ORIGINAL ARTICLE

Development and validation of Malaysian noise and chemical exposure questionnaire towards hearing among hospital workers

Ailin Razali, PhD[1], Fathin 'Izzaty Azmy, B.AuD[2], Aina Mastura Khairul Anwar, B.AuD[3]

[1]Department of Otorhinolaryngology-Head and Neck Surgery (ORL-HNS), Ear and Hearing Clinic, Kulliyyah of Medicine, International Islamic University of Malaysia (IIUM), Kuantan, Malaysia, [2]Department of Ear, Nose & Throat (ENT), Audiology Unit, Sultan Ahmad Shah Medical Centre (SASMEC) @ IIUM, Kuantan, Malaysia, [3]Ear and Hearing Clinic, Kulliyyah of Medicine, International Islamic University of Malaysia (IIUM), Kuantan, Malaysia

ABSTRACT

Introduction: Questionnaire is one of the effective, easy, and quick preliminary tools, which is widely used in today's healthcare assessment. It is important to have a suitable questionnaire according to the target population and also one that is culturally appropriate based on the intended countries' laws and regulations. The objective of the study is to develop and validate a Malaysian version of noise and chemical exposure questionnaire.

Materials and Methods: The questionnaire was developed and validated by experts and undergone a viability pilot study that involved a total of 60 workers, divided into two groups, 30 workers for the non-exposed (control group) and 30 workers who were exposed (target group) to both noise and chemicals in their workplace. The workers were recruited from a hospital in Kuantan, Pahang. The workers were requested to complete the Malaysian version of the questionnaire, disseminated through email and the WhatsApp platform.

Results: The final questionnaire consisted of 62 items, which was reviewed by experts. The validity process of the internal consistency showed good reliability, with a Cronbach's alpha of 0.76 and Pearson Correlation of r=0.638, ρ<0.01. The null hypothesis is rejected, there is an association between workers working at high risk workplace and risk of developing chemical-induced hearing loss. Thus, questionnaire can serve as a preliminary tool to select workers with a significant exposure for further evaluation.

Conclusion: The noise and chemical exposure questionnaire is valid and suitable to be used in Malaysia as it is in the native Malay language and abides by the culture, laws, and regulation of the country.

KEYWORDS:
Malaysia; hearing loss; chemical exposure; noise; questionnaire

INTRODUCTION

Application of the preliminary tools as an early assessment in the healthcare field is important to prevent further unnecessary evaluation as it can be seen as less time consuming, low to no cost, and can be used to generate a large amount of data. The same scenario is applicable for the assessment of noise-induced hearing loss (NIHL) and chemical-induced hearing loss (CIHL) among industrial workers. It is widely known that occupational hearing loss had been a major economic burden around the world. Several guidelines and regulations had been introduced in Malaysia by Ministry of Human Resources, Department of Occupational Safety and Health in 2022 such as the Occupational Safety and Health (Noise Exposure) Regulation 2019, Industry Code of Practice for Management of Occupational Noise Exposure and Hearing Conservation 2019, Guidelines on Management of Occupational Noise Related Hearing Disorders and safety data sheets (SDS) for the chemical exposure.[1]

Chemical hazard has been identified to cause hearing loss; specifically, organic solvents together with the presence of noise had been found to induce a synergistic oto-traumatic effect on the auditory function worse than the exposure to noise and solvents alone.[2] Since it has been widely known that solvents and noise co-exist in many industrial sectors, attention has been shifted towards finding audiological tools that are effective in detecting the ototoxicity effects of the solvent exposure. It is established that audiological assessments are the main tools in the diagnosis of hearing loss, but the inclusion of preliminary tools, such as questionnaires and pre-examination, is what is needed for the assessor to get an early impression of what to expect.

