Original Article

Hearing Conservation Program for Vector Control Workers: Short-Term Outcomes from a Randomized – Cluster Controlled Trial

Rama Krishna Supramanian,[a,*] Marzuki Isahak,[a] Noran Naqiah Hairi[a, b]

[a] *Department of Social and Preventive Medicine, University of Malaya, Malaysia.*
[b] *Centre for Epidemiology and Evidence Based Practice*

*Corresponding author: ramakrishna659@yahoo.com

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ABSTRACT : *Noise-Induced Hearing Loss (NIHL) is one of the highest recorded occupational diseases, despite being preventable. The purpose of this study was to determine the effectiveness of a Hearing Conservation Program (HCP) in preventing or reducing audiometric threshold changes among vector control workers. This is a cluster randomized controlled trial involving 183 vector control workers. The HCP was implemented among participants of the intervention group. Audiometric threshold changes observed in the intervention group showed improvement in hearing threshold levels for all frequencies except 500 Hz and 8000 Hz for the left ear. The hearing threshold changes range from 1.4 dB to 5.2 dB, with the largest improvement at higher frequencies, mainly 4000 Hz and 6000 Hz. Meanwhile, the mean hearing threshold level remained similar for the right ear at 4000 Hz and 6000 Hz after three months of intervention. Thus, the HCP is effective in preserving the hearing of vector control workers involved in fogging activities.*

Keywords - *Audiometry, Hearing Conservation, Noise-Induced Hearing Loss, Program Evaluation, Vector Control Worker*

1.0 INTRODUCTION

The burden of occupational Noise-Induced Hearing Loss (NIHL) remains on the rise, especially in developing countries. It has been reported that 16% of the global adult-onset hearing loss or over 4 million Disability-Adjusted Life Years (DALYs) is attributed to occupational noise exposure (Dobie, 2008; Nelson, Nelson, Concha-Barrientos, & Fingerhut, 2005). In Malaysia, NIHL was the highest reported occupational disease in 2017, accounting for 63.7% of all occupational diseases (Department of Occupational Safety and Health, 2018). The burden of NIHL in the manufacturing sector showed workers were at high risk of developing NIHL, with the highest risk of 32% seen in the motor vehicle parts industry (Noraita, Syed Mohamed, Jamal Hisham, & Jaseema, 2014). Although NIHL is preventable, it remains of high public health importance due to the increasing burden.

Vector control workers are responsible for carrying out fogging activities as part of an integrated vector control approach recommended by the World Health Organisation (WHO) for dengue prevention and control (World Health Organization, 2012). They are exposed to noise emitted by fogging machines putting them at risk of developing NIHL. It has been reported that the fogging machines emit noise levels above 90 dB(A) at a distance of 0.5m (Masilamani, Rasib, Darus, & Ting, 2014). Furthermore, exposure to ototoxic chemicals such as organophosphate pesticides and diesel (diluent) during fogging activities may synergistically exacerbate hearing loss (Hoshino, Pacheco-Ferreira, Taguchi,Tomita, & Miranda, 2008; Sheikh, Williams, & Connolly, 2016). In addition to the auditory effects, mainly hearing loss, noiseexposure may also cause non-auditory effects on health such as anxiety, hypertension, cardiovascular diseases, and impaired cognitive performance (Basner et al., 2014). Furthermore, NIHL is associated with reduced quality of life due to social, emotional communication hindrance (Mulrow et al., 1990).

Many local studies have been conducted to determine the prevalence and associated factors of NIHL among various occupation groups such as quarry workers (57%), airport workers (33.5%), dental staff nurses (5%), traffic police personnel (80%) and vector control workers (26.5%) (Daud et al., 2011; Habib, 2012; Ismail, Daud, Ismail, & Abdullah, 2013; Masilamani et al., 2014; Thomas, Mariah, Fuad, Kuljit, Hnorl, et al., 2007). Although NIHL is a highly preventable disease and HCPs are in place in the industries, it remains a major occupational health problem in Malaysia and is of high public health importance. Another local study reported a lack of compliance towards HCP among industries and required improvement to prevent NIHL among workers (Nor Saleha & Noor Hassim, 2006).

