Validation of Self-Reported Hearing Loss Among Multi-Ethnic Community Dwelling older Adults in Malaysia

WAN SYAFIRA ISHAK¹, SITI ZAMRATOL-MAI SARAH MUKARF², NASHRAH MAAMOR², WAN FAZLINA WAN HASHIM³

ABSTRACT
Introduction: Little is known about the prevalence of hearing loss and the usefulness of self-reported hearing loss among older adults in Malaysia.

Aim: We conducted a population-based study to investigate the prevalence of self-reported hearing problem and its relationship with audiometric hearing thresholds in older adults in Selangor, Malaysia. We also investigated demographic factors that were associated with the self-reported hearing loss.

Materials and Methods: The participants were recruited from Selangor using multi-stage clustered sampling involving 324 participants aged between 60 to 88 years (68.3±5.9 years). All participants underwent a face-to-face interview and pure tone audiometry. Self-reported hearing loss was obtained using three questions.

RESULTS: The prevalence of self-reported hearing problems was 53.4%. This prevalence did not differ significantly among age group, gender, race and education level (p>0.05). Univariate and logistic regression analyses found that tinnitus and Pure Tone Average (PTA) of at least moderate hearing loss at 0.5 kHz to 4 kHz contributed significantly to the likelihood of self-reported hearing problem. Participants with tinnitus and participants with PTA of at least moderate hearing loss at 0.5 kHz to 4 kHz were twice as likely to report hearing problem than their counterparts. The questions yielded poor sensitivity in identifying at least mild loss and moderate sensitivity for at least moderate hearing loss.

Conclusion: The present study highlights the need for a more effective self-report inventory or audiometry instrument that is less sensitive to background noise to better estimate hearing loss prevalence among adults in Malaysia.

Keywords: Self-reported hearing problem, Sensitivity, Specificity, Tinnitus

INTRODUCTION
Hearing loss has been identified as the third most reported chronic health problems affecting individuals aged 60 years and above [1]. The World Health Organization reported the prevalence of hearing loss among this age group to vary between 21% to 85%, with the prevalence being lower in developed nations and higher in less developed countries [2]. This discrepancy is partly due to the lack of awareness on hearing health and limited access to the services in lower income countries than those in developed countries. In Malaysia, a nationwide study found that the prevalence of hearing loss among the 60 years old and above was 69.9% [3].

The advancement of health technology and medical care has contributed to the declining death rates and increasing life expectancy, which in turn increased the older adults population. In Malaysia, over the past three decades, the average life expectancy has increased from 70 years to 75 years in 2016 [4]. Population-based epidemiological data on hearing loss prevalence among older adults is important to serve as a guide in estimating the needs of hearing conservation and rehabilitation programs. Such data, however, is available mostly for more developed nations and still lacking in resource-poor countries where the prevalence of hearing loss is generally higher [5-7]. This lack of prevalence data on hearing loss in less developed nations is partly due to the fact that population-based studies are costly to run. This is because such studies require not only special equipment such as a mobile sound proof room, a sound level meter and conventional pure tone audiometry, but also specially trained personnel to operate. The use of a cheaper instrument than the conventional pure tone audiometry to detect hearing loss can overcome some of these problems. Questionnaires have been widely used as alternatives to audiometric screening in hearing loss prevalence studies [8,9]. The use of a questionnaire offers several advantages because it is less costly, does not require specially trained personnel and can cover large study population in a short duration. Studies using questionnaires or self-reported hearing problem found the prevalence to range from 17% to 60% [9-12]. Single questions such as “Do you feel that you have hearing loss?” and “Do you have problem with your hearing?” have been found to have acceptable validity between 65% and 78% [9,11], indicating that such questions may be used as a screening tool to estimate the prevalence of hearing loss. However, the sensitivity of these questions was found to vary between studies [7,12]. A study using similar question conducted in Malaysia, for example yielded a low sensitivity to identify significant hearing loss [12].

This study aimed to investigate the prevalence of self-reported hearing problem among older adults aged 60 years and over. Additionally, this study also examined the relationship between self-reported hearing loss and audiometric hearing thresholds in community dwelling older adults. We also investigated demographic factors which were associated with self-reported hearing loss.

