Prevalence of occupational noise-induced hearing loss and its associated factors among marine technicians working on the Royal Malaysian Navy vessels

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ABSTRACT

Introduction: Noise-induced hearing loss (NIHL) is the second most common form of sensorineural hearing loss. It is one of the occupational health concerns worldwide with a prevalence rate of 16%. In Malaysia, there is an increasing trend of occupational NIHL prevalence encompassing agriculture, manufacturing, transportation, and construction sectors. The Malaysian Armed Forces (MAF) personnel, particularly the marine technicians of the Royal Malaysian Navy (RMN), have a heightened risk of developing NIHL due to prolonged exposure to hazardous noise levels onboard the military vessels. Previous studies involving MAF participants recorded a prevalence rate of approximately 22%. However, limited information is available regarding occupational NIHL among the RMN marine technicians. This study aimed to determine the prevalence of occupational NIHL and its associated factors among marine technicians working on the RMN vessels.

Materials and Methods: A cross-sectional study was conducted among 127 randomly selected participants among marine technicians working on RMN vessels stationed at the Lumut Naval Base, Perak, Malaysia. The research instruments were questionnaires that contained information about sociodemographic, socioeconomic, occupational characteristics, and lifestyle behaviours, followed by a pure tone audiometric (PTA) assessment. Diagnosis of NIHL was made when the hearing threshold was ≥25 dB at 3 kHz to 6 kHz, with a recovery at 8 kHz on PTA.

Results: The participants' median age was 32 years (interquartile range=27–37 years). The prevalence of occupational NIHL was 29.9% (95% CI=22.1–38.7). Factors associated with occupational NIHL on unadjusted regression analysis include age >30 years (OR=2.56, p=0.0185), middle household income (OR=2.76, p=0.0227), military rank especially the warrant officer (OR=7.12, p=0.0038), and length of service ≥15 years (OR=2.40, p=0.0246). After adjusting for ethnicity, smoking status, types of vessels, and participation in noise-related leisure activities, middle household income (OR=3.15, 95% CI=1.29–7.87, p=0.0121) and warrant officer (OR=4.38, 95% CI=1.08–20.52, p=0.0384) remained as significant predictors for occupational NIHL in this population.

Conclusion: In this study, the marine technicians working on board the RMN vessels had a higher prevalence of occupational NIHL compared to the prevalence among other MAF personnel as well as the global data. In addition, the probabilities of having occupational NIHL were significantly higher for middle-income technicians and those who ranked as warrant officers. These findings highlight the need for routine audiometric assessment and adoption of hearing conservation initiatives for individuals at high risk within this occupational cohort.

KEYWORDS:
Noise-induced hearing loss, occupational NIHL, marine technicians, Royal Malaysian Navy, Malaysian Armed Forces

INTRODUCTION

Noise-induced hearing loss (NIHL) affects approximately 5% of the global population, and it is the second most common type of sensorineural hearing loss.[1] Additionally, about 16% of hearing loss in adults is caused by NIHL.[2] Excessive exposure to loud noise that occurs at workplaces, known as occupational NIHL, usually affects those who work in the manufacturing, construction, mining, and military sectors.[3,4] The occurrence of NIHL is caused by continuous exposures to loud sounds measuring >85 decibels (dB) for more than eight hours per day or a single exposure to an impulse sound of >140 dB without any hearing protection.[5] The affected individuals often complain of ear-related symptoms such as temporary or permanent hearing loss and tinnitus, as well as impaired functioning and quality of life, including sleep deprivation and reduced work performance, potentially leading to psychological stress.[6] Apart from prolonged exposures to loud noise, other identified risk factors of occupational NIHL comprised age, male gender, duration of employment, and active cigarette smoking.[7]