Despite its known implications on health, safety, cost, and productivity, there still lacks research in Malaysia to prevent NIHL (Fuente & Hickson, 2011; Girard et al., 2015). In Malaysia, the Permissible Exposure Limit (PEL) is set at 85 dB(A) under the Occupational Safety and Health (Noise Exposure) Regulations 2019, and measures to reduce excessive noise are needed if this limit is exceeded (Department of Occupational Safety and Health, 2019). Furthermore, according to US Occupational Safety and Health Administration (OSHA) regulations, a HCP is to be implemented if employees are exposed to levels higher than an 8-hour Time-Weighted Average (TWA) of 85 dB(A) (US Department of Labor,2013). Therefore, the purpose of this study is to evaluate the effectiveness of a Hearing Conservation Program (HCP) in preventing or reducing audiometric threshold changes among vector control workers.

2.0 METHOD

2.1 Participants

The sample size for this study was 183 participants, determined using OpenEpi version 3.01 with reference to outcome from a study by Davies et al. (Davies, Marion, & Teschke, 2008). Participants were recruited voluntarily from nine District Health Offices (DHO) in Perak, Malaysia. Participants comprised both permanent and contract basis vector control workers under the Ministry of Health (MOH). The latter is directly involved in fogging activities and can read and understand the Malay language. Vector control workers with hearing loss were excluded from other causes besides work, such as ear infection, perforated tympanic membrane, and other conductive hearing loss conditions. The Medical Ethics Committee approved this study, University Malaya Medical Centre (MREC ID: 2017220-4936) and registered with the National Medical Research Register (NMRR-17-375-34724) as well as Thai Clinical Trials Registry (TCTR2019010900).

2.2 Study Design

A cluster-randomized design was used, with DHO as the unit of randomization. Nine out of 11 DHOs were randomly assigned to either the intervention or control group using a computer-generated random numbers. Each DHO was first coded before randomization to ensure allocation concealment, and all vector control workers from each selected DHO were included in this study. A single blinding method was applied where data collectors and outcome assessors, mainly personnel performing the audiometry test to measure hearing threshold levels, were unaware of the participant's group allocation. Given that the intervention involved a training and education program delivered by the researcher, it was impossibleto blind the participants and researchers. However, since both intervention and control groups consist of DHOs that were geographically separated, it is not necessary to blind the participants in this trial.

The intervention period lasted for three months in which the HCP was implemented, and participants were given a training and education program described further under the intervention section. The workers' annual audiometry for 2017 (pre-intervention) was used as the baseline audiometry for this study. The outcome measured participants' hearing threshold levels at the frequencies 500, 1000, 2000, 3000, 4000, 6000, and 8000 kHz assessed using calibrated audiometric booths. Participants were required to have 14 hours of the silent period before the audiometric testing, and participants who had any upper respiratory tract infection symptoms were rescheduled. In addition, socio-demographic information and the job characteristics data of participants were collected during the baseline screening using a brief questionnaire. Meanwhile, participants' environmental factors, lifestyle, past occupational history, and medical condition information were gathered during the following three months using a hearing assessment form.

A total of 183 participants with baseline audiometry testing were enrolled in this study, with 154 participants repeating the audiometry test for the next three months. The follow-up rate for both intervention and control groups was above 90% at one-month post-intervention, with the intervention group achieving a 100% response rate. Meanwhile, during the final follow-up at three months post-intervention, the follow-up rate was well above 80% for each group.

2.3 Hearing Conservation Program (Intervention)

The Hearing Conservation Program (HCP) was developed by incorporating information obtained from three key domains; systematic literature review, comparing local and international guidelines, and interviews with key stakeholders. This HCP aims to prevent NIHL among vector control workers exposed to noise emitted from fogging machines. The HCP was implemented in four DHOs from the intervention group for three months.An HCP coordinator oversaw the program that the safety committee elected in each DHO. It consists of the following eight elements:

- Safety and Health Policy

  A documented safety and health policy by the Ministry of Health was made available at DHOs. Awareness of this policy was also raised among participants by establishing a safety and health committee during the training and education program.

- Noise Monitoring

  A noise survey which included personal noise monitoring, area noise monitoring, and noise mapping, was conducted.