MATERIALS AND METHODS

Study Participants
This cross-sectional study was conducted over a period of 1 year between 2013 and 2014. The participants of this study were recruited in conjunction with the Long-term Research Grant Scheme Project (LRGS/BU/2012/UKM-UKM/K02), a multidisciplinary study investigating medical, nutritional dietary, social and economic factors contributing to aging [13]. The participants were individuals aged 60 years and above who lived in Selangor, one of the states in Malaysia.
Malaysia. A multi-stage cluster sampling technique was conducted to select subjects that would represent the population of Selangor. The sampling technique was as described in Shahar et al., [13]. Family members in the sampled households who were 60-year-old or older, had good understanding of the Malay language, and free from any critical illness which may limit their mobility, were invited to participate by attending the nearby community hall during the data collection day. A total of 392 participants fulfilled the inclusion criteria and participated in the hearing study. This study was approved by the Ethics and Research Committee, Universiti Kebangsaan, Malaysia and was carried out under informed consent of the participants.

Self-Reported Hearing Problem
In the present study three questions were used to screen self-reported hearing problem. Besides the commonly used single question “Do you feel you have hearing problem?” (Q1), two other questions were included; they are Q2: “Do you feel that people mumble?” and Q3: “Has anybody told you that you don’t hear well?”. The inclusion of Q2 and Q3 was based on the premise that a locally conducted study has found Q1 to have inadequate sensitivity among Malaysian population [12]. Additionally, it is widely accepted that some individuals may be unaware of their hearing loss and blame others for not talking clearly (Q2). Similarly, Q3 was added because hearing loss may be noticed by others. For each of these questions, participants were required to choose either “Yes”, “No” or “Unsure”. “Unsure” response was treated as a missing value. A self-reported hearing problem was defined as “yes” answer to any of the three questions.

Audiotmetric Assessment
The audiological examination consisted of an otoscopic examination, a screening tympanometry (Interacoustic Titan), and a pure-tone audiotmetry. Pure tone audiotmetry was conducted by a trained personnel in a mobile sound proof booth using Madsen Itera II diagnostic audiometer equipped with TDH-39 headphones. All equipments were calibrated electroacoustically prior to the start of the data collection and were biologically calibrated every morning during the data collection days. Ambient noise levels in the mobile sound-proof booth were measured and were routinely monitored using a sound level meter (Quest Model 2900) to ensure that testing conditions complied with American National Standards Institute (ANSI) ambient noise limits [14].

We measured pure tone air conduction thresholds at 0.5, 1, 2, 4 and 8 kHz. In this study, PTAs were calculated at: 1) better ear across 0.5 to 2.0 kHz (BE0.5–2.0kHz); 2) better ear across 0.5 to 4.0 kHz (BE0.5–4.0kHz); and 3) better ear at high frequencies of 4.0 to 8.0 kHz (BEHF4.0–8.0kHz). Hearing loss was categorized into at least mild loss (PTA > 25 dBHL) and at least moderate loss (PTA > 40 dBHL). [Table/Fig-2] shows the mean, standard deviation, range and frequency distribution according to these cut off points for each frequency range category.

The participants hearing thresholds were also measured at better ear across 0.5 to 8.0 kHz. The pure tone average (PTA) was categorized into three different frequency ranges which were 0.5 – 2.0 kHz, 0.5 – 4.0 kHz and 4.0 – 8.0 kHz. For each of the frequency range, the PTA was calculated at two cut-off points: 1) at least mild hearing loss (PTA > 25 dBHL); and 2) at least moderate hearing loss (PTA > 40 dBHL). [Table/Fig-2] shows the mean, standard deviation, range and frequency distribution according to these cut off points for each frequency range category.

Prevalence of Self-Reported Hearing Loss
Overall, the prevalence of self-reported hearing loss was 173 (53.4%). Chi-square tests were performed to determine whether there were

<table>
<thead>
<tr>
<th>Hearing Loss categories</th>
<th>Mean (SD) (dBHL)</th>
<th>Min (dBHL)</th>
<th>Max (dBHL)</th>
<th>Degree of hearing loss, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>At least mild (PTA &gt; 25 dBHL)</td>
<td>221 (68.2)</td>
<td>93.0</td>
<td>321</td>
<td>67 (20.7)</td>
</tr>
<tr>
<td>At least moderate (PTA &gt; 40 dBHL)</td>
<td>251 (77.5)</td>
<td>86.3</td>
<td>321</td>
<td>90 (27.8)</td>
</tr>
</tbody>
</table>

**RESULTS**

Demographic Data
Of the 392 participants, complete data were available from 324. The age of the participants ranged from 60 to 88 years with mean age of 68.3±5.9 years. In this cohort of older adults, 178 (54.9%) were female and 196 (60.5%) belonged to the 60 to 69-year-old group. The majority of the participants lived in urban areas 201 (62%), were Chinese 190 (58.6%) and had received no formal or primary school education 192 (59.3%). Demographic characteristics of the study participants were shown in [Table/Fig-1].