Assessment of the effects of noise exposure has already been established with pure-tone audiometry; however, the effect of chemical exposure is still under research. The organic solvent study conducted by Sliwinska-Kowalska et al.,[3] Liu et al.,[4] and Kaufman et al.[5] included detailed inquiries about the present and previous exposure to solvents and noise, medical history, and non-occupational exposure to ototoxic agents. The medical history questions inquired about signs and symptoms relating to the auditory system include and not limited to history of middle-ear diseases and surgery, hereditary disorders, chronic systemic diseases, cholesterol level and hypertension, head trauma, and current and past medications containing potential ototoxic agents. Another research by Fuente et al., also used a medical and

This article was accepted: 07 May 2022
Corresponding Author: Ailin Razali
Email: ailin@iium.edu.my

occupational history questionnaire to filter out the participants with the pre-existing medical conditions associated with hearing and a participant's noise exposure level based on their observations.[6]

Currently, there are several noise and chemical questionnaires available, although none is specific to the Malaysian population. The recently enacted Noise Regulation 2019 had enforced the need to fill a hearing-related questionnaire in Industry Code of Practice for Management of Occupational Noise Exposure and Hearing Conservation 2019 in every audiometric testing conducted. Alas, the chemical-related questions were not included, which prompted Yusof et al.[7] to use the adapted noise and chemical (NOISECHEM) questionnaire developed by Prasher et. al.[8] to screen for the prevalence of CIHL in Malaysia. Looking at the NOISECHEM adaptation, we felt there is a need for a local version of this questionnaire, which became the main objective of the study, that is, to develop a Malaysian noise and chemical exposure questionnaire for our workers, which is appropriate to the culture, laws, and regulations of our country.

MATERIALS AND METHODS

Development of Questionnaire

Firstly, literature reviews related to both noise and chemical exposure were conducted through online search platforms such as Google Scholar, PubMed, and Medline. The search for available questionnaire regarding the exposure agents had also been carried out to search for the focus items and question that is often being asked in the intended survey. A focus group discussion with three experts from audiology, and occupational safety and health were conducted to gain insight into the details for the question and addition of a few items.

To assess both exposures to noise and chemicals, the questionnaire was divided into four domains. Firstly, demographic data (eight items) on each of the respondents such as age, gender, race, and educational level were included. Secondly, we assessed the risk of developing NIHL, which depends on two parameters of sound levels, i.e., duration of time, and level of intensity.[9] For the assessment of the chemical exposure, a column was prepared for those who are aware of what types of chemicals they are exposed to. Additionally, activities involving chemicals were also included considering some workers may not know the name of chemicals that they are exposed to. Other parameters include duration and chemical exposure levels. Responses are towards open-ended and multiple-choice questions with a varied number of responses. Three native Malay speakers fluent in both English and Malay had been chosen to assess the correct semantical and grammatical use of the languages in the questionnaire.

Validation of Questionnaire

Three versions of the questionnaire were reviewed through focus group discussions which included an audiologist from Audiology unit, Sultan Ahmad Shah Medical Centre (SASMEC), audiological medicine doctor from Ear & Hearing Clinic, Kulliyyah of Medicine, and occupational health doctor from Kulliyyah of Allied Health Sciences, both are from International Islamic University of Malaysia before the final draft of the questionnaire was produced and sent to other experts from other institutions for validation purposes. The content validation process of the Malaysian noise and chemical questionnaire was assessed by experts in various fields, i.e., Industrial Audiology, Audiological Medicine, and Occupational Health, to check for the degree of relevancy and appropriate representativeness of each item on the questionnaire and the item content validity indices (I-CVIs), and multi-rater kappa statistics were calculated. For the face validity, the review experts represented their subjective opinion for the assessment items to see whether it is appropriate to the targeted construct and objectives of the questionnaire based on the feasibility, readability, and clarity of the language used. Then, the construct validity of the questionnaire was obtained through a statistical analysis of inter-reliability of Cronbach's alpha and Pearson correlation coefficient.

