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Application of the Wireless Audiometric Testing System at a Refugee Center with a Multilingual Population

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APPLICATION OF THE WIRELESS AUDIOMETRIC TESTING SYSTEM AT A REFUGEE CENTER WITH A MULTILINGUAL POPULATION

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has been approved as meeting the requirement for the Degree of Doctor of Audiology in the College of Natural and Health Sciences in the Department of Audiology and Speech-Language Sciences.

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ABSTRACT

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The purpose of this study was to assess the state of hearing health in the immigrant and refugee community of northern Colorado, while also determining if the new wireless automated hearing test system (WAHTS) technology is a feasible means of bringing entry-level care to this multilingual population. Twenty adult participants were recruited from various cultural/lingual groups including: Rohingya, Karenni, Spanish, and Somali. Data were analyzed for 19 participants, 57.9% of who were female and 42.1% of who were male. Mean age of participants was 52.3 years (SD= 16.05). Audiometric thresholds were obtained at .5 to 8 kHz in both ears with the use of the WAHTS in classrooms and stairwells at a community center. Recorded ambient noise measurements in these locations were well within ANSI S3.1-1999 (R2013) standards when the attenuation of the WAHTS headset was considered. An interpreter was utilized to facilitate listener instruction, and a doctoral audiology student carried out all testing procedures. Participant interviews were conducted to determine self-reported hearing health history and subjective experience with the WAHTS. The point prevalence of hearing loss in this group was 52.6%. Overall, the use of the WAHTS was successful in this multilingual population, as most participants completed the task with simple translated instructions. The information gathered suggests a higher prevalence of hearing

loss when compared to data for the general United States adult population and a rate of treatment acquisition that is about 20% lower than the general population. High rates of hearing loss in this population could have significant impacts for individuals trying to learn a new language. In a group that is in need of hearing healthcare, the WAHTS may be useful in low-resource settings in the future, with some slight software modifications to enhance usability.

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CHAPTER I

INTRODUCTION

Although hearing loss is a condition experienced by people all over the world, its prevalence is not equally distributed. The World Health Organization (WHO) stated that hearing loss significantly impacts over 360 million individuals around the world (2012). Of those people, WHO reported only 11% to be living in high-income regions. Congruently, it has been estimated that approximately 80% of all hearing loss occurs in developing nations (Appold, 2012). Though data from these regions were not abundant, the highest rates of hearing loss are expected to exist in sub-Saharan Africa and South and Southeast Asia (Stevens et al., 2011).

After learning of this imbalance, it is natural to inquire *why* the possibility of hearing loss exists as a greater risk to those living in third-world countries. Despite efforts to implement hearing screening procedures, financial and situational barriers continue to overshadow any progress in this realm. Although hearing loss has the potential to truly impact an individual's daily life, treatment is often discounted when widespread poverty and fatal diseases are having a sweeping daily impact on these communities (Olusanya, Luxon, & Wirz, 2004). Access to hearing healthcare services is limited by a lack of qualified audiologists in a given area, shortage of government funding, inadequate education, and culturally influenced beliefs of potential clients (Appold, 2012). With this reality in mind, healthcare professionals are still trying to find ways to help. Researchers are exploring newer and more portable technology for implementation in developing nations and non-traditional healthcare settings.

Purpose of the Study

Although healthcare within the United States is available and accessible to the average citizen, this study aimed to determine the status of hearing healthcare among immigrants and refugees who have settled in an urban-cluster community in the United States. Refugees are those who have escaped harsh circumstances, typically in politically unstable developing nations. With hearing loss present in such elevated proportions and services lacking in the developing world, it is necessary to determine if these individuals are receiving the preventative and rehabilitative care they need when they arrive in the United States. The purpose of this study was to trial the use of newly developed wireless audiometric equipment to evaluate the feasibility of its use in the refugee/immigrant population and determine the overall hearing status of immigrants affiliated with a community refugee center in northern Colorado.

Through the combination of objective audiometric thresholds utilizing new, portable technology and subjective participant interview responses, the data collected were valuable in determining the state of hearing health among the overall community, barriers to hearing healthcare, attitudes toward hearing healthcare, and the general prevalence of self-reported hearing loss in the immigrant population. By addressing these concerns among a small group of refugees and immigrants, it will be possible to start examining the issue more broadly and begin to steer toward a healthier future.

Research Questions

Q1 What is the prevalence of hearing loss among immigrants affiliated with a refugee center in northern Colorado?

