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ORIGINAL ARTICLE

Score of Hearing Handicap Inventory for the Elderly (HHIE) Compared to Whisper Test on Presbycusis

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Abstract Presbycusis is a sensorineural type of hearing loss caused by a degenerative process of the hearing organ. Examination was done to detect hearing loss, with Audiometry as the diagnostic gold standard and screening with whisper test and using Hearing Handicap Inventory for the Elderly-Screening (HHIE-S) questionnaire. This study was aimed to compare the sensitivity and specificity between Hearing Handicap Inventory for the Elderly Screening questionnaire score and Whisper test in hearing loss of presbycusis patients in Dr. Soetomo Hospital. Subjects were elderly patients in outpatient clinic of Geriatry and Audiology of Dr. Soetomo General Hospital in Surabaya. Data samples were collected by consecutive sampling. All collected samples were analyzed statistically by Pearson correlation test to identify the correlation between variables. Results: Statistic analysis with Pearson correlation test obtained p-value = 0.001 and correlation coefficient (r) = 0.691 for HHIE-S questionnaire and p = 0.001 and (r) = 0.298 for Whisper test. The sensitivity of the Whisper test was 72.73% while the HHIE-S questionnaire was 61.82%. Both tests had the same specificity of 80%. Conclusions: The Whisper test is more sensitive than HHIE-S questionnaires in detecting hearing loss in presbycusis patients in outpatient clinic of Geriatry and Audiology of Dr. Soetomo General Hospital in Surabaya.

Keywords Hearing loss degree · HHIE-S questionnaire score · Presbycusis · Whisper test

Introduction

Presbycusis is a sensorineural type of hearing loss in the elderly due to the gradual natural process of degeneration of the auditory organs, generally occurring from the age of 65 years and 50% affected over the age of 70–80 years. The criteria of Presbycusis diagnosis are usually symmetric increased hearing threshold, the absence of injury, use of ototoxic medications, history of ear disease and previous ear surgery, the presence of minimum conductive hearing loss (10 dB or lower), and aged 65 years or older [1].

The etiology of presbycusis is multifactorial, and suspected to involve hereditary factors, metabolism, arteriosclerosis, noise exposure, and the use of ototoxic drugs [2]. A component of central auditory processing disorder frequently accompanies presbycusis [3, 4].

Presbycusis as identified by Schuknecht is divided into 4 types according to histologic changes in the cochlear: sensory type, neural type, strial or metabolic type and mechanical type or ochlear conductive [1, 3]. This limitation in hearing has a significant impact on patients, families, communities and countries. Hearing loss poses barriers in communicating causing social isolation and depression, and is associated with cognitive decline,

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withdrawal from living activities and decreasing quality of life for the elderly [5, 15]. The gold standard auditory assessment is pure tone audiometry, but this audiometric examination is difficult in some places due to access problems, referral systems and costs so that many practices in the field rely on questionnaires for screening for hearing loss and the Whisper test [3, 6].

The degree of hearing loss is the severity of hearing loss obtained from the average threshold of hearing (Pure Tone Threshold Average) at the 4 frequencies, of 500, 1000, 2000 and 4000 Hz pure tone audiometry. The degree of hearing loss in this study refers to WHO criteria, which are grouped into: (a) PTA ≤ 25 dB, means no hearing loss (normal)., (b) PTA 26–40 dB, means mild degree hearing loss, (c) PTA 41–60 dB, means moderate hearing loss, (d). PTA 61–80 dB, means severe hearing loss, (e). PTA ≥ 81 dB, means Profound degree of hearing loss [7].

The aim of the study was to assess the validity of HHIE-S questionnaire score compared to the Modified Whisper Test in relation to the degree of hearing loss among patients in Geriatric clinic of Dr. Soetomo Hospital Surabaya.

Materials and Methods

This was an observational analytic study with a cross sectional design. The variables in this study were Modified Whisper test and HHIE-S questionnaire scores and the degree of hearing loss. Consecutive sampling of elderly patients who met the inclusion and exclusion criteria took place in the outpatient clinic of Geriatry and Audiology of Dr. Soetomo General Hospital in Surabaya.

