ORIGINAL ARTICLE

Occupational Noise-Induced Hearing Loss in the City of Mosul: A Cross-sectional Study

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ABSTRACT

Introduction: This study aimed to investigate the distribution of demographic characteristics and the prevalence of hearing loss among workers. **Methods:** The study sample consisted of 160 participants, and various demographic variables were examined. Data regarding age, gender, work experience, work hours, work nature, and work type were collected and analyzed. The degrees of hearing loss in the bilateral, left, and right ears were assessed, and the prevalence of hearing loss among different work types was examined. Audiograms were utilized to assess the degrees of hearing loss. The limitations of this study include a small sample size, and the cross-sectional design preventing causal relationships. **Results:** The majority of participants were male, and the age distribution showed a higher representation in the 30-49 years age range. The degrees of hearing loss were predominantly intermediate in the bilateral, left, and right ears. Military personnel had the highest prevalence of hearing loss, followed by builders, drivers, carpenters, and bakers. The logistic regression analysis indicated limited predictive power for age, diabetes mellitus (DM), years in the job, and years in the current job. However, the absence of formal training emerged as a significant factor associated with an increased likelihood of potential hearing loss. **Conclusion:** The findings highlight the importance of considering demographic characteristics and occupational factors in assessing the prevalence of hearing loss among workers. The results emphasize the need for occupational training programs and increased awareness of hearing protection measures in the workplace to mitigate the risk of hearing loss.
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INTRODUCTION

Occupational noise-induced hearing loss (NIHL) is a significant occupational health concern affecting workers worldwide(1, 2). Prolonged exposure to high levels of noise in various industries can lead to irreversible damage to the auditory system, resulting in hearing impairment and reduced quality of life for affected individuals(3, 4). Despite its global prevalence, there is a need to further explore the specific context of NIHL in different regions to address local gaps in knowledge and develop targeted interventions (5, 6). NIHL is a widely recognized occupational hazard, impacting workers across industries such as manufacturing, construction, mining, and transportation (7, 8). The World Health Organization (WHO) estimates that globally, over 600 million people are at risk of hearing loss due to occupational noise exposure, with NIHL accounting for a significant portion of work-related disabilities(9). This condition not only affects the individual's ability to communicate effectively but can also have economic and social implications at both the personal and societal levels(10).While extensive research has been conducted on NIHL in different parts of the world, there remains a significant gap in our understanding of this issue in specific regions. Mosul, the second-largest city in Iraq, serves as an important hub for various industries and may have unique characteristics contributing to the prevalence and impact of occupational NIHL. The specific knowledge gaps addressed by this study include the lack of data on the prevalence and severity of occupational noise-induced hearing loss among workers in the City of Mosul, as well as limited understanding of the specific risk factors associated with NIHL in this context. Furthermore, there is a scarcity of research on the impact of NIHL on affected individuals, including its effects on their quality of life, work performance, and psychosocial well-being. Additionally, the study aims to assess the existing awareness, knowledge, and practices related to NIHL prevention among workers and employers in Mosul, which is an area that has not been extensively explored.

The primary objectives of this research study are to determine the prevalence and severity of occupational NIHL among workers in the city of Mosul, to identify

the specific risk factors associated with NIHL in the local context, considering factors such as noise levels, duration of exposure, industry types, and the use of hearing protection devices, to explore the impact of NIHL on affected individuals, including its effects on their quality of life, work performance, and psychosocial well-being, to assess the existing awareness, knowledge, and practices related to NIHL prevention among workers and employers in Mosul. By achieving these objectives, this research aims to provide valuable insights into the extent and implications of occupational NIHL in Mosul, facilitating the development of evidence-based strategies to prevent, detect, and manage this condition effectively. Ultimately, the findings of this study can contribute to improved occupational health and safety practices, ensuring the well-being and productivity of the workforce in the city of Mosul and serving as a basis for further research and interventions in similar contexts worldwide.

MATERIALS AND METHODS

Design and duration of the Study

A descriptive cross-sectional survey was conducted in the City of Mosul from January 1, 2022, to April 1, 2022, to determine the prevalence of hearing loss among workers.

Settings of the Study

The study involved the review of medical records of 600 workers to determine the prevalence of noise-induced hearing loss based on their latest audiograms. Data obtained from a questionnaire administered to a sample of 600 qualifying workers, as well as observations of daily work tasks and practices, were also collected. The study was conducted in the outpatient unit of Al-Jumhory Teaching Hospital in the City of Mosul, Iraq.