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In Malaysia, noise exposure at the workplace is regulated under the Occupational Safety and Health (Noise Exposure) Regulations 2019 which limits the daily noise exposure to 85 dB(A), a daily dose of self-noise at 100%, maximum noise pressure at 115 dB(A) at any time, and peak sound pressure level at 140 dB(C).[8] The prevalence of occupational NIHL among Malaysian workers has seen a dramatic increase. For the past decade, the number of occupational NIHL has risen from 358 reported cases in 2014 to 5,101 cases in 2023, equivalent to a staggering increase of 1,325%.[9,10] However, these data did not include individuals who were serving in the military, rather they were aggregated from other sectors such as agriculture, manufacturing, transportation, and construction.[11] Similar to industrial workers, military personnel are regularly exposed to high noise levels above 85 dB from their daily routine which involves handling sophisticated military vehicles and machines, weapon-firing practices, as well as the usage of explosions.[12,13] Out of various military branches and ranks, marine technicians working on board navy vessels are particularly among those who have high exposure to loud noises. This is because the vessels constantly have higher noise levels compared to the recommended upper-limit values when they are being operated at sea, especially in the enclosed space of the engine room where marine technicians typically work.[14] According to a recently published paper, the noise levels onboard a navy vessel in various spaces on all decks exceeded the international standards set by the International Maritime Organization (IMO), Det Norske Veritas (DNV), and China Classification Society (CCS).[15] The maximum sound level was recorded in the engine room and the engine control room at 175.2 dB (+59.3%) and 112.7 dB (+32.6%), respectively, which were comparatively higher than the standard limits.[15] Meanwhile, the maximum sound levels in other parts of the vessel ranged from 70.5–85.2 dB or approximately 0.72%–21.7% higher compared to the standard limits.[15]

The roles of the Royal Malaysian Navy (RMN) marine technicians include operating and maintaining the engine and drive systems, as well as monitoring the auxiliary, power generation, and distribution systems of the vessels. To complete these tasks, marine technicians are often required to be present in the engine room for approximately 4 hours per shift. This arrangement leads to significant exposure to loud noises with a subsequently marked increase in their risk of contracting NIHL since the engine room had the loudest noise of >100 dB as compared to the other parts of a vessel.[14,16] Due to the difficulty in implementing engineering controls such as modification using insulation or barrier towards the noise source on the vessel, workers at risk of occupational NIHL are expected to strictly adhere to the usage of personal hearing protectors (PHP) during duty. However, about one in five military personnel did not use PHP,[17] with one in three personnel reporting that they had never received guidance on how to properly use the equipment.[18]

At present, the information regarding occupational NIHL among Malaysian military personnel is scarce, with only two studies conducted so far, involving technicians in the Royal Malaysian Air Force (RMAF) as well as divers and non-divers of the RMN, respectively.[19,20] Among the RMAF technicians, the overall NIHL prevalence was 24.2% with loud-sound leisure activities and a history of tinnitus as its significant associated factors.[19] As for the RMN divers and non-divers, NIHL was associated with older age and longer duration of service, with an overall prevalence of 18.9%.[20] Given that the occupational NIHL is understudied among the Malaysian Armed Forces (MAF) personnel, investigation regarding the presence of this preventable disease especially among the RMN marine technicians is crucial and of utmost importance as the initial step in planning for prevention strategies. Therefore, the current study aimed to determine the prevalence of occupational NIHL and its associated factors among the marine technicians working on board the RMN vessels.

MATERIALS AND METHODS

Study design and setting

A cross-sectional study was conducted among marine technicians working on the RMN vessels stationed at the Lumut Naval Base, Perak Malaysia from February to April 2023. Lumut Naval Base is strategically situated on the west coast of Peninsular Malaysia, approximately 160 kilometres from Kuala Lumpur. It lies along the eastern coast of the Malacca Strait, providing easy access to important maritime routes and serving as a crucial operational hub for the RMN. The base accommodates various RMN units such as Western Fleet Command, Naval Education and Training Command, Naval Special Forces, Naval Air, Diving Headquarters and Mine Warfare, Navy Provost Unit, and Malaysian Army Unit which encompasses the 96 Armed Forces Hospital. It also houses various naval facilities, including berths for warships, maintenance and repair facilities, administrative buildings, training facilities, and support infrastructure.

Ethical approval

This study had been approved by the UPNM Research Ethics Committee (Ethics No.: UPNM (FPKP) 14.01/02) and the Clinical Research Committee of the Malaysian Armed Forces Health Services (Ethics No.: PKAT/JKE/40-08).

Sample size and sampling technique

There was a total of 238 marine technicians in the Lumut Naval Base. The inclusion criteria for this study include all marine technicians of any rank with normal preliminary otoscope findings and who were actively serving in the RMN vessels stationed at the base during the study period. Marine technicians who had been drafted out of vessels, those with existing hearing loss other than NIHL, and a history of recent ear infections, trauma, or surgeries were excluded. Based on the NIHL prevalence of 31.4% as reported by Irgen-Hansen et al. (2015), absolute precision at 5%, and 95% confidence interval, the sample size calculated using "Sample Size for Frequency in a Population" (https://www.openepi.com/) was 139.[21,22] The name list containing all marine technicians in the base was assigned a number, followed by subject selection using a random number generator to ensure that each personnel had an equal chance of being included. A total of 127 eligible subjects agreed to participate in this study with a response rate of 91.4%.