Reliability of Questionnaire

Reliability of the questionnaire was determined through internal consistency analysis using Cronbach's alpha, a function of the average intercorrelations of items and the number of items in the scale. The internal consistency of 0.7 and more indicated a good internal consistency.[10] Then, for the feasibility analysis, a pilot study was conducted to identify potential problem areas and deficiencies in the research instruments and protocol before implementation during the full study.[11,12] The potentially exposed workers had been selected for the study at a hospital in Kuantan, Pahang. Selected respondents were categorised into a control and exposed group. Before the selection, permission was sought both from the individual respondent and their head of department. Workers exposed to organic solvents and noise with a total of 60 respondents volunteering to participate in the research. Primarily, targeted sampling methods were used to categorise the respondents' group according to their workplace of no exposure and exposure to noise and chemical. Then, the respondents' percentages of answer rate of 'YES' to the selected items associated with the chemical and noise exposure were reviewed to categorise them into the final group of exposure, 60% of 'YES' answer and non-exposure, 40% of 'YES' answer. Descriptive analyses were used to analyse the demographic data such as age, gender, and educational level. The data were analysed using IBM SPSS Statistics 24.

RESULTS

Validation of Questionnaire

The face and content of the questionnaire were validated by experts in Industrial Audiology, Occupational Medicine, and Audiological Medicine with a total of five experts: one from Industrial Audiology, one from Audiological Medicine, and three from Occupational Medicine. The panel experts have given their opinion and comment regarding the face validity, and their ideas were revised and incorporated in the questionnaire accordingly. However, for the content validity, the evaluation was conducted using a Likert scale of five intervals (1 – not relevant, 2 – not quite relevant, 3 – quite relevant, 4 – relevant, 5 – strongly relevant) to check for the

Table I: Calculation of I-CVIs of expert evaluation

No	Items	Relevant (rating of 3,4, or 5)	Not relevant (rating of 1 or 2)	I-CVIs	Interpretation
1	Job title and working unit	4	1	0.8	Appropriate
2	Specific task	5	0	1	Appropriate
3	Years and months of working	5	0	1	Appropriate
4	Days and hours of working	5	0	1	Appropriate
5	The current workplace noise level	4	1	0.8	Appropriate
6	Wearing of personal hearing protection and its type	4	1	0.8	Appropriate
7	Use of noisy powered tools or machinery	4	1	0.8	Appropriate
8	At your current workplace, is there a warning sign of excessive noise?	4	1	0.8	Appropriate
9	At work, do you need to yell or raise a voice with someone 1 meter away?	4	1	0.8	Appropriate
10	After work, do you experience a change in hearing or ability to understand speech? If yes, which ear?	4	1	0.8	Appropriate
11	After work, do you feel ringing or humming in the ear? If yes, which ear and its frequency?	4	1	0.8	Appropriate
12	Previously, do you work in a noisy workplace?	5	0	1	Appropriate
13	How long have you worked there?	5	0	1	Appropriate
14	Do you wear a personal hearing protector and its type?	4	1	0.8	Appropriate
15	Are you exposed to chemicals in the current workplace?	4	1	0.8	Appropriate
16	At the current workplace, do you use pesticides or herbicides?	4	1	0.8	Appropriate
17	At the current workplace, do you use harsh chemicals (varnish, glue, acid)?	4	1	0.8	Appropriate
18	At the current workplace, do you do welding or soldering?	4	1	0.8	Appropriate
19	At the current workplace, do you use metals (lead, mercury, etc.)?	4	1	0.8	Appropriate
20	At the current workplace, do you use to paint?	4	1	0.8	Appropriate
21	At the current workplace, do you use cleaning chemicals?	4	1	0.8	Appropriate
22	If there is a usage of the above materials or activities, state how many hours per day, days per week, and years of exposure.	4	1	0.8	Appropriate
23	Are you exposed to the materials or activities above previously?	4	1	0.8	Appropriate
24	If yes, state the name of materials or activities, how many hours per day, days per week, and years of exposure.	4	1	0.8	Appropriate
25	Does your current workplace smell uncomfortable and pungent?	4	1	0.8	Appropriate
26	Do you experience headache or dizziness caused by the pungent smell?	4	1	0.8	Appropriate
27	Do you feel your headache or dizziness getting better over the weekend?	4	1	0.8	Appropriate
28	Are you wearing protective equipment such as a glove, apron, and respirator? If yes, please state the type.	5	0	1	Appropriate
29	Current hearing level (right and left)	4	1	0.8	Appropriate
30	If not good, how long have you had the hearing problem?	4	1	0.8	Appropriate
31	Have you had any disease or problem related to ear or hearing since childhood until now? If yes, please state the name of the disease.	4	1	0.8	Appropriate
32	Have you ever had measles?	3	2	0.6	Eliminated
33	Have you ever had hypertension?	2	3	0.4	Eliminated
34	Have you ever had tuberculosis?	3	2	0.6	Eliminated
35	Have you ever had diabetes?	3	2	0.6	Eliminated
36	Have you ever had mumps?	3	2	0.6	Eliminated
37	If you ever had any disease above; state for how long, medication taken, and any effect on hearing.	3	2	0.6	Eliminated