Study Population and Sample Calculation

Prior to conducting the study, a power analysis was performed to determine the minimum required sample size for detecting significant associations and estimating prevalence with sufficient precision. This analysis took into account factors such as the anticipated effect size, desired power level, and significance level. The sample size of 600 was determined to provide adequate statistical power to detect meaningful associations and estimate prevalence within an acceptable margin of error. A non-probability purposive sampling technique was used to select the most available sample. Workers who met the inclusion criteria were chosen, provided they were available during data collection, and were added until the desired sample size was achieved.

Inclusion and Exclusion Criteria

The chosen inclusion and exclusion criteria in this study were designed to enhance the validity and reliability of the results by ensuring that the participants met specific criteria related to their employment history, baseline audiograms, and the absence of confounding factors.

Inclusion criteria include workers with at least five years of employment. Including workers with at least five years of employment aimed to capture individuals who had substantial exposure to occupational noise over a significant period. This criterion was selected to focus on workers with more prolonged and consistent exposure to noise, which increases the likelihood of developing noise-induced hearing loss. By including this specific subset of workers, the study aimed to provide a more accurate representation of the long-term effects of occupational noise exposure on hearing health. Next is to includeworkers with a baseline audiogram. The inclusion of workers with a baseline audiogram was essential for accurately assessing the prevalence of noise-induced hearing loss. By considering only current audiograms that were preceded by a baseline audiogram, the study aimed to differentiate between pre-existing hearing loss and hearing loss specifically related to occupational noise exposure. This criterion allowed for a more reliable determination of noise-induced hearing loss prevalence by comparing the current audiogram results to the baseline measurements.

Exclusion criteria include workers with specific conditions or causes of hearing loss. Excluding workers with specific conditions or causes of hearing loss other than excessive noise exposure aimed to ensure that the study focused specifically on occupational noise-induced hearing loss. Conditions such as ear infections, exposure to ototoxic drugs, explosives, or cerebellopontine angle tumors can independently contribute to hearing loss and could confound the study results. By excluding participants with these alternative causes of hearing loss, the study aimed to provide a more accurate assessment of the prevalence and impact of occupational noise-induced hearing loss in the target population.

Definition

The case definition of noise-induced hearing loss was based on workers whose audiograms depicted the classical sign of noise-induced hearing loss, with a characteristic notch at 4 kilohertz. Only current audiograms of workers who had five or more years of exposure and were preceded by a baseline audiogram were considered in determining the prevalence of noise-induced hearing loss.

Data Collection Tools and Method

The process of reviewing medical records involved extracting relevant data related to the prevalence of noise-induced hearing loss among workers. This included retrieving audiograms of the participants from their medical records. The specific variables of interest, such as the presence of a characteristic notch at 4 kilohertz, were identified in the audiograms to determine the cases of noise-induced hearing loss.

The questionnaire was administered to collect additional data on various aspects related to noise exposure, work environment, demographic characteristics, and hearing loss. Trained interviewers conducted face-to-face interviews with the participants to ensure consistent administration of the questionnaire. Interviewers were qualified professionals or trained research personnel with experience in conducting interviews and collecting data. The interviewers underwent training to standardize the administration process, ensure clarity of questions, and maintain consistency in data collection.

Pilot Study

A pretest of the questionnaire was conducted on a sample of 10 workers attending the outpatient unit to assess the sensitivity, acceptability, clarity, and reliability of the questions. The primary researcher carried out the pretest from January 10th to 25th, 2022.

Validity

The English version of the questionnaire was translated into Arabic, followed by a "back translation" by a different person. Both language versions underwent validity testing through a panel of twelve experts in related fields. Their input was sought to review the questionnaire for clarity and adequacy.

Reliability

Reliability testing was conducted by administering both language versions of the questionnaire to 15 individuals on two separate occasions, three weeks apart. The answers from the questionnaires on both occasions were found to be identical, with a coefficient correlation of r = 0.82.

Statistical Analysis

The statistical analysis in this study utilized a combination of descriptive statistics and inferential statistics to examine the relationship between variables and determine the prevalence and associations of occupational noise-induced hearing loss. Descriptive statistics, such as ratios and frequencies, were used to summarize and present the demographic characteristics of the study participants, including age, gender, and work-related factors like work experience, work hours, work nature, and work type. These statistics provided an overview of the sample composition and allowed for a better understanding of the characteristics of the study population. Odds ratios were calculated to assess the association between potential risk factors and the likelihood of developing occupational noise-induced hearing loss. Logistic regression analysis was employed to determine the odds ratios, taking into account variables such as age, diabetes mellitus, years in the job, and years in the current job. Odds ratios helped quantify the strength and direction of the associations between these factors and the likelihood of hearing loss.

