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Original Article

Evaluation of the Hearing Test Pro Application as a Screening Tool for Hearing Loss Assessment

Shuaib Kayode Aremu

ENT Department, Federal Teaching Hospital, Ido Ekiti/Afe Babalola University, Ado Ekiti, Ekiti State, Nigeria

Abstract

Background: Disabling hearing loss is considered a significant health problem globally with high incidence in developing countries. In Africa, different studies have shown that one in five Africans uses smartphones. This dispositive can be used to screen hearing loss. **Aim:** The study aims to appraise the effectiveness of Hearing Test Pro, an Android-based application, as a screening tool for hearing loss. **Methods:** This is a prospective study developed in the Federal Teaching Hospital, Ido-Ekiti, Ekiti State, Nigeria, between September and December 2018. The study was approved by the institutional ethics committee. Consent of adult android users was conveniently obtained for the study. A regular audiometric test with Amplivox 260 was done after otoscopy (to exclude other ear pathology). The results were compared with the test developed by an android Hearing Test Pro app. A threshold of >40 decibels was used to determine any evidence of hearing loss at the specific frequency of 250–8000 Hz. $P < 0.05$ was considered statistically significant. **Results:** Three hundred and sixty ears of 180 patients were evaluated, of which 100 were male and 80 were female. The male-to-female ratio was 1.25:1. At lower frequency, a statistical difference between classical pure-tone thresholds recorded with the audiometer and the android phone was documented. However, this difference was not noted at higher frequencies. **Conclusion:** The Hearing Test Pro app effectively distinguishes between high-frequency hearing loss and thus can be useful as part of the hearing loss screening programs.

Keywords: Amplivox 260, audiometry, hearing loss, Hearing Test Pro app

Introduction

The World Health Organization (WHO), in 2012, estimated that disabling hearing impairment (DHI) was found to affect close to 360 million people, which reaches 5.3% of the global population.[1,2] The DHI means a pure-tone average of thresholds at 500, 1000, 2000, and 4000 hertz (Hz) in the better hearing ear of >30 decibels (dB) in children and >40 dB in adults. Different studies have shown the incidence of this disability, demonstrating that nearly 4% of school children have hearing loss in Nigeria,[3] whereas the rate in adults is about 21% in Ilorin, North Central Nigeria.[4]

The greatest number of individuals with DHI are found in low- and middle-income countries (LMICs), mostly in the Asian Pacific, southern Asian, and Sub-Saharan African regions.[5] The predicted global prevalence of hearing loss is increasing.[5] The recognized three types of hearing loss are as follows: sensorineural, conductive, and mixed hearing loss. A conductive hearing loss appears as a result of a reduction in the transmitted sound through the typical structures of the ear. A sensorineural hearing loss is produced when there is a significant damage to the cochlear and auditory nerves. A mixed hearing loss appears when there is a combination of conductive and sensorineural hearing loss in the same ear.[1] The presence of risk factors, such as noise exposure, alcoholism, family history, smoking, hypertension, use of ototoxic drugs, and head injury, is relatively common.[5]

Currently, tools to screen the loss of hearing are few, expensive, and, most of the time, they are in urban areas. As a result of this statement, there is an increased need for a low-cost, portable, and effective tool to screen hearing loss in our area.

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Address for correspondence: Dr. Shuaib Kayode Aremu, ENT Department, Federal Teaching Hospital, Ido Ekiti/Afe Babalola University, Ado Ekiti 371101, Ekiti State, Nigeria.
E-mail: shuaib.aremu@gmail.com

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Several studies have demonstrated the common use of a smartphone by the population. In Africa, it has been estimated that 1 out of every 5 persons has this portable device.[6] Researchers started working on the effectiveness of iOS-based hearing test app developed for the iPhone.[7,8]

Methods

This is a prospective study developed in the Federal Teaching Hospital, Ido-Ekiti, Ekiti State, Nigeria, between September and December 2018. The study was approved by the ethical committee of the medical center. Consent of adult android users was conveniently selected for the study. A total of 180 consented adults [Table 1] who were able to operate android phones were enrolled in the study using a convenience sampling technique. A regular audiometric test was performed using Amplivox 260 (Amplivox limited, Birmingham Business Park, Birmingham, West Midlands, B37 7YG) on each patient after otoscopy (to exclude other ear pathology). The results were compared with the test performed by an android Hearing Test Pro app (e-audiologia. pl, Gwiaździsta 23/1 m. 2, 55–010 Radwanice, Poland) [Figures 1-3]. The same android phone was used for all the patients.