Table I: Calculation of I-CVIs of expert evaluation (con't)

No	Items	Relevant (rating of 3,4, or 5)	Not relevant (rating of 1 or 2)	I-CVIs	Interpretation
38	Have you ever experienced any head injury and loss of consciousness? If yes, which ear, when, and further explanation?	5	0	1	Appropriate
39	Have you ever had an explosion that caused hearing problems? If yes, which ear, when, and further explanation?	4	1	0.8	Appropriate
40	Have you ever had ear surgery? If yes, which ear, when, and further explanation?	4	1	0.8	Appropriate
41	Are there any family members who have had hearing problems since childhood? If yes, who?	4	1	0.8	Appropriate
42	Do you have tinnitus (ringing or buzzing in the ears)?	4	1	0.8	Appropriate
43	If yes, which ear and its frequency?	4	1	0.8	Appropriate
44	Do you smoke or vape?	4	1	0.8	Appropriate
45	If yes, for how long and how many cigarettes or vapes per day?	4	1	0.8	Appropriate
46	If not, are there family members or friends who smoke or vape and live in the same house as you?	4	1	0.8	Appropriate
47	Do you consume liquor or alcohol?	4	1	0.8	Appropriate
48	If yes, state the frequency.	4	1	0.8	Appropriate
49	Have you been doing woodworking?	4	1	0.8	Appropriate
50	Have you been doing metalworking	4	1	0.8	Appropriate
51	Have you ever used heavy equipment?	2	3	0.4	Eliminated
52	Have you ever used a chain saw?	4	1	0.8	Appropriate
53	Have you ever used grinders or chippers?	4	1	0.8	Appropriate
54	Have you ever used air-driven tools?	4	1	0.8	Appropriate
55	Have you ever done motorsports?	4	1	0.8	Appropriate
56	Have you ever done farming?	4	1	0.8	Appropriate
57	Have you ever boarded a plane?	2	3	0.4	Eliminated
58	Have you ever played music (musical instruments, headphones, etc.)?	5	0	1	Appropriate
59	Have you ever used a firearm?	5	0	1	Appropriate
60	Have you ever used a leaf blower or trimmer?	2	3	0.4	Eliminated
61	Have you ever visited an entertainment centre (karaoke, concerts)?	2	3	0.4	Eliminated
62	If you did the above activity, state the duration of exposure and whether you wore hearing protection during the activity.	4	1	0.8	Appropriate

Table II: Frequency of the percentage of answer 'YES' of respondents in the questionnaire

Percentage (%) of answer 'YES'	Frequency
0	3
10	4
20	4
30	6
40	7
50	6
60	2
70	8
80	13
90	7
100	0

relevancy and clarity of each item. The Likert data were then calculated for content validity index for relevancy and clarity of each item (I-CVIs), and the score of each item set as relevant or clear (a rating of 3, 4, or 5) was divided by the number of content experts. The analysis of the five-point Likert scale is as follows.