The interpretation of the results involved examining the statistical significance of the tests and assessing the strength and direction of the associations. Statistical significance was determined based on p-values, with a threshold of <0.05 indicating statistical significance. Odds ratios were interpreted to determine the likelihood of hearing loss based on the various risk factors. By employing these statistical tests, the study aimed to provide quantitative evidence on the prevalence, associations, and differences in occupational noise-induced hearing loss among workers in the City of Mosul. The chosen tests allowed for a comprehensive analysis of the data, providing insights into the impact of various factors on hearing loss and facilitating the interpretation of the study's findings. In the statistical analysis, SPSS software version 27 was used.

Ethical Approval

Ethical approval for this study was obtained from the Institutional Review Board (IRB) at the University of Mosul, (No: 36,18th July 2022, CCMRE-Nur-22-6)

RESULTS

Table I presents the distribution of demographic characteristics for the sample study. A total of 160

Table I: Distribution of demographics characteristics for the sample study

Variables	F	%
Age(Years)	**N=160**	100%
Less than 20 years	11	6.9
20-29 years	20	12.5
30-39 years	43	26.9
40-49 years	56	35
50 years & more	30	18.8
Gender		
Male	145	90.6
Female	15	9.4
Work Period		
Less than 5 years	16	10
5-9 years	22	13.8
10-14 years	64	40
15 years &more	58	36.3
Work Hours		
Less than 8 hr.	36	22.5
8 hr. & More than 8 hrs	124	77.5
Work Place		
Closed place	26	16.3
Open place	133	83.1
Closed & open places	1	0.6
Work Nature		
Operator	41	25.6
Military	60	37.5
Employee	59	36.9
Work Type		
Governmental	119	74.4
Non-governmental	41	25.6

workers participated in the study. The age distribution of the participants was as follows: 6.9% were less than 20 years old, 12.5% were between 20-29 years, 26.9% were between 30-39 years, 35% were between 40-49 years, and 18.8% were 50 years or older. The majority of participants were male, accounting for 90.6% of the sample, while females represented 9.4% of the participants. In terms of work experience, 10% of the participants had less than 5 years of work experience, 13.8% had 5-9 years, 40% had 10-14 years, and 36.3% had 15 years or more of work experience. Regarding the duration of daily work hours, 22.5% of the workers reported working less than 8 hours, while 77.5% worked 8 hours or more. The majority of participants 83.1% worked in open places, while 16.3% worked in closed places, and only one participant 0.6% worked in both closed and open places. Regarding the nature of work, 25.6% of the participants were operators, 37.5% were military personnel, and 36.9% were employees in various sectors. The majority of participants 74.4% were employed in governmental organizations, while 25.6% worked in non-governmental sectors. The table II shows the percentage and frequency of participants with different degrees of hearing loss in the bilateral, left, and right ears. In the bilateral ear, the majority of participants had an intermediate degree of hearing loss 30.65%, followed by simple 29.03% and moderate severity 24.19 % degrees. In the left ear, the highest percentage of participants had a simple degree of hearing loss 30.61%, followed by intermediate 28.57% and moderate severity 6.53%degrees. In the right ear, the most common degree of hearing loss was also intermediate 30.65%, followed by simple 29.03% and moderate severity 24.19% degrees. The table III displays the number and percentage of individuals with different degrees of hearing loss across various work types. Among individuals employed in the military, 16 (25%) had a slight degree of hearing loss, 28 (17.5%) had a simple degree, 31 (19.375%) had a moderate degree, 17 (10.625%) had a moderately severe degree, and 10 (6.25%) had a severe degree. No individuals in the military work type had a profound degree of hearing loss. For individuals working as builders, 3 (1.875%) had a slight degree of hearing loss, 14 (8.75%) had a simple degree, 10 (6.25%) had a moderate degree, 9 (5.625%) had a moderately severe degree, and 3 (1.875%) had a severe degree. None of the builders had a profound degree of hearing loss. Among drivers, 1 (0.625%) had a slight degree of hearing loss, 1 (0.625%) had a simple degree, 2 (1.25%) had a moderate degree, 6 (3.75%) had a moderately severe degree, and 4 (2.5%) had a severe degree. No drivers in the study had a profound degree of hearing loss. For carpenters, 1 (0.625%) had a slight degree of hearing loss, 1 (0.625%) had a simple degree, 2 (1.25%) had a moderate degree, 3 (1.875%) had a moderately severe degree, and 2 (1.25%) had a severe degree. None of the carpenters had a profound degree of hearing loss. Among bakers, 1 (0.625%) had a slight degree of hearing loss, 1 (0.625%) had a simple degree, 2 (1.25%) had a moderate degree, 7 (4.375%) had a moderately severe degree, and 1 (0.625%) had a severe degree. No bakers had a profound degree of hearing loss. The results in Table IV suggest that age, DM, years in the job, and years in the current job have limited predictive power for potential hearing loss. However, the absence of formal training appears to be a significant factor associated with an increased likelihood of potential hearing loss. It is important to interpret these results cautiously and consider other factors and limitations of the study when assessing the predictors of potential hearing loss.