- Noise Control

  Administrative control measures were implemented using an equipment preventive maintenance checklist for each fogging machine to ensure that maintenance is conducted according to recommended intervals. Besides that, a safe distance of seven meters from the fogging machine during fogging activities were recommended (based on noise mapping findings)

- Provision of Hearing Protection

  Appropriate Hearing Protection Devices (HPD) that provide adequate protection were made available to participants.

- Training and Education Program

  This training and education program involved a two-hour presentation, a video presentation on proper care and use of earmuffs (five mins), and hands-on training on the appropriate use of earmuffs (25 mins). It contains general information about NIHL and hazard communication of noise exposure monitoring results and was delivered by the researcher.

- Audiometry Testing

  Participants underwent ear examination and audiometric testing before implementing HCP (pre-intervention) and three months after (post-intervention). In addition, participants received an appointment card to serve as a reminder of upcoming medical examinations and audiometric testing.

- Record Keeping

  All records (personal details of the vector control worker, job title, audiometric test results, training, and noise exposure results) were filed systematically and maintained in a confidential manner by the HCP coordinator.

- Monitoring and Evaluation

  Monitoring and evaluation of the program were done annually to assess the progress and success of the HCP.

The data were analyzed using the Statistical Package for Social Science (SPSS) software desktop version 20.0. The level of significance was set at 0.05, with all variables being tested for normality. All analyses were done according to Per-Protocol (PP) principles to avoid overestimating the effect of HCP on the hearing threshold levels of the participants. The effectiveness of the program was evaluated by comparing the mean difference of hearing threshold levels between pre-and post-intervention within (intragroup) and between (intergroup) the intervention and control groups using an independent t-test.

3.0 RESULTS

3.1 Recruitment and Participant Flow

A total of 183 vector control workers were recruited voluntarily from nine DHO to participate in this study based on a 95% confidence interval and a 5% margin for error. The recruitment process commenced three months, from November 2017 till January 2018 (Fig. 1). Part of the intervention included a training and education program delivered to participants from the intervention group, and the response rate was 100%. After three months, this study's loss to follow-up rate is 3.3% for the intervention group and 22% for the control group. Participants faced difficulties with follow-ups primarily due to being transferred to different units or simply not being present during the outcome measurement, but the numbers wereminimal. A couple of steps were taken to keep the loss to follow-up rate to a minimum. For example, they used an appointmentcard for audiometry testing and contacted their supervisors before the follow-up to serve as a reminder.

