Original Article

Validation of a questionnaire to identify noise-induced hearing loss among drivers

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Abstract

Objective: To assess the validity of a questionnaire (consisting of 10 items/questions) to identify hearing loss (HL) among three-wheeler tempo and noncommercial car drivers. **Materials and Methods:** This was a cross-sectional study conducted in an urban area of Lucknow city. Three-wheeler tempo drivers and noncommercial car drivers were assessed for HL by audiometry. A total of 300 subjects, who fulfilled the study criteria, were selected for the interview and health assessment. The pure tone audiometry was conducted after >12 hours of the last noise exposure to avoid temporary threshold shift. **Results:** The percentage of respondents aged between 31 and 40 years was 36%. The highest affirmative response item was "Do you have trouble hearing in noisy background?" constituting 68% and the lowest affirmative response item was "Do you have trouble understanding the speech of women and children?" constituting 33.7%. Kappa values showed that there was significantly (<0.05) mild agreement between most of the items and the gold standard for mid and high-frequency HL. The area under the curve for low, mid, and high frequency HL was 0.76% (95% CI = 0.68–0.84), 0.69 (95% CI = 0.73–0.75), and 0.67 (95% CI = 0.62–0.73), respectively. The sensitivity and specificity were reasonable for all the definition of HL at different cutoff scores. **Conclusion:** A self-reported questionnaire-based approach may be used for the assessment of HL especially when audiometry is not feasible.

Keywords: Hearing loss, tempo car drivers, validity

Introduction

Noise-induced hearing loss (HL) is one of the most common disability, affecting millions of people around the world.[1]

HL is a universal public health problem affecting people of all ages. The epidemiological data on HL severity and magnitude can be helpful in designing preventive policies. The epidemiological studies usually cover large population; however, the use of pure tone audiometry (PTA) for epidemiological studies is inadequate especially in developing countries as it requires trained professionals, technical equipment, and soundproof space for the accurate assessment of hearing. Because of operational constraints as well as costs involved in using the audiometry, many authors use the self-reported approach for the assessment of HL.[2-4]

Audiometry is a gold-standard test to evaluate the ability of hearing. However, its conduction sometimes get hindered because of the problems of access, reference, and reimbursement. Therefore, many researchers adapt the self-administered questionnaires.[5] The identification of prevalence and trends of HL in large geographical areas as well as in subgroups of risk populations, large-scale trials on hearing impairment investigations may be useful. The self-administered questionnaire-based investigations may be a quick and cheap way of providing estimates to large populations.[6] National Institute for Deafness

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and Communication Disorders (NIDCD) has developed a questionnaire (consisting of 10 items/questions) to assess a person's hearing ability.[7] However, the validity of NIDCD questionnaire is not validated for taxi and car drivers, especially in the Indian context. The self-reported questionnaire-based assessment of hearing could be a reliable indicator of hearing impairment. It is also quick, cheap, and easy to administer.[8]

This study was conducted to assess the validity of an NIDCD questionnaire (consisting of 10 items/questions) to identify HL among three-wheeler tempo and noncommercial car drivers.

Materials and Methods

Study design

This was a cross-sectional study.

Study area

Urban area of old Lucknow.

Study participants

Light motor vehicle drivers.

Ethical approval and consent

The study was approved by the ethical committee of the institute and consent was taken from each participant before including in the study.

Materials and Methods

The subjects, tempo drivers, and noncommercial car drivers, who were previously exposed to nontraffic occupational noise, had a history of diabetes mellitus illness, head injury, chronic suppurative otitis media, and who had ever been suffered from ear infection were excluded from the study. The exclusion criteria for selection of tempo drives and non-commercial car drivers were kept same except one more exclusion criterion included in the selection of non-commercial car drives, that is, those car drivers who had ever worked as commercial vehicle drivers were also excluded. The tempo drives were selected from three tempo routes (1) Chowk – Charbagh, (2) Chowk – Dubagga, and (3) Madiyaon – Kaisarbagh, and nonprofessional car drivers were selected from academic and research institutions, who were working as personal car drivers of academicians and scientists. A total of 300 subjects, 150 tempo drivers, and 150 noncommercial car drivers, who fulfilled the study criteria, were selected by using simple random sampling for the interview and health assessment.