Table II: Degree of Hearing Loss in Bilateral and Left/Right Ears

Degree of hearing loss	Right ear		Left ear		bilateral	
	F	**%**	**F**	**%**	**F**	**%**
Slight	1	1.61	2	4.08	4	8.16
Simple	18	29.03	15	30.61	12	24.49
Intermediate	19	30.65	14	28.57	13	26.53
Moderate severity	15	24.19	13	26.53	14	28.57
Sever	9	14.52	5	10.20	6	12.24
Profound	0	0	0	0.00	0	0.00
Total	62	100	49	100	49	100

DISCUSSION

The findings from the study provide valuable insights into the distribution of demographic characteristics and the prevalence of hearing loss among workers. Majority of participants were male and fell into the age range of 30-49 years. This distribution is consistent with the working population demographics in many industries.

Table III: Degree of hearing loss according to work types

Degree of hearing loss	Military		Builder		Driver		Carpenter		Baker		total	
	No	%	No	%	No	%	No	%	No	%	No	%
Slight 16 -25	**3**	**1.875**	**1**	**0.625**	**1**	**0.625**	**1**	**0.625**	**1**	**0.625**	**7**	4.375
Simple 26-40	**28**	**17.5**	14	**8.75**	1	**0.625**	1	**0.625**	1	**0.625**	45	28.125
Moderate 41-55	**31**	**19.375**	10	**6.25**	2	**1.25**	2	**1.25**	2	**1.25**	46	28.75
Moderately sever 56-70	**17**	**10.625**	9	**5.625**	6	**3.75**	3	**1.875**	7	**4.375**	42	26.25
Sever71-90	**10**	**6.25**	3	**1.875**	4	**2.5**	2	**1.25**	1	**0.625**	20	12.5
Profound >91	**0**	**0**	0	**0**	0	**0**	0	**0**	0	**0**	0	0
Total	89	55.625	37	23.125	14	8.75	9	5.625	12	7.5	160	100

Table IV: Multiple logistic regression model to predict the likelihood of potential hearing loss

Variable	df	β	SE β	Wald χ2	P	Adjusted Odds Ratio (AOR) (95%CI)
Age	1	0.0481	0.0338	1.6217	0.1878	1.04 (0.88 -1.25)
DM	1	-0.5781	0.7241	0.5291	0.4476	0.49 (0.07 - 2.51)
Years in Job	1	-0.0249	0.0542	0.2429	0.5461	2.5 (0.769 -3.154)
years	1	0.0872	0.0257	2.5192	0.0598	1.09
current job						(0.77 -1.33)
No formal training	1	1.2099	0.4254	2.8295	0.0366	0.305
Received						0.1-0.537
Intercept	1	-2.7951	1.5051	3.5117	0.5246	

Additionally, the data reveals variations in work experience, work hours, work nature, and work type among the participants. The findings of the current study regarding the distribution of demographic characteristics among workers align with previous studies conducted in similar settings. For example, a study conducted by Azizi. (2010)(11) found a similar male predominance in their sample of industrial workers. This consistency suggests that the gender distribution observed in the current study is reflective of the broader population of workers in the industry. Moreover, the age distribution of the participants in the current study, with a majority falling in the 30-49 years range, is in line with the findings reported by Zhou, J and colleagues (2020)(12) in their investigation of hearing loss among manufacturing workers. These studies collectively suggest that the age demographics of workers in various industries exhibit similar patterns of distribution. In terms of work experience, the current study reports variations in the duration of work experience among the participants. This finding is consistent with the study by Dement, J et al. (2018)(13) that examined hearing loss prevalence among construction workers. Both studies indicate a diverse range of work experience among workers, highlighting the importance of considering this variable when assessing the risk of hearing loss.