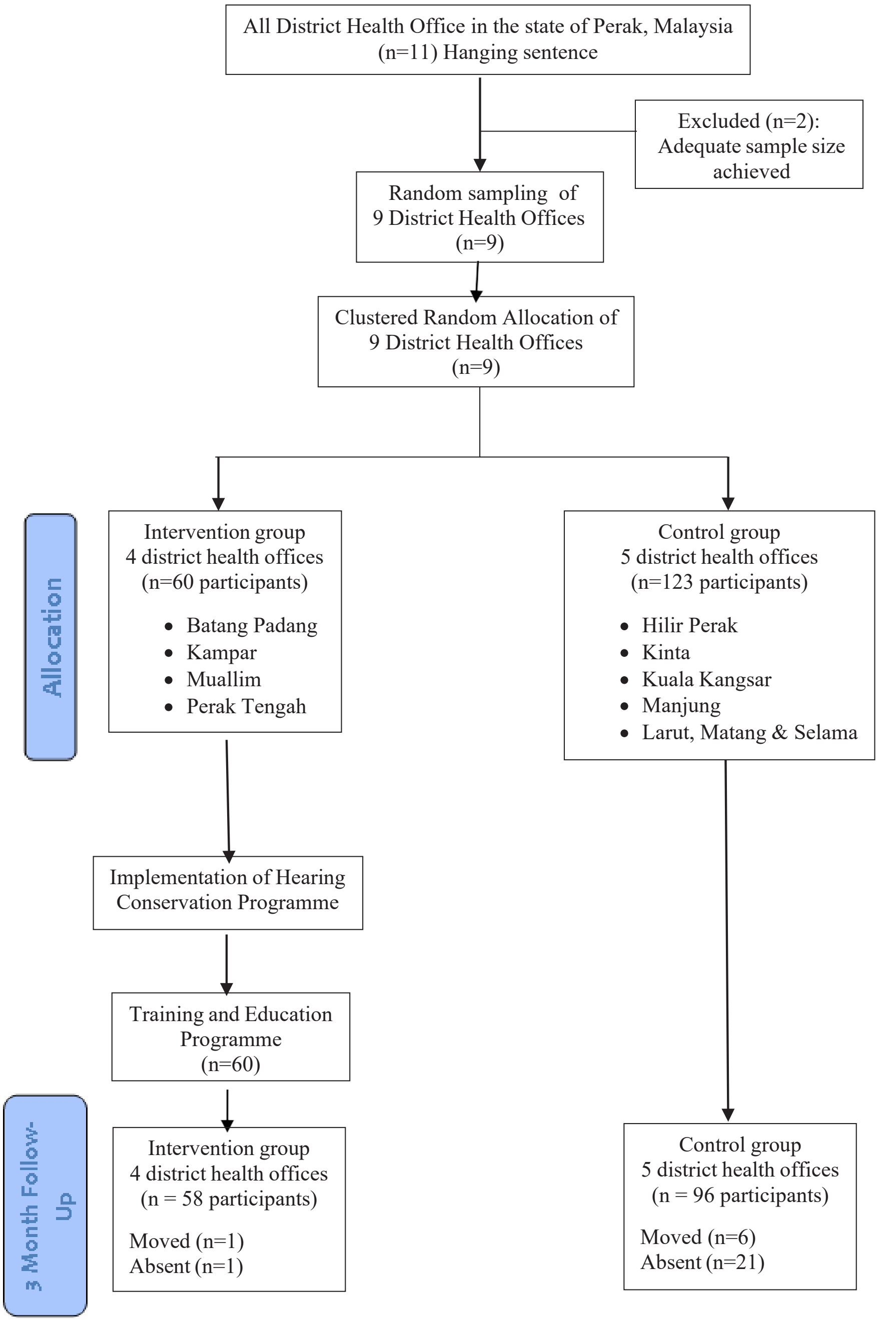

Figure 1 Participant Flowchart

3.2 Characteristics of the Sample

Summary of participants' characteristics, including their job and noise exposure characteristics, is presented in Table 1. Most of the participants were male (99.5%) with an average age of 37 years and classified as general workers (78%) based on their job title. In terms of noise exposure, about half of the participants (48.6%) were exposed to noise from their previous occupations, and the majority handled fogging machines currently (83.6%). In addition, a small percentage of participants live in a noisy residential area (7.1%) and indulge in activities that may cause hearing loss, such as diving and the use of guns or explosives (9.1%).

Table 1 Socio-Demographic Characteristics of Participants

	All Frequency (%)	Intervention (n=60)	Control (n=123)	p-value
Gender				
Male	182 (99.5)	60 (100.0)	122 (99.1)	1.000
Female	1 (0.5)	-	1 (0.9)	
Age (years) (Mean±SD)	37.3±8.4	37.7±1.3	36.6±7.0	0.279
Duration of employment (years) (n=179) (Mean±SD)	8.6±11.2	7.5±0.9	9.3±1.3	0.656
Job title (n=154)				
i. General worker	78 (50.6)	25 (43.1)	53 (55.2)	
ii. Public Health Assistant	55 (35.7)	21 (36.2)	34 (35.4)	
iii. Senior Public Health Assistant	3 (1.9)	1 (1.7)	2 (2.1)	
iv. Assistant Environmental Health Officer	4 (2.6)	2 (3.4)	2 (2.1)	0.162