From Table I, judgement on each item was made as follows: If the I-CVI is higher than 79%, the item will be appropriate. If it is between 70% and 79%, it needs revision. If it is less than 70%, it is eliminated.[13]

The result showed that 52 out of 62 items had a score of 79 percent and above, signifying the majority of the items put forth is relevant and appropriate. The 10 items scoring below 70% were considered for elimination. Prior to that, the items were re-evaluated accordingly. Subsequently, four items were deleted, one item was changed, and five items maintained as

Table III: Demographic characteristics of participants

Group		Control		Exposure	
Socio-demographic variable		**Frequency (n=30)**	**Percentage (%)**	**Frequency (n=30)**	**Percentage (%)**
Age (year)	20-29	16	53.3	18	60.0
	30-39	11	36.7	11	36.7
	40-49	0	0.0	1	3.3
	50-59	3	10.0	0	0.0
Gender	Males	14	46.7	8	26.7
	Females	16	53.3	22	73.3
Educational level	SPM	6	20.0	0	0.0
	STPM/Diploma	11	36.7	14	46.7
	Bachelor's degree	11	36.7	13	43.3
	Master's degree	1	3.3	3	10.0
	Ph.D.	1	3.3	0	0.0

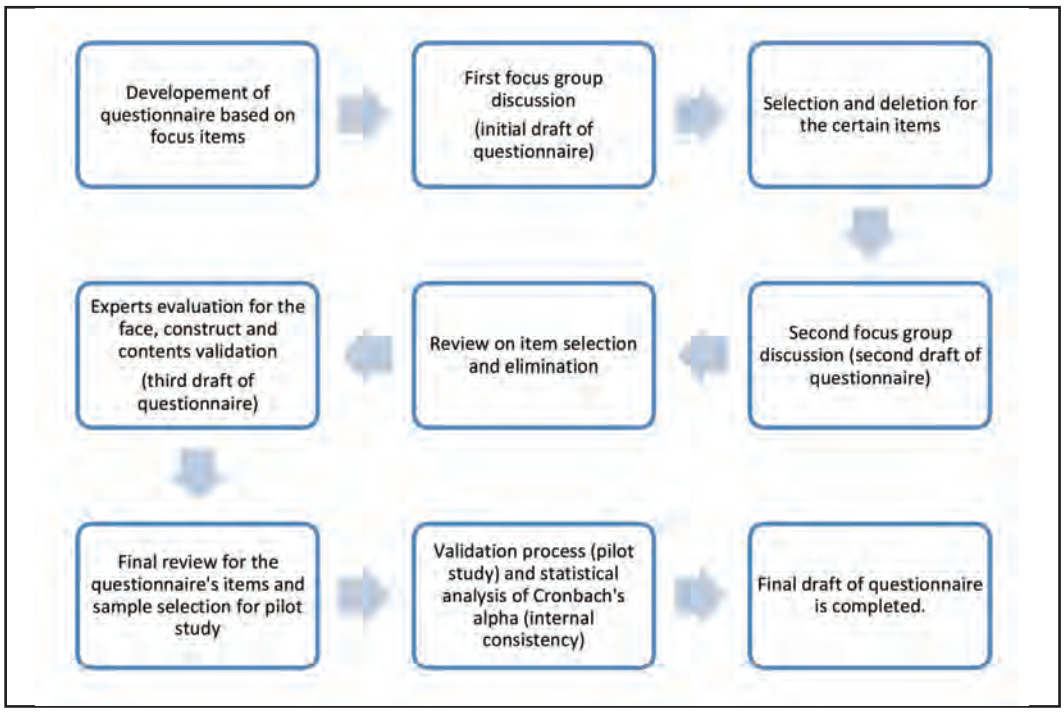

Fig. 1: Flowchart of the development process of Malaysian Noise and Chemical Exposure Questionnaire

we felt their association with the hearing condition is well established and it serves as an additional information for the researchers.