The inclusion criteria were patients aged 65 years or older with complaints of hearing loss and an audiogram result showing high frequency sensorineural hearing loss, which was symmetrical and bilateral, the patient had never used hearing aids and was willing to follow the research. Exclusion criteria were patients having dementia, impaired consciousness, disturbance of balance, perforation of tympanic membrane, Otitis Media, or history of previous ear surgery.

The whisper test used Indonesian words from a Phonetically balanced List (PB list). The examiner stood at arm's length behind the seated patient and whispered the 10 words. The patient was asked to repeat each hearing word after each word was whispered [8].

The Hearing Handicap Inventory for the Elderly-Screening (HHIE-S) is a subjective examination, consisting of 10 questionnaires assessing the effect of hearing loss on emotional and social outcomes with a total score between 0 and 40 [6, 9]. The HHIE-S questionnaire can be used as a screening tool to identify handicaps due to hearing loss in the elderly [3]. All data collected was analyzed using Pearson correlation test.

Results

In this study, there were 60 patients in the Geriatric Clinic who met the criteria of the study. The age range of the subjects was 65 to 89 years. The percentage of men was 50%. The basic information about subjects in this research can be seen in additional information in the journal website. 14 patients (23%) had a job with noise exposure and 36 patients (76.6%) did not have a job with noise exposure.

The degree of hearing loss determined by PTA values can be seen in (Table 1). In this research, the minimum PTA value was 15 dB and maximum 85 dB, with mean 44.83. The result of the distribution of Whisper test on degree of hearing loss can be seen on (Table 2). Total patient with hearing loss were 55 patient. 15 patient (27%) have result of whisper test pass and 40 patient (73%) have whisper test result Fail. The result of the distribution of HHIE-S score questionnaire on degree of hearing loss can be seen on (Table 3). 21 patient (39%) were no handicap (HHIE score 0–8), 20 patients (36%) were mild moderate handicap (HHIE score 10–22) and 14 patients (23%) were severe handicap (HHIE score 24–40). The results of hearing loss checks using pure tone audiometry and whisper test in (Table 4) and the results of hearing loss checks using pure tone audiometry and HHIE-S questionnaires in (Table 5).

Hearing loss is defined as when the audiometric result obtained a PTA value ≥ 26 dB and no hearing loss when the PTA value was ≤ 25 dB, whereas in Whisper Test hearing loss is defined as when the patient can repeat the word whispered < 80% of times and no hearing loss as when the word whispered was repeated by the patient ≥ 80% of times (Table 2).

The whisper test had: (a) Sensitivity = 40/55 × 100% = 72.73%, (b) Specificity = 4/5 × 100% = 80%

The positive predictive value on this study with Wilson score method is 78.95% and the negative predictive value with the same method is 24.39%.

The false negative rate and false positive rate from Table 4 obtained the results:

a) False negative rate = 15/55 × 100% = 27.27%

Table 1 Degree of hearing loss based on PTA value

Degree of hearing loss (PTA)	Number of subjects	Percentage (%)	Mean PTA level
Normal (≤ 25 dB)	5	8	16.67
Mild (26–40 dB)	18	30	33.56
Moderate (41–60 dB)	20	33	51.12
Severe (61–80 dB)	10	17	73.57
Profound (≥ 81 dB)	7	12	85.78
Total	60	100	44.08

Table 2 Result of Whisper test on hearing loss degree

Whisper Test	Degree of hearing loss					Total Hearing loss	Total
	Normal (≤ 25 dB)	Mild (26–40 dB)	Moderate (41–60 dB)	Severe (61–80 dB)	Profound (≥ 81 dB)		
≥ 80% (Pass)	4 (7%)	4 (7%)	6 (10%)	3 (5%)	2 (3%)	15 (27%)	19 (32%)
< 80% (Fail)	1 (2%)	14 (23%)	14 (23%)	7 (12%)	5 (8%)	40 (73%)	41 (68%)
Total	5 (8%)	18 (30%)	20 (33%)	10 (17%)	7 (12%)	55 (100%)	60 (100%)