v. Senior Assistant Environmental Health Officer	1 (0.7)	1 (1.7)	-	
vi. Health Inspector	2 (1.4)	1 (1.7)	1 (1)	
vii. Driver	9 (5.8)	7 (12.2)	2 (2.1)	
viii. Contract worker	2 (1.3)	-	2 (2.1)	
Past occupational exposure to noise (n=183)				
Yes	89 (48.6)	33 (55)	56 (45.5)	0.271
No	94 (51.4)	27 (45)	67 (54.5)	
Use of fogging machine (n=183)				
Yes	153 (83.6)	45 (75)	108 (87.8)	
No	30 (16.4)	15 (25)	15 (12.2)	0.034
Living in a noisy residential area (n=154)				
Yes	11 (7.1)	3 (5.2)	8 (8.3)	0.537
No	143 (92.9)	55 (94.8)	88 (91.7)	
Smoking history (n=183)				
Yes	54 (29.5)	21 (35)	33 (26.8)	0.301
No	129 (70.5)	39 (65)	90 (73.2)	
History of diving/ using guns or explosives (n=154)				
Yes	14 (9.1)	5 (8.6)	9 (9.4)	1.000
No	140 (90.9)	53 (91.4)	87 (90.6)	

3.3 Noise Exposure Monitoring Results

Two types of fogging machines were used during fogging activities, mainly the thermal fogging machine and ultra-low volume (ULV) fogging machine. As for workers using the ultra-low volume (ULV) fogging machine, personal noise exposure level for an 8-hour Time Weighted Average (TWA) was well below the permitted daily noise exposure level of 85 dB(A). Meanwhile, the personal monitoring results of workers handling the thermal fogging machine from each group showed an 8-hour Time Weighted Average (TWA) of 87.3 dB(A) and 93.1 dB(A), respectively.

3.4 Effectiveness of Hearing Conservation Program (HCP)

Fig. 2 and 3 show the trend in hearing threshold level changes for the left and right ears after three months of intervention by a randomized group. Both intervention and control groups showed a reduced hearing threshold for all frequencies after three months for the left ear. However, the intervention group showed an increase of hearing threshold levels three months post-intervention for the frequencies 500 Hz and 8000 Hz. The most significant reduction in hearing threshold post-intervention was observed at 6000 Hz (5.4 dB) for the intervention group and 500 Hz (3.5 dB) for the control group. Meanwhile, for the right ear, the intervention group showed a trend of higher hearing threshold levels at all frequencies three months post-intervention, mainly involving lower frequencies (500, 1000, 2000, and 3000 Hz). The control group showed a reduction in hearing threshold levels after three months for all frequencies except 6000 Hz. The level of hearing threshold remained similar after three months at 8000 Hz for the control group.

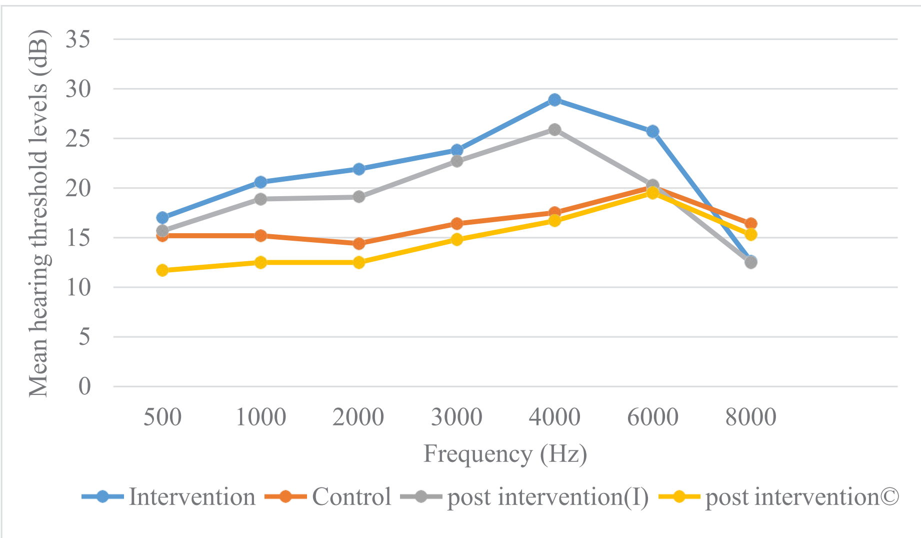

Figure 2 Changes in Mean Hearing Threshold Levels for The Left Ear After 3 Months for the Intervention and Control Group

