ORIGINAL ARTICLE

Accuracy of Single Question Hearing Screening in Detecting Hearing Loss among Traffic Workers: An Exploratory Study

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ABSTRACT

Background and Objective. Traffic workers play a vital role in maintaining public order and ensuring road safety. A key component of their profession is ensuring a smooth and efficient flow of traffic along our thoroughfares. A recent study on traffic workers from the Metropolitan Manila Development Authority (MMDA) assigned in Epifanio delos Santos Avenue (EDSA), occupational noise exposure levels >85 dBA, were at least 25% more likely to develop pure tone abnormalities, especially at frequencies above 2000 Hz. There is a need to screen workers who are at-risk for occupational noise-induced hearing loss (NIHL) such as these traffic workers. This is an exploratory study aimed to determine the accuracy of a single question hearing screening in Filipino (SQ-F) in detecting noise-induced hearing loss among traffic workers in EDSA.

Methods. This was an exploratory diagnostic accuracy cross-sectional study that determined the sensitivity, specificity, positive, and negative likelihood ratios of SQ-F in detecting NIHL among 108 traffic workers of the MMDA. The reference standard used was the air conduction pure tone threshold average at the 2000, 4000, and 6000 Hz of the worse hearing ear.

Results. The sensitivity and specificity of SQ-F were 26.5% (95% confidence interval [CI]: 15.0 to 41.1%) and 86.4% (95% CI: 75.0 to 94.0%), respectively. The positive (LR+) and negative (LR-) likelihood ratios were 1.96 (95% CI: 0.88 to 4.33) and 0.85 (95% CI: 0.7 to 1.0), respectively.

Conclusion. This study suggested that SQ-F might not be a good screening tool in detecting NIHL.

Keywords: hearing conservation, occupational hearing loss, noise exposure, road traffic noise, Philippines

INTRODUCTION

Traffic workers play a vital role in maintaining public order and ensuring road safety. A key component of their profession is ensuring a smooth and efficient flow of traffic along our thoroughfares. The Philippines' National Capital Region is a highly urbanized area that has the ninth-worst traffic congestion in the world, according to the 2023 TomTom Traffic Index, the leading location technology

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specialist.[1] Because of this, traffic enforcers are exposed to various types of health and safety hazards, which includes exposure to noise pollution that has been strongly linked to occupational hearing loss.[2,3]

Occupational noise-induced hearing loss (NIHL) is highly preventable. In developed countries, hearing conservation programs have generally been recommended for workers with occupational noise exposures above 85 dBA.[4,5] In the Philippines, the Department of Labor and Employment Occupational Safety and Health Center enforce the 90-dBA permissible exposure limit.[6] If noise exposure levels exceed this limit, various hazard controls must be utilized by the employer to reduce the sound to an acceptable level.

However, in a recent study on traffic workers from the Metropolitan Manila Development Authority (MMDA) assigned in Epifanio delos Santos Avenue (EDSA), occupational noise exposure levels > 85 dBA, were at least 25% more likely to develop pure tone abnormalities, especially at frequencies above 2000 Hz.[7] Thirteen percent of the participants were exposed to high levels of occupational noise, with field personnel likelier to be exposed compared to office-based personnel.

Noise-induced hearing loss typically affects the higher frequencies first at the 3000 to 6000 Hz, but eventually also affects the mid-frequencies.[7–11] A previous study associated high frequency hearing loss with problems in speech discrimination especially in the presence of background noise.[12] It can also affect sound localization and difficulty understanding soft speech. Thus, there is a need to screen workers who are at-risk for occupational noise-induced hearing loss such as these traffic workers. Hearing conservation programs generally require the use of an audiometer by trained personnel.[4,13] Formal hearing conservation programs are seen as too costly and resource-intensive. Coupled that with the common belief by non-ear specialists that hearing impairment can be sufficiently detected by self-report, there has not been much motivation to actively advocate for the establishment of hearing conservation programs in the noise-exposed.

