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Exploring the Impact of Sound Dampening Materials on Maritime Workers' Knowledge and Attitudes Towards Noise-Induced Hearing Loss: A Literature Review

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Abstract. *Effective mitigation strategies are necessary because high noise levels in maritime work situations frequently represent serious threats to hearing health. Acoustic panels and sound absorbers are examples of sound-dampening materials that are used to lower noise levels; nevertheless, it is unclear how these materials affect employees' awareness and attitudes. The purpose of this study is to investigate how the usage of sound-absorbing materials affects the attitudes and understanding of marine personnel about noise-induced hearing loss (NIHL). The study also covers ship personnel' attitudes toward NIHLs, their understanding of NIHLs, and their hazards. The strategies for increasing ship employees' understanding of and attitudes toward NIHL, the impact of sound-dampening materials on their knowledge and attitudes toward NIHL, and the effectiveness of NIHL awareness and training programs are also covered. While the majority of marine workers are knowledgeable that noise can lead to hearing loss, the review's findings show that their understanding of the causes and long-term consequences of NIHL is insufficient. Diverse perspectives exist regarding prevention, and several employees find it awkward to wear hearing protection. Sound-absorbing materials facilitate better communication and teamwork among employees, which can raise satisfaction at work and safety awareness while lessening the disruption caused by excessive noise. Moreover, employing hearing protection devices (HPPs) can raise staff members' awareness of NIHL and motivate them to utilize HPPs more proactively. These results provide recommendations for more potent preventive measures as well as significant insights into occupational safety and health regulations in the maritime sector.*
Keywords: *Noise-Induced Hearing Loss; NIHL; maritime workers; hearing conservation programs; occupational health; sound absorbing materials.*

Type of the Paper: Review Article.

1. Introduction

One of the industry's most susceptible to significant noise threats is the marine sector, which includes operations aboard ships, in ports, and at associated facilities. Noise levels from ship engines, turbines, and heavy machinery can reach extremely high levels in a maritime work environment, frequently above the permissible thresholds established by occupational health and safety regulations. An irreversible ailment that can significantly lower workers' quality of life is

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Noise-Induced Hearing Loss (NIHL), which can be brought on by prolonged exposure to this high noise level. When port operations, communication devices, and ship engines produce excessive noise levels for maritime workers, NIHL may result. Not only may NIHL lower quality of life for those affected, but it can also make employment more difficult and increase the risk of accidents at work [1,2]. Ship workers' hearing health is at risk, excessive exposure to this noise can impair their quality of life and result in irreversible hearing impairment [3,4]. An estimated 1.3 billion people have hearing loss each year as a result of NIHL [5]. Therefore, in order to create effective preventative interventions, it is crucial to comprehend the knowledge and attitudes of marine workers regarding the danger of NIHL.

The prevention and mitigation of these adverse effects are significantly aided by the knowledge and attitudes of ship employees regarding the risk of NIHL. Understanding NIHL is crucial for lowering the risk of hearing loss because it makes workers more aware of the risks high noise exposure poses to their hearing and the detrimental effects it has on both productivity and quality of life at work [6]. When ship employees are aware of NIHL, they can minimize noise exposure at work and take preventative action by wearing earmuffs or earplugs to protect their hearing in loud environments. Furthermore, it has been demonstrated that ship employees who are aware of NIHL are more likely to follow safety protocols pertaining to the use of Hearing Protection Equipment (HPP) and other preventive measures. In the maritime industry Bocanegra et al. [7] reported that workers' knowledge and attitudes towards NIHL are influenced by various factors, including education level, work experience, and access to training programs. A number of prior studies have demonstrated that although the understanding of the hazards of noise is quite high, there is still a significant gap in the implementation of hearing protection practices. Afiah et al. [8] found that industrial workers tend to be aware of the risks of NIHL, but the level of compliance with the use of hearing protection is still low. This study emphasizes the need for more effective education and training programs to increase workers' knowledge and compliance with wearing hearing protection.