Q2 What is the self-reported hearing status and access to hearing healthcare of the adult immigrant population in northern Colorado?

Q3 Is the wireless headset technology a feasible means of bringing entry-level hearing healthcare into the adult immigrant community who may not have English as a primary language?

Q4 What is the subjective impression of using the wireless headset technology for hearing testing at the refugee center from the listeners' perspective?

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

Although hearing loss is a worldwide problem, it affects different regions in varying ways. Culture, socioeconomic status, healthcare system, and overall wellbeing of a country's population play a large role in how hearing loss is identified, diagnosed, and treated. It is well known that hearing loss poses a greater impact for people residing in the developing world than for communities located in well-developed nations (Appold, 2012). The increased occurrence of hearing loss in these regions results in life-altering impacts on the personal wellbeing of citizens, as well as repercussions regarding community and national healthcare systems. Higher rates of hearing loss exist in these areas where hearing loss often remains undetected and/or untreated. In instances of untreated hearing loss, an individual is likely to lose more than just their hearing. Surveys show that untreated hearing loss has negative effects on a person's emotional health, mental health, and social interactions with the potential to significantly lower the quality of life (Kirkwood, 1999). As the severity of the hearing loss increases, the more likely it is to impact their daily living, both mentally and physically. As a result, an increased level of frustration is common for both the hearing-impaired individual and their family members (Dalton et al., 2003). Although hearing loss is more easily identifiable in developed nations such as the United States, there are still people who suffer from lack of treatment. Among these individuals may be those who emigrated from developing nations. Although each country has its own circumstances when it comes to healthcare and hearing loss specifically, the world has become smaller in this technological age. For this reason, the global risk of hearing loss directly relates to, and impacts, smaller communities both in developed countries and abroad. The following outlines the worldwide prevalence of hearing loss, how screening methods vary in developed and underdeveloped nations, and finally, the accessibility of services both in an individual's country of origin and in their new home in the United States.

Global Risk of Hearing Loss

Epidemiology

Hearing loss is a condition that can take many forms. Although it can present in isolation, it may also occur as a secondary characteristic of an existing systemic condition. Hearing loss can be present at birth (congenital), or it may be acquired later in life. In addition, hearing loss can be the result of damage to several different areas of the auditory system. While some individuals present with a hearing loss originating in the cochlea, others may suffer from a pathology affecting the middle ear or the auditory nerve (Morton, 1991). The many variables that affect type, onset, severity, and etiology of hearing loss are studied in a science known as epidemiology. When considering the differences between hearing losses among diverse populations, a review of common epidemiologic data is valuable.

Morton (1991) described some of the genetic epidemiology of hearing impairment across populations. It was estimated that among children with profound hearing loss, 51% have hearing loss that is a result of single gene mechanisms. The other 49% is acquired or caused by environmental mutations to genes. For those 51% that are genetic mutations, different inheritance patterns are recorded. An autosomal recessive pattern results in 77% of these cases. Autosomal dominants result in 22% of instances. Finally, sex linkage is only responsible for about 1% of profound hearing loss cases resulting from genetic mutations. In a similar way, adult or late childhood onset hearing loss can also be a result of many causes. These may include noise pollution, disease, heredity, and presbycusis. Very little information is currently known about the genetic influences associated with late-onset hearing impairment (Morton, 1991).

Although the general data reported here are informative, population-specific epidemiologic data serve to focus on possible genetic and environmental influences that make certain communities more susceptible to hearing loss than the overall population. Lebeko, Bosch, Noubiap, Dandara, and Wonkam (2015) studied previous data collected on causes of hearing loss in sub-Saharan Africa to consolidate genetic records. It was documented that in sub-Saharan Africa, environmental factors play a larger role in the presence of hearing loss than in developed nations. In these locations, environmental influences are estimated to be responsible for approximately 50-70% of hearing losses. Lebeko et al. (2015) stated that these factors include limited prenatal and perinatal care, malnutrition during pregnancy, deficiency of gestational vitamin A, and infection such as cytomegalovirus or bacterial meningitis. The other 30-50% of congenital hearing losses are initiated by genetic causes, with only 30% of those being attributed to syndromic origins. Consequently, 70% of those genetic hearing losses are acquired through genetic mutations. It has been documented in the developed world that the most common mutations for autosomal recessive nonsyndromic hearing loss are the connexin genes

GJB2 and GJB6. Although these genes have been recognized in populations with European descent, it was discovered that these two genes are not the major genetic causes among individuals of African descent (Lebeko et al., 2015). It is still unknown exactly which genes are most responsible for genetic hearing loss in the sub-Saharan region. Yet with this knowledge of differing environmental and genetic influences, it is vital that global hearing loss is not viewed through a single lens.

