Original Article

Exploring Uhear Hearing Application as a mobile screening tool for the underprivileged

Khairullah Bin Anuar, Mohd Dzulkhairi Bin Mohd Rani, Shahrul Bin Hitam, Azila Binti Noh

Faculty of Medicine and Health Sciences, Universiti Sains Islam, and Department of Otorhinolaryngology, Hospital Ampang, Selangor, Malaysia

Objectives: To assess the effectiveness of hearing application as an initial hearing assessment in adult, to analyse and compare between the Uhear hearing application and conventional audiometer of its usage and to make recommendation about the use the hearing application as the screening tools for the underprivileged.

Methodology: We recruited 140 patients at Hospital Ampang. Patients with otorrhea and cognitive impairment were excluded. All patients completed Uhear test in clinic and underwent standard audiogram.

Results: The mean PTA (Pure tone average) of all ears measured by the standard audiogram was 32 dB. The PTA of all ears measured by Uhear was 15 dB less compared to the standard audiogram ($p<0.0001$). Of the 74 ears with moderate hearing loss, (PTA>40 dB HL) documented on the audiogram, 34 had a PTA?40 dB by Uhear testing. This translates to sensitivity of 54%. Of the 206 ears without moderate or worse hearing loss documented on the audiogram, one had moderate or worse hearing loss by Uhear testing. This translates to a specificity of 99%. **Conclusion:** Uhear hearing application is a conceivable screening test to rule out significant hearing loss. In Kappa analysis, it is in the 'fair' range in almost all frequencies. Portability and ease of use make it appropriate to use for hearing screening for the underprivileged. (Rawal Med J 201;43:717-720)

Keywords: Uhear, hearing application,hearing loss, audiogram.

INTRODUCTION

Data from WHO showed that 5% of the world population (approximately 360 million people) suffer from permanent disabling hearing loss and more than 32 million of these are children.[1,2] Most of them are from the middle and lower income families.[3] The estimated global prevalence of disabling hearing loss is increasing due to occupational, recreational and environmental noise exposure and due to ototoxic medications.[4] Hearing loss has substantial impact on psychosocial wellbeing and economic independence.[3] It also has societal costs, mainly due to losses in productivity.[5] In many middle and lower income countries, there is severe shortage of audiologist and ear, nose and throat specialist.[6]

Hearing impairment should be identified as early as possible to enable intervention to take full advantage of the plasticity of the developing sensory system.[7] In a longitudinal study of young children with hearing loss, Yoshinaga et al found that pre school children that had been identified early for hearing loss had significantly higher developmental functioning in general development, expressive and receptive language and personal social areas.[8] However, in developing countries, up to 80% people with hearing loss have no prospect for early detection.[9]

Smartphone hearing app is a simple, cost effective and mobile screening tool, which is more convenient than conventional audiometer. It is easier and cheaper to screen people including children and the elderly for hearing loss, only a few minutes and the data can be uploaded to the mobile network and can be utilized for screening especially to the rural areas and the underprivileged.[9,10] As patients reports of hearing loss can be very subjective, objective measures using conventional audiometry are necessary. The emergence of recent technologies gives patients options for some form of initial audiometric assessment.[10,11]

Uhear is a personal electronic device hearing

application. It is a free software, easy to use and can be used on any apple's devices using IOS mobile phones, ipads or ipod. The advantage of *Uhear* compared to other hearing applications is it uses pure tones, which is similar to the tone of conventional audiometer.[10] The other hearing apps do not use pure tone but using warble tone or white noise, which is not suitable for screening of hearing loss. To our best knowledge, there was only one study that compare *Uhear* hearing app to the conventional audiometer in diagnosing hearing impaired patients. However, the study sample size was small (only 25 patients), therefore, may not be representative for the population.[10] In our study, we evaluated the effectiveness of this app as an initial screening tool and compared the the results with the conventional audiometer.

