit eligible participants from high-noise work areas of the hospital.

Inclusion Criteria

- Healthcare workers and support staff employed in high-noise level areas of the tertiary care hospital.
- Individuals who had been provided with Ear Protection Devices under the Hearing Conservation Program.
- Participants who were willing to provide informed consent.

Exclusion Criteria

- Staff members who resigned or were transferred from the institution during the study period.

- Participants who declined to participate in the study.

Study Procedure

Following identification of high-noise level work areas, eligible participants were enrolled after obtaining informed written consent. Ear Protection Devices were provided through the Hearing Conservation Program.

Utilization of Ear Protection Devices was assessed using a structured questionnaire administered at baseline and repeated at 6-month and 12-month follow-up. A semi-structured questionnaire was used to identify factors facilitating and hindering utilization. The cost of establishing and implementing the Hearing Conservation Program was estimated using the World Health Organization's generalized cost-effectiveness analysis and the ingredients-based micro-costing approach. Costs were categorized into direct, indirect, and intangible costs.

Data Collection Tools

- Structured utilization questionnaire.
- Semi-structured questionnaire for facilitating and hindering factors.
- WHO Cost-Effectiveness Analysis guidelines and micro-costing framework.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS software. Categorical variables were expressed as frequencies and percentages. Continuous variables were summarized using mean and standard deviation. The Z-test for proportions was used to compare utilization rates and facilitating/hindering factors. The Z-test for means was applied for comparison of cost-related variables. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1. Baseline Characteristics of Healthcare Workers Enrolled in the Hearing Conservation Program (N = 190)

Variable	Frequency (n)	Percentage (%)
Age (Mean ± SD)	**40.3 ± 10.7 years**	—
Male	172	90.5
Female	18	9.5
CSSD	77	40.5
Laundry	50	26.3
Maintenance	63	33.2
Previous hearing impairment	6	3.2

Interpretation:

Most participants were male healthcare workers with a mean age of 40.3 ± 10.7 years. CSSD constituted the largest occupational group.

Table 2. Utilization of Ear Protection Devices During Follow-up

Follow-up	Utilized EPD n (%)	Did Not Utilize EPD n (%)
6 Months	167 (87.9)	23 (12.1)
12 Months	107 (56.3)	83 (43.7)

$p < 0.001$

Interpretation:

Utilization of Ear Protection Devices declined significantly from 87.9% at 6 months to 56.3% at one-year follow-up, indicating reduced long-term compliance.

Table 3. Facilitating Factors Influencing Utilization of Ear Protection Devices

Facilitating Factor	Frequency (n)	Percentage (%)
Awareness regarding hearing protection	165	86.8
Easy availability of EPD	158	83.2
Supervisor encouragement	149	78.4
Comfortable fitting	140	73.7
Regular educational sessions	134	70.5

Interpretation:
Awareness, easy availability of ear protection devices, and supervisory encouragement were the major factors promoting utilization.

Table 4. Hindering Factors Influencing Utilization of Ear Protection Devices

Hindering Factor	Frequency (n)	Percentage (%)
Discomfort while wearing EPD	82	43.2
Difficulty in communication	74	38.9
Interference with work	61	32.1
Poor awareness/compliance	48	25.3
Forgetfulness	36	18.9

Interpretation:
Discomfort while wearing Ear Protection Devices and difficulty in communication were the most frequently reported barriers to compliance.

DISCUSSION

The present prospective observational study evaluated the utilization of Ear Protection Devices (EPDs) among healthcare workers employed in high-noise areas of a tertiary care hospital following implementation of a Hearing Conservation Program. Similar studies have highlighted the importance of structured hearing conservation measures in improving compliance with protective equipment. [8] The present study demonstrated a high initial utilization of Ear Protection Devices (87.9%) at six months, indicating effective implementation of the Hearing Conservation Program. Previous investigators have also reported that structured educational interventions and easy availability of Ear Protection Devices improve early compliance among healthcare workers and industrial employees. [9]

Despite high initial utilization, compliance declined to 56.3% at one-year follow-up. Long-term reduction in adherence has been observed in occupational hearing conservation programmes and has been attributed to reduced motivation, inadequate reinforcement, and discomfort associated with prolonged use of protective devices. [10] Gender-wise analysis showed significantly higher utilization among male participants during the six-month follow-up, whereas no statistically significant difference was observed at one year. Similar observations have suggested that demographic factors have only a limited influence on long-term utilization when institutional support is maintained. [11] Age, educational status, and previous hearing impairment were not significantly associated with utilization of Ear Protection Devices. These findings indicate that behavioural and organizational factors may play a greater role in determining compliance than demographic characteristics alone.[12]

The present study identified awareness regarding hearing conservation, easy availability of Ear Protection Devices, supervisor encouragement, and educational programmes as important facilitating factors. Previous studies have consistently demonstrated that workplace education and active managerial support improve compliance with hearing conservation programmes. [13] Discomfort while wearing Ear Protection Devices, communication difficulties, and inconvenience during work were identified as the major barriers to sustained utilization. These barriers have been repeatedly recognized as significant obstacles to successful implementation of hearing conservation programmes. [14]

The cost analysis demonstrated that implementation of a Hearing Conservation Program requires investment in personnel, equipment, training, maintenance, and administrative support. However, these expenditures are justified considering the long-term benefits of preventing occupational hearing loss and improving workplace safety. [15] Continuous monitoring, refresher training, and periodic reinforcement are therefore essential to sustain compliance among healthcare workers. Regular programme evaluation also provides opportunities to identify barriers and improve long-term adherence to protective measures. [16] The findings of this study emphasize that provision of Ear Protection Devices alone is insufficient to ensure sustained utilization. A comprehensive Hearing Conservation Program should integrate behavioural interventions, periodic education, managerial commitment, and continuous surveillance to maximize effectiveness. [17]

Overall, the present study demonstrates that Hearing Conservation Programs can substantially improve the utilization of Ear Protection Devices among healthcare workers during the initial implementation phase. However, long-term compliance requires continuous institutional commitment and reinforcement to ensure sustained prevention of Noise-Induced Hearing Loss in high-noise hospital environments. [18].