The PTA of both the ears of the subjects was conducted minimum 12 hours after the last noise exposure to exclude the effect of temporary threshold shift.

Audiometric testing was performed using a Medical Grade MAICO (Model: MA42) Audiometer. This was carried out by doing air conduction test at frequencies of 250, 500, 1000, 2000, 3000, 4000, 6000, and 8000 Hz, taken for each ear in a soundproof closed room, had an ambient noise level <25 dBA.

PTA was further classified into mean threshold tonal value in the sound frequencies of 250, 500, and 1000 Hz as low-frequency HL (PTA-1), mean threshold tonal value in the sound frequencies of 2000, 3000, and 4000 Hz as mid-frequency HL (PTA-2), and mean threshold tonal value in the sound frequencies of 6000 and 8000 Hz as high-frequency HL (PTA-3). Mean threshold tonal value of PTA-1, PTA-2, and PTA-3 ≤25 dB classified as normal hearing and >25 dB classified as altered hearing. Self-reported hearing problems (SRHPs) of NIDCD questionnaires were used for assessment of HL.

Statistical analysis

Statistical analysis was done using SPSS version 23.0 for Windows (SPSS Inc., Chicago, IL, USA). The Kappa statistic was calculated to find the agreement between questions and audiometry as a gold standard. The receiving operating curve analysis was carried out. The area under the curve (AUC) with its 95% confidence interval (CI) was calculated. The sensitivity, specificity, positive predictive value, and negative predictive value were calculated. Multiple logistic regression analysis was done to analyze these variables.

Results

More than one-third of respondents were between 31 and 40 years of age (36%). Majority belonged to the Hindu community (42.7%) and 57% were from a backward caste. A majority of respondents were married (75.7%) and 63% belonged to the joint family. More than one-third of respondents had secondary level education [Table 1].

Table 2 depicts the distribution of questionnaire item responses with audiogram results for the three definitions of HL. The highest affirmative response item was "Do you have trouble hearing in a noisy background?" constituting 68% and the lowest affirmative response item was "Do you have trouble understanding the speech of women and children?" constituting 33.7%. Kappa values showed that there was significantly (<0.05) mild agreement between most of the items and the gold standard for mid-frequency (PTA-2) and high-frequency (PTA-3) HL.

The predictive values of each definition of HL were calculated. SRHP cutoff >11 for low frequency correctly detected HL among 8.3% with sensitivity and specificity of 73.5% (95% CI = 58.7–88.4) and 71.8% (95% CI = 66.4–77.2), respectively. However, SRHP cutoff >9 for middle frequency correctly detected HL among 21.3% with sensitivity and specificity of 60.4% (95% CI = 51.1–69.7) and 67.5% (95% CI = 60.9–74.1), respectively. SRHP cutoff >9 for high frequency correctly detected HL among 21% with sensitivity and specificity of 59.4% (95% CI = 50.1–68.8) and 63.9% (95% CI = 57.2–70.7), respectively [Tables 3-5].

The AUC for low-, mid-, and high-frequency HL was 0.76 (95% CI = 0.67–0.86), 0.69 (95% CI = 0.62–0.76), and 0.67 (95% CI = 0.61–0.74), respectively [Figures 1-3].

Discussion

The findings of this study revealed that the use of NIDCD questionnaire to assess HL has good sensitivity; however, fair specificity as with audiometry test used, being the gold standard. These findings are adequate to support a self-administered approach in identifying hearing impairment.