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total subjects (n=324)</th>
<th>Self-reported hearing loss (n=173)</th>
<th>( \chi^2 )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group (in years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60-69</td>
<td>196 (60.5)</td>
<td>98 (50.0)</td>
<td>2.298</td>
<td>0.13</td>
</tr>
<tr>
<td>70+</td>
<td>128 (39.5)</td>
<td>75 (58.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malay</td>
<td>79 (24.4)</td>
<td>40 (50.6)</td>
<td>0.753</td>
<td>0.6866</td>
</tr>
<tr>
<td>Chinese</td>
<td>190 (58.6)</td>
<td>101 (53.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indian</td>
<td>55 (17.0)</td>
<td>32 (58.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>146 (45.1)</td>
<td>85 (58.2)</td>
<td>2.485</td>
<td>0.115</td>
</tr>
<tr>
<td>Female</td>
<td>178 (54.9)</td>
<td>88 (49.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area of residence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>201 (62.0)</td>
<td>97 (48.3)</td>
<td>5.613</td>
<td>0.019*</td>
</tr>
<tr>
<td>Rural</td>
<td>123 (38.0)</td>
<td>76 (61.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No formal education to primary school</td>
<td>192 (59.3)</td>
<td>112 (58.3)</td>
<td>4.618</td>
<td>0.032*</td>
</tr>
<tr>
<td>Secondary school and higher</td>
<td>132 (40.7)</td>
<td>61 (46.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tinnitus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>63 (19.4)</td>
<td>42 (66.7)</td>
<td>5.336</td>
<td>0.019*</td>
</tr>
<tr>
<td>No</td>
<td>261 (80.6)</td>
<td>131 (50.2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Other Variables**
Demographic characteristics of the study participants were obtained from face-to-face interviews. Participants were also asked whether they had tinnitus or not through a yes/no question.

**STATISTICAL ANALYSIS**
In addition to the descriptive statistics, Chi-square tests were used in univariate analysis to assess the possible associated factors for self-reported hearing problem. Subsequently, a multiple logistic regression analysis was done to determine whether the possible associated factors for self-reported hearing problem remained significant after adjusting for other factors. Since the Q1 question “Do you feel you have hearing loss?” is widely used as a screening tool, the performance of the question was also calculated against the pure tone hearing thresholds [12,17,18].
significant differences in self-reported hearing loss prevalence for each of the demographic characteristics listed in [Table/Fig-1]. The results revealed no significant differences in self-reported hearing loss prevalence between gender, age group and race (p>0.05). Area of residence, education level and history of tinnitus were significantly associated with self-reported hearing loss [Table/Fig-1]. Participants who resided in rural areas were more likely to admit having hearing loss (61.8%) than those who lived in urban areas (48.3%), (χ²=5.613, p=0.018). Participants who had lower education level (58.3%) were more likely to report hearing loss than those who had higher education level (46.2%), (χ²=4.618, p=0.032). Likewise, the prevalence of self-reported hearing loss was significantly higher among participants who had history of tinnitus (66.7%) than those who did not (50.2%) (χ²=5.336, p=0.019).

The self-reported hearing problem was also compared to the better ear Pure Tone Average (PTA) across 0.5 to 4 kHz (BE0.5–4.0kHz). Out of 324 participants, 251(77.5%) participants had at least mild hearing loss (0.25 dBHL) at 0.5 to 4 kHz. Of those who had hearing loss as measured by audiometric test, only 182(56.2%) participants admitted having hearing problem. The PTA of participants who reported hearing problem was significantly higher compared to the group without the complaint (t=4.04, p<0.001, mean difference=5.70, CI 95% =2.92–8.47) with mean threshold of 38.4 dBHL (SD=14.2) and 32.7 dBHL (SD=10.6), respectively. Among those with self-reported hearing loss, the PTA (BE0.5–4.0kHz) was found to be significantly higher in 70+ years old group than the younger age group (t=3.54, p=0.001, mean difference=7.48, CI 95%=-3.31–11.64) and in tinnitus group than non-tinnitus group (t=2.89, p=0.004, mean difference=7.12, CI 95%=2.25–11.99). The PTA for the 70+ years group and tinnitus group were 42.7 dBHL (SD=14.6) and 43.8 dBHL (SD=16.8), respectively.