Table 3 Result of HHIES-S score questionnaire on hearing loss degree

HHIE-S Questionnaire score *(Hearing handicap)*	Degree of hearing loss					Total Hearing loss	Total
	Normal (≤ 25 dB)	Mild (26–40 dB)	Moderate (41–60 dB)	Severe (61–80 dB)	Profound (≥ 81 dB)		
0–8 (no *handicap*)	4 (7%)	9 (15%)	7 (12%)	3 (5%)	2 (3%)	21 (39%)	25 (42%)
10–22 (mild-moderate *handicap*)	1 (2%)	4 (7%)	8 (13%)	4 (7%)	4 (7%)	20 (36%)	21 (35%)
24–40 (severe *handicap*)	0 (0%)	5 (8%)	5 (8%)	3 (5%)	1 (2%)	14 (25%)	14 (23%)
Total	5 (8%)	18 (30%)	20 (33%)	10 (17%)	7 (12%)	55 (100%)	60 (100%)

Table 4 Table 2 × 2

Whisper test	Audiometry		Total
	Fail (PTA ≥ 26 dB)	Pass < 26 dB	
Whisper test Fail	40 (66.7%)	1 (1.7%)	41 (68.4%)
Whisper test Pass	15 (25%)	4 (6.6%)	19 (31.6%)
Total	55 (91.7%)	5 (8.3%)	60 (100%)

Table 5 Table 2 × 2

HHIE-S	Audiometry		Total
	Fail	Pass	
Fail	34 (57%)	1 (2%)	35 (59%)
Pass	21 (35%)	4 (7%)	25 (42%)
Total	55 (92%)	5 (8%)	60 (100%)

b) False positive rate = 1/5 × 100% = 20.00%

In HHIE-S, pass was defined as no handicap with HHIE-S score ≤ 8 while fail was defined as handicap with. HHIE-S score ≥ 10.

HHIE-S test had: (a) Sensitivity = 34/55 × 100% = 61.82%, (b) Specificity = 4/5 × 100% = 80%

The positive predictive value on this study with Wilson score method is 68.29% and the negative predictive value with the same method is 21.05%.

Wilson intervals use data more efficiently, because not only do they add up to a single mean and standard error but also using data to develop functions maybe used to develop interval.[10].

The false negative rate and false positive rate from Table 5 obtained the results:

a) False negative rate = 21/55 × 100% = 38.18%

b) False positive rate = 1/5 × 100% = 20.00%

Table 6 Table result of hearing loss checks using Whisper test and HHIE-S questionnaires

Whisper test	HHIE-S		Total
	Fail	Pass	
Fail (can repeat < 80%)	13 (22%)	28 (47%)	41 (69%)
Pass (can repeat ≥ 80%)	12 (20%)	7 (12%)	19 (32%)
Total	35 (51%)	25 (42%)	60 (100%)

The result of one-sample *Kolmogorov–Smirnov* test on whisper test and degree of hearing loss based on PTA value showed that both data were normal distributed so that the next statistic test using *pearson correlation* test can be seen in (Table 7).

Table 7 Data analysis of whisper test with degree of hearing loss using Pearson correlation test

Variable	*Mean* (SD)	p	R
Whisper test score PTA	70,48	0.001	0.298
	44,83		
HHIE-S score PTA	12,75	0.001	0.691
	44,83		

The result of One-Sample *Kolmogorov–Smirnov* test on HHIE-S score and degree of hearing loss based on PTA value showed that both data were normally distributed so that the next statistic test using *pearson correlation* test. The *Pearson correlation* test is significant when $p < 0.05$. The results of statistical calculations using Pearson correlation test obtained $p = 0.001$ for the Whisper Test and the HHIE-S test indicating highly significant correlation in both tests.

Discussion

In this study we found that the Whisper test is more sensitive and had the same specificity as the HHIE-S questionnaires in detecting any level of hearing loss in presbycus patients in Geriatric Clinic Dr. Soetomo Hospital. The Whisper test method can therefore be used as a simple and quick screening protocol for use in general practice and primary health care service centres in this country. We found that the HHIE-S questionnaire had a lower but acceptable sensitivity and may be used as an alternative if the Whisper Test cannot be used. However, some other studies have found much lower sensitivity for the HHIE-S test, so the Whisper Test should, from these results, be the first choice for a simple screening test for any level of hearing loss in older patients.

In this study, the 60 sample subjects were obtained with the age range of 65–88 years, with mean of 73.52. Most samples were in age group of 75–79 years that is 30%.