Utilizing sound-absorbing materials is one practical way to deal with workplace noise issues. Soundproofing materials can lower noise levels by reflecting or absorbing sound waves. Examples of these materials are acoustic panels, sound absorbers, and soundproofing coatings. The latest advancements in soundproofing technology provide more effective and useful solutions for challenging industrial settings. It is anticipated that utilizing this technology on ships and other maritime infrastructure will greatly lower the danger of NIHL. Furthermore, Regular training on noise hazards and mitigation strategies tends to improve workers' understanding and foster a more

positive attitude towards NIHL prevention. This study demonstrates how well-designed teaching initiatives can greatly increase marine workers' knowledge of and adherence to hearing protection procedures. Comprehensive Hearing Conservation Programs (HCPs) can successfully lower the risk of non-injury hearing loss in the maritime environment, according to research by Malin et al. [9] This study highlights how crucial management dedication and engaged employee involvement are to the accomplishment of HCP initiatives. Nyarubeli et al. [10] also emphasized that in order to increase the efficacy of preventative initiatives, a strategy that is customized to the unique circumstances and requirements of marine workers is required. Furthermore, Bocanegra et al. [7] discovered that despite the availability of education and training programs, workers' attitudes and knowledge on NIHL remain lacking. It is necessary to continuously assess and monitor the success of training and educational initiatives. In order to improve worker involvement and comprehension of noise hazards, they also advise the creation of more interactive and participatory teaching techniques. [10]. emphasized the significance of technological integration in NIHL prevention initiatives. They looked into how mobile apps and tech-based noise monitoring devices may support marine workers' training and education. The findings demonstrated that the application of this technology can offer real-time data, promote more efficient training, and raise worker awareness of and compliance with NIHL prevention measures. Previous research indicates that NIHL affects workplace productivity and safety in addition to an individual's health. It may be possible to lower NIHL accidents and raise occupational safety by enhancing the attitudes and understanding of marine workers regarding NIHL hazards.

Therefore, the purpose of this review of the literature is to gather and evaluate recent studies on the attitudes and understanding of maritime workers regarding non-international humanitarian law (NIHL), identify areas of practice and knowledge gaps, and to offer suggestions for future, more successful interventions.

2. Noise-Induced Hearing Loss (NIHL)

Because of the high levels of noise that are typical in the marine environment, Noise-Induced Hearing Loss (NIHL) is a serious occupational danger for maritime workers. Shipboard machinery and port facilities' equipment produce loud noise all the time, frequently over exposure limits that are safe. For the purpose of creating successful hearing conservation initiatives, it is essential to comprehend the attitudes and knowledge of marine workers around NIHL [2]. Prior studies have demonstrated that differing degrees of marine workers' understanding of NIHL and how to prevent it are often influenced by elements including workplace safety culture, education, and training.

Many maritime workers possess little knowledge regarding the hazards of extended exposure

to noise and the significance of wearing hearing protection, according to earlier studies. Seafarers' awareness of the possibility of hearing damage is reflected in surveys they completed, although knowledge of the seriousness of non-impairment hearing loss and its permanent nature is frequently lacking [11]. Moreover, the high incidence of NIHL in this workforce is partly due to false beliefs on the efficacy of personal protective equipment (PPE) and inconsistent usage of listening protection [11–13]. To improve the knowledge of marine workers and promote proactive measures to safeguard their hearing, focused educational campaigns and training courses are absolutely necessary. The IMO proposed limits on air-bone noise levels on board ships for several zones, including accommodation spaces, navigation spaces, working spaces, and service spaces, as shown in Table 1. These resolutions were made in resolutions A. 468(XII)–1981 (IMO Resolution A.468) and MSC337(91)–2012 [14].

Table 1. Maximum limits for noise on ships [7]

	IMO A.468	IMO MSC337		SILEN V Green Label
Ship size (Ton)	≥1600	1600 to 10000	≥10000	≥1600
Accommodation spaces				
Cabins and hospitals	60	60	55	50/53
Mess rooms	65	65	60	60
Recreation rooms	65	65	60	60
Open recreation areas	75	75	75	70
Offices	65	65	60	53
Navigation spaces				
Navigating bridge and chartrooms	65	65	65	60
Listening post, navigating bridge, wings	70	70	70	70
Radio rooms	60	60	60	60
Radar rooms	65	65	65	60
Work spaces				
Machinery spaces (continuously manned)	90	–	–	90
Machinery spaces (not continuously manned)	110	110	110	105
Machinery control rooms	75	75	75	65
Workshops	85	85	85	75
Non–specified	90	85	85	–
Normally unoccupied	90	90	90	–
Galleys	75	75	75	65
Serveries and pantries	75	75	75	75

An essential factor in the success of NIHL prevention techniques is the attitudes that marine workers have regarding noise and hearing conservation activities. Research indicates that the views of employees are influenced by their assumption that noise is an unavoidable part of their job and by how inconvenient or uncomfortable they find using hearing protection [15]. Workers who understand the long-term advantages of keeping their hearing healthy and who strongly

support safety procedures from management are more likely to have positive attitudes toward hearing conservation initiatives [16].