Table 1: Demographic profile of respondents

Demographic profile	No. (*n*=300)	Percentage
Age, years		
<20	5	1.7
20-30	89	29.7
31-40	108	36.0
41-50	98	32.7
Religion		
Hindu	218	72.7
Muslim	79	26.3
Sikh	3	1.0
Category		
Unreserved	94	31.3
Scheduled caste	35	11.7
Backward caste	171	57.0
Marital status		
Single	70	23.3
Married	227	75.7
Divorcee/separated	3	1.0
Type of family		
Nuclear	101	33.7
Joint	189	63.0
Three generation	10	3.3
Education		
Illiterate	58	19.3
Primary school	101	33.7
Secondary school	112	37.3
Graduate and above	29	9.7

The comparison of the results of this study with other studies is limited because of age range and type of study subjects. This study found low agreement between most of the question and audiogram results. The highest affirmative response item was "Do you have trouble hearing in a noisy background?" constituting 68% but had a poor agreement at all the frequencies. McCullagh reported that the 10-item questionnaire did not perform with fewer items reported in separate studies.[9]

The Epidemiology of Hearing Loss Study evaluated the validity of four questions in addition to the Hearing Handicap Inventory for the Elderly-Screening (HHIE-S) to identify hearing impairment in an older community. These questions were: "Do you feel you have a hearing loss?"; "In general, would you say your hearing is excellent, very good, good, fair, poor?"; "Have you ever worn a hearing aid or amplifying device?"; "Do your friends and relatives think you have a hearing problem?" The most sensitive (sensitivity, specificity 71%) question was, "Do you feel you have a hearing loss?" with overall prevalence estimates within 3.2% of the audiometric.[6]

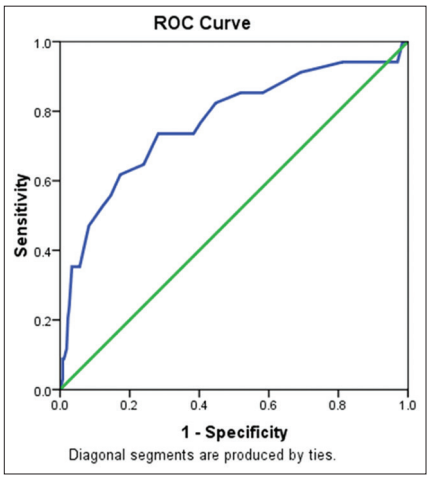

Figure 1: ROC curve showing predictive value of SRHP for low-frequency HL. HL: hearing loss, ROC: receiving operating curve, SRHP: self-reported hearing problem

Table 2: Distribution of questionnaire item responses with audiogram results for the three definitions of hearing loss

Questionnaire item	Response, No. (%)		Kappa (*P*)		
	Yes	No	PTA-1	PTA-2	PTA-3
Do you have problem hearing over telephone/mobile phones?	153 (51.0)	147 (49.0)	0.07 (0.03)*	0.10 (0.06)	0.15 (0.004)*
Do you have trouble following the conversation when two or more people are talking at the same time?	182 (60.7)	118 (39.3)	0.07 (0.01)*	0.15 (0.002)*	0.14 (0.004)*
Do people complain that you watch TV at a high volume?	195 (65.0)	105 (35.0)	0.02 (0.46)	0.06 (0.19)	0.07 (0.12)
Do you have to strain to understand conversation?	168 (56.0)	132 (44.0)	0.12 (0.001)*	0.09 (0.06)	0.08 (0.10)
Do you have trouble hearing in a noisy background?	204 (68.0)	94 (32.0)	0.01 (0.96)	0.01 (0.81)	0.03 (0.45)
Do you find yourself asking people to repeat themselves?	193 (64.3)	107 (35.7)	0.07 (0.007)*	0.14 (0.003)*	0.20 (0.001)*
Do many people you talk to, seem to mumble (or not speak clearly)?	147 (49.0)	153 (51.0)	0.08 (0.02)*	0.22 (0.001)*	0.17 (0.002)*
Do you misunderstand what others are saying and you respond inappropriately?	159 (53.0)	141 (47.0)	0.11 (0.001)*	0.19 (0.001)*	0.18 (0.001)*
Do you have trouble understanding the speech of women and children?	101 (33.7)	199 (66.3)	0.15 (0.001)*	0.09 (0.10)	0.13 (0.01)*
Do people get annoyed because you misunderstand what they say?	146 (48.7)	154 (51.3)	0.12 (0.001)*	0.20 (0.001)*	0.18 (0.001)*