**Performance of The Self-Report Questions**

Since Q1 has been widely used to determine self-reported hearing loss in many studies, we compared the performance of the self-reported hearing loss based on the multi questions (Q1–Q3) and Q1 alone as screening tools. [Table/Fig-3] shows the performance of these questions in identifying hearing loss against different frequencies pure tone averages and cut-off points. Overall, the sensitivity of self-reported hearing problem based on a “yes” to any of the questions (Q1–Q3) (54.9%–73.3%) was better than that of Q1 alone (30.8%–58.2%). Using a cut-off point of 25 dBHL, the multi questions were more sensitive in identifying those with hearing loss compared to the use of the single question. The sensitivity increased up to 73% when a cut-off point of 40 dBHL was used. Generally, irrespective of cut-off point used, Q1 alone had a much lower sensitivity to identify hearing loss than the multi questions. The Q1 question had higher specificity (78.6%–89.0%) and PPV (41.5%–89.4) than the multi questions. The Q1 demonstrated poor accuracy (38.6%–49.1%) in identifying at least mild hearing loss and better accuracy for at least moderate loss (57.7%–74.4%). Nonetheless, the self-reported hearing problem based on multi questions showed accuracy between 54.9%-60.5% only.

**Factors Associated with Self-Reported Hearing Loss**

Binary logistic regression analysis was done to evaluate the association between self-reported hearing problem (Q–Q3) and demographic characteristics, PTAs and self-reported tinnitus. The Chi-square tests were first performed on the possible associated factors for self-reported hearing loss. Based on the findings [Table/Fig-1], the factors that had significant association with self-reported hearing problem were area of residence, education level and self-reported tinnitus. Separate independent t-tests were also done to determine whether the mean of PTAs of participants with self-reported hearing loss based on multi questions differed from those who did not. We found that differences were present only for PTAs of at least moderate hearing loss (>40 dBHL) (p<0.05). Therefore, these factors were added to the logistic regression model. The logistic regression model was statistically significant indicating that the predictors, as a set, reliably distinguish between those who reported and did not report hearing problems [χ²(6)=35.836, p<0.001]. The model explained 14% (Nagelkerke R²) of the variance in self-reported hearing loss and correctly classified 63.6% of cases.

A multiple binary logistic regression indicated that only PTA BE0.5–4.0kHz was independently associated with self-reported hearing loss (OR=2.16, 95 CI (1.15–4.05), p=0.017). Furthermore, the Wald criterion demonstrated that only history of tinnitus contributed significantly to the prediction (p=0.023), in which those with history of tinnitus were twice more likely to also report a hearing problem than those without. [Table/Fig-4] shows the binary logistic regression analysis for self-report hearing loss among older adults in Malaysia.

**Table/Fig-3**: Screening performance characteristic for the self-reported hearing problem (Q1 – Q3) and the question 1 "Do you think you have hearing loss?".
DISCUSSION

Our research found that the prevalence of self-reported hearing problem among older adults based on the multi questions was 53.4%. This finding is in line with a similar study which also used a few questions to identify hearing problem [17,18]. Their set of questions that consists of question each on self-report and hearing loss, difficulty hearing in noise, presence of tinnitus and report on intolerance toward everyday sound, yielded a prevalence of 60.8%. The current finding was also similar to studies conducted in other countries such as the United States and Australia. The prevalence of self-reported hearing loss in those countries was between 40.8% and 60.7% [9,11,19].

To our knowledge, there was only one available local study that measured the prevalence of self-reported hearing problem [12]. In their study, they identified only 24.3% older adults who reported hearing loss, which is lower than the current study. This discrepancy is expected since they used a single question “Do you have hearing loss?” to identify self-reported hearing loss. Furthermore, we recruited participants from a community-dwelling older adult population while Rosdina et al., study only concentrated on patients attending a primary care facility.