Prevalence in the United States

Specifically, within the United States, hearing loss is a growing concern. As the population of the country ages and the baby boomers enter their senior years, the number of adults with hearing loss continues to grow. In addition, new technology has brought with it abundant noise, both from industrial and recreational sources. This exposure can affect people of all ages and, therefore, also contributes to the growing population of those with hearing loss in the United States today. Agrawal, Platz, and Niparko (2008) estimated the national prevalence of hearing loss. Data were obtained from subjects who had participated in the National Health and Nutrition Examination Survey (NHANES) between 1999 and 2004. Hearing loss was classified as hearing thresholds worse than 25 decibels hearing level (dB HL) between 500 Hz and 6,000 Hz. A total of 5,742 individuals ages 20 to 69 years of age were recruited for participation in the study, which represented half of the total subjects documented by the NHANES data set. Additionally, participants were excluded if they could not remove their hearing aids or if they presented with significant otalgia. Hearing testing was conducted in a mobile testing unit by trained technicians. In addition to audiometric records, questionnaires were considered that highlighted demographic characteristics, health history, previous noise exposure, and self-determined hearing status. It was discovered that 16.1% of participants presented with hearing loss in the speech frequencies (.5-, 1-, 2-, and 4 kHz). Of those, approximately half of the participants revealed a unilateral loss and half revealed a bilateral loss. Furthermore, multiple logistic regression analysis was utilized to determine the correlation between hearing loss and certain demographic characteristics, with adjustments made for levels of noise exposure and cardiovascular risks. It was found that males were 5.5 times more likely to have a hearing loss than women. In addition, hearing loss was much more prevalent among White participants when compared to Black participants with likelihood of hearing loss being 70% lower in the Black population (Agrawal et al., 2008).

Utilizing the same survey to examine data from more recent years, Lin, Niparko, and Ferrucci (2011) analyzed the records obtained from the National Health and Nutritional Examination Survey from 2001 to 2008. Audiometric data were obtained and analyzed for 3,143 participants 12-19 years old, 3,630 participants 20-69 years old, and 717 participants older than 70 years. Hearing loss was defined as having a speech frequency pure tone average (.5-, 1-, 2-, and 4 kHz) of greater than 25 dB HL in both ears, as per criteria established by the World Health Organization (WHO). Results prompted the estimation that 12.7% of United States citizens over the age of 12 years presented with a bilateral hearing loss between the years of 2001 and 2008. This percentage equates to approximately 30 million individuals. Furthermore, that number increased to 20.3%, or 48.1 million people, when unilateral hearing loss was included. In addition to overall prevalence, demographics were analyzed in terms of age, male, female, White, Black and Hispanic categorizations. It was found that hearing loss is most prevalent in older, White, and male populations. From these two studies, national estimates were obtained through subjective self-report of hearing loss as well as audiometric data.

Though the previous two studies focused on the adult population, data exist on hearing loss prevalence in the pediatric community as well. In a study conducted by Niskar et al. (1998), a population-based cross-sectional survey was conducted among 6,166 children between the ages of 6 and 19 years. An in-person interview and audiometric pure tone data for frequencies of .5 to 8 kHz were obtained for each participant. Analysis was conducted through calculation of both a low (.5-, 1-, and 2 kHz) and a high (3-, 4-, and 6 kHz) pure tone average, referred to as LPTA or HPTA, respectively. Hearing loss for children was defined as at least 16 dB HL or worse pure tone average in at least one ear. Through this evaluation, it was estimated that 14.9% of children in the United States present with either low- or high-frequency hearing loss. More specifically, the prevalence of low-frequency hearing loss was 7.1%, the prevalence of high-frequency hearing loss was 12.7%, and the prevalence of children who presented with both types was 4.9%. When compared to demographic characteristics such as gender, race/ethnicity, age range, and poverty-income ratio, it was found that low-frequency hearing loss did not differ significantly, yet high-frequency hearing loss did. The occurrence of high-frequency hearing loss was 5.6 % greater among males when compared to females in the 12- to 19-year-old group, yet the 6- to 11-year-old group showed no variation between genders. In addition, when race/ethnicity was compared across the entire age group, high-frequency hearing loss was most prevalent among

Mexican-American children. Hearing loss in the high frequencies also became more common as household income decreased (Niskar et al., 1998).

