

Community-Based Hearing Screening of Disabled Elders Using the Thai-FMHT: Clinical Implications and Cost-Effectiveness

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Objective: The aim of this study was to evaluate the feasibility of using the two-stage hearing test to detect hearing disabilities in the community elders.

Material and Method: A prospective cohort study was conducted in the Phuwiang District, Khon Kaen, Thailand from December 1, 2012 to January 31, 2013. All of the elders more than 60 years of age were invited. First, screening using the Thai version of five-minute hearing test (Thai-FMHT) with a score equal to or greater than 12 was included in the group and then given the next audiometric examination.

Results: Two hundred fifty-eight elders were interested in this program, but only 192 subjects consented to participate in the entire study. Six participants withdrew before completing the protocol; therefore, 107 males and 79 females were included. The age ranged 60-92 years old. Only 152 participants (81.7%; 95% CI: 75.5-86.6%) had a hearing disability that could be rehabilitated using a hearing aid. The cost of hearing screening using this program was reduced from \$114.15 to \$28.60 per positive case with the need for hearing rehabilitation.

Conclusion: The two-stage hearing screening using the Thai-FMHT followed by an audiometric examination was found to be a suitable test for community-based mass screening of hearing loss, particularly in an area with limited resources.

Keywords: Screening, Five-minute hearing test, Hearing loss, Community

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Hearing loss is the most common cause of disability globally. In 2004, the WHO estimated that 124.2 million people had adult-onset hearing loss and that that population was extremely high in the low- and middle-income countries⁽¹⁾. The prevalence of hearing loss increases with the aging of the population, ranging from 20% to 40% in those aged 50 years or older and being more than 80% in those aged 80 years or older⁽²⁻⁶⁾. The problems and consequences of hearing impairment include a reduced ability to detect, localize and interpret sounds, communicative disabilities and a poor quality of life that is related to isolation, reduced social activity and the feeling of being excluded, leading

to an increase in the symptoms of depression⁽⁷⁾. Thus, hearing impairment should be detected and corrected early. To diagnose hearing impairment, hearing must be evaluated by the standardized pure-tone audiometry. Unfortunately, this test is time consuming, requires expensive devices and must be administered by audiologists. Therefore, this test is unsuitable for mass screening. In recent decades, screening questionnaires to identify hearing loss early have been developed. Weinstein et al, who first advocated the use of self-reporting, developed the Hearing Handicap Inventory for the Elderly (HHIE-S)⁽⁸⁾ and the Hearing Handicap Inventory for Adults⁽⁹⁾. These tests were adapted to measure the social and emotional handicaps resulting from hearing impairment. The numerous variations of the self-reporting single-question screening tests include "Do you feel you have a hearing loss?", "Do you have a hearing problem now?" or "Would you say you have any difficulty hearing?" These screening

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tests are useful; nonetheless, there are problems with using these tests, including the probability of identifying hearing impairment in the absence of a hearing handicap ($\text{HHIE} \leq 8$)⁽¹⁰⁾, their insensibility to the effects of age and the unreliable prevalence of age-related hearing loss⁽¹¹⁾.

Another questionnaire, the five-minute hearing test (FMHT), was developed by the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS). This questionnaire consists of 15 items. The advantages of the FMHT include a significant correlation with all of the audiological measurements and a reasonable estimate of the degree of hearing loss⁽¹²⁾. The FMHT was translated into the Thai language and was validated by comparing its results with those of audiometry, with the standardized pure-tone averages of mild (>25 dB) and moderate (>40 dB) hearing loss in the speech-frequency range. Accordingly, because a moderate level of hearing disability may require rehabilitation using hearing aids, this study focused on moderate hearing loss. At the cut-off score of 12, the Thai-FMHT is a valuable method of screening for moderate hearing loss (79.3% sensitivity, 95% CI: 60.3-92.0%; 76.0% specificity, 95% CI: 72.1-79.6%; 3.30 positive-likelihood ratio, 95% CI: 2.6-4.2). The area under the curve (AUC) of the Thai-FMHT for screening moderate hearing loss was 0.86 (95% CI: 0.80-0.93), showing that this method is suitable for identifying a hearing disability⁽¹³⁾. Because mass hearing screening in a community-based setting using this method takes little time, we designed a screening test that used the Thai-FMHT as the first step, followed by audiometry, to identify hearing disabilities in elders who were potential hearing-aid users. The aim of this study was to evaluate the feasibility and cost-effectiveness of the two-stage hearing test in community-based screening.