Tools

In this study, data on sociodemographic, lifestyle, and occupational characteristics were obtained from participants.[19] Sociodemographic information encompassed

age, ethnicity, education level, and household income, while lifestyle behaviours included smoking, alcohol consumption, and participation in noise-exposed leisure activities. Household income was further divided into low-income (<RM 3,660) and middle-income (RM 3,660–7,639) categories according to the report by the Department of Statistics Malaysia for the State of Perak.[23] Participation in noise-exposed leisure activities included attending night clubs, involvement in motorsports and shooting clubs, listening to music in vehicles with loud sound systems, listening to music using headsets or earphones at high volume, and attending concerts.[19] Participants could also choose none or individually mention the type of noise-exposed leisure activities if they were not listed as options in the questionnaire. Meanwhile, the occupational characteristics recorded comprised rank, length of service, and types of vessels.

Hearing assessments and NIHL diagnosis

Hearing assessments were conducted using the GSI 61 Clinical Audiometer (Grason-Stadler, Minnesota, USA) in the Otorhinolaryngology (ORL) clinic at 96 Hospital Angkatan Tentera located within the Lumut Naval Base. Before the test, all participants were instructed to avoid exposure to any loud noise for at least 16 hours. Participants underwent testing in a soundproof booth with a background noise level below 25 dB(A), with each ear tested independently. Audiometric assessments followed the Hughson-Westlake method, measuring pure tone air conduction.[24] Starting at 1 kHz with an intensity of 30 dB, participants signalled sound detection via a button press. The sound intensity was decreased gradually by 10 dB until no response was elicited, followed by 5 dB gradual increments until response reoccurred. This procedure was repeated three times to identify the threshold, which was defined as the lowest intensity level that elicited two responses out of three presentations. Following the completion of lower frequency testing, the audiometry procedure returned to 1 kHz for rechecking before continuing to higher frequencies.[24] Diagnosis of NIHL is made according to the American College of Occupational and Environmental Medicine's criteria, which requires a threshold of ≥25 dB at 3 kHz, 4 kHz, and 6 kHz, with subsequent recovery at 8 kHz.[3]

Statistical analysis

Data were analysed using SPSS® Statistics® v26 (IBM Corp., New York, USA) and R v4.3.1 (Bell Labs., New Jersey, USA) in the RStudio v2023.12.1 environment (Posit Software, Massachusetts, USA). Continuous data were presented as median and interquartile range following non-normal distribution assessed by the Kolmogorov-Smirnov test, whereas categorical data were presented as counts and percentages. Factors associated with occupational NIHL were initially examined by Pearson χ^2 or Fisher exact tests, followed by further analysis using Firth bias-reduced logistic regression with and without covariates adjustments.[25] This method was applied to reduce the inflated bias caused by covariates with zero counts in the contingency table. Significant results were determined when $p<0.05$ (two-sided).

RESULTS

The socio-demographic characteristics are listed in Table I. The median age of the participants was 32 years, and they mostly came from the Malay ethnicity (n=121, 95.3%). There was a higher proportion of the participants who had a secondary education level (n=82, 64.6%) while the rest had a tertiary education level (n=45, 35.4%). The median household income was RM 2,600. Most of the participants denied alcohol consumption (n=125, 98.4%) or participation in noise-related leisure activities (n=103, 81.1%). Over half of the participants were self-identified as active smokers (n=69, 54.3%).

In terms of military rank, approximately half of the participants were junior able (n=66, 52.0%), followed by petty officer (n=51, 40.2%) and warrant officer (n=10, 7.9%). Most of the participants (n=59, 46.5%) were stationed at the support flotilla, followed by the attack flotilla (n=48, 37.8%), patrol flotilla (n=18, 14.2%), and training flotilla (n=2, 1.6%). The median length of service among participants was 11 years.

Out of 127 subjects, 38 participants were diagnosed with occupational NIHL, with a prevalence rate of 29.9% (95% CI=22.1–38.7) as shown in Table II.