*Significant. PTA: Pure tone audiometry

Table 3: Predictive value of SRHP for low-frequency HL

SRHP cutoff	Low-frequency HL (hearing loss)				Total	
	Yes		No			
	No.	Percentage	No.	Percentage	No.	Percentage
>11	25	8.3	75	25.0	100	33.3
≤11	9	3.0	191	63.7	200	66.7
Total	34	11.3	266	88.7	300	100.0
Predictive values, % (95%CI)						
Sensitivity			73.5 (58.7-88.4)			
Specificity			71.8 (66.4-77.2)			
PPV			25.0 (16.5-33.5)			
NPV			95.5 (92.6-98.4)			
AUC (95%CI)			0.76 (0.67-0.86)			
%age is from total no. of cases						

AUC: Area under the curve, CI: Confidence interval, HL: Hearing loss, NPV: Negative predictive value, PPV: Positive predictive value, SRHP: Self-reported hearing problem

Table 4: Predictive value of SRHP for middle-frequency HL

SRHP cutoff	Low-frequency HL (hearing loss)				Total	
	Yes		No			
	No.	Percentage	No.	Percentage	No.	Percentage
>9	64	21.3	63	21.0	127	42.3
≤9	42	14.0	131	43.7	173	57.7
Total	106	35.3	194	64.7	300	100.0
Predictive values, % (95%CI)						
Sensitivity			60.4 (51.1-69.7)			
Specificity			67.5 (60.9-74.1)			
PPV			50.4 (41.7-59.1)			
NPV			75.7 (69.3-82.1)			
AUC (95%CI)			0.69 (0.62-0.76)			
%age is from total no. of cases						

AUC: Atra under the curve, CI: Confidence interval, HL: Hearing loss, NPV: Negative predictive value, PPV: Positive predictive value, SRHP: Self-reported hearing problem

Table 5: Predictive value of SRHP for high-frequency HL

SRHP cutoff	Low-frequency HL (Hearing loss)				Total	
	Yes		No			
	No.	Percentage	No.	Percentage	No.	Percentage
>8	63	21.0	70	23.3	133	44.3
≤8	43	14.3	124	41.3	167	55.7
Total	106	35.3	194	64.7	300	100.0
Predictive values, % (95%CI)						
Sensitivity			59.4 (50.1-68.8)			
Specificity			63.9 (57.2-70.7)			
PPV			47.4 (38.9-55.9)			
NPV			74.3 (67.6-80.9)			
AUC (95%CI)			0.67 (0.61-0.74)			
%age is from total no. of cases						

AUC: Atra under the curve, CI: Confidence interval, HL: Hearing loss, NPV: Negative predictive value, PPV: Positive predictive value, SRHP: Self-reported hearing problem

Some studies have reported poor sensitivity for single questions to assess mild HL. A study conducted on 2278 people aged 40–64 years in South-East of England showed the sensitivity and specificity of a single question "Do you have difficulty in hearing and understanding most things people say, without seeing their face and lips?" to be 58.3% and 91.8%, respectively.[10]

Louw *et al.* evaluated self-reported HL by a single question, PTA screening by mobile phone using hearScreen Android application, and pure tone diagnostic testing by a clinical audiometer. They showed that the sensitivity and specificity of self-reported HL were 71.9 and 72.2, respectively. However, when self-reported HL and audiometry screening were combined, it showed high test accuracy (81.0%) for HL and being most accurate (86.1%) at a high-frequency HL, when compared with clinical audiometry test.[11]

