Assessing the Effectiveness of the hearWHO Application in Rapid Screening of Hearing Loss Among Military Personnel of the Philippine Air Force

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ABSTRACT

Rationale/Background: Hearing loss is a significant global issue, particularly affecting low- and middle-income countries like the Philippines, where low awareness and diagnosis rates prevail. Exposure to frequent loud noises, such as in military training, along with less recognized risks from firearms and aircraft, make military personnel highly susceptible to hearing damage. The hearWHO mobile application, introduced in 2019, shows promise as a rapid screening tool in these settings, potentially improving accessibility and increasing awareness of the challenges in managing hearing health.
Objectives: This study evaluated the effectiveness of the hearWHO application in rapid screening of hearing loss among Philippine Air Force military personnel and verifies its results with Pure Tone Audiometry. It aimed to establish baseline data for future research on technological advancements in otolaryngology.
Methodology: The study employed a cross-sectional design and recruited 44 volunteer subjects from the Philippine Air Force using inclusion criteria. Six participants withdrew due to an urgent mission, leaving 38 subjects who were screened using the hearWHO application and subsequently tested with Pure Tone Audiometry. A statistician analyzed the collected data.
Results: A one-sample t-test revealed negative mean differences between hearWHO and Pure Tone Audiometry results indicating that they were not significant. Confounders such as testing room location, use of adapters and non-purposive sampling may have affected the results.
Conclusion: The results suggested that the hearWHO application was not effective in rapid screening of hearing loss among the military personnel of the Philippine Air Force.

Keywords: hearWHO, Rapid screening, Hearing loss, Military personnel, Philippine Air Force

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INTRODUCTION

Hearing loss is a growing global problem. It confers a disproportionate burden on low- and middle-income

countries like the Philippines. Among the older population, the loss of ability to communicate with others and delayed language development may lead to social isolation, loneliness and frustration, which are some of the biggest impacts of hearing loss, according to the World Health Organization (WHO). On a national level, a survey study published by Newall and his co-authors[1] last July 2020 revealed that the prevalence of hearing loss appears to be comparatively high in the Philippines. Among citizens, lack of awareness and tendency to overlook hearing loss symptoms are common reasons contributing to the low number of diagnosed cases.

One of the primary causes of hearing loss is frequent exposure to loud noises. The populations that are at risk for this would include: (1) adolescents and young adults who are fond of listening to music at high volumes, bands and going to concerts, (2) adults whose occupations implement the use of headphones all day, such as call center agents, gamers and DJs, and (3) military personnel who engage in firing exercises as part of their training, as well as those whose work involves frequent exposure to aircraft.

One of the less talked about factors associated with hearing loss would be the effect of firearms and aircraft on hearing health. According to the American Speech-Language-Hearing Association (ASHA), people who use firearms have a high risk of developing hearing loss, particularly high-frequency permanent hearing loss. Previous studies reported occupational noise-induced hearing loss in military pilots, which poses not only an economic burden but also impaired speech perception, functional hearing and risk of accidental injuries.[2] The maximum noise levels during aircraft take-off can reach 130 dB.[3] Military ground staff who are exposed to aircraft noise were also shown to be vulnerable to acquiring noise-induced hearing loss,[4] consistent with broader findings on military noise exposure and hearing loss.[5] Hearing loss has also been well documented among military personnel deployed in combat zones, which may share similar acoustic hazards.[6]

Early detection or screening opens the door to future care and appropriate treatment as it is vital to monitor hearing loss. The use of technology is highly incorporated within the lives of today's generation. Hence, exploring new means to conduct rapid screening for one's health is important. The hearWHO mobile application was launched in 2019 and is considered relatively new. Exploring the effectiveness of using this mobile application would mean easier accessibility to healthcare, especially in middle- and low-income countries. It would also promote awareness regarding the gaps in hearing health in the community.