Factors associated with occupational NIHL among the RMN marine technicians are listed in Table III. Based on the Pearson χ^2 test, age (p=0.0183), household income (p=0.0198) and length of service (p=0.0233) had a significant association with occupational NIHL, whereas the education level, smoking status, and participation in noise-related leisure activities were not associated with NIHL. On the Fisher exact test, the military rank (p=0.0120) also showed a significant association with occupational NIHL but not for other variables including ethnicity, alcohol intake, and type of vessels.

Predictors of occupational NIHL among the RMN marine technicians are presented in Table IV. Unadjusted logistic regression analysis (model 1) revealed four variables significantly associated with occupational NIHL. These include age >30 years (OR=2.56, 95% CI=1.17–5.88), middle household income of ≥RM 3,660 (OR=2.76, 95% CI=1.15–6.61), military rank especially the warrant officer (OR=7.12, 95% CI=1.87–32.43), and length of service of ≥15 years (OR=2.40, 95% CI=1.12–5.22) (all $p<0.05$).

In model 2, logistic regression was performed for each predictor with adjustment for ethnicity, smoking status, and type of vessels, since these three variables showed $p<0.2$ on the initial analysis using Pearson χ^2 or Fisher exact tests. Following covariates adjustment, two variables retained a significant association with occupational NIHL, including middle household income (OR=3.21, 95% CI=1.31–8.05) and warrant officer (OR=4.48, 95% CI=1.11–21.04) (all $p<0.05$) (Table IV).

Additional adjustment for noise-related leisure activities was performed in model 3 to further confirm the association of household income and military rank on occupational NIHL. The results showed that middle household income had a 3.15 times increased probability of having occupational NIHL as compared to low household income (95% CI=1.29–7.87, p=0.0112). Additionally, warrant officers had a 4.38 times

Table I: Baseline characteristics of the study population

Characteristics	Frequency (%) (n=127)	Median (IQR)
Age (years)		32 (27–37)
Ethnicity		
Non-Malay	6 (4.7)	
Malay	121 (95.3)	
Education level		
Secondary	82 (64.6)	
Tertiary	45 (35.4)	
Household income (RM)		2,600 (2,000–3,300)
Smoking status		
Non-smoker	58 (45.7)	
Active smoker	69 (54.3)	
Alcohol intake		
No	125 (98.4)	
Yes	2 (1.6)	
Noise-related leisure activities		
No	103 (81.1)	
Yes	24 (18.9)	
Military rank		
Junior able	66 (52.0)	
Petty officer	51 (40.2)	
Warrant officer	10 (7.9)	
Types of vessels		
Attack flotilla	48 (37.8)	
Patrol flotilla	18 (14.2)	
Support flotilla	59 (46.5)	
Training flotilla	2 (1.6)	
Length of service (years)		11 (6–17)

Continuous data are presented as median (IQR) and categorical data are presented as count (percentage).

Table II: Prevalence of occupational NIHL among the RMN marine technicians

Occupational NIHL	Frequency (%) (n=127)	95% CI (%)
Yes	38 (29.9)	22.1–38.7
No	89 (70.1)	61.3–77.9

Abbreviations: CI (confidence interval), NIHL (noise-induced hearing loss), RMN (Royal Malaysian Navy).

higher probability of having occupational NIHL than junior able (95% CI=1.08–20.52, p=0.0384) (Table IV).

DISCUSSION

The current study found that approximately one in every three marine technicians (29.9%) working on board the RMN vessels suffered from occupational NIHL, which is markedly higher than the 5% global prevalence.[1] This is not surprising since military personnel are regularly exposed to a higher degree of noise compared to the general population. The source of noise in the military settings includes military weapon systems that could generate more than 140 dB peak sound pressure level (dBP) with some weapon classes generating even higher noise of more than 180 dBP.[26] As for the marine technicians, the sound generated inside the engine room where they typically work is within the range of 108–118 dB(A),[26] significantly higher than the cut-off criteria of noise exposure in NIHL diagnosis.[5] The prevalence of occupational NIHL among RMN marine technicians in this study is comparatively lower compared to previously reported data from the foreign military. For instance, a study among 605 Royal Norwegian Navy personnel found that the total prevalence of hearing loss was 31.4% with the highest recorded prevalence among the engine room workers at 38.0%.[22] Similarly, among 150 personnel of the Belgian Armed Forces, the prevalence of hearing loss was 62.7% whereas the highest percentage was also recorded among the navy at approximately 80%.[27] However, both studies included all types of hearing loss and did not focus specifically on occupational NIHL which could explain the higher prevalence observed.