The audiometry with the app and that of the audiometer were both carried out on each patient in the audiometric booth. A threshold of >40 dB was used to determine any evidence of hearing loss at the specific frequency of 250–8000 Hz. $P < 0.05$ was considered statistically significant [Table 2]. A statistical difference between classical tone thresholds recorded with the audiometer and the android phone app at lower frequencies was documented. However, this difference was not noted at higher frequencies [Table 3 and Figure 3].

Table 1: Age distribution of patients

Age (group of years)	Number of patients	Frequency (%)
21-30	45	25.0
31-40	46	25.6
41-50	62	34.4
51-60	23	12.8
61-70	3	1.7
71-80	1	0.6
Total	180	100.0

Table 2: Frequency table showing average hearing threshold (dB) of 360 ears screened at lower frequencies (50-60 Hz)

Hearing threshold	Android phone, *n* (%)	Audiometer, *n* (%)	χ^2	*P*
<25	156 (43.4)	89 (24.7)	29.856	<0.001*
25-40	98 (27.2)	112 (31.1)		
>40	106 (29.4)	159 (44.2)		
Total	360 (100.0)	360 (100.0)		

*P<0.05 (i.e., statistically significant)

Results

Three hundred and sixty ears of 180 patients were evaluated, of which 100 were male and 80 were female. The male-to-female ratio was 1.25:1. The age range was 20–80 years with

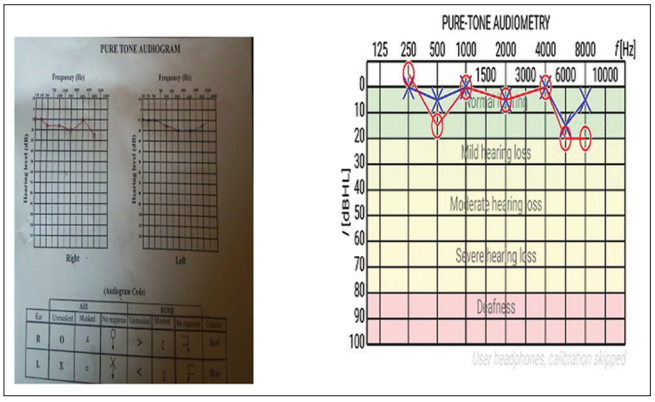

Figure 1: Comparison between the pure-tone audiometry results using Amplivox 260 and Hearing Test Pro in a patient with normal hearing loss (Red: Right; Blue: Left)

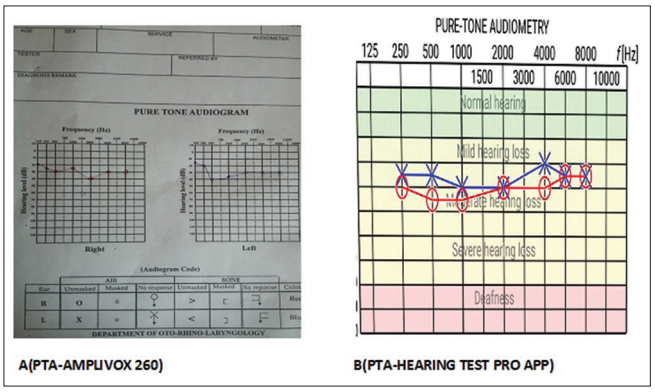

Figure 2: Comparison between the pure-tone audiometry results using Amplivox 260 and Hearing Test Pro in a patient with mild–moderate hearing loss (Red: Right; Blue: Left)