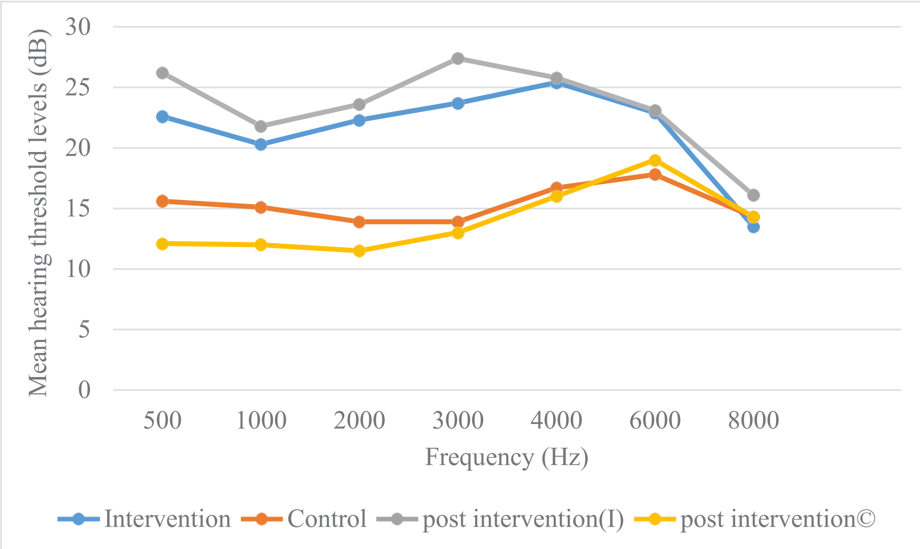

Figure 3 Changes in Mean Hearing Threshold Levels for The Right Ear After 3 Months for the Intervention and Control Group

The effectiveness of the HCP was determined by comparing the difference in mean hearing threshold levels between the control and intervention groups. A positive intergroup mean difference indicates a more significant improvement in the intervention group than the comparison group. The intragroup and intergroup hearing threshold changes in bilateral ear for all frequencies after three months for both control and intervention groups are shown in Table 2 and 3. The left ear means hearing threshold in the intervention group showed significant improvement for all frequencies post-intervention, with the most considerable reduction seen at 6000 Hz with a 5.4 dB reduction and is statistically significant ($p<0.05$). At 8000 Hz, the mean hearing threshold remained similar post-intervention, with only a 0.2 dB reduction observed. The control group also showed a reduction in the left ear mean hearing threshold for all frequencies, with the most significant reduction seen at 500 Hz with a 30 dB reduction and is statistically significant ($p<0.05$). After three months, the mean hearing threshold remained similar for 4000 Hz and 6000 Hz with only a 0.8 dB and 0.6 dB reduction. Positive values of intergroup mean difference were observed at 2000 Hz (0.97 dB) and 4000 Hz (2.24 dB), with the most significant improvement seen at the latter frequency even though it was statistically not significant.

Meanwhile, for the right ear, the intervention group showed an increase in the mean hearing threshold for all frequencies, with the most significant increase observed at 3000 Hz with a 3.7 dB increase that was statistically significant. The mean hearing threshold remained almost similar at 4000 Hz and 6000 Hz with only a minimal 0.4 dB and 0.2 dB increase after three months of post-intervention. The control group showed a reduction in mean hearing threshold after three months for all frequencies except 6000 Hz and 8000 Hz, with the most significant reduction seen at 500 Hz with a 3.5 dB reduction and found to be statistically significant ($p<0.05$). However, the mean hearing threshold remained almost similar at 3, 4, and 8 kHz after three months. As for the intergroup mean difference, negative values were observed at all frequencies except 6000 Hz (1.08) but not statistically significant.

Table 2 Participants' Left Ear Hearing Threshold Level Changes After Three Months