In Malaysia, there were two reported studies regarding the prevalence of occupational NIHL among military personnel. The overall prevalence of occupational NIHL was 24.2% among 263 RMAF aircraft technicians and 18.9% among 233 RMN personnel,[19,20] both of which were comparatively lower than the prevalence observed in the current study. The differences in the prevalence could be explained by the variation in the populations being studied that was closely related to their work environment. In the current study,

Table III: Factors associated with occupational NIHL among the RMN marine technicians

Parameters	Occupational NIHL		p-value
	Yes (n=38)	No (n=89)	
Age[a]			0.0183*
≤30 years	11 (19.3)	46 (80.7)	
>30 years	27 (38.6)	43 (61.4)	
Ethnicity[b]			0.1775
Non-Malay	0 (0.0)	6 (100.0)	
Malay	38 (31.4)	83 (68.6)	
Education level[a]			0.8283
Secondary	24 (29.3)	58 (70.7)	
Tertiary	14 (31.1)	31 (68.9)	
Household income[a]			0.0198*
Low	25 (25.0)	75 (75.0)	
Middle	13 (48.1)	14 (51.9)	
Smoking status[a]			0.1561
Non-smoker	21 (36.2)	37 (63.8)	
Active smoker	17 (24.6)	52 (75.4)	
Alcohol intake[b]			1.0000
No	38 (30.4)	87 (69.6)	
Yes	0 (0.0)	2 (100.0)	
Noise-related leisure activities[a]			0.9286
No	31 (30.1)	72 (69.9)	
Yes	7 (29.2)	17 (70.8)	
Military rank[b]			0.0120*
Junior able	15 (22.7)	51 (77.3)	
Petty officer	16 (31.4)	35 (68.6)	
Warrant officer	7 (70.0)	3 (30.0)	
Types of vessels[b]			0.1033
Attack flotilla	15 (31.3)	33 (68.8)	
Patrol flotilla	7 (38.9)	11 (61.1)	
Support flotilla	14 (23.7)	45 (76.3)	
Training flotilla	2 (100.0)	0 (0.0)	
Length of service[a]			0.0233*
<15 years	17 (22.4)	59 (77.6)	
≥15 years	21 (41.2)	30 (58.8)	

Data were analysed using [a]Pearson χ^2 and [b]Fisher exact tests. *Significant results at p<0.05. Abbreviations: IQR (interquartile range), NIHL (noise-induced hearing loss), RMN (Royal Malaysian Navy).

Table IV: Predictors of occupational NIHL among the RMN marine technicians

Predictors	Model 1 OR (95% CI)	p-value	Model 2 OR (95% CI)	p-value	Model 3 OR (95% CI)	p-value
Age						
≤30 years	1 (Ref.)	-	1 (Ref.)	-	1 (Ref.)	-
>30 years	2.56 (1.17–5.88)	0.0185*	1.81 (0.78–4.38)	0.1705	1.79 (0.77–4.31)	0.1759
Household income						
Low	1 (Ref.)	-	1 (Ref.)	-	1 (Ref.)	-
Middle	2.76 (1.15–6.61)	0.0227*	3.21 (1.31–8.05)	0.0112*	3.15 (1.29–7.87)	0.0121*
Military rank						
Junior able	1 (Ref.)	-	1 (Ref.)	-	1 (Ref.)	-
Petty officer	1.54 (0.68–3.51)	0.2954	1.10 (0.45–2.63)	0.8329	1.09 (0.45–2.60)	0.8467
Warrant officer	7.12 (1.87–32.43)	0.0038*	4.48 (1.11–21.04)	0.0355*	4.38 (1.08–20.52)	0.0384*
Length of service						
<15 years	1 (Ref.)	-	1 (Ref.)	-	1 (Ref.)	-
≥15 years	2.40 (1.12–5.22)	0.0246*	1.73 (0.78–3.86)	0.1756	1.71 (0.77–3.81)	0.1865

Data were analysed using Firth bias-reduced logistic regression. Model 1: no covariate adjustment, Model 2: adjusted for ethnicity, smoking status, and types of vessels, Model 3: adjusted for covariates in Model 2 + noise-related leisure activities. *Significant results at p<0.05. Abbreviations: CI (confidence interval), NIHL (noise-induced hearing loss), OR (odds ratio), Ref. (reference), RMN (Royal Malaysian Navy).