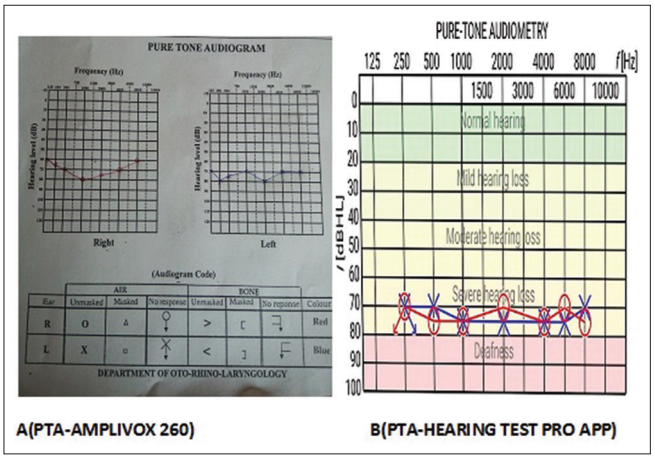

Figure 3: Comparison between the pure-tone audiometry results using Amplivox 260 and Hearing Test Pro in a patient with severe hearing loss (Red: Right; Blue: Left)

Table 3: Frequency table showing average hearing threshold (dB) of 360 ears screened at higher frequencies (10,000 Hz and above)

Hearing threshold	Android phone, *n* (%)	Audiometer, *n* (%)	χ^2	*P*
<25	115 (31.9)	117 (32.5)	0.026	0.987
25-40	108 (30.0)	107 (29.7)		
>40	137 (38.1)	136 (37.8)		
Total	360 (100.0)	360 (100.0)		

a mean age of 45 years [Table 1]. At lower frequency, a statistical difference between classical pure-tone thresholds recorded with the audiometer and the android phone was documented ($P < 0.001$) [Table 2]. However, this difference was not noted at higher frequencies ($P = 0.987$) [Tables 2 and 3].

Discussion

The development of hearing screening programs is essential to recognize a possible hearing loss in the population. The accurate identification will lead to the initiation of an adequate intervention. The screening of individuals with risk factors of hearing loss such as diabetes mellitus, positive family history of hearing impairment, smokers, and noisy environment workers should be part of any program developed with this objective.[4,9,10] Screening for hearing impairment can be useful for a range of age groups: new born, school children, and the elderly.

In addition, screening for hearing impairment in population-based surveys is important to determine its magnitude and plan services accordingly.[11]

A search was carried out on Google Play and Apple App Store in July 2015 revealed the main types of apps which could perform tuning fork test, audiometry, tympanometry, otoacoustic emissions, auditory brainstem response testing, and otoscopy.[12] Hearing Test Pro, a newly developed android app, was found to perform audiometry. Others include shoeBOX audiometry, uHear, AudCal, and EarTrumpet.

In this study, there was a slight male preponderance. The mean age group was 45 years, suggesting that young adults operate the android phones more than elderly patients.

The level of hearing loss is graded by the WHO utilizing the dB scale. The level of hearing loss can be divided into the following categories: mild (26–40 dB), moderate (41–60 dB), severe (61–80 dB), and profound (81 dB and above).[10] The hearing loss more than 40 dB in adults and 30 dB in children is defined as disabling hearing loss according to the WHO.[10]

Substantial challenges in hearing impairment screening (especially in LMICs) such as the need for a quiet testing environment, expensive assessment equipment which requires regular calibration, and skilled professionals to conduct clinical tests necessitate the reason for another effective and easily accessible options. The Hearing Test Pro among some other Android app has been found useful for this purpose. Figures 1-3 show the pure-tone audiometry findings of both the Amplivox 260 and that of the Hearing Test Pro app. No significant difference was noted at high frequency.

The disabling hearing loss in higher frequencies was detected in our study by the screening method of utilizing the Hearing Test Pro application. The values achieved were comparable to those obtained with a traditional audiometer. The result obtained is similar to other studies that used mobile apps to screen hearing loss taking only in consideration of higher frequencies. [9] One research developed in the Middle East has shown that the smartphone app does not give an accurate hearing threshold in clinical settings.[7,13]

Conclusion

The Hearing Test Pro app is helpful in distinguishing high-frequency hearing loss. However, it is not accurate for low-frequency hearing loss. As a result, this app can be used as part of the hearing loss screening programs in rural areas. However, further research needs to be done related to this topic.

Limitation

The limitations of the study are in the sample size and the fact that the Hearing Test Pro only access air conduction but no bone conduction.

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Conflicts of interest

There are no conflicts of interest.

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