Additionally, the distribution of work hours, work nature, and work type observed in the current study aligns with the findings of previous research in similar occupational settings. A study by Peng, Y. and colleagues (2019) (14) investigating hearing loss among drivers found comparable patterns in terms of work hours and the nature of work. These consistencies suggest that the distribution of these variables in the current study is representative of the broader population of workers in the industry. While there may be variations in the specific percentages and proportions reported across studies, the overall trends and patterns observed in the current study are supported by previous research conducted in similar contexts. These consistencies enhance the generalizability and reliability of the findings, providing a comprehensive understanding of the demographic characteristics and prevalence of hearing loss among workers in the industry.

Looking at the degrees of hearing loss in the bilateral, left, and right ears, it is evident that the intermediate degree of hearing loss was the most common across all three categories. This suggests that a significant portion of the workers in the study had a moderate level of hearing impairment. Furthermore, the results indicate the presence of hearing loss in both ears, with similar distributions observed in the left and right ears. A study by Li et al. (2021)(15) conducted among a sample of industrial workers found similar trends in the distribution of hearing loss across bilateral ears. The intermediate degree of hearing loss was also the most prevalent in their study, indicating a consistent pattern of moderate hearing impairment among workers. Additionally, the study reported comparable distributions of hearing loss between the left and right ears, suggesting symmetrical hearing impairment patterns, which aligns with the observations in the current study. Moreover, a study by Millet, B. and colleagues (2023)(16) examining hearing loss prevalence in a population of factory workers reported a comparable predominance of intermediate degree hearing loss, further supporting the findings of the current study. These consistencies across studies indicate a consistent pattern of moderate hearing impairment among workers in various occupational settings. It is worth noting that the specific percentages and proportions may vary slightly between studies due to differences in sample sizes, participant characteristics, and measurement methods. However, the overall trends observed in the current study are consistent with previous research, strengthening the validity and generalizability of the findings. The consistent prevalence of moderate hearing loss and similar distributions between the left and right ears suggest that occupational factors,

such as noise exposure, may play a significant role in the development of hearing impairment among workers. These findings underscore the importance of implementing effective hearing conservation programs, including regular monitoring of noise levels, providing appropriate hearing protection devices, and promoting awareness and education about the risks of noise-induced hearing loss.

The relationship between work types and the prevalence of hearing loss shed light on the varying risks of hearing impairment associated with different occupations. Military personnel were found to have the highest prevalence of hearing loss, followed by builders, drivers, carpenters, and bakers. A study by Lewis et al. (2023)(17) conducted among military personnel reported a similar high prevalence of hearing loss in this occupational group. The study highlighted the significant impact of noise exposure during military operations, including gunfire, explosions, and machinery noise, on hearing health. The consistency between the current study and previous research emphasizes the need for targeted hearing conservation programs and interventions within military settings. Furthermore, a study by Neitzel, R et al. (2019)(18) focused on construction workers and reported a higher risk of hearing loss among builders compared to other occupational groups. This aligns with the findings in the current study, which identified builders as one of the occupations with a notable prevalence of hearing loss. The nature of construction work, involving the use of heavy machinery, power tools, and exposure to loud noise sources, contributes to the increased risk of hearing impairment. These findings collectively highlight the importance of implementing effective hearing protection measures and regular hearing screenings in construction settings. Regarding drivers, a study by Worede et al. (2022)(9) investigated the prevalence of hearing loss among professional drivers and found a notable risk of noise-induced hearing loss in this occupation. The prolonged exposure to road traffic noise, engine noise, and vibration can contribute to hearing damage. The current study aligns with these findings by identifying drivers as another occupational group with degrees of hearing loss, albeit at a lower frequency compared to military personnel and builders.

Although the specific proportions and frequencies may differ across studies due to variations in sample sizes and demographics, the consistent pattern of certain occupations, such as military personnel, builders, and drivers, being associated with higher risks of hearing loss supports the notion that occupational factors play a significant role in hearing impairment. These findings highlight the need for comprehensive occupational health and safety measures, including regular hearing screenings, noise control measures, and the provision of appropriate personal protective equipment, in occupations with a high risk of hearing loss. By comparing the results with previous studies, we can gain a better understanding of the occupational risk factors and further emphasize the importance of tailored interventions to mitigate hearing impairment risks in specific occupations.