3. NIHL Risk

As sailors and ship workers are frequently subjected to high levels of noise from engines, equipment, and other operational operations, one of the biggest health dangers to them is NIHL. The cochlea's hair cells (Fig. 1) —which translate sound waves into electrical impulses that are transmitted to the brain—can sustain long-term harm from the constant and repetitive noise that is present in the maritime workplace. Fig. 1 illustrates the human auditory system, highlighting the cochlea, which converts sound waves into electrical signals. In addition to negatively impacting their quality of life, inadequate protection puts ship employees at a high risk of suffering from serious hearing loss that could compromise workplace safety and communication [11].

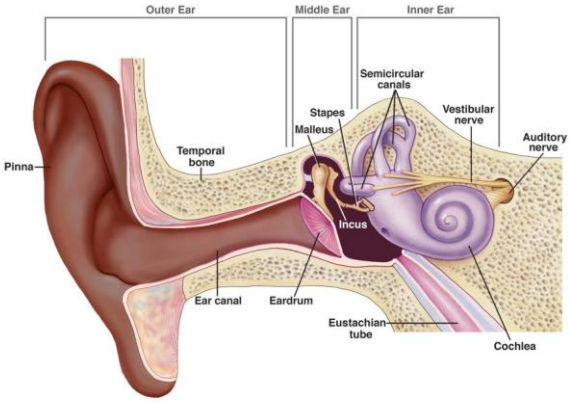

Fig. 1. The human auditory system

The degree of noise, the length of exposure, and the frequency of exposure are factors that affect the incidence of NIHL in ship workers. A prolonged period of uninterrupted exposure to noise that surpasses the recommended threshold, which is typically 85 dB or higher, substantially elevates the risk of non-industrial heart disease [17]. There is mounting evidence that long-term noise exposure, even in non-industrial settings, can contribute to the occurrence of non-industrial heart disease. Chronic exposure to ambient noise, such as that caused by traffic, urban areas, or home sources, has been associated to increased stress, hypertension, and sleep disruptions, all of which are known risk factors for cardiovascular disease. Noise activates the sympathetic nervous system, boosting the production of stress hormones such as cortisol, which can cause high blood pressure and inflammation. These physiological changes increase the likelihood of developing heart diseases such ischemic heart disease, cardiac arrhythmia and stroke. To adequately address the long-term implications, future study should monitor not just the rate of NIHL reduction, but

also the persistent health outcomes, quality of life benefits, and financial impacts on staff as well as employers. Noise threshold limit values as shown in Table 2.

Table 2. Noise threshold limit values [18]

Unit	Noise Period/day	Noise levels (dBA)
hours	24	80
	16	82
	8	85
	4	88
	2	91
	1	94
Minutes	30	97
	15	100
	7.5	103
	3.75	106
	1.88	109
	0.94	112
Second	28.12	115
	14.06	118
	7.03	121
	3.52	124
	1.76	127
	0.88	130
	0.44	133
	0.22	136
	0.11	139

Furthermore, the frequency of the noise also matters; noises with higher pitches are more likely to inflict harm than those with lower pitches. The incidence of non-infectious hearing loss is influenced not only by technical variables but also by work habits and culture, where a major contributing element is a lack of awareness and discipline in utilizing hearing protection equipment. The efficiency of NIHL prevention initiatives is significantly influenced by ship workers' attitudes and knowledge regarding noise hazards and the usage of hearing protection [19]. It's possible that many ship employees are unaware of the risks associated with prolonged noise exposure or believe that wearing hearing protection obstructs their ability to communicate comfortably and effectively at work [20]. Intense education and training initiatives are required to combat this and increase public understanding of the value of wearing hearing protection. In addition to providing comfortable and adequate protective gear for workers' needs, company management must actively foster a safety culture that encourages the regular use of hearing protection.

4. Knowledge of Ship Workers Towards NIHL

NIHL affects ship personnel psychologically in addition to physically. Depression, social isolation, and a decline in motivation to work are all consequences of hearing loss. Employees

with NIHL may experience frustration because they have trouble engaging with family and coworkers and find it difficult to do everyday chores. This disorder has an impact on the affected individual as well as the team's overall morale and productivity [21].