Material and Method

Participants

Subjects aged 60 years or older with a good understanding of the Thai language, no Broca's aphasia, no severe psychiatric problems or other disorders that would interfere with the audiometric examination and who lived in the Phuwieng District, Khon Kaen, Thailand between December 2012 and January 2013 were included in the study. This study was conducted under the main project "Effectiveness of NECTEC Model Body-worn P02 Digital Hearing Aids and the Cost of Screening and Hearing Aid Services". The project was reviewed and approved by the Ethics

Committee for Human Research (HE551268) of Khon Kaen University and was registered under the Clinicaltrials.gov (NCT01902914).

Data collection

Public-health personnel interviewed the subjects using questionnaires. Subjects who had Thai-FMHT scores equal to or greater than 12 were invited to participate in the study. Three audiologists who were blinded to the results of the FMHT performed pure-tone audiometric examinations using portable soundproof booths. Air-conduction hearing was tested in the frequency range of 250 to 8,000 Hz. The bone-conduction threshold of the participants who were suspected of having conductive or mixed-hearing loss was determined. Based on the final diagnosis, all of the participants were examined using otoscopy by two otolaryngologists.

Data analysis

A pure-tone air-conduction threshold average of greater than 25 dB in the speech-frequency range (at 0.5, 1, 2, and 4 kHz) was used to classify the degree of hearing loss according to the ASHA criteria⁽¹⁴⁾. In the case of bilateral hearing loss, the hearing disability was classified according to the speech-frequency hearing of the better-hearing ear at greater than 40 dB. Additionally, the cost of the screening was analyzed, including the capital costs, labor costs, and the cost of the materials. The values for all of the parameters were analyzed using Sata statistical software (release version 10).

Results

The authors invited the elderly members of the population to have their hearing screened. Among the 258 elders who were interested in this screening program, only 192 elders agreed to participate in the study. Six participants withdrew before completing the program. Therefore, 107 males and 79 females with a Thai-FMHT score of ≥ 12 were included. The average age was 72.7 years old, with a range of 60 to 92 years. The mean Thai-FMHT score was 32.8 ± 0.62 (95% CI: 31.6-34.0), with a range of 12 to 45. Most of the participants presented with hearing loss (96.7%); 45.7% of the participants presented with tinnitus and 39.8% presented with aural fullness. Of the 372 ears that were examined, 61.8% exhibited presbycusis, 29.3% exhibited idiopathic sensorineural hearing loss, and 7.5% exhibited otitis media (Table 1).

The degree of hearing of all of the participants

Table 1. Demographic data

Characteristics	
Gender (%)	
Male	107 (57.5)
Female	79 (42.5)
Age	60-92 year
FMHT score	32.8±0.62 (95% CI: 31.6-34.0)
Clinical presentation (n = 186 participants) (%)	
Aural fullness	74 (39.8)
Otalgia	15 (8.1)
Otorrhea	25 (13.4)
Hearing loss	180 (96.8)
Tinnitus	85 (45.7)
Vertigo	51 (27.4)
Diagnosis (n = 372 ears) (%)	
Idiopathic sensorineural hearing loss	109 (29.3)
Presbycusis	230 (61.8)
Otitis media	28 (7.5)
Noise induced-hearing loss	3 (0.8)
Other: otomycosis, meniere's disease	2 (0.5)

were determined using the pure-tone audiometric hearing thresholds of the better ear in the speech-frequency range according to the classification guidelines of the ASHA^(14,15) and are shown in Fig. 1. Most of the participants had moderate to severe bilateral hearing loss (71/156; 38.2%). The WHO recommends that patients who have bilateral hearing loss with a threshold level of greater than 40 dB (moderate hearing loss) should undergo hearing rehabilitation. In our study, of the 152 participants who had an abnormal hearing threshold (81.7%; 95% CI: 75.5-86.6%) 25.8% were found to have moderate hearing loss, 38.2% to have moderate to severe hearing loss, 15.1% to have severe hearing loss, and 2.7% to have profound hearing loss.

Regarding the cost-effectiveness of the two-stage hearing screening program, the elders were invited, interviewed and given the Thai-FMHT at a cost of approximately \$0.30 per person (1 US Dollar = 30.50 Baht). In the second step, 258 participants were examined by otolaryngologists and followed by audiometry at a cost of approximately \$22.10 per person, including a capital cost of \$10.50, a materials cost of \$4.50 and a labor cost of \$7.10.