Frequency (Hz)	Intervention group (n=58)			Control group			Intergroup	
	Pre-intervention Mean (SD)	Post-intervention Mean (SD)	Intragroup mean difference (SD)	Pre-intervention Mean (SD)	Post-intervention Mean (SD)	Intragroup mean difference (SD)	Intergroup mean difference (95% CI)	p-value
500	17.0#(6.7)	15.7#(11.9)	-1.3 (10.3)	15.2##(7.3)	11.7##(8.7)	-3.5* (8.2)	-2.27 (-5.64, 1.11)	0.186
1000	20.6(8.5)	18.9 (10.7)	-1.7 (6.7)	15.2 (7.4)	12.5 (9.3)	-2.6* (8.7)	-0.90 (-3.53, 1.73)	0.500
2000	21.9(9.3)	19.1 (11.5)	-2.8* (5.8)	14.4 (8.2)	12.5 (10.1)	-1.9* (8.3)	0.97 (-1.49, 3.43)	0.437
3000	23.8(11.9)	22.7 (13.4)	-1.1 (7.4)	16.4 (9.4)	14.8 (13.6)	-1.6 (9.9)	-0.44 (-3.41, 2.53)	0.769
4000	28.9(16.4)	25.9 (15.5)	-3.0* (8.2)	17.5 (11.1)	16.7 (15.9)	-0.8 (11.3)	2.24 (-1.13, 5.60)	0.191
6000	25.7(20.3)	20.3 (19.8)	-5.4*(12.4)	20.1 (13.8)	19.5 (16.6)	-0.6 (11.6)	4.86 (0.95, 8.77)	0.015
8000	12.6^(22.7)	12.5^(19.3)	-0.2 (11.5)	16.7 (15.5)	15.3 (18.4)	-1.4 (11.1)	-1.18 (-4.90, 2.54)	0.532

*statistically significant intragroup mean difference ($p<0.05$); # n=43; ## n=79; ^ n=57
Intragroup mean difference = mean post-intervention – mean pre-intervention
Intergroup mean difference = mean difference control group – mean difference intervention group

Table 3 Participants' Right Ear Hearing Threshold Level Changes After Three Months

Frequency (Hz)	Intervention group (n=58)			Control group (n=96)			Intergroup	
	Pre-intervention Mean (SD)	Post-intervention Mean (SD)	Intragroup mean difference (SD)	Pre-intervention Mean (SD)	Post-intervention Mean (SD)	Intragroup mean difference (SD)	Intergroup mean difference (95% CI)	p-value
500	22.6#(8.1)	26.2#(18.1)	3.6 (17.3)	15.6##(6.1)	12.1##(8.4)	-3.5*(9.4)	-7.15 (-11.92, -2.38)	0.004
1000	20.3(7.8)	21.8(16.7)	1.5(14.4)	15.1(6.9)	12.0(8.7)	-3.0*(9.2)	-4.49 (-8.24, -0.73)	0.019
2000	22.3(12.4)	23.6(19.1)	1.3(12.6)	13.9(8.2)	11.5(8.7)	-2.3*(8.7)	-3.64 (-7.04, -0.24)	0.036
3000	23.7(13.8)	27.4(20.4)	3.7*(12.7)	13.9(7.6)	13.0(10.4)	-0.8(10.0)	-4.55 (-8.20, -0.90)	0.015
4000	25.4^(15.7)	25.8^(22.4)	0.4(16.2)	16.7(10.7)	16.0(14.4)	-0.7(11.3)	-1.12 (-5.53, -3.30)	0.618
6000	22.9(21.5)	23.1(26.0)	0.2(17.0)	17.8(11.0)	19.0(15.5)	1.3(12.3)	1.08 (-3.60, 5.75)	0.650
8000	13.5^(22.2)	16.1^(24.4)	2.6(19.3)	14.3(13.5)	14.3(16.6)	0(12.5)	-2.63 (-7.70, 2.44)	0.307

*statistically significant intragroup mean difference ($p<0.05$); # n=43; ## n=79; ^ n=57
Intragroup mean difference = mean post-intervention – mean pre-intervention
Intergroup mean difference = mean difference control group – mean difference intervention group

4.0 DISCUSSION

A marked improvement in hearing threshold levels was observed three months post-intervention, especially at higher frequencies, despite the control group having a better baseline mean hearing threshold level in the bilateral ear than the intervention group. This may not be due to age-related changes since the mean age of participants in both the intervention (37.7 years) and control group (36.6 years) were almost similar. It has been reported that in the early stages of NIHL, the average hearing thresholds at the lower frequencies (500, 1000, and 2000 Hz) are better than the average thresholds at higher frequencies (3000, 4000, and 6000 Hz) (Kirchner et al., 2012). The role of extended high-frequency audiometry testing in the early detection of NIHL with employment duration has been studied. It has been reported that the frequencies 12500, 14000, and 16000 Hz are first affected during the first decade of employment. Changes at 2000 and 4000Hz were only observed during the second decade of employment. Hearing threshold changes at lower frequencies (250, 500, and 1000Hz) were observed after two decades of employment (Riga, Korres, Balatsouras, & Korres, 2010). The mean duration of participants' employment in this study was less than ten years, causing hearing threshold changes to be less evident since the extended higher frequencies were not tested as only conventional audiometry was used.