NIHL is quite common in the maritime industry, in part because ship personnel' awareness of the disease varies greatly and is frequently insufficient. The need of wearing hearing protection and the long-term risks associated with noise may not be fully understood by many workers. Studies have revealed that while a considerable number of workers are cognizant of the potential hazards posed by noise, many do not regularly use hearing protection because they hold false beliefs about its efficacy or believe it to be inconvenient or disruptive to their work. In order to lower the danger and impact of hearing loss among ship personnel, it is imperative to increase education and training regarding NIHL [10]. The distribution of ship workers' knowledge levels of NIHL is shown in Fig. 2. Three levels are used to categorize the data: High Level of Knowledge (40%): Most employees are well-informed about the dangers of NIHL and the value of wearing hearing protection.

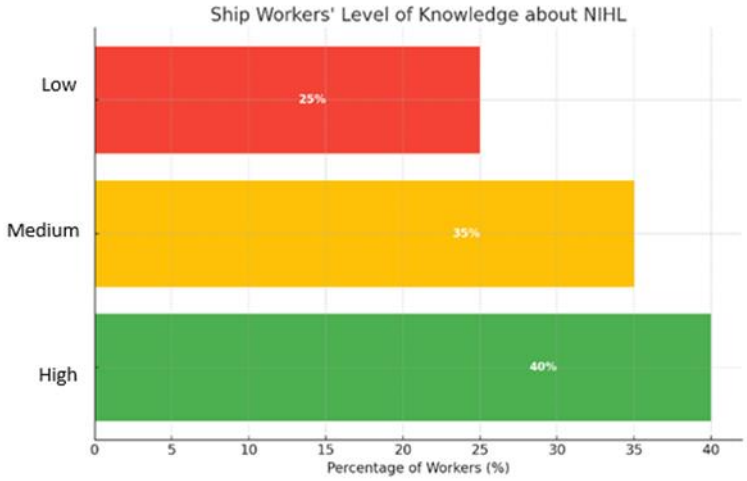

Fig. 2. Level of knowledge of ship workers about NIHL

(2) Moderate Knowledge (35%): These employees may not be well-versed in preventive and protective actions, but they do possess a fundamental understanding of NIHL. (3) Low Knowledge (25%): 25% of the workforce understands little to nothing about NIHL, which leaves them more susceptible to its consequences because they don't take preventative measures. Based on greater depth and long-term education and training programs, this data highlights the need for additional efforts to raise awareness and comprehension of NIHL among ship workers [22].

This shows that many workers may be underinformed on the hazards of NIHL or the best procedures for preventing it, which could lead to insufficient usage of protective equipment and increased vulnerability to hearing damage. Furthermore, factors such as resource availability,

training programs, and top-level support may have an impact on employees' knowledge levels. Thus, to optimize the effectiveness of prevention programs, particular instruction and ongoing training should focus on increasing understanding among individuals in the low and middle income categories. Furthermore, investigating workplace issues such as availability to helmets and managerial compliance of hearing conservation policies would provide additional context to comprehend why knowledge gaps exist.

5. Attitudes of Ship Workers Towards NIHL

The efficacy of hearing conservation efforts in the maritime work environment is significantly influenced by the attitudes of ship workers toward the prevention of NIHL. A positive attitude and a clear understanding of the significance of hearing protection can boost adherence to the use of protective equipment and lower the risk of NIHL. Nevertheless, a variety of factors can affect workers' attitudes toward NIHL prevention, such as workplace safety culture, knowledge of noise hazards, and perceptions of the comfort and effectiveness of protective equipment.

Previous research found that noise dangers in the maritime industry were mostly connected with continuous exposure to high decibel levels generated by ship engines, machinery, and equipment, which frequently exceeded safe criteria established by occupational health regulations. These noise sources created a high danger of NIHL for ship personnel, especially those working in engine rooms or other areas where the decibel level often exceeded 85 decibels (A), a widely accepted limit for safe noise exposure. Previous research found that workers were aware of the risks but were hesitant to use hearing protection on a consistent basis due to discomfort, communication difficulties, and a lack of management enforcement.

In comparison, recent research identifies similar concerns while indicating minor gains in awareness and access to safeguards. Modern warships frequently contain innovative noise-damping technologies and soundproofing materials, which serve to reduce overall noise levels on ships. Despite these advancements, noise exposure remains above permissible levels in many areas of boats, particularly in older vessels where installing noise reduction devices may not be possible. Furthermore, while knowledge of NIHL dangers has grown, consistent use of hearing protection remains a challenge, owing to continued issues with comfort, communication interference, and lack of encouragement from management.