We calculated the predictive values of the SRHP questionnaire in predicting HL at different HL frequency levels, that is, at

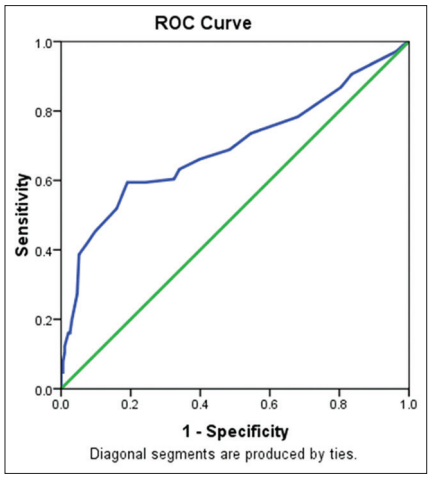

Figure 2: Predictive value of SRHP for middle-frequency HL. HL: hearing loss, SRHP: self-reported hearing problem

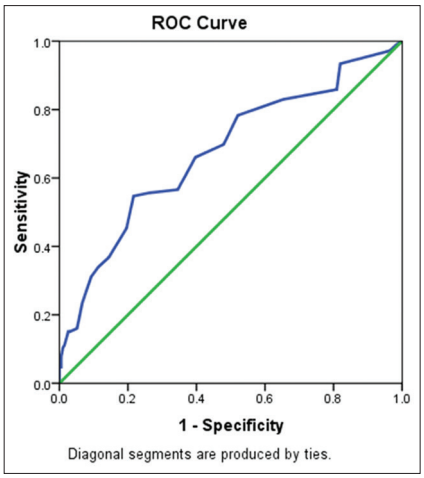

Figure 3: Predictive value of SRHP for high-frequency HL, HL: hearing loss, SRHP: self-reported hearing problem

low, middle, and high frequency. The findings showed that there were reasonable sensitivity and specificity for a different cutoff of SRHP score at low, middle, and high frequency. 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 HL, respectively.[12] In Singapore, Wu *et al.* reported the sensitivity of the question as 58%.[13] Nondahl *et al.* reported the sensitivity and specificity of the single question in identifying older adults with HL in the USA as 71%.[6] The performance of a set of questions or a questionnaire such as HHIE-S was found to yield better sensitivity and specificity.[14] These differences in results could reflect the difference in term of the definition used to describe HL, questions for HL identification, and population under studies.

WHO estimated that 466 million persons of the world live with disabling HL in 2018, disabling HL is unequally distributed all around the world, and South Asia is the highest contributor (27%), and also, projected that number of persons with disabling HL grows with the years, 630 million by 2030 and 900 million by 2050.[15]

The management of ear diseases of rural population is guided and strengthened by revised updated Indian Public Health Standards (IPHS) since 2012 for National Programme for Prevention and Control of Deafness (NPPCD) for rural health facilities such as subcenter, primary health center, and community health center.[16] However, even despite the existence of IPHS, the coverage and quality impact of IPHS on ear care from the primary care level are still questionable.[17]

NPPCD emphasizes on early identification of cases of hearing impairment and their management in collaboration with NRHM at the primary health care level, the detailed guidelines, and facilities essentially required have also been mentioned for all levels of health care but facility of audiometry is being not provided at the primary health care level.[18]

One of the basic challenges with the primary care physicians for hearing care of their patients is finding a suitable HL screening tool that is user-friendly, simple, affordable, and efficient. The findings of this study showed that HL could be assessed by using self-reported questionnaire protocol. Therefore, the NIDCD questionnaire may be used as a tool for screening of HL by the primary care physicians in the absence of audiometry facility.

Conclusion

When audiometry is not feasible, a self-reported, questionnaire-based approach can be used as an easy, cheap, and simple tool for HL assessment.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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