The multi-rater kappa statistics were calculated for chance of agreement through IBM SPSS Statistic 24 software. Kappa values above 0.74, between 0.60 and 0.74, and between 0.40 and 0.59 are considered as excellent, good, and fair, respectively. The result for the kappa analysis is 0.68, which therefore can be considered as good.

For the non-occupational section, confusion may arise from the usage of the words. For example, music can be playing a musical instrument or listening to music through headphones or a speaker. Thus, we have included an example for the music exposure, which included both playing musical instruments and listening to music via headphones. These misunderstandings can be minimised if the mode of administration is through an interview session instead of self-administered.

Pilot Study for Viability of Questionnaire

After the development and validation of the questionnaire, we proceeded with viability analysis through a pilot study that involved a group of workers from a tertiary hospital in Kuantan, Pahang. The validated questionnaire was disseminated through WhatsApp and email platform to 60 respondents, where 30 were selected from office workers categorised into the control group (non-exposed) and 30 respondents from the lab and pharmacy department who were put into the exposed group. The criteria selection for respondents in the exposed group are based on items related to noise exposure (items 5-12) and chemical exposure (items 15-21, 23, 25-27). Respondents with a 60% answer rate of 'YES' to the intended items are categorised under the exposed group. Meanwhile, the remaining respondents, who self-claimed to have no-to-low exposure and answered 'NO' (40% answer rate) to the appropriate items, were categorised into the non-exposed or control group. In relation to the division of the respondents, we were able to distinguish the respondents using the questionnaire; the respondent's workstation tallied with our observation of no-to-low

occupational exposure, and similarly, the exposed group with high risk of hazardous chemical and noise exposure especially during working hours can also be identified via the questionnaire. Table II shows primary data of targeted sampling and categorisation based on the questionnaire.

The questionnaire was reported to take around 10 minutes to answer, and data collection had taken place from August 2021 until October 2021. The face-to-face method was minimised in view of the COVID-19 pandemic. The demographic data of the respondents are shown in Table III. Respondents randomly selected from the control group have a mean age of 30.80±8.39 years with no exposure to either noise or chemicals. Meanwhile, the designated target group has a mean age of 28.42±4.13 years selected from a specific department in the hospital known to be exposed to noise and chemicals at work.

The gender distribution of the respondents are 36.7% males and 63.3% females. For the educational level of the respondents; a majority of them had a diploma (41.7%), followed by a bachelor's degree (40.0%), SPM (10.0%), master's degree (6.7%), and one with Ph.D. qualification (1.7%). Additionally, 39 people (65.0%) had worked for at least three years in their position and throughout the week, and 43 of them (71.7%) need to work for five days a week. Forty-five people worked for eight hours per day, only 20.0% of them worked for more than eight hours, and the remaining 5.0% worked for less than normal working hours.

The 60 respondents were also asked to include their opinions regarding the clarity of the language used and overall comprehensiveness of the questionnaire. From this, we have identified a few items that are quite difficult to understand. One example is the amount of exposure where the respondents could not recall the exact exposure duration. The respondents' subjective opinion regarding the face validity, however, did not result in major changes to the questionnaire as these items could not be avoided to ensure the questionnaire is able to cover all possible information regarding noise and chemical exposure.