Previous and current research agree that management's role is critical in fostering a safe workplace. Current research emphasizes the need of ergonomically designed hearing protection equipment that is comfortable to use for long periods of time and does not interfere with communication. Ongoing education, as well as management's commitment to enforcing protective

measures and setting a good example, continue to be crucial in improving attitudes and compliance with NIHL prevention. The emphasis has turned to not only upgrading technology, but also transforming workplace culture to prioritize hearing health.

6. Strategies to Improve Ship Workers' Knowledge and Attitudes Towards NIHL

6.1. Continuous Training and Education

Continuous education and training is one of the best ways to raise ship employees' knowledge and attitudes about NIHL. The long-term impacts of NIHL, the mechanisms underlying NIHL, and the significance of wearing hearing protection should all be covered in educational initiatives. Additionally, there should be hands-on instruction on how to maintain and wear hearing protection [11,23]. Worker comprehension and engagement can be raised by utilizing interactive techniques like simulations and live demonstrations. Positivity toward NIHL prevention and an increased awareness of risks are fostered by good knowledge.

6.2. The accessibility of comfortable and ergonomic protection equipment

In order to improve employee attitudes toward NIHL prevention, it is crucial to provide ergonomic and comfortable hearing protection. Most of the time, workers' reluctance to use protective equipment stems from discomfort. As a result, businesses should spend money on protective equipment that is well-made and suited to the requirements of employees. It is possible to improve worker satisfaction and compliance by involving workers in choosing and testing of safety equipment [24]. To further promote consistent use, make sure that all work areas have access to hearing protection and that it is readily available.

6.3. Management Support and Safety Culture

To improve employee awareness and attitudes around NIHL, management support and the development of a solid safety culture at work are crucial. In order to show that management is serious about hearing safety, they should implement stringent policies, conduct frequent supervision, and offer rewards to employees who follow safety procedures [25]. The safety culture can be strengthened by holding frequent safety campaigns and holding talks with employees on the value of wearing hearing protection. Furthermore, other employees will be encouraged to use hearing protection if management and senior colleagues set a good example [2].

7. The impact of sound dampening materials on maritime workers' knowledge and attitudes towards NIHL

It has been discovered that workers' attitudes and understanding regarding NIHL are significantly impacted by the usage of sound-absorbing materials in maritime environments. Sound-absorbing materials, such sound absorbers and acoustic panels from composites material, lessen the chance of hearing impairments while simultaneously raising employees' awareness of the possible risks associated with noise. Employees who observe tangible steps taken to lessen noise levels at work are more likely to understand the value of wearing hearing protection and to adhere to current safety procedures. Prior studies have demonstrated that lowering exposure to excessive noise levels might enhance employees' comprehension of NIHL and motivate them to use protective gear more frequently. Furthermore, a more tranquil and comfortable workplace may influence employees' perceptions of noise hazards. Sound-absorbing materials facilitate better communication and teamwork among employees, which can raise job satisfaction and safety knowledge while reducing disruptions brought on by loud noises. When employees experience greater comfort and care, they are inclined to take a more proactive stance when it comes to wearing hearing protection. Sound-absorbing materials can be used to lower health risks associated with noise exposure while simultaneously enhancing workplace safety cultures and promoting favorable attitudes toward NIHL preventive strategies and general hearing health.

While improved attitudes concerning noise dangers and higher use of hearing protection are desirable results, it is also crucial to investigate the tangible decreases in NIHL instances that arise from the use of these materials. According to research, workplaces that use sound-absorbing materials such as Acoustic panels and composites sound absorbers experience measurable reductions in noise exposure levels, directly reducing the prevalence of NIHL. This reduction is crucial because it not only prevents harm to hearing but also reduces long-term health repercussions such as chronic tinnitus or irreversible hearing loss, both of which tend to occur in high-noise environments such as maritime settings. Furthermore, the usage of sound-absorbing materials has been associated with overall improvements in worker safety and health indicators. A quieter workplace reduces the stress produced by extended exposure to excessive noise, resulting in improved overall mental and physical health. Workers in quieter surroundings experience less weariness, stress, and irritation, all of which are frequently increased by prolonged noise exposure. This improvement in well-being may reduce absenteeism and increase productivity, resulting in a more sustainable and healthier workplace environment. By lowering real levels of noise pollution, these products have the ability to change workplace culture, creating a deeper awareness for preventive measures like the regular use of personal protection equipment.