In this study, mean hearing threshold shift changes were observed for all frequencies evaluate the effectiveness ofthe HCP. The American National Standards Institute (ANSI) also recommends a similar method to evaluate the effectivenessof an HCP. Therefore, changes in mean hearing threshold levels (threshold shifts) from individual audiometric frequencies (0.5, 1, 2, 3, 4, 6, and 8 kHz) and grouped frequency combinations (0.5-3 kHz and 2-4 kHz) were measured and compared. This way, one can rule out systematic threshold shifts due to variation in audiometric calibration. Hence, this method serves as a reliable early indicator of the HCP performance besides indirectly reflecting the audiometric testing program integrity (Simpson, Stewart, & Kaltenbach, 1994). However, there is also a risk of false-positive threshold shifts during audiometric testing caused by various factors such as calibration errors, test-retest variability, absence of baseline audiogram, and absence of detailed case-history information (Schlauch & Carney, 2010).

The changes in mean hearing threshold observed for both grouped frequencies (2-4 kHz and 0.5-3 kHz) showed dominant positive changes in the left ear compared to the right ear. Thus, NIHL commonly presents as bilateral symmetrical hearing loss. However, it has been reported that up to 80% of audiometric shifts meeting the OSHA standards were found to be unilateral (Simpson, McDonald, & Stewart, 1993).

This is mainly attributable to asymmetric individual baseline hearing threshold levels and participants from the control group showing better average hearing thresholds for each frequency than the intervention group. This could be caused by various factors such as varying individual susceptibility to age-related hearing loss and noise damage and other non-occupational noise sources (power tools, attendance at sporting events, motor races, and loud concerts) (Franks, 2001; Royster, 2017).

In terms of evidence-based practice, this study's randomized cluster methodological design provides the highest level of evidence, especially in determining a causal relationship between an intervention and the desired outcome. Randomization reduces the risk of selection bias and facilitates blinding by masking the identity of the participants' groups from the outcome assessors. The risk of selection bias was also reduced by ensuring allocation concealment during group assignments of the DHO. While there were reported improvements in hearing threshold levels, especially for most frequencies inthe intervention arm, the long-term impact of this HCP remains unknown, especially with the progressive nature of NIHL.

5.0 CONCLUSION

Vector control workers in the Ministry of Health (MOH), Malaysia, are exposed to hazardous noise emitted by the thermal fogging machines well above the 85 dB(A) daily noise exposure level recommended by the Malaysian Occupational Safety and Health Act (OSHA) (Noise Exposure) Regulations 2019. Therefore, there is a need for a comprehensive HCP to be implemented at all DHO for vector control workers. There were improvements in participants' average hearing threshold levels three months after implementing the HCP. A significant reduction in the proportion of participants with hearing loss was also observed, especially for higher frequencies (3000 – 8000 Hz). This indicates the program is effective in preventing NIHL. This HCP will prevent vector control workers from developing NIHL and, in turn, reduce the overall burden of NIHL in Malaysia. Similar studies are needed to look into the long-term effectiveness of this program in hearing conservation of workers, especially since the NIHL is a progressive occupational disease that takes five to 10 years to occur.

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improvements in participants' average hearing threshold levels three months after implementing the HCP. A significant reduction in the proportion of participants with hearing loss was also observed, especially for higher frequencies (3000 – 8000 Hz). This indicates the program is effective in preventing NIHL. This HCP will prevent vector control workers from developing NIHL and, in turn, reduce the overall burden of NIHL in Malaysia. Similar studies are needed to look into the long-term effectiveness of this program in hearing conservation of workers, especially since the NIHL is a progressive occupational disease that takes five to 10 years to occur.

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