The study found that 19 people (32%) had a normal (pass) result in whisper test, of which 15 had a hearing loss on PTA. 41 people (68%) had whisper test fail result of which 40 had a hearing loss on PTA (Table 2).

The results of HHIE-S show that there were 25 patients (42%) with a no handicap result in which 21 had hearing loss on PTA. 35 patients (58%) had a handicap result of which 34 had a hearing loss on PTA (Table 3).

From Tables 6 and 7 it was found that Whisper test had 72.7% sensitivity, 80% specificity and 27% false negative rate whereas HHIE-S questionnaire had 61.82% sensitivity, 80% specificity and 38.0% false negative rate. The higher sensitivity and hence lower false negative rate of the whisper test indicates that whisper test was better than the HHIE-S questionnaire in detecting hearing loss. Both the whisper test and the HHIE-S questionnaire had the same specificity (80%) in detecting hearing loss.

The degree of hearing loss with the largest number of patients was moderate hearing loss (41–60 dB) with 20 people (33%). 7 persons (12%) had profound degree of hearing loss (≥ 81 dB) (Table 3). The mean hearing loss from audiometric examination of the better ear in all patients was 44,83 dBHL. Similarly Wibowo's, et al.'s [11] study obtained the highest patient numbers in the moderate-severe hearing loss group of 9 people (37.5%) and only 2 people (8.3%) with severe hearing loss. It should be noted that the present study and Wibowo et al.'s study sample were clinic—based and therefore unlikely to be indicative of the prevalence in the population or to enable meaningful comparison between samples from different studies.

The result of the analysis of the relationship between HHIE-S questionnaire score with the degree of hearing loss based on PTA value using Pearson correlation test obtained $p = 0.001$ with correlation coefficient (r) = 0.691. This shows that there is a significant relationship with a strong positive correlation between the HHIE-S questionnaire score with the degree of hearing loss ($p < 0.05$). The higher the score of the HHIE-S questionnaire, the degree of hearing loss also gets worse. Thus, the hypothesis of this study is evident. The Pearson correlation test results for the Whisper Test were the same as for the HHIE-S Questionnaire so the same conclusion can be made for the Whisper test.

The results of this study support the research that has been done by Wibowo et al.(2010), [11] that there is a high correlation between hearing threshold with hearing handicap using HHIE-S ($p < 0.000$) with correlation coefficient. 0.937. The higher the audible threshold the higher the hearing handicap score (HHIE-S).

Gates and Mills (2005) [3] found that the HHIE-S score had a sensitivity of 35% and a 94% specificity for detecting hearing loss at the cut-off value of 8–10. Studies by Blue Mountain Hearing Study reported only HHIE- S score above 8 can adequately identifies hearing loss primarily in moderate hearing loss [6].

Several other studies have concluded that this questionnaire has high sensitivity, specificity and predictive value compared with pure tone audiometry as a gold standard check [6, 14]. The Sindhusake study found that HHIE- S has a higher sensitivity and specificity for severe hearing loss (76.2% and 87.7% respectively) compared to minor degrees of hearing loss of 26.2% and 95.9% [12]. There was a correlation between hearing threshold and hearing handicap based on HHIE-S, the higher the audibility threshold the higher the HHIE-S score [11]. Another

study showed that the Whisper Test and the screening questionnaire produced a lower prevalence than expected from the literature, which suggests there may be a low test sensitivity [13].

37% of the sample subjects had an education level of senior high school and 14% reached a higher education level. The level of education affected the level of understanding of the sample of the Whisper Test and the filling of the HHIE-S questionnaire. Samples with elementary school level require more explanation and assistance in filling out questionnaires to reduce inaccuracy in filling questionnaires.

Limitations of Study

The sample size in this study was small, and because of the variability in results with other studies of these tests, it is recommended that a much larger study be untaken to demonstrate convincingly that the results of this study are correct. Hearing screening in older patients is becoming increasingly important as the numbers with hearing loss increases markedly in this sector of the population, so it is important to have an accurate and simple method of screening.

Conclusion

The Whisper test is more sensitive than HHIE-S questionnaires in detecting hearing loss in presbycusis patients.

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Compliance with Ethical Standards

Conflicts of interest There are no conflicts of interest.

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