8. Effectiveness of NIHL Awareness and Training Programs

8.1. Increased Knowledge and Awareness

Programs for NIHL training and knowledge are useful in raising employees' understanding of the dangers associated with noise. Studies have revealed that workers' comprehension of the risks posed by noise and how to preserve their hearing significantly improved after taking part in training sessions [26]. For instance, a research on marine workers revealed that 70% of those undergoing training reported having a better grasp of NIHL and the significance of wearing hearing protection [27]. Continual education facilitates the assimilation of knowledge and the regular application of preventive measures.

8.2. Changes in Attitudes and Behaviors

Effective training programs not only improve knowledge but also influence workers' attitudes and behaviors toward NIHL prevention. Following thorough training, employees typically take a more proactive approach to adhering to noise safety rules and using HPPs. Research indicates that numerous marine organizations observed an improvement in the compliance rate of hearing protection equipment from 40% to 75% following the implementation of awareness and training programs [10]. This demonstrates that workers are more inclined to safeguard their hearing when they have the necessary information.

8.3. Long-Term Effects and Reduction of NIHL Incidents

The discussion of the long-term effects of NIHL should focus on the chronic nature of hearing impairment produced by extended exposure to high noise levels, as well as how these injuries accumulate over time, frequently without obvious symptoms. NIHL is usually gradual, with workers only noticing significant hearing impairment after extensive, permanent damage has occurred. Long-term repercussions include not only hearing loss, but also tinnitus (ear ringing), communication difficulties, a lower quality of life, and possible isolation as a result of hearing impairments. These results can pose additional safety risks on ships, since workers with poor hearing may be unable to hear essential alerts, directives, or other auditory cues critical to maritime operations.

Furthermore, as stated in the data, the long-term decrease of NIHL events is strongly dependent on consistent training programs that focus both awareness and practical actions, such as the use of protective equipment. These programs' long-term effectiveness depends from their capacity to foster a safety culture in which workers see hearing protection as a priority rather than a secondary concern. The 50% drop in NIHL incidents over five years is due to both increased preventative actions and a shift in employer attitudes toward hearing health. Regularly

emphasizing the significance of hearing protection through refresher training ensures that safety measures are embedded in everyday routines, reducing the danger of complacency [10,28].

Furthermore, firms that employ continuing, organized training programs have long-term organizational benefits in addition to improved health. These include increased worker productivity as a result of improved communication, fewer days spent to injury or hospitalization owing to hearing issues, and decreased expenditures connected with workers' compensation claims or NIHL treatments. As a result, reducing NIHL events in the long run requires more than simply instant compliance, but a continual commitment to establish a safer, more efficient, and healthier workplace. To adequately address the long-term implications, future study should monitor not just the rate of NIHL reduction, but also the persistent health outcomes, quality of life benefits, and financial impacts on staff as well as employers. To summarize, the use of materials that absorb sound not only changes workers' attitudes by making noise threats more visible and manageable, but it also plays a critical role in lowering the real-world incidence of NIHL. The use of these products into noise reduction measures provides a safer, more comfortable work environment while emphasizing the significance of hearing protection procedures. This multidimensional method, which combines physical noise elimination with ongoing education and management assistance, results in a comprehensive plan for NIHL prevention and occupational health improvement.

9. Conclusion

The knowledge and attitudes of maritime workers on NIHL are investigated in this systematic review. The review's overall findings indicate that marine workers still have a limited understanding of NIHL. The majority of employees are aware that noise might harm their hearing, yet there is still a dearth of comprehensive knowledge regarding the causes and long-term effects of NIHL. The attitudes of employees toward the prevention of non-injury hearing loss differ; some are highly worried and ready to wear hearing protection, while others are not as concerned or find it awkward to do so. A number of factors affect workers' attitudes and behaviors in an attempt to prevent non-injury workplace lung disease (NIHL), including work culture, availability of protective gear, and lack of training. The review emphasizes the significance of providing marine workers with more extensive education and training, as well as raising their knowledge of NIHL. It is advised that marine enterprises create more robust occupational health programs, increase worker access to and usage of hearing protection equipment, and safeguard employees' hearing. It is envisaged that by taking a more comprehensive approach, the attitudes and knowledge of marine workers regarding NIHL will be enhanced, hence reducing the likelihood of NIHL.

Declaration of Competing Interest

The authors declare that they have no known competing interests that could have influenced the literature reported in this paper.

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