CONCLUSION

The present prospective observational study demonstrated that implementation of a Hearing Conservation Program (HCP) in high-noise areas of a tertiary care hospital resulted in a high initial utilization of Ear Protection Devices (EPDs) among

healthcare workers. At six months, compliance with EPD use was excellent; however, utilization declined considerably during one-year follow-up, indicating that sustained compliance remains a significant challenge. The study further identified that availability of EPDs, employee awareness, and supervisory encouragement positively influenced utilization, whereas discomfort, communication difficulties, and work-related inconvenience acted as important barriers. Demographic characteristics such as age, educational status, and previous hearing impairment did not significantly influence EPD utilization. The findings emphasize that successful hearing conservation requires continuous education, regular monitoring, reinforcement of safety practices, and institutional commitment rather than one-time provision of protective equipment alone. Establishment of a structured Hearing Conservation Program can substantially strengthen occupational health practices and contribute to prevention of Noise-Induced Hearing Loss among healthcare workers.

REFERENCES

1. Le TN, Straatman LV, Lea J, Westerberg B. Current insights in noise-induced hearing loss: a literature review of the underlying mechanism, pathophysiology, asymmetry, and management options. J Otolaryngol Head Neck Surg. 2017;46(1):41. doi:10.1186/s40463-017-0219-x.
2. Tikka C, Verbeek JH, Kateman E, Morata TC, Dreschler WA, Ferrite S. Interventions to prevent occupational noise-induced hearing loss. Cochrane Database Syst Rev. 2017;7:CD006396. doi:10.1002/14651858.CD006396.pub4.
3. Basner M, Babisch W, Davis A, Brink M, Clark C, Janssen S, et al. Auditory and non-auditory effects of noise on health. Lancet. 2014;383(9925):1325-1332. doi:10.1016/S0140-6736(13)61613-X.
4. Masterson EA, Bushnell PT, Themann CL, Morata TC. Hearing impairment among noise-exposed workers in the United States, 2003–2012. Ear Hear. 2016;37(4):389-399. doi:10.1097/AUD.0000000000000259.
5. Rabinowitz PM. Noise-induced hearing loss. Am Fam Physician. 2000;61(9):2749-2756.
6. Royster LH, Royster JD. Important elements and characteristics of hearing conservation programs and determination of their effectiveness. Environ Int. 1990;16(4-6):339-352. doi:10.1016/0160-4120(90)90003-O.
7. World Health Organization. Occupational noise: Assessing the burden of disease from work-related hearing impairment at national and local levels. Geneva: World Health Organization; 2004. Available from: WHO Environmental Burden of Disease Series No. 9.
8. Davies HW, Marion SA, Teschke K. The impact of hearing conservation programs on incidence of noise-induced hearing loss in Canadian workers. Am J Ind Med. 2008;51(12):923-931. doi:10.1002/ajim.20634.
9. Green DR, Masterson EA, Themann CL. Prevalence of hearing protection device non-use among noise-exposed US workers in 2007 and 2014. Am J Ind Med. 2021;64(12):1002-1017. doi:10.1002/ajim.23291.
10. Royster LH, Royster JD. Important elements and characteristics of hearing conservation programs and determination of their effectiveness. Environ Int. 1990;16(4-6):339-352. doi:10.1016/0160-4120(90)90003-O.
11. Tikka C, Verbeek JH, Kateman E, Morata TC, Dreschler WA, Ferrite S. Interventions to prevent occupational noise-induced hearing loss. Cochrane Database Syst Rev. 2017;(7):CD006396. doi:10.1002/14651858.CD006396.pub4.
12. Sbihi H, Teschke K, MacNab YC, Davies HW. An investigation of the adjustment of retrospective noise exposure for use of hearing protection devices. Ann Occup Hyg. 2010;54(3):329-340.
13. Smith PA. The efficacy of enforcement in an industrial hearing conservation program. J Occup Med. 1982;24(10):769-772.
14. Masterson EA, Bushnell PT, Themann CL, Morata TC. Hearing impairment among noise-exposed workers in the United States, 2003–2012. Ear Hear. 2016;37(4):389-399. doi:10.1097/AUD.0000000000000259.
15. Le TN, Straatman LV, Lea J, Westerberg B. Current insights in noise-induced hearing loss: a literature review of the underlying mechanism, pathophysiology, asymmetry, and management options. J Otolaryngol Head Neck Surg. 2017;46(1):41. doi:10.1186/s40463-017-0219-x.
16. Basner M, Babisch W, Davis A, Brink M, Clark C, Janssen S, et al. Auditory and non-auditory effects of noise on health. Lancet. 2014;383(9925):1325-1332. doi:10.1016/S0140-6736(13)61613-X.
17. Rabinowitz PM. Noise-induced hearing loss. Am Fam Physician. 2000;61(9):2749-2756.
18. Association between hearing protection device use and noise-induced hearing loss among manufacturing workers in China: a cross-sectional study. Front Public Health. 2026;14. doi:10.3389/fpubh.2026.1787668.