The hearWHO app is based on the validated digits-in-noise (DIN) test developed by the World Health Organization and researchers from the University of Pretoria. The application plays a series of three-digit combinations masked by background noise and prompts users to identify them. The noise level is automatically adjusted to determine the user's speech reception threshold (SRT), which is the minimum signal-to-noise ratio at which digits can be correctly identified 50% of the time. The test primarily targets frequencies in the range of 500 to 4000 Hz, which are critical for understanding speech. A score of ≥75 is considered 'good hearing', 50–74 is categorized as 'hearing loss risk', and <50 suggests the likelihood of a hearing problem. The app was designed to be used globally across various smartphone devices and is available in multiple languages to broaden accessibility.[7,8]

Proving that the hearWHO mobile application is effective would benefit the military personnel of the Philippine Air Force as they are given access to a rapid, self-administered screening test for hearing loss that they can do for free, without the need for a trained specialist. Additionally, they will be able to test themselves for possible hearing loss without the shame or stigma that comes with having to see a doctor. Provided that this is a mobile application, anyone who has a smartphone may easily download it, making it more accessible to patients who are susceptible to hearing loss but may not have easy access to proper health care. This mobile application is not only limited to a rapid screen test but also allows its users to monitor their hearing levels and make them aware of their listening habits that may put them at risk for hearing loss. Overall, the hearWHO mobile application would enhance the diagnostic procedures in otolaryngology and promote awareness of ear and hearing care.

Only a few studies have explored the use of mobile applications in the rapid screening of diseases. [9] eHealth technologies have shown promise in expanding access to hearing screening, particularly

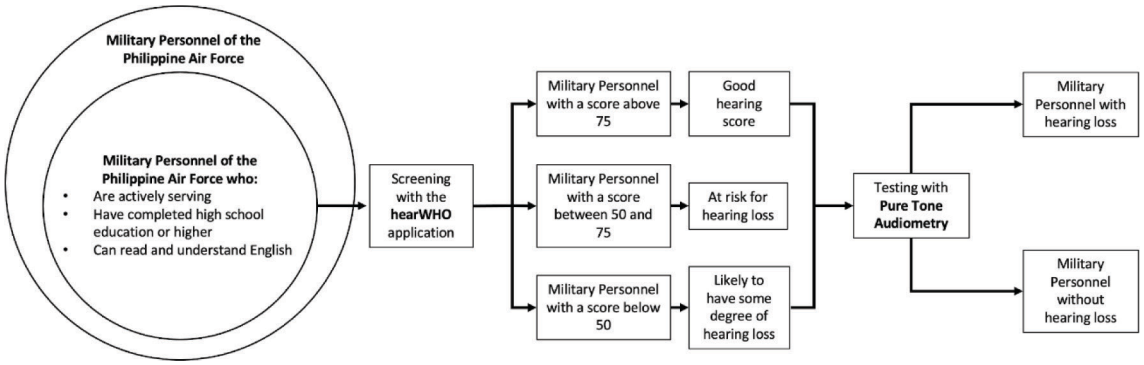

Figure 1: Study Design

in resource-limited settings.[10] Therefore, this study may serve as a baseline research and will set the foundation for future studies regarding technological advancements in this field of medicine. The results of this research may motivate specialists in other medical fields to incorporate the use of mobile applications to advance their diagnostic procedures.[11] In this way, efficient healthcare is made available to anyone who may need it.[12]

The general objective of this study was to determine the effectiveness of the hearWHO application in screening hearing loss among the military personnel of the Philippine Air Force. More specifically, this study aimed to validate whether there was consistency between the hearWHO application results and the Pure Tone Audiometry test results. The researchers hypothesized that use of the hearWHO application was effective in rapid screening of hearing loss among the military personnel of the Philippine Air Force.

METHODOLOGY

A cross-sectional design is observational and utilized in descriptive research. It aids in forming inferences or hypotheses about relationships or collating data that may support further research. This design involves data measurement at a single point in time and does not involve variable manipulation. A cross-sectional design allows researchers to view multiple characteristics at once, provides information about ongoing issues and is used to determine prevailing characteristics in the population. However, the challenges to a cross-sectional design are the inability of researchers to distinguish between the cause and effect and presence of report biases.

With regards to the application of this design to the study, the researchers will gather subjects who meet the inclusion criteria and take their basic demographic information. They will be screened with the hearWHO application and further tested with Pure Tone Audiometry to confirm the application's effectiveness (Figure 1).

The subjects included in this study were Filipino males and females aged below 60 years, actively serving in the Philippine Air Force, and able to comprehend the English language. All of them were regularly exposed to noise and high-frequency sounds due to the nature of their work with firearms and/or aircraft. Employees that were above 60 years of age, have a history of or are currently using hearing aids, as well as currently taking medications that can cause or prevent hearing loss, were excluded from the study.