marine technicians operated within the confined spaces of RMN vessels, whereas the RMAF aircraft technicians mostly worked on open spaces such as airstrips or hangars. Compared to open spaces, confined spaces like the engine room with limited entry and exit openings are more hazardous.[28] Sounds originating from the generators, engines, and other machinery would undergo reverberation from the walls causing sound amplification and potential long-term effects on hearing.[29] Although the other study was also conducted among RMN personnel,[20] the study population was not focused on marine technicians. Rather, it included various roles in the RMN broadly classified into those who were in the diving and non-diving units.[20] Similar to marine technicians, divers are also exposed to high noise levels between 88.3–91.8 dB(A) from breathing apparatus and communication devices.[30] However, these noises are generally lower than the 104 dB(A) produced within engine room,[14] which could explain the higher prevalence of occupational NIHL in the current study.

To uncover the associated factors of occupational NIHL among RMN marine technicians, we analysed several parameters including the sociodemographic and socioeconomic characteristics (i.e., age, ethnicity, education level, and household income), lifestyle characteristics (i.e., smoking status, alcohol intake, and participation in the noise-related leisure activities), as well as occupational characteristics (i.e., military rank, types of vessels, and length of service). Data analysis without covariate adjustments revealed that four parameters showed significant associations with occupational NIHL in the current study, comprising age >30 years, middle household income of ≥RM 3,660, military rank especially the warrant officer, and length of service ≥15 years. Upon further analysis with covariate adjustments, only two parameters retained a significant association with occupational NIHL including higher household income and higher military rank.

Higher household income was associated with 3.15 times increased probability of having occupational NIHL in the current study. This is in contrast with findings from previously published papers involving working adult populations. For instance, a study among 16,078 participants of the National Health and Nutrition Examination Survey (NHANES) in the United States indicated that there was no association between income and occupational NIHL (OR=1.02, p=0.755).[31] Similarly, income had no association with occupational NIHL (OR=0.88, p=0.230) as reported in another study involving 10,850 participants of the Korea National Health and Nutrition Examination Survey (KNHANES).[32] Although there was a significant association between income and high-frequency hearing loss, data from 3,999 participants of the Canadian Health Measures Survey (CHMS) showed that the prevalence of occupational hearing loss was lower in the middle and high-income categories compared to low-income group (31.1%, 28.6%, and 41.0%, respectively, p<0.05).[33]

At present, there is no data regarding the association between household income and occupational NIHL in military settings. However, the association between household income and NIHL in the current study has a similar direction when compared to previous studies using non-working populations. For example, a study among 1,845 South Korean adolescents aged 12–19 years found that those who came from a high household income family had 1.39 times increased odds of having NIHL (95% CI=1.00–1.99, p<0.05).[34] Meanwhile, among 245 Jordanian university students, hearing symptoms including hearing loss and usage of hearing aids were more prevalent among individuals from above-average income families compared to those from average and below-average income families (57.6%, 33.3%, and 22.2%, respectively, p=0.017).[35] Individuals who have better socioeconomic status might not need to pursue part-time jobs and would have more free time to engage in loud noise-related leisure activities.[35] They might also have higher purchasing power and could afford to purchase personal music devices, smartphones, or sound systems,[34] which further increases their exposure to loud noises, resulting in a higher risk of NIHL. However, there was no association between participation in noise-related leisure activities with occupational NIHL found in the current study.

Higher military rank, specifically the warrant officer, is associated with a 4.38 times higher probability of having occupational NIHL as observed in the present study. On the contrary, Kim et al. (2021) reported that among 13,470 Republic of Korean military personnel, the enlisted soldiers, of lower ranks, had 1.92–2.58 higher odds of having occupational NIHL as compared to the warrant and commissioned officers (p<0.05).[36] The increased probability for occupational NIHL among higher military ranks in the present study could be explained by military personnel's composition and allocation for each flotilla. The number of warrant officers for marine technicians in each RMN vessel is limited to one or two depending on the vessel's size. If repair is required during sailing, the warrant officer will remain stationed within the engine room for the entire duration of the repair process. This is because the warrant officer will be the most knowledgeable and experienced in handling the repair. Comparatively, the lower-ranked personnel will have the flexibility to take turns in performing the repair procedure. Consequently, the warrant officers would have more prolonged exposure to the noise in the engine room, thus, increasing their risk for occupational NIHL.