Construct validity was assessed firstly through the inter-reliability of the questionnaire via the analysis of Cronbach's alpha. The reliability of 62 items in the questionnaire had been calculated using SPSS, and the score was 0.76, which indicated a good internal consistency. Another method for assessing construct validity is through Pearson correlation coefficient. The general null hypothesis (H_0) and alternative hypothesis (H_1) of the significance test for correlation of two-tailed test are H0: $\rho=0$ ('There is no association between workers working at high risk workplace and risk of developing chemical-induced hearing loss'), and H1: $\rho\neq0$ ('There is an association between workers working at high risk workplace and risk of developing chemical-induced hearing loss'). From the correlation coefficient, between workers working at high-risk workplace and risk of developing chemical-induced hearing loss, a statistically significant linear relationship ($r=0.638$, $p<0.01$) was found. Workers at high-risk workplace and at risk of developing chemical-induced hearing loss are positively correlated, whereas workers at high-risk workstation are associated with greater risk of developing a hearing loss due to the chemical exposure. The magnitude, or strength, of the association is considered moderately correlated ($0.5< | r | <0.7$). Thus, the null hypothesis, where $\rho\neq0$, is rejected.

DISCUSSION

The feedback from respondents during the validation process compelled us to administer the questionnaire through interview session instead of self-administration. This is to ensure the answers for the questionnaire are aligned to the objectives of the questionnaire development. Additionally, the face, content, and construct validity were obtained and refined, which further improved the questionnaire's overall validity. The questions are now more technically accurate and can provide more detailed information about respondents' risk of developing early hearing impairment due to the presence of noise and chemical exposure.

Available noise and chemical (NOISECHEM) questionnaire from the previous study by Prasher et al.[8] included items such as eye and skin colour. Differences in the features are not prominent in Malaysia compared to Westerners, which is why we excluded them. They also included items for alcohol and drug intake, which can be considered as culturally insensitive queries here in Malaysia. Thus, we had omitted those items as well during the development of the questionnaire.

Previous study by Cabello-López et al.[14] reported that it is hard to estimate a single chemical exposure when mixtures of chemicals were involved. Cabello-López et al.[14] also stated the need to include a more accurate exposure modelling for specific elements due to a lack of details of exposure histories and current exposure levels. It has become crucial for researchers studying the same field to sought for more specific details of the exposure indirectly from the activities related to the chemicals instead of the name of a specific chemical. This is justified by the fact that workers usually do not know the scientific term of the chemicals and will use only layperson terms to describe it, which can also lead to inaccurate interpretation.

The advantage of this questionnaire is that it covers all aspects of hearing loss either exposed to noise or chemical, confounding factors, and exposure outside the workplace. This has saved the researchers a lot of time in determining any hearing or ear-related issues. Additionally, this is the first noise and chemical exposure questionnaire available for Malaysian population. We produced the questionnaire as an alternative assessment that conforms to our culture, laws, and regulations. Penafiel[9] in 2007, developed a noise exposure questionnaire for children, which highlighted the importance of using questionnaires as a useful tool for the screening of specific target population. Thus, the questionnaire is a cost-effective and time-saving assessment method preceding further audiological testing.

However, this study also comes with a few shortcomings. The mode of distribution for this questionnaire was via online platform, which was intended to be self-administered. A few significant items that require respondents' response could not

be properly obtained, which lead to recall bias. We felt that these non-responses could have been overcome had it been a personal interview. Additionally, accurate exposure data could not be obtained in the questionnaire where Fuente et al.[15] in 2013, and Mohammadi et al.[16] in 2010, also noted as a limitation in their studies. One of the alternative suggestions is to get the precise exposure data from a chemical health risk assessment conducted at the workplace. The items regarding exposure in the questionnaire are only to serve as an observation regarding the worker's self-awareness towards hazardous exposure.

The questionnaire was also able to categorise the workers into the exposed and non-exposed groups. This is according to the percentage of answer of 'YES' and 'NO' to the selected items regarding the noise and chemical exposure at the workplace, which will determine the group they belong to. Moreover, the non-occupational domain serves as additional data to the researchers on exposures outside of the workplace. The Malaysian Noise & Chemical Questionnaire is a screening tool to select workers who have been exposed to both noise and chemicals for further evaluation and diagnostic of hearing loss and not a measure to specific chemical exposure. Hence, the questionnaire serves its purpose as a preliminary tool to the audiological assessment in workers at risk of developing hearing loss from hazardous exposure to noise and chemical at work.