This study was developed to explore the accuracy of self-reported hearing loss in detecting noise-induced hearing loss. Self-reported hearing loss will be elicited by asking a single question, "Do you have a hearing problem?". Available studies on the accuracy of this single question screening have shown variable results and were performed mostly on older adults using the midfrequency pure tone average at 500, 1000, 2000 and 4000 Hz of the better hearing ear as the reference standard.[14–17] A study on older Chinese adults yielded a sensitivity of 58% (95% CI: 29 to 84%) and specificity of 34% (95% CI: 19 to 54%),[15] while a study on Thai older adults showed better results, with a sensitivity of 88.7 % (95% CI: 85 to 91.5%) and specificity of 55.9% (95% CI: 52 to 59.7%)[14]. Meanwhile, a study performed in the primary healthcare clinics of South Africa estimated the accuracy of self-reported single question hearing loss at 71.9% (95% CI: 64.8 to 78%) sensitivity and 66.4% (95% CI: 63 to 69.5%) specificity.[16] The working age group is a fundamentally different population compared to the population in the studies presented above as it is composed of generally healthy individuals, and as such, hearing conservation is the priority. Thus, this study determined the accuracy of a single question hearing screening in Filipino (SQ-F) in detecting noise-induced hearing loss among traffic workers in EDSA.

MATERIALS AND METHODS

Study Design

This was an exploratory diagnostic accuracy cross-sectional study that used data from a previous study involving EDSA traffic workers of the MMDA. This study was approved by the University of the Philippines Manila Research Ethics Board (UPMREB 2022-0018-01).

Study Population

The study included MMDA employees assigned as traffic workers in EDSA. The employees were aged 25 to 65 years old, with at least five years of service in their current position. Employees with a history of chronic ear infection or any form of hearing loss where onset occurred prior to employment in the MMDA, current active ear infection, those with ear deformities (e.g. ear atresia), those with otologic findings suggestive of conductive hearing loss (ear drum perforation, middle ear effusion, or atelectasis, or Rinne negative on tuning fork test) and those with history of intake of TB medication were excluded. Employees with at least five years history of work other than the current that could predispose to occupational hearing loss (e.g., factory workers, construction) were also excluded.

Recruitment

A total of 258 employees from the Traffic Division volunteered for screening, with 156 deemed eligible based on the predetermined inclusion and exclusion criteria. One hundred eight (108) participants were randomly recruited to the original study.[7] See Figure 1 for the flow diagram. The data was collected from September to December 2022.

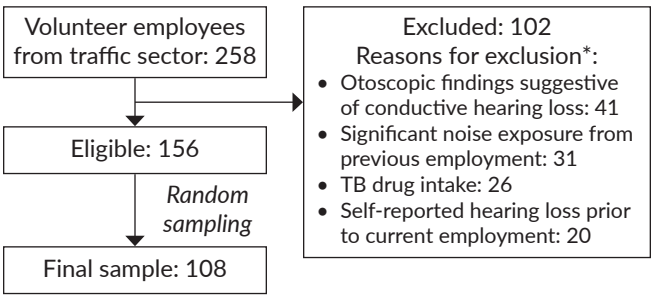

Figure 1. Flow diagram of study sample.

(*) Some participants were excluded for multiple reasons.

Study Test: Single Question Hearing Screening in Filipino (SQ-F)

Participants were asked the following question: "Do you experience any problems with hearing?" *("Mayroon ba kayong problema sa pandinig?")*. Their responses were recorded as either Yes or No.

Reference Standard: Air Conduction Pure Tone Audiometry

Air conduction pure tone audiometry (MADSEN Xeta Diagnostic Audiometer, Natus, USA) in the following frequencies were obtained 16 hours after their last work shift: 500, 1000, 2000, 4000, 6000, and 8000 Hz. The hearing examinations were performed in a sound-measured room in the MMDA Main Office with sound pressure levels (SPLs) ranging from 48 to 51 dB. Correction factors in each frequency per ear were applied to the obtained pure tone thresholds. To obtain these correction factors, three normal hearing individuals underwent pure tone audiometry in the sound-proof booth in the UP-Philippine General Hospital Ear Unit (35 dB SPL) and in the sound-measured room in the MMDA Main Office. The average difference in the obtained pure tone thresholds in each frequency per ear for the three individuals was considered the correction factor. NIHL was defined as having a pure tone average of 35 dB or more in at least one ear at the frequencies various studies have consistently found to be earlier affected by noise (2000, 4000, and 6000 Hz). In other words, the reference standard was the pure tone average for the worse hearing ear. An additional analysis was also performed wherein the reference standard was the pure tone average for the better hearing ear for comparison.

Statistical Analysis

We calculated summary statistics to describe the characteristics of the study sample. For categorical variables, frequencies and percentages were reported, while means and standard deviations were used for quantitative variables. To assess the diagnostic accuracy of the SQ-F, we computed the sensitivity, specificity, and likelihood ratios using Stata 14.0 (STATA Corp, LLC, USA). There were no missing data.

RESULTS

One hundred eight employees were included in the study. The employees were predominantly male (78%) and had a mean age (SD) of 44.6 (8.8) years. Seventy percent were field-based traffic workers, while the remaining 30% were office-based personnel. Furthermore, the mean (SD) duration of employment was 16.4 (8.1%) years (Table 1).