Given the sensitive and confidential nature of the Philippine Air Force's population, the researchers were not granted access to their personnel data and population count. The researchers utilized a volunteer sampling design, which allowed data to be gathered from qualified subjects who were available at the time of data collection. Seeing that this is a non-probability sampling design, standard errors cannot be computed and statistics for inference are not applicable. On the day of data collection, the Philippine Air Force was able to provide 44 subjects to participate in the study, with 6 subjects dropping out due to urgent responsibilities. The recruitment process was managed by the officer-in-charge from the Philippine Air Force during the coordination period with researchers from September 2022 to December 2022.

The study was conducted at the Philippine Air Force General Hospital, Pasay, Metro Manila, Philippines, in January 2023. The researchers utilized three main areas for the study. First, one (1) big room where the study procedure was explained to the subjects and their basic demographic information and

informed consent was obtained. Second, one (1) quiet conference room that holds three (3) subjects at a time. This is where testing with the hearWHO application was conducted. Lastly, three (3) quiet consultation rooms were utilized to test the subjects with Pure Tone Audiometry, conducted by three certified audiologists.

Approval from the University of Santo Tomas - Faculty of Medicine and Surgery (UST-FMS) Ethics Review Committee and the Commanding General of the Philippine Air Force (PAF) was obtained prior to data collection. The researchers coordinated with the PAF's officer-in-charge and determined a date and time suitable for both parties. Given that volunteer sampling was employed, the subjects were recruited from military personnel who were present or available at the military base on the agreed-upon date and time of data collection.

At the Philippine Air Force General Hospital, the subjects were oriented regarding the data collection process and asked to sign an informed consent form. They were also given a data collection form to fill out to determine their basic demographic information. After completing this step, the subjects were escorted to a quiet room where they used the hearWHO application as a rapid hearing screening tool. Here, they were provided with standardized hardware (earphones/earbuds, headphone connectors and mobile phones of the same type). The mobile phone was set at a standardized volume to ensure consistency of results. The score of the hearWHO test was recorded and classified subjects as either: (a) With a good hearing score if they garnered a result of 70 and above, (b) At risk for hearing loss if they garnered a result between 50 to 70, or likely to have some degree of hearing loss if they garner a score of 50 and below.

After rapid screening, the subjects were escorted to another quiet room where they were tested using Pure Tone Audiometry, conducted by certified audiologists, who also interpreted the results.[13] The collected data was then submitted to a statistician for analysis.

Efforts were made to address the possibility of information or measurement bias by ensuring that the hardware used was all uniform. Report biases were addressed by ensuring proper screening of subjects with the inclusion and exclusion criteria.

The desired outcome was to verify that the results of the hearWHO application are consistent with the results of the Pure Tone Audiometry Test. The exposures applied in this study involve the use of the hearWHO as a screening tool and the Pure Tone Audiometry testing. Predictors that will affect the study outcome include the subjects' history of frequent noise exposure. A potential confounder encountered in the data collection process was the use of rooms for Pure Tone Audiometry Testing, which should typically be soundproof. In this study, three (3) quiet rooms were provided for Pure Tone Audiometry testing. While these rooms are located in a quiet area of the hospital, they were not soundproofed. Additionally, the hospital was located within the airbase, which may mean possible exposure to aircraft noise. The use of external device connectors, particularly the lighting to 3.5 mm headphone jack adapters for mobile phones and earphones, may affect audio quality transmission.

The measures of location helped analyze this data and determine the rank of values relative to one another. A limited number of studies have explored the use of the hearWHO application as a rapid screening tool. This paper may serve as a baseline and may set the foundation for future research. Because of this, the study did not include inferences, conclusions or estimates regarding the population.

RESULTS

Forty-four (44) subjects volunteered to participate in this study, signed the informed consent form and filled out the basic demographic form on the day of data collection. Six (6) subjects dropped out due to an urgent mission that required their attention. Thirty-eight (38) subjects were screened using the hearWHO application and subsequently using Pure Tone Audiometry, conducted by certified audiologists (Figure 2).

There were 27 male participants (71%) and 11 female participants (29%). Most of the participants (47%) were between 24 to 31 years old. The majority (16.1%) had been noise-exposed as military personnel for 15 years and the least (2.1%) had been exposed for five years (Figure 3). Most of the subjects had been exposed to noise through different types of aircraft (42.1%), some have specifically worked with helicopters (15.8%), through base or ground operations (7.9%), a minority of the group were in search and rescue operations (5.3%) and exposed to the use of firearms (2.6%) (Figure 4).