Henderson, Testa, and Hartnick (2011) further investigated trends in adolescent hearing loss utilizing the NHANES surveys for the years of 1988-1994 and 2005-2006. During these periods, 4,310 children (ages 12-19 years) received audiometric testing. The data from these tests were used to determine trends in noise-induced threshold shifts (NITS), high-frequency hearing loss (HFHL), and low-frequency hearing loss (LFHS). Researchers classified NITS as audiometric thresholds greater than 15 dB between 3,000 and 6,000 Hz only. Additionally, HFHL and LFHL were determined by high- and low-frequency pure tone averages. Among the overall participant population, the prevalence of NITS, HFHL, and LFHL did not significantly increase between the first and second survey intervals. Despite that, it was found that noise exposure increased, with 15% more participants claiming to have been exposed to loud or recreational-based noise in the past 24 hours during the second survey period. In addition, females were found to have a significantly increased occurrence of NITS. While only 11.6% of females experienced NITS in the 1988-1994 periods, 16.7% experienced it in the 2005-2006 cycle. This rise in prevalence of noise-induced hearing loss is thought to be a direct result of increased noise exposure in youth populations (Henderson et al., 2011).

Although there are data regarding prevalence of childhood hearing loss in the United States, it has been suggested that those numbers underestimate the true impact. Pape, Kennedy, Kaf, and Zahirsha (2014) suggested that due to the continual increase of immigration, childhood hearing loss estimates are often miscalculated. The researchers sought to analyze the prevalence rates of other countries so it could be determined if these rates, combined with rates of immigration into the United States, could be altering the prevalence estimates of hearing loss in this country. Pape et al. (2014) utilized a collection of information via peer-reviewed journals, government reports, and online searches to provide an estimation of the number of children who have immigrated into the United States with hearing loss from both Mexico and China. Mexico and China were chosen in this study because 22.1% of all immigrants residing in the United States in 2012 originated from these two countries. Through this inquiry, it was estimated that approximately 4,557 and 45 children from Mexico and China, respectively, immigrated to the United States with possible undocumented hearing loss in 2012. Based upon the rates of immigration and concurrent pediatric hearing loss in these two countries alone, it was estimated that the United States is presented with a 7.5% rise in the estimated occurrence of childhood hearing loss (Pape et al., 2014). With immigration rates and refugee community sizes increasing, it is necessary to not only be aware of hearing loss prevalence in this country, but also around the world (Zong & Batalova, 2016).

Prevalence in Developing Countries

Hearing loss is a problem affecting all types of communities. Whether it is genetic, related to age, or injury-related, hearing loss ranks as one of the world's leading physical ailments (Appold, 2012). Although the condition is present all over the globe, its presence is not equally distributed. The World Health Organization (2012) estimated that 360 million people worldwide suffer from a "disabling" hearing loss, which is classified as a loss greater than 40 dB HL in the better ear for adults and a loss greater than 30 dB HL in the better ear for children younger than 15 years of age. Of those 360 million individuals, only 11% reside in high-income countries, making the prevalence in low-income countries almost double. It was reported by WHO that the prevalence of disabling hearing loss in both children and adults over the age of 65 is the highest in the regions of South Asia, the Asia Pacific, and sub-Saharan Africa. In addition, it was also noted by the WHO (2012) that global hearing loss in children appears to be directly related to literacy rates of parents. As the parent literacy rate in a certain region begins to increase, the prevalence of childhood hearing loss begins to decrease. Unfortunately, underdeveloped countries often have limited financial, educational, and health-based resources. The direct relationship that is present between parental education level and hearing loss is simply representative of the fact that individuals living in impoverished areas have inadequate access to basic services that exist in the United States. These statistics do not mean that hearing loss exists as a result of illiterate parents; yet, they indicate that hearing loss is often more prevalent in areas where healthcare and educational initiatives are not well established.

Although it is presumed that hearing loss is more widespread in low-income regions, the data are incomplete due to the limited resources in these countries when it comes to screening and documenting hearing loss. Stevens et al. (2011) aimed to consolidate the information from 42 studies conducted in 29 different countries to determine if more attention needs to be drawn to global hearing impairment. Hearing impairment was defined as having a pure tone average of 35 dB HL or worse in the better ear. Following statistical analysis utilizing Bayesian hierarchical logistic regression, the highest occurrences of hearing loss were estimated to be present in sub-Saharan Africa as well as in South and Southeast Asia (Stevens et al., 2011). In addition to geographical region, other demographic factors were evaluated indicating that occurrence of hearing impairment increases with age and male gender and in middle- and low-income areas. Although additional cross-sectional studies are needed to declare a trend, data analysis outcomes indicated that that low- and middle-income countries have a higher prevalence of hearing loss than high-income regions. Stevens et al. (2011) proposed that some possible reasons for this correlation include higher rates of related health issues such as cerumen impaction, otitis media, pre- and post-natal infections, and ototoxic medications. With the presence of these potential contributing factors, continued research is necessary to understand the causes of increased hearing loss in specific regions.