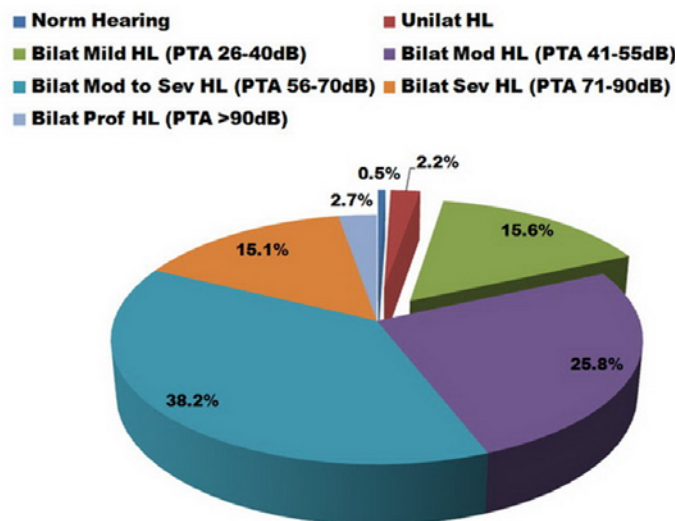
Hearing threshold in better hearing ear

Fig. 1 The hearing level of the better-hearing ear of the 186 participants was classified using the ASHA guidelines. Most of the participants had bilateral moderate to severe hearing loss (38.2%); whereas, only 0.5% of them had normal hearing. Regarding hearing disability, the WHO advocated that if the hearing threshold was greater than 40 dB in the better-hearing ear, rehabilitation should be considered. In our study, 152 participants (81.7%; 95% CI: 75.5-86.6%) were observed to have hearing loss of more than 40 dB, including 25.8% with moderate hearing loss, 38.2% with moderate to severe hearing loss, 15.1% with severe hearing loss, and 2.7% with profound hearing loss. Hearing rehabilitation should be provided to this group to improve their quality of life.

Discussion

For mass community-based hearing screening, brief questionnaires are required. A single questionnaire allowed a simple and brief examination, but it had a poor level of validity. Previous studies reported that the validity of a single question involved sensitivity ranging from 14-100%, specificity ranging from 50-95%, a positive predictive value (PPV) ranging from 5-97% and a negative predictive value (NPV) ranging from 3-100%⁽¹⁶⁻¹⁸⁾. The ranges may be too broad, depending on the patient's age and the definition of hearing loss utilized in each study. Although a literature review reported that a single global question performed well in identifying elderly people with hearing loss⁽¹⁹⁾, the utility of a single question depends on the individual health status and may be affected by psychosomatic symptoms and the individual's mental health status⁽¹⁸⁾.

Recently, many tools have been developed to screen hearing loss. The five-minute hearing test (FMHT) is one of the screening questionnaires that is suitable for identifying hearing loss. The results of this simplified test exhibited good correlation with those of an audiogram (coefficient of 0.26 for speech discrimination score (SDS); 0.24 for speech reception threshold (SRT); 0.59 for air-conduction speech-frequency pure-tone average (SFPTA) and 0.65 for air-conduction high-frequency pure-tone average (HFPTA)). The FMHT cutoff score of 15 provided reasonable ROC curve, with sensitivity of 80% and specificity of 55.2% (Koike et al 1994). The FMHT comprises 15 questions that evaluate many parameters of a patient's hearing; therefore, we chose this questionnaire and translated it into Thai. The Thai-FMHT was evaluated as a diagnostic test but did not perform as well as the original FMHT due to confounding factors, including the different language and culture and the situations and surroundings of the sites in which the audiometric examinations were performed; therefore, the cut-off point of 12 was used to screen moderate hearing loss, which provided 79.3% sensitivity and 76.0% specificity⁽¹³⁾. This questionnaire was used in the first step of screening and was followed by audiometry. The authors' study is the first to create a screening program for identifying hearing disability on a mass community-based level. The questionnaire can be used to exclude the elders who have normal hearing or mild hearing loss, reducing the number of elders who require a confirmatory test with audiometry. In the authors' trial, there were only 258 elders who needed to have their hearing loss confirmed

using audiometry; however, only 186 elders were interested in completing the screening program. One hundred fifty-two of the 186 elders (81.7%), whose hearing loss was confirmed using audiometry, could be rehabilitated with hearing aids.

Regarding its cost-effectiveness, the Thai FMHT was a useful screening test with a low cost, of only \$0.30 per person, which was effective for the identification of moderate hearing loss with the test positive of 23.7% (at a score of 12)⁽¹³⁾. There were 21,834 elders in our community. If all of the elders had been able to participate in our screening program, the authors estimate that we would have identified 5,174 elders who had a probable hearing disability with a Thai FMHT score of 12 who needed audiometry for confirmation of their hearing status. The total cost of our screening program was \$120,895, including \$6,550 for screening using the Thai FMHT (21,834 x \$0.30) and \$114,345 for the audiometric confirmation (5,174 x \$22.10), whereas the cost of a screening hearing test using audiometry alone would be \$482,531 (21,834 x \$22.10). The number of positive cases in our community, who needed hearing rehabilitation, was estimated at 4,227 persons (5,174 x 81.7%); therefore, using our screening method reduced the cost from \$114.15 to \$28.60 per positive case.