We found that self-reported hearing loss was not predicted by gender, age, race and education. These results were consistent with a few of the previous studies [9,12]. Nonetheless, there are studies that found significant associations between such demographic characteristics and self-reported hearing problem. For example, Mutsuko et al., found that older participants tend to report hearing loss compared to their younger counterparts [20]. A more dated research found that women tended to perceive themselves to have hearing problem than men [19].

The present study found that tinnitus and PTA of 40 dBHL and over across 0.5 to 4 kHz were significantly associated with self-reported hearing problem. Participants who resided in rural areas and those with self-reported tinnitus were twice more likely to report hearing problem than their urban or non-tinnitus counterparts. The contribution of tinnitus in the likelihood of self-reporting hearing problem is expected. This is because participants with tinnitus as a group had a significantly higher PTA than the non-tinnitus group. Furthermore, many studies have found the contribution of abnormal peripheral auditory system to the generation of tinnitus [21-23]. This finding ties with the significant contribution of at least moderate hearing loss at 0.5 kHz to 4 kHz, with twice more likely report of hearing problem. This finding could be partly explained by the fact that having a significant hearing loss at these frequencies may significantly impact conversation; hence those with higher thresholds have more tendencies to report hearing loss than their better hearing counterparts.

A single question such as “Do you have hearing loss?” was recommended as a tool to screen for hearing loss because it showed good screening performance [24]. However, the present study found that the question (Q1) had poor sensitivity, especially, in detecting at least mild hearing loss (PTA > 25 dBHL). The sensitivity improved when the hearing loss was based on > 40 dBHL. Likewise, the self-reporting hearing problem questions (Q1–Q3) also show better sensitivity when using the 40 dBHL cut-off level. This finding is expected because more severe hearing loss is likely to result in worse hearing difficulty. As a typical conversational level is between 60-70 dB SPL, those with more elevated hearing thresholds may find more difficulty during conversation, especially with the presence of competing sounds, as compared to those with better hearing thresholds [25].

Although the multi self-reported hearing problem questions (Q1–Q3) were better able to detect at least mild hearing loss than the single Q1 question, it has a higher probability of falsely identifying a positive result. Nonetheless, based on the overall results of this study, it can be concluded that the multi questions are superior to single question in identifying hearing loss among older adults. The sensitivity, however, is poorer than the recommended value for good screening tools. The finding was comparable with a few previous studies. A study by Rosdina et al., found the sensitivity of the single question to be at 41.4% and 55% for the identification of at least mild and moderate hearing loss, respectively [12]. In Singapore, Wu et al reported the sensitivity of the question as 58% [26].

In contrast to our findings, other large scales studies reported that the question “Do you feel you have hearing loss” to have better sensitivity to identify at least mild hearing loss. For example, the Blue Mountain Hearing Study found the question yielded high sensitivity and specificity of 78% and 67%, respectively [9]. Similarly, Nondahl et al., reported the sensitivity and specificity of the single question in identifying older adults with hearing loss in United States as 71% [11]. The performance of a set of questions or a questionnaire such as Hearing Handicap Inventory for the Elderly-Screening (HHIE) was found to yield better sensitivity and specificity [18]. These differences in results could reflect the different in term of definition used to describe hearing loss, questions for hearing loss identification and population under studies.

LIMITATION

The present study had strengths and limitations. Compared to other local studies, the current study is a large-scale population based study which has higher degree of generalisation. The large sample size and recruitment of participants from the various districts in Selangor enables us to make reasonable presentation of results specific to gender and age groups. However, the proportion of the races in this study did not reflect the proportion of races in Selangor, particularly, and Malaysia generally. Therefore, the prevalence of measured and self-reported hearing loss, and sensitivity and specificity of the questions need to be interpreted with caution as the findings may not be representing the three major races in Malaysia.

CONCLUSION

The prevalence of self-reported hearing loss in the present study was high. The use of multi questions could better reflect true prevalence of measured hearing loss than single questions provided that the questions have higher sensitivity in identifying hearing loss among community dwelling older adults. However, the current study found these questions to be a poor measure of hearing impairment in our local population. Therefore, the use of a more effective self-report inventory or audiometry instrument that is less sensitive to background noise is recommended so that population based hearing screening can be more feasible in order to estimate hearing loss prevalence among adults in Malaysia.

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