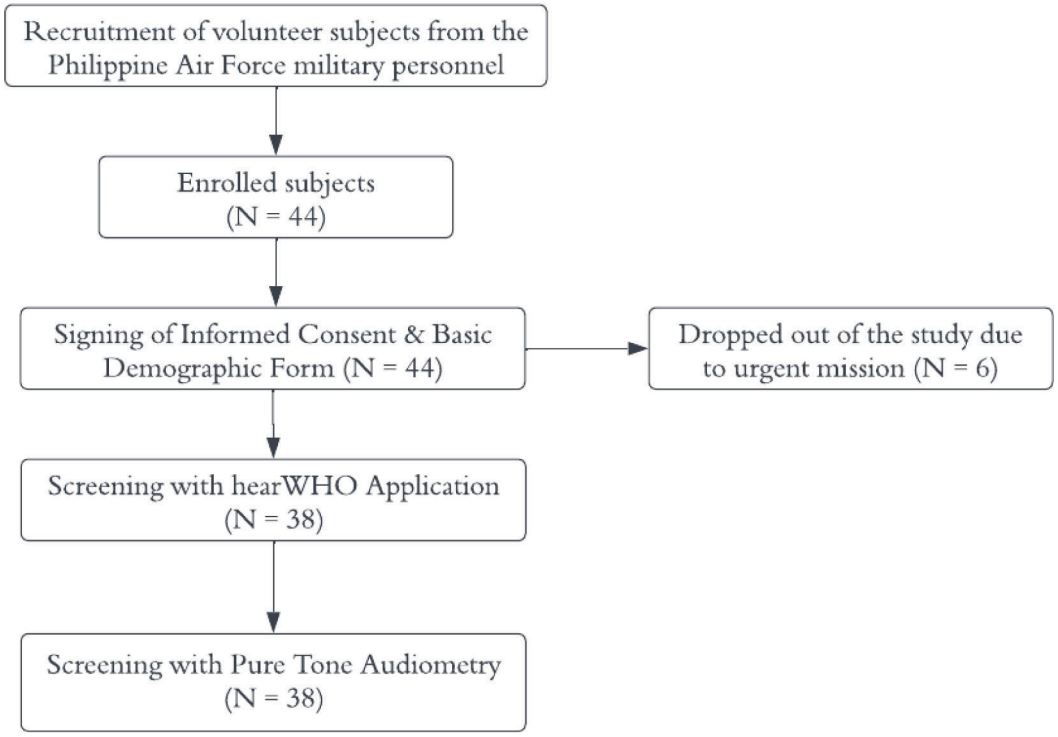

Figure 2: Subjects per stage of the study

One confounding variable encountered in the study was the use of rooms that were not soundproof. The location provided to researchers was within the premises of the airbase; therefore, noise could not be eliminated. The researchers utilized standard wired in-ear earphones with silicone tips that go over the ear in an effort to address this confounding variable.

Among the 38 participants, 36 gained a score of <50 (95%) in the hearWHO application, 1 participant gained a score of 50-70 and 1 participant gained a score of >70 (Table 1). The clinical profile showed that the majority of these participants (79%) had essentially normal otoscopy findings bilaterally, with 8 (21%) of them having an abnormality in