Several limitations have been identified in this study. First, we did not measure the level of noise exposure using a personal dosimeter or noise mapping for each flotilla type using a sound level meter due to cost restrictions. Consequently, we also did not assess the usage of PHP such as earplugs and earmuffs to avoid misunderstanding among the marine technicians that they were being evaluated on competency and discipline in following the standard operating procedures as implemented by the RMN that could affect the response rate. Finally, the baseline audiogram data for each participant were unavailable for comparison. Therefore, we could not confidently determine whether the occupational NIHL was present before or after the participants had started working on board the RMN vessels. Since participants were randomly selected and the distribution of flotilla types as well as ranks of the marine technicians are similar across other Malaysian naval bases, the results from this study can be applied to the whole population of marine technicians serving on board the RMN vessels.

CONCLUSION

The marine technicians working on board the RMN vessels had a higher prevalence of occupational NIHL compared to the prevalence among other Malaysian Armed Forces (MAF) personnel as well as the global data. Higher household income and higher military rank are the associated factors and significant predictors for occupational NIHL among RMN marine technicians. These findings may necessitate regular audiometric testing as well as the implementation of a hearing conservative programme, especially for individuals at high risk.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. Natarajan N, Batts S, Stankovic KM. Noise-induced hearing loss. J Clin Med 2023; 12(6): 2347.
2. Śliwińska-Kowalska M, Zaborowski K. WHO environmental noise guidelines for the European region: A systematic review on environmental noise and permanent hearing loss and tinnitus. Int J Environ Res Public Health 2017; 14(10): 1139.
3. Mirza R, Kirchner DB, Dobie RA, Crawford J. Occupational noise-induced hearing loss. J Occup Environ Med 2018; 60(9): e498–501.
4. Themann CL, Masterson EA. Occupational noise exposure: A review of its effects, epidemiology, and impact with recommendations for reducing its burden. J Acoust Soc Am 2019; 146(5): 3879.
5. Yong JSE, Wang DY. Impact of noise on hearing in the military. Mil Med Res 2015; 2: 6.
6. Graydon K, Gunasekera H, Miller H, Waterworth C. Global burden of hearing impairment and ear disease. J Laryngol Otol 2019; 133(1): 18–25.
7. Halim I, Azizul I, David CCH, Hanis A, Hafiz B, Naiemy R, et al. Noise-induced hearing loss among manufacturing factory workers in Kuching, Sarawak: Prevalence and associated risk factors. Med J Malaysia 2023; 78(5): 559–65.
8. Ministry of Human Resources. Occupational Safety and Health (Noise Exposure) Regulations 2019. Putrajaya: Ministry of Human Resources; 2019.
9. Social Security Organisation. 2014 Annual Report. Kuala Lumpur: Social Security Organisation; 2014.
10. Bernama. DOSH records over 5,000 cases of hearing problems due to occupational noise: The New Straits Times; [updated 17 August 2023, cited 1 March 2024]. Available from: https://www.nst.com.my/news/nation/2023/08/944121/dosh-records-over-5000-cases-hearing-problems-due-occupational-noise.
11. Department of Statistics Malaysia. National Occupational Accident and Disease Statistics 2021; [updated 31 December 2021, cited 1 March 2024]. Available from: https://www.ilmia.gov.my/index.php/en/bda-noa.
12. Collée A, Legrand C, Govaerts B, Van Der Veken P, De Boodt F, Degrave E. Occupational exposure to noise and the prevalence of hearing loss in a Belgian military population: A cross-sectional study. Noise Health 2011; 13(50): 64–70.
13. Nair S, Kashyap RC. Prevalence of noise induced hearing loss in Indian Air Force personnel. Med J Armed Forces India 2009; 65(3): 247–51.
14. Oldenburg M, Felten C, Hedtmann J, Jensen HJ. Physical influences on seafarers are different during their voyage episodes of port stay, river passage and sea passage: A maritime field study. PLoS One 2020; 15(4): 1–12.