METHODOLOGY

This prospective experimental study was conducted in Otorhinolaryngology Clinic, Hospital Ampang, Selangor, Malaysia from March 2015 to March 2017. The sample size needed was based on prevalence of hearing loss in local population of 24%.[12] All patients recruited were on voluntary basis. Written informed consent was obtained from the patients in accordance with the Declaration of Helsinki. While patient who were less than 18 year of age, unfit and unable to visualize the tympanic membrane were excluded from the study.

A total of 140 patients were recruited and that would be 280 ears. Ipad mini was used with Uhear hearing application loaded onto it with a good commercial earphone. It was a self-test to find the range of the patients hearing at specific frequencies, which were 250Hz, 500Hz, 100Hz, 2000Hz, 4KHz and 8Khz. The test was only for air conduction threshold and not for bone conduction threshold. Data were analyzed using SPSS version 23 with appropriate statistical methods using descriptive and parametric with paired t test. Paired t test with $p<0.05$ as statistically significant. Kappa analysis was use to measure agreement between *Uhear* and PTA.

RESULTS

140 patients and 280 ears were included in the study. Demographics are shown in Table 1.

Table 1. Participant Demographics

	Number
Total number	140
Age (yr)	
Mean	33
Range	8-73
Number according to age (yr)	
≤ 20	5
21-40	76
41-60	35
61-80	19
> 80	1
Gender	
Female	67
Male	73
Race	
Malay	103
Chinese	27
Indian	10
Ears with PTA (dB), *n*	
≤ 25 (normal)	166
26 – 40 (mild loss)	40
41 – 55 (moderate loss)	25
56 – 70 (moderate to severe loss)	15
71 – 90 (severe loss)	16
≥ 91 (profound loss)	18

ASHA = American Speech-Language-Hearing Association; PTA = pure-tone average

Table 2. Accuracy of *u*Hear as a Screening Test Compared to a Standard Audiogram

	Audiogram, *n*	
uHear, *n*	PTA ≤ 40 dB	PTA > 40dB
PTA ≤ 40 dB	205	34
PTA > 40 dB	1	40
Total	206	74

Out of the 280 ears, 74 ears with moderate hearing loss (PTA>40 dB HL) documented on the audiogram, 34 had a PTA?40 dB by *Uhear* testing (Table 2). This translates to sensitivity of 54%.

Of the 206 ears without moderate or worse hearing loss documented on the audiogram, 1 had moderate or worse hearing loss by *Uhear* testing. This translates to a specificity of 99%. Kappa analysis was performed on *Uhear* thresholds compared with the standard audiogram to detect agreement at all six frequencies. It describes how well the threshold at particular frequency measured by *Uhear* correlated with the thresholds at the same frequency of standard audiogram (Tables 3 and 4).

Table 3. Kappa range of values and their correlation.

Kappa values	'Agreement'/ Comparison
< 0.2	Poor
0.21 – 0.4	Fair
0.41 – 0.6	Moderate
0.61 – 0.8	Good
0.81 – 1.0	Very good

Table 4. Kappa values seen with uHear and standard audiogram thresholds.

Frequency (Hz)	Kappa values
250	0.254
500	0.314
1000	0.303
2000	0.290
4000	0.291
8000	0.397

Table 5. The mean PTA of all ears and ears with PTA > 25dB measured by audiogram and *Uhear*.

Test	All Ears		Ears with PTA > 25 dB	
	Mean (dB)	n	Mean (dB)	n
Audiogram	32	280	57	114
Uhear	17	280	36	114

The *Uhear* app did not correlate well at all frequencies tested, being in the range of 'fair'. The mean PTA of all ears measured by the standard audiogram was 32 dB. The PTA of all ears measured by *Uhear* was 15 dB less compared to the standard audiogram (p<0.0001) (Table 5).

Fig. 1. *U*Hear and the standard audiogram.