CONCLUSION

A reliable and valid questionnaire has been developed in this study, which enables one to assess knowledge and exposure to noise and chemical towards the hearing system, especially among the exposed workers. Although it needs further review and improvement, it can be used to identify workers at high risk of exposure to noise and chemical hazards and allow more detailed exposure monitoring followed by appropriate control measures.

FUNDING

The research was funded by Sultan Ahmad Shah Medical Center (SASMEC) @ International Islamic University Malaysia (IIUM); grant number SRG21-050-0050.

REFERENCES

1. Ministry of Human Resources, Department of Occupational Safety and Health, 2022. Legislation [cited 16 June 2022]. Available from: https://www.dosh.gov.my/index.php/legislation
2. Warner R, Fuente A, Hickson L. Jet fuel, noise, and the central auditory nervous system: A literature review. Mil Med 2015; 180(9): 950-5.
3. Sliwinska-Kowalska M, Fuente A, Zamyslowska-Szmytke E. Cochlear dysfunction is associated with styrene exposure in humans. PLoS ONE 2020; 15(1): e0227978.
4. Liu Y, Wang H, Weng S, Su W, Wang X. Occupational hearing loss among Chinese municipal solid waste landfill workers : A cross-sectional study. PLoS ONE 2015; 10(6): e0128719.
5. Kaufman LR, Lemasters GK, Olsen DM, Succop P. Effects of concurrent noise and jet fuel exposure on hearing loss. J Occup Environ Med 2005; 47(3): 212-8.
6. Fuente A, Hickson L, Morata TC, Williams W, Khan A, Fuentes-Lopez E. Jet fuel exposure and auditory outcomes in Australian air force personnel. BMC Public Health 2019; 19: 675.
7. Yusof Y, Fuente A, Qahar M, Anwar K, Razali A. Cross cultural adaptation of NOISECHEM Questionnaire. Unpublished. P.g 4
8. Prasher D, Morata T, Campo P, Fechter L, Johnson AC, Lund SP, et al. NoiseChem: A European Commission research project on the effects of exposure to noise and industrial chemicals on hearing and balance. Noise Health 2002; 4:41-8
9. Penafiel E. Developing a questionnaire to assess noise exposure in children and teens [Research Paper]. The Ohio State University; 2007.
10. Kimberlin CL, Winterstein A G. Validity and reliability of measurement instruments used in research. Am J Health Syst Pharm 2008; 65(23): 2276-84.
11. Lancaster GA, Dodd S, Williamson PR. Design and analysis of pilot studies: Recommendations for good practice. J Eval Clin Pract 2004; 10(2): 307-12.
12. Kraemer HC, Mintz J, Noda A, Tinklenberg J, Yesavage JA. Caution regarding the use of pilot studies to guide power calculations for study proposals. Arch Gen Psychiatry 2006; 63(5): 484-9.
13. Zamanzadeh V, Ghahramanian A, Rassouli M, Abbaszadeh A, Alavi-Majd H, Nikanfar AR. Design and implementation content validity study: Development of an instrument for measuring patient-centered communication. J Caring Sci 2015; 4(2): 165-78.
14. Cabello-López A, Chávez-Gómez NL, Torres-Valenzuela A, Aguilar-Madrid G, Trujillo-Reyes O, Madrigal-Esquivel C, et al. Audiometric findings of printing press workers exposed to noise and organic solvents. Int J Audiol 2020; 60(1): 8-15.
15. Fuente A, McPherson B, Hickson L. Auditory dysfunction associated with solvent exposure. BMC Public Health 2013; 13: 39.
16. Mohammadi S, Labbafinejad Y, Attarchi M. Combined effects of ototoxic solvents and noise on hearing in automobile plant workers in Iran. Arh Hig Rada Toksikol 2010; 61(3): 267-74.