The sensitivity and specificity of SQ-F were 26.5% (95% confidence interval [CI]: 15.0 to 41.1%) and 86.4% (95% CI: 75.0 to 94.0%), respectively when the worse hearing ear was used as reference. This showed that less than a third of the workers with NIHL would have been detected by SQ-F, and the probability of NIHL is high with a positive response to SQ-F. The positive (LR+) and negative (LR-) likelihood ratios were 1.96 (95% CI: 0.88 to 4.33) and 0.85 (95% CI: 0.7 to 1.0), respectively. Table 2 shows the 2×2 table representing this data.

Table 1. Demographic Characteristics of Study Participants (n=108)

Characteristic	n (%)
Age (years), mean (SD)	44.6 (8.8)
Sex	
Male	84 (77.8)
Female	24 (22.2)
Educational Attainment	
High School	7 (6.5)
Vocational/ College Undergraduate	36 (33.3)
College Degree	63 (58.3)
Post Graduate Degree	2 (1.9)
With Diabetes Mellitus	23 (21.3)
Hypertensive	63 (58.3)
Smoking Status	
Never smoked	62 (57.4)
Past smoker	21 (19.4)
Current smoker	25 (23.2)
Alcohol Status	
Non-drinker	23 (21.3)
Occasional drinker	53 (49.1)
Regular drinker	32 (29.6)
Work Assignment	
Office-based	32 (29.6)
Field-based	76 (70.4)
Employment Duration in years, median (IQR)	14 (10.5 to 21)
Occupational Noise Exposure Level >85 dBA	14 (13.0)
With Self-reported Decreased Hearing	21 (19.4)
With tinnitus	20 (18.5)
Exposed to Recreational Noise	66 (61.1)
Prevalence of NIHL (worse ear)	49 (45.3)
Prevalence of NIHL (better ear)	29 (26.9)

When the better hearing ear was used as reference, the sensitivity and specificity of SQ-F were 31% (95% confidence interval [CI]: 15.3 to 50.8%) and 84.8% (95% CI: 75.0 to 91.9%), respectively, while the positive (LR+) and negative (LR-) likelihood ratios were 2.04 (95% CI: 0.96 to 4.33) and 0.81 (95% CI: 0.63 to 1.06), respectively. Table 3 shows the 2×2 table representing this data.

DISCUSSION

This was an exploratory study that determined the diagnostic accuracy of a singlequestion in screening for NIHL among EDSA traffic workers. The results revealed that using SQ-F as a screening tool may not be effective in detecting NIHL, having a sensitivity of only 26% and a

Table 2. Accuracy of Single Question Hearing Screening in Filipino (SQ-F) in Diagnosing Noise-Induced Hearing Loss (NIHL) Using the Worse Hearing Ear as Reference

SQ-F	NIHL		Total
	Present	Absent	
Present	13	8	21
Absent	36	51	87
Total	49	59	108

Table 3. Accuracy of Single Question Hearing Screening in Filipino (SQ-F) in Diagnosing Noise-Induced Hearing Loss (NIHL) Using the Better Hearing Ear as Reference

SQ-F	NIHL		Total
	Present	Absent	
Present	9	12	21
Absent	20	67	87
Total	29	79	108

specificity of 86%. The findings of this study were similar to the study by Rosso et al. that determined the accuracy of a screening questionnaire for NIHL in workers at printing and woodworking companies.[18] The sensitivity and specificity of the question "Do you feel you have hearing loss?" in detecting NIHL was at 29% and 82%, respectively. The use of the full questionnaire in the study of Rosso et al., which included questions that screened for high-frequency hearing loss and functional hearing loss, yielded a sensitivity and specificity of 32% and 79%,[18] which was not much different from asking the single question. Hong et al. performed a study on construction workers where self-rated hearing was reported on a 5-point rating scale using the question "How do you rate your hearing?", showing a slightly higher sensitivity at 51 to 55%, and a specificity of 83 to 89%.[19]

In contrast, the study of Manar et al. that administered a questionnaire to drivers to identify NIHL showed that the sensitivity and specificity in using self-reported hearing loss in detecting mid-frequency (2000, 3000, 4000 Hz) hearing loss, the sensitivity and specificity were computed at 60.4% and 67.5%, respectively, while for high frequency (6000 and 8000 Hz) hearing loss, they were computed at 59.4% and 63.9%, respectively.[20] The questionnaires by Rosso et al. and Manar et al. both involved questions on functional evaluation of hearing such as whether people complain about the participant watching TV at a high volume, or whether they have difficulty conversing through phone.[18,20] The former was interviewer-administered, composed of 28 questions, and underwent translations to the local language and subsequent validity and reliability testing while the latter study was composed of 10 items, but it was unclear who administered the questionnaire.