In a community-based situation, screening using audiometry alone is difficult because this method takes a long time and has a high cost; therefore, the public health service should be encouraged to conduct the Thai-FMHT to improve the accessibility of hearing assessment to people who have hearing disabilities.

Conclusion

The two-stage hearing screening test for elders was feasible in a community-based setting. The test identified 81.7% of those with moderate hearing loss that could result in poor communication and a reduced quality of life. Such hearing loss must be corrected with surgery and/or rehabilitation, such as hearing aids. This program appears to be a superior and powerful screening method with a simple questionnaire that could be utilized in the primary care unit as a first step. If the patient's score is equal to or greater than 12, then the patient should be consulted by an otolaryngologist and be given an audiometry for confirmation of hearing.

What is already known on this topic?

Regarding hearing screening in community, the standard audiometry is very difficult to test due to being time consuming and expensive. Although some

screening questionnaires have been created there are problems with using these tests, including the probability of identifying hearing impairment in the absence of a hearing handicap, their insensibility to the effects of age and the unreliable prevalence of age-related hearing loss. For Thais, the authors developed the Thai-FMHT that showed a valuable method of hearing screening. Furthermore, the authors' two-stage hearing screening program provides effective mass screening and economizes screening in the community.

What does this study add?

The authors' study yields that Thai-FMHT is an appropriate hearing screening in community-based situation. Using the authors' screening program reduced the cost from \$114.15 to \$28.60 per positive case.

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Potential conflicts of interest

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การตรวจคัดกรองการสูญเสียการได้ยินของผู้สูงอายุในชุมชนด้วยการใช้แบบทดสอบการได้ยินห้านาทีฉบับภาษาไทย: การประยุกต์ใช้ทางคลินิก และความคุ้มค่า

พรเทพ เกษมศิริ, ขวัญชนก ยิ้มแต้ม, พนิดา ธนาวิรัตน์นิจ, สุภวรรณ เล้าศิริวงศ์, พิภพ สิริเพาประดิษฐ์, ปุณณรุฬร กิ่งแก้ว

วัตถุประสงค์: เพื่อประเมินความเป็นไปได้ในการตรวจการได้ยินแบบสองขั้นตอนในชุมชนผู้สูงอายุเพื่อหาภาวะการสูญเสียการได้ยิน

วัสดุและวิธีการ: เป็นการศึกษาแบบไปข้างหน้า โดยทำการศึกษาที่ อำเภอกุเวียง จังหวัดขอนแก่น ประเทศไทย ตั้งแต่ วันที่ 1 ธันวาคม พ.ศ. 2555 ถึง 31 มกราคม พ.ศ. 2556 ผู้สูงอายุมากกว่า 60 ปีขึ้นไปทุกคน ได้รับการเชิญเข้าร่วมตรวจคัดกรองการได้ยินโดยขั้นตอนแรกให้ทำแบบทดสอบการได้ยินห้านาทีฉบับภาษาไทย หากมีคะแนนมากกว่า 12 ขึ้นไปจะต้องเข้ารับการตรวจการได้ยินในขั้นต่อไป

ผลการศึกษา: ผู้สูงอายุที่สนใจเข้าร่วม 258 คน มีเพียง 192 คนที่ยินยอมเป็นอาสาสมัครแต่มี 6 คน ขอดอนตัวก่อนจบโครงการ ดังนั้นเหลือเพียงชาย 107 คน หญิง 79 คน อายุ 60-92 ปี มี 152 คน (81.7%; 95% CI: 75.5-86.6%) ที่มีการสูญเสียการได้ยินและควรได้รับเครื่องช่วยฟังค่าใช้จ่ายในการตรวจคัดกรองผู้สูงอายุที่มีปัญหาการได้ยินซึ่งจำเป็นต้องใช้เครื่องช่วยฟังนั้นลดลงจาก 3,482 เป็น 872 บาท

สรุป: การตรวจการได้ยินสองขั้นตอนโดยใช้แบบทดสอบการได้ยินห้านาที ฉบับภาษาไทย แล้วตามด้วยการตรวจการได้ยินนั้น เหมาะในการตรวจคัดกรองภาวะการสูญเสียการได้ยินในผู้ป่วยสูงอายุในชุมชนและในสถานพยาบาลที่มีเครื่องมือจำกัด