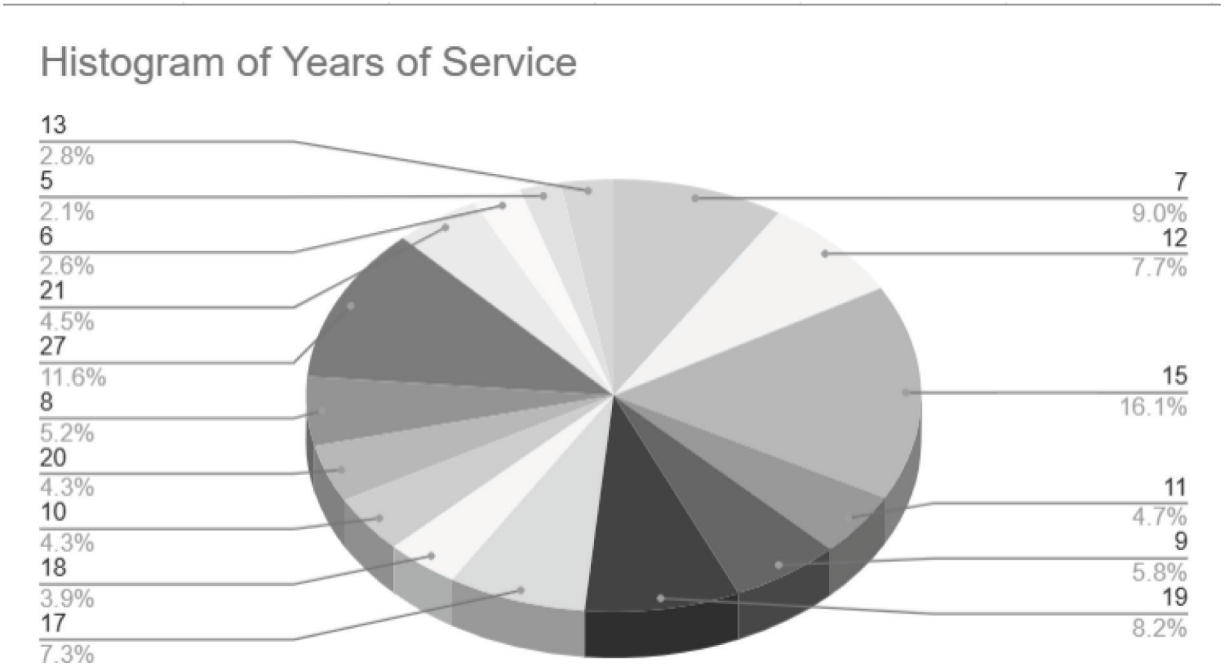

Figure 3: Years of service

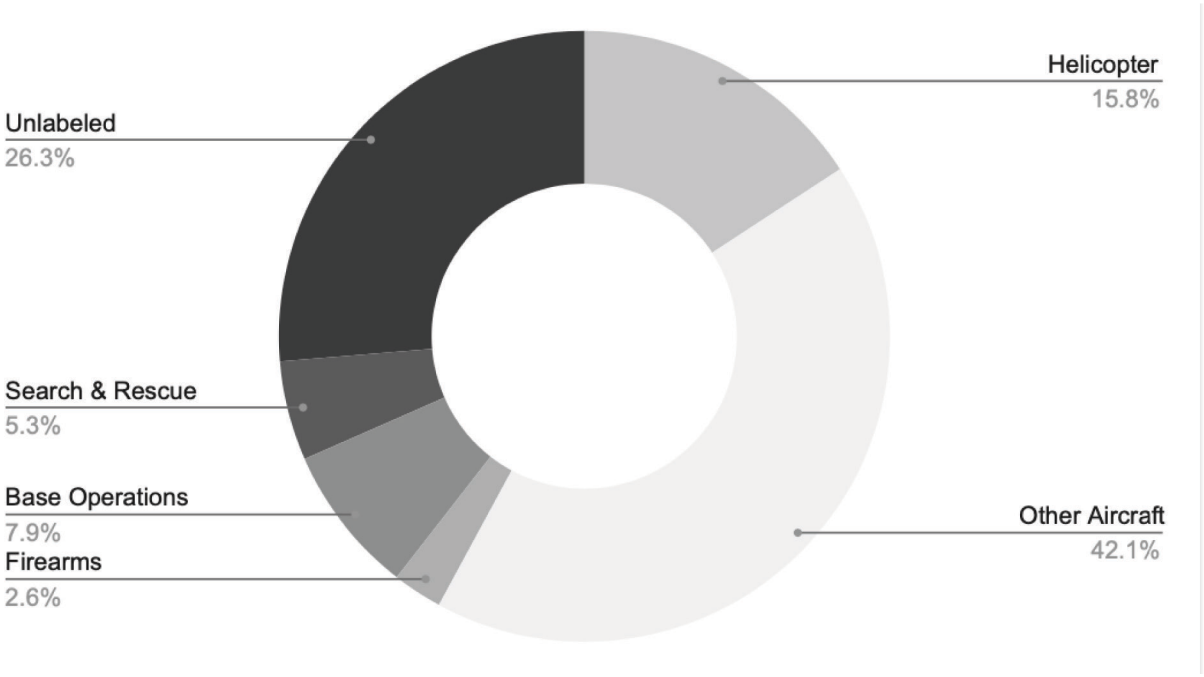

Figure 4: Types of exposure

Table 1: hearWHO Scores

hearWHO Score	<50	50-70	>70
No. of Participants	36	1	1

Table 2: Descriptive Statistics

	Mean	Std. Deviation	N
hearWHO scores	40.8421	9.41398	38
Right ear PTA	17.1389	6.99189	38
Left ear PTA	17.9382	5.58158	38

either ear. Majority of the abnormalities seen were retained cerumen, dull and thin tympanic membrane, and perforated tympanic membrane.