The LR+ and LR- ratios were 1.96 (95% CI: 0.88 to 4.33) and 0.85 (95% CI: 0.7 to 1.0), respectively. A positive SQ-F was twice more likely in a worker with NIHL compared to a worker without. However, a negative SQ-F was only slightly more likely in a worker without NIHL than a worker with NIHL. These values, together with the sensitivity and specificity, suggest that SQ-F might not be a good pre-audiometric screening tool in detecting NIHL. A large proportion of workers with NIHL would be missed by asking this question. There are several possible reasons that can explain these results. Firstly, the SQ-F was analyzed against the audiometric thresholds for the worse hearing ear. This means that their better hearing ear may be sufficiently functional that they are unable to perceive any hearing problem when performing daily activities. An analysis using the better hearing ear as the reference standard showed some improvement in the sensitivity of SQ-F. Secondly, patients with mild hearing loss would not have problems hearing conversational speech in quiet environments and may only have difficulty hearing conversational speech in noisy environments.[21] This was consistent with previous studies that have shown that about two-thirds of participants with audiometric hearing loss report good hearing.[22,23] In relation to this, these patients may attribute their hearing difficulties to external factors instead of attributing them to having hearing problems. These factors may include being in a noisy environment, or perceiving that people are mumbling, or not speaking clearly or loudly enough. Lastly, subjective hearing impairment has been shown in another study to correlate better with speech frequencies (500, 1000, 2000, 3000 Hz) than at higher frequencies (4000 and 6000 Hz)[19], which SQ-F was tested against in this study. In the study by Hong et al., sensitivity was higher in the speech frequencies (82-89%) and lower in the higher frequencies (51-55%).[14]

There were several limitations to this study. This study was conducted as an exploratory investigation, utilizing data collected from a previous research project. We acknowledge that our study was limited by its small sample size, which affected the statistical power and generalizability of our findings. Furthermore, this study has only included office- and field-based traffic personnel along EDSA, and the findings might not be applicable to traffic personnel outside of EDSA, or other noise-exposed groups. However, despite this, the effect estimates were similar to some of the published studies on the topic. Hearing conservation requires early detection of NIHL so that appropriate preventive measures can be implemented to prevent further decline in hearing. Further studies with a larger and formally calculated sample size may be done, as well as the inclusion of diverse populations in varying work environments. However, given the very low sensitivity, we also recommend looking into other screening tools that can be used to detect NIHL.

There was also selection bias as the screened employees were volunteers and may not have properly represented all employees in the traffic division working along EDSA. Additionally, nearly a quarter of the study sample consisted of employees aged 50 and older, suggesting that the study

may have included cases of age-related hearing loss. In our cross-sectional study design, we did not have the benefit of a baseline audiogram, which would have allowed us to make age corrections or comparisons over time. However, previous studies indicate that single-question screenings tended to be more sensitive when applied to older adults. Therefore, we can expect that the sensitivity of the SQ-F will likely decrease even further when accounting for age-related hearing loss.

Another limitation was the lack of blinding of the audiologists to the participants' subjective hearing loss. Audiologists were not provided the data prior to testing but neither were they restricted in their interactions with the participants. Some audiologists may have asked participants about their subjective hearing loss as they normally would when interacting with a patient. This detection bias could have caused an increase in the accuracy of SQ-F. Improving the blinding process in future studies should be done. Social desirability bias, a type of response bias wherein individuals tend to provide answers that are viewed favorably by others, may have affected the results of this study. In this context, participants may have underreported their hearing difficulties due to *hiya* (or sense of shame), to avoid the stigma associated with hearing loss or to present themselves as healthy, which could have led to an underestimation of true cases and thereby reduced the sensitivity of SQ-F.

Finally, future research may also include the formal validation, cross-cultural adaptation, and linguistic testing of the SQ-F because our current study only used an ad hoc translation.

CONCLUSION

SQ-F has a sensitivity, specificity, LR+ and LR- of 26%, 86%, 1.96 and 0.85, respectively. It does not appear effective as a screening tool in detecting NIHL. Employers and employees alike should be educated that the absence of symptoms does not equate to the absence of a hearing abnormality. Other methods of screening should be explored. This study provided preliminary proof that self-reported hearing loss cannot be relied upon to detect NIHL.

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Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

All authors declared no conflicts of interest.

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