One such study conducted by Sanders, Houghton, Dewes, McCool, and Thorne (2015) aimed to estimate the prevalence of hearing loss and availability of hearing services in the Pacific Island nations. With the Stevens et al. (2011) study in mind, Sanders et al. (2015) intended to provide further information on the Asia-Pacific region, which was previously found to have a high prevalence of hearing loss. Through data collection via literature reviews, regional estimates, contact with providers, and census data, prevalence was projected for the Cook Islands, Fiji, Samoa, Tokelau, and Tonga. More specifically, regional prevalence data, originally derived from the Bayesian-model, was expanded to offer an estimation of prevalence in each specific country. Census data from either 2006 or 2007 was used in this process, and data from New Zealand was used to represent high-income countries. Following analysis, Sanders et al. (2015) found that while the prevalence of hearing loss greater than 20 dB HL in New Zealand is approximately 18.1%, the prevalence in the Pacific Island nations ranged from 27.7% in Tonga to 30.7% in the Cook Islands. Furthermore, it was estimated that 10% of the population in the Pacific Island nations present with a hearing loss greater than 35 dB HL in the better ear, classifying them as having a "significant disability" according to the WHO. In addition, Sanders et al. (2015) reported that the Pacific Island nations have higher incidences of acute and chronic otitis media, along with higher risk of developing significant hearing loss as a result of middle ear infection. As previously hypothesized by Stevens et al. (2011), presence of other health issues related to hearing loss in these underdeveloped countries is a key factor. In support of this claim, Sanders et al. (2015) provided data on an estimated number of children with congenital deafness versus those with acquired profound hearing loss from meningitis. While approximately 248 children aged 0-4 years were diagnosed as congenitally deaf according to Fiji's 2007 census, 960 children aged 5-19 years of age were diagnosed with either congenital or meningitis-acquired deafness (Sanders et al., 2015). This suggests that higher rates of hearing loss are associated with formerly acquired diseases and inadequate healthcare in low-income regions.

As the high rates of hearing loss in developing countries become increasingly acknowledged, steps can then be taken to resolve the problem. Multiple publications from health agencies have been released in recent years to highlight these statistics, while also offering insight and possible solutions. In the mid-1980's, Wilson (1985) reported that 80% of hearing loss was found in developing countries. More current studies indicated that no positive shift has occurred. Recently, Appold (2012) documented the same prevalence ratio at 80%, while also indicating that this number is likely higher due to lack of newborn hearing screenings and general diagnosis in these countries. Although data in this area are sparse and many of these numbers are termed "estimates," the few studies that have been conducted all point to similar information. In a report on the global burden of hearing loss, Mathers, Smith, and Concha (2000) illustrated high prevalence in Asia and Africa by providing a graph of regional-specific occurrence obtained from individual studies. The countries with the highest occurrence proved to be India, Nepal, Sri Lanka, and Thailand, with consistently lower rates present in Europe, the Americas, and Australia (Mathers et al., 2000). Despite these regionally higher rates, increased amounts of hearing loss are occurring across the globe. It has been noted by Olusanya, Neumann, and Saunders (2014) that from 1985 to 1995, the prevalence of global hearing impairment increased from 0.9% to 2.1%; more than doubling in frequency. Although these numbers are inclusive of developed nations, Olusanya et al. (2014) indicated that 50% of hearing loss is preventable and suggested two probable causes of this increase that center on situations specific to developing countries. First, the combination of decreased healthcare and increased disease was mentioned. In addition, it was proposed that the growth of cities and general urbanization in developing countries poses a threat to hearing due to the lack of proper legislation and noise exposure regulations (Olusanya et al., 2014). These two reasons for increased hearing loss are controllable and, therefore, preventive measures can be taken to find a solution. Unfortunately, the statistics of hearing loss discussed here may be underestimated due to lack of proper screening and diagnosis in low-income regions. It is important to determine what wealthy nations are doing differently than impoverished ones and how differing screening procedures play a role in epidemiological outcomes.