15. Ibrahim F, Abu Zarim MAUA, Razali MN, Mat Radzi Z, Zainal Abidin N, Ahmad MA, et al. Noise level analysis onboard a Vessel X during sailing at sea. Zulfaqar J Def Sci Eng Technol 2023; 6(1): 1–7.
16. Kaerlev L, Jensen A, Nielsen PS, Olsen J, Hannerz H, Tüchsen F. Hospital contacts for noise-related hearing loss among Danish seafarers and fishermen: A population-based cohort study. Noise Health 2008; 10(39): 41–5.
17. Luha A, Kaart T, Merisalu E, Indermitte E, Orru H. Hearing problems among the members of the defence forces in relation to personal and occupational risk factors. Mil Med 2020; 185(11–12): e2115–23.
18. Heupa AB, de Oliveira Gonçalves CG, Coifman H. Effects of impact noise on the hearing of military personnel. Braz J Otorhinolaryngol 2011; 77(6): 747–53.
19. Zamri MD, Anita AR, Azuhairi AA, Haizar MH, Mariah H. Predictors of aircraft related noise induced hearing loss (NIHL) among technicians in Royal Malaysian Air Force (RMAF). Int J Public Heal Clin Sci 2017; 4(3): 120–30.
20. Ahmad MA. A Study on Prevalence of Hearing Impairment and Ear Diseases among Navy Personnel of the Royal Malaysian Navy, Lumut, Perak. Universiti Sains Malaysia; 2011.
21. Sullivan KM, Dean A, Soe MM. OpenEpi: A web-based epidemiologic and statistical calculator for public health. Public Health Rep 2009; 124(3): 471–4.
22. Irgens-Hansen K, Sunde E, Bråtveit M, Baste V, Oftedal G, Koefoed V, et al. Hearing loss in the Royal Norwegian Navy: A cross-sectional study. Int Arch Occup Environ Health 2015; 88(5): 641–9.
23. Department of Statistics Malaysia. Household Income and Basic Amenities Survey Report by State and Administrative District - Perak (2019). Putrajaya: Ministry of Economy; 2020.
24. Hughson W, Westlake HD. Manual for program outline for rehabilitation of aural casualties both military and civilian. Trans Am Acad Ophthalmol Otolaryngol 1944; 48(Suppl): 1–15.
25. Heinze G, Schemper M. A solution to the problem of separation in logistic regression. Stat Med 2002; 21(16): 2409–19.
26. Jokel C, Yankaskas K, Robinette MB. Noise of military weapons, ground vehicles, planes and ships. J Acoust Soc Am 2019; 146(5): 3832–8.
27. Orru H, Luha A, Pindus M, Jõgeva R, Vahisalu M, Lekk U, et al. Hearing loss among military personnel in relation to occupational and leisure noise exposure and usage of personal protective equipment. Noise Health 2020; 22(107): 90–8.
28. Selman J, Spickett J, Jansz J, Mullins B. Confined space rescue: A proposed procedure to reduce the risks. Saf Sci 2019; 113: 78–90.
29. Aretz M, Orlowski R. Sound strength and reverberation time in small concert halls. Appl Acoust 2009; 70(8): 1099–110.
30. Nedwell JR, Mason TI, Collett AG, Gardiner RWK. Noise exposure of commercial divers in the Norwegian sector of the North Sea. Undersea Hyperb Med 2015; 42(2): 151–8.
31. Sun R. Occupational and Socioeconomic Risk Factors of Noise-induced Hearing Loss. Yale University; 2022.

32. Lee HJ, Lee J, Yoon C, Park Y, Joo YH, Park JO, et al. Association of dietary factors with noise-induced hearing loss in Korean population: A 3-year national cohort study. PLoS One 2022; 17(12): e0279884.
33. Feder K, Michaud D, McNamee J, Fitzpatrick E, Davies H, Leroux T. Prevalence of hazardous occupational noise exposure, hearing loss, and hearing protection usage among a representative sample of working Canadians. J Occup Environ Med 2017; 59(1): 92-113.
34. Kim SH, Cha ES, Cha HE, Song JJ, Chae SW. Prevalence and clinical aspects of hearing loss among the South Korean adolescent: Data from a population-based study. Int J Pediatr Otorhinolaryngol 2020; 128: 109698.
35. Alnuman N, Ghnimat T. Awareness of noise-induced hearing loss and use of hearing protection among young adults in Jordan. Int J Environ Res Public Health 2019; 16(16): 2961.
36. Kim HJ, Oh SY, Won SY, Kim HJ, Kim TK, Ko BC, et al. Associations between earplug use and hearing loss in ROK military personnel. BMJ Mil Heal 2021; 167(6): 398–401.