The same participants were also subjected to the Pure Tone Audiometry testing in order to verify the results of the hearWHO application. Findings of the Pure Tone Audiometry test are usually reported through the Pure Tone Average (PTA), which is the summary of the standard pure-tone audiometric findings of each ear's thresholds at 500, 1000 and 2000 Hz.[14] Findings of the right ear showed that 34 participants had normal hearing with their PTA scores ranging from 7 to 25 decibels, while 4 participants had mild hearing loss with their PTA scores ranging from 27 to 32 decibels. Findings of the left ear showed that 35 participants had normal hearing with their PTA scores ranging from 8 to 25 decibels, while 3 participants had mild hearing loss with their PTA scores ranging from 27 to 28 decibels. Out of the 38 participants, 20 were recommended to undergo an annual hearing test and 5 of them were advised to wear proper protective equipment while on duty.

The mean hearWHO application scores of the participants were 40.8421, with a standard deviation of 9.41398. The Pure Tone Audiometry assessment of the left ear (M= 17.9382, SD = 5.58158) yielded a slightly higher score than those of the right ear (M= 17.1389, SD = 6.99189) (Table 2).

The p-value of the hearWHO group (-21.055) was lower than the test value (40.84), suggesting the test result of the One Sample t-Test rejects the null hypothesis that use of the hearWHO application was not effective in rapid screening of hearing loss among military personnel of the Philippine Air Force. Table 3 shows that the hearWHO and Pure Tone Audiometry results show negative mean differences, which means that the results are not significant. This suggested that the use of the hearWHO application was not effective in rapid screening of hearing loss among military personnel of the Philippine Air Force. No other analyses were performed.

Table 3: One Sample t-Test Test Value = 40.84

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
hearWHO	-21.055	36	.000	-23.94784	-26.2546	-21.6411
Pure Tone Audiometry	-24.725	36	.000	-22.95757	-24.8407	-21.0745

DISCUSSION

In determining the effectiveness of hearWHO application in screening hearing loss among military personnel of the Philippine Air Force, the following were done:

The level of agreement or discrepancy between results obtained from the hearWHO application and the Pure Tone Audiometry Test was determined.

The percentage of cases where the application accurately identified or missed hearing loss compared to the gold standard was quantified.

Early screening, which led to timely intervention to mitigate the progression of hearing impairment, was assessed.

The results of the study show that the hearWHO application is not a recommended rapid hearing screening tool. The scores obtained from the hearWHO application and Pure Tone Audiometry were found to be incongruent. The presence of possible confounders, such as the testing room and quality of earphones or audio jack adapters/connectors, may have affected the results. Pure Tone Audiometry testing is ideally done in a soundproof booth. While testing was conducted in quiet rooms, they were still not considered soundproof as they were not properly calibrated. The audio jack adapters/connectors may have also affected the audio quality of the hearWHO application. The use of non-purposive sampling may have limited the results as well. No multiplicity of analyses was considered, as this study only considered two variables. No similar studies have evaluated the specificity or sensitivity of the hearWHO application, nor have there been any other studies that compared the screening tool to the gold standard of assessment of hearing loss. The lack of regulatory oversight and standardization of mobile health applications continues to pose challenges in evaluating their reliability.[15]

This study's limitations include the non-probability sampling method, which does not represent a large portion of the chosen population.[16] There may be the presence of sampling bias as some units in the population had no chance of being included since the selection of participants was based only on their availability during the period of data collection. Another limitation was the inability to generalize data collected beyond the sample utilized and the difficulty of assessing quality of results; hence, a probability sampling method was recommended to provide an unbiased population representation and better generalizability of results.

CONCLUSION

Given that results of the hearWHO application were not consistent with Pure Tone Audiometry testing, this suggests that the application is not recommended as a rapid screening tool for hearing loss. This study was limited by the sample size and sampling method. Consequently, the findings may not be generalizable beyond the specific sample used. A more favorable outcome may be achieved if the study was done with a bigger sample size. This study may also be performed on other populations that are also exposed to loud noises as part of the nature of their work, such as soldiers serving in the army, airport ground staff and construction workers. A better testing environment would also be useful in improving the reliability of testing, where a quieter environment with less noise and distractions is used to lessen the risk of testing errors.

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