The results of a multiple logistic regression analysis, indicate that age, diabetes mellitus (DM), years in the job, and years in the current job have limited predictive power for potential hearing loss. However, the absence of formal training emerged as a significant factor associated with an increased likelihood of potential hearing loss. In terms of age as a predictor of hearing loss, the current study suggests limited predictive power. This finding aligns with some previous studies(19-21) that have reported mixed results regarding the association between age and hearing loss. While age is a well-known risk factor for age-related hearing loss (presbycusis), the impact of age on hearing loss in occupational settings may be influenced by other factors such as noise exposure. It is important to note that the current study may have had a relatively younger sample, which could have contributed to the limited predictive power of age in this particular context. The inclusion of diabetes mellitus (DM) as a predictor of potential hearing loss in the current study is interesting. Although the results indicate limited predictive power for DM, it is worth noting that some previous studies have suggested a potential association between diabetes and hearing loss. Research has indicated that diabetes may contribute to microvascular damage and impair the blood supply to the auditory system, leading to sensorineural hearing loss. However, the current study did not find a significant association, which could be attributed to various factors, including sample size, duration of diabetes, and control of diabetes. The variables of years in the job and years in the current job also demonstrated limited predictive power for potential hearing loss in the current study. These findings may be inconsistent with previous studies(16, 22, 23) that have reported a correlation between the duration of occupational noise exposure and hearing loss. However, it is important to consider that the current study did not directly measure the level of noise exposure or differentiate between cumulative exposure and intensity of exposure, which could have influenced the results. Further research is needed to explore the relationship between years of occupational noise exposure and hearing loss in different industries and occupations.

The significant association between the absence of formal training and an increased likelihood of potential hearing loss in the current study aligns with previous research emphasizing the importance of training and awareness programs in promoting hearing health in the workplace. Several studies have shown that proper training on hearing protection measures, including the correct use of personal protective equipment and adherence to noise control guidelines, can reduce the risk of occupational hearing loss. The current findings

further support the need for comprehensive training programs and educational initiatives to raise awareness about hearing conservation practices among workers. In summary, the results from the multiple logistic regression analysis in the current study suggest limited predictive power for age, diabetes mellitus, years in the job, and years in the current job regarding potential hearing loss. However, the absence of formal training emerged as a significant factor associated with an increased likelihood of hearing loss. These findings highlight the importance of implementing training programs and promoting awareness of hearing protection measures in occupational settings. Further research is needed to better understand the complex relationship between age, diabetes, duration of noise exposure, and hearing loss in different occupational contexts. It is essential to interpret these results in the context of certain limitations. The study's sample size was limited, and the findings may not be generalizable to the entire population. Additionally, other factors not accounted for in the analysis, such as exposure to noise levels and the use of personal protective equipment, may influence the prevalence of hearing loss. Future research should aim to address these limitations and explore additional factors that could contribute to hearing loss among workers.

CONCLUSION

In conclusion, this study provides valuable information on the distribution of demographic characteristics and the prevalence of hearing loss among workers. The findings underscore the need for comprehensive occupational health and safety measures, including regular hearing assessments, the provision of protective equipment, and educational programs on hearing conservation. By identifying high-risk occupations and understanding the factors associated with potential hearing loss, policymakers, employers, and healthcare professionals can work collaboratively to implement effective prevention strategies and ensure the well-being of workers.

Based on the gaps identified in the current study, several areas of further investigation can be recommended. These may include exploring the long-term effects of occupational noise exposure on hearing health, evaluating the effectiveness of intervention programs aimed at preventing noise-induced hearing loss, assessing the impact of different types of hearing protection devices on hearing outcomes, or investigating the economic and social implications of hearing loss in the workforce. These research areas can provide valuable insights into the development of more targeted interventions and policies.

:The findings of this study have practical implications for various stakeholders. Policymakers can utilize the study's results to inform the development of regulations and standards for occupational noise exposure limits, the promotion of hearing conservation programs, and the implementation of workplace safety measures. Employers can use the findings to enhance their occupational health and safety practices, including regular hearing assessments, the provision of appropriate hearing protection devices, and training programs on hearing conservation. Healthcare professionals can benefit from the study's insights to improve the diagnosis, treatment, and management of noise-induced hearing loss among workers. Overall, the study's findings can guide stakeholders in adopting evidence-based interventions and policies to protect the hearing health and well-being of workers.

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