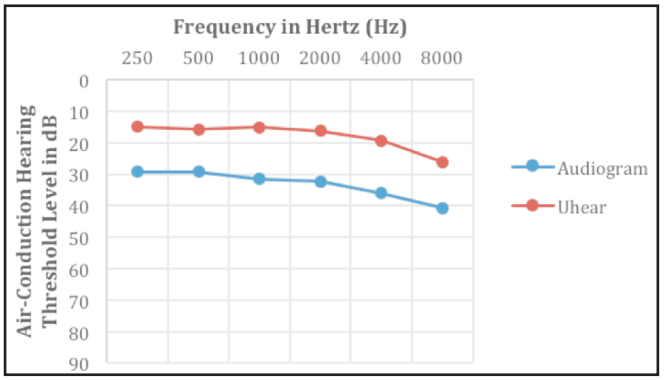

Figure 1 shows the mean pure-tone air conduction threshold for all ears tested by the uHear and the standard audiogram. It also shows average air-conduction hearing thresholds among all ears as measured by audiogram and uHear.

Fig. 2. Mean pure-tone air conduction.

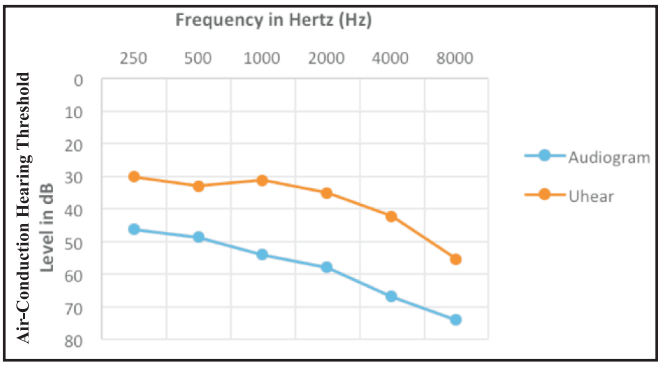

Figure 2 shows the mean pure-tone air conduction threshold that only includes the 114 ears that had mild or worse hearing loss (PTA > 25 dB) according to the standard audiogram. The mean PTA of ears with PTA>25 dB as measured by the standard audiogram was 57 dB. The same ears measured by *Uhear* yielded mean PTA with 21 dB less compared to the standard audiogram (p<0.0001

DISCUSSION

The audiogram is unquestionably the gold standard for measuring hearing sensitivity.[13] However, there could be geographic, financial or logistical obstacles to obtain an audiogram. This could lead delays in diagnosis of hearing loss. Substituting PTA with automated computer based audiometry can provide comparable results on threshold testing.[14]

From the results of the 74 ears with moderate hearing loss (PTA>40 dB HL) documented on the audiogram, 34 had a PTA?40 dB by *Uhear* testing. This translated to sensitivity of 54%. It was only moderately sensitive compared to other studies which is highly sensitive >90%.

From the Kappa analysis comparing the agreement of the app thresholds with the formal audiogram threshold noted it was in the fair range. However, the values were in the much better range for high frequencies 2000, 4000 and 8000 Hz. It did not correlate well in low frequencies. Other studies also show that in lower frequencies the kappa value is also at the fair range between *Uhear* and Audiogram.

From the pure tone average, it can be seen that the graph configuration is similar for both *Uhear* and

audiogram. From this it indicates that the *Uhear* application is a feasible as a screening tool, which is better for medium to high frequencies.

Some of the study limitations include background noise or environmental noise may have been a cause for the poor result, especially at lower frequencies. Even though the test is self explanatory but there can be language barrier and difficulty in understanding the instruction. Regarding calibration to minimize that we use the same earphones, which is clean with alcohol swab before and after use and using the same ipad.

In the future, it may need correction factor for each frequency, correction factor for each degree of hearing loss and a bigger sample size. A large number of apps for measuring ear and hearing function are thought to exist but their scientific validity was not reviewed in depth.[15]

CONCLUSION

From this study, the Uhear hearing app is a conceivable as an initial screening tool for the underprivileged or community, who didn't have the audiometry facility.

Author Contributions:
Conception and design: Khairullah, Dzulkhairi
Collection and assembly of data: Khairullah, Shahrul
Analysis and interpretation of the data: Dzulkhairi
Drafting of the article: Khairullah, Azila
Critical revision of the article for important intellectual content: Khairullah
Statistical expertise: Azila
Final approval and guarantor of the article:
Corresponding author email: Khairullah: khairullah4195@yahoo.co.nz
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