Hearing Screening Procedures

Hearing Screening in the United States

Conventional methods. Within the United States, children are typically screened for hearing loss many times throughout their lives. Beginning with the newborn hearing screening in the hospital, it is typical that parents are informed within days of their child's birth that a hearing loss is present. According to the Joint Committee on Infant Hearing (2007), there are specific national protocols in place when it comes to screening infants for hearing loss. The first step is what is termed as the screening and rescreening process. Infants need to be screened by 1 month of age. Screening is typically done in the hospital by means of otoacoustic emissions, which assesses the cochlea sensory system, or auditory brainstem response, which tests the function of the auditory system up to the brainstem. For children who are receiving care in the neonatal intensive care unit, the auditory brainstem response screening is highly encouraged as neural hearing loss is a concern. If a child does not pass the original screening, they are rescreened before discharge from the hospital. In the well-infant nursery, either the same technology may be used for the rescreen, or a two-step protocol utilizing the other technological option could be employed to decrease the rate of false positives. If and when a child does not pass the subsequent screening, they are referred to an audiologist for a full diagnostic hearing evaluation, which is to be completed by 3 months of age. This standardized protocol helps to consistently identify children who are born with hearing loss so that literacy skills and linguistic proficiency are achieved before children reach the age of schooling (Joint Committee on Infant Hearing, 2007). The importance of early detection lies in the knowledge that if children have access to language during the sensitive first six months of life, even those with profound hearing loss can develop proper linguistic acuity (Yoshinaga-Itano, 2003).

Although the importance of early identification is well known among the medical community, there are still some individuals that will not be identified until they reach school age or beyond. This might be because a mild hearing loss was missed at birth, or because the hearing loss was acquired after birth. After newborn hearing screenings, the typical child is not screened again until they enter the school system. Later on, as an adult, an individual might be screened at a health fair or wellness check. Hearing screening procedures implemented with patients above the age of 5 are typically very similar and utilize pure tone air conduction testing. Though both screenings and clinical evaluations utilize pure tone audiometry, a screening at this level can be differentiated from an evaluation by defining it as a basic, fast, and cost-effective way to determine if an individual needs subsequent evaluation (American Speech-Language-Hearing Association [ASHA], 2018b). According to the ASHA guidelines, it is recommended that an audiologist, speech-language pathologist, or persons under the direction of a healthcare professional perform screenings. For children between the ages of 5 and 18 years, it is suggested that hearing screenings should take place in kindergarten, 1st, 2nd, 3rd, 7th, and 11th grades (ASHA, 1997).

Although ASHA has offered recommendations for the screening of school-age children, each state is equipped with its own school-based hearing screening guidelines that vary from region to region. Meinke and Dice (2007) consolidated school screening protocols from 46 states. It was found that 15 states used the same criteria recommended by ASHA, which is to obtain a response of at least 20 dB HL at 1000, 2000, and 4000 Hz. In other states, testing was recorded to additionally take place at 500 and 6000 Hz. Less frequently, 250 and 8000 Hz are tested in states such as Nevada and New Mexico. Colorado has one of the most comprehensive protocols, requiring responses at 500 and 6000 Hz at 25 dB HL and 1000, 2000, and 4000 Hz at 20 dB HL. As of 2005, Hawaii, North Dakota, and West Virginia had no universally accepted screening protocol (Meinke & Dice, 2007).

After leaving the school system, adults over the age of 18 are typically screened by choice or due to a concerning condition or situation that puts them at risk for hearing loss. It has been determined by the U.S. Preventive Services Task Force (USPSTF) that there is currently an inadequate amount of evidence to support or oppose screening asymptomatic adults over the age of 50 for hearing loss (Chou, Dana, Bougatsos, Fleming, & Beil, 2011). However, for those individuals who have a concern regarding their hearing, a primary care doctor is likely to be the first person of contact. Many studies have been conducted which consider various methods of screening for adults, some of which may be helpful when a suspected hearing loss or related issue is presented.

Although portable pure tone testing can also be used on adults, there are other, simpler screening options that may be used to determine the need for a full evaluation. A self-assessment scale may be given to a client to evaluate perceived hearing ability. Schow, Smedley, and Longhurst (1990) conducted a study to find the relationship between self-assessment scores and objective hearing sensitivity, and reported that the results were generally well correlated. It was noted that although a direct relationship exists, it is important that questionnaires be used as a supplement and be followed by objective testing due to the presence of those who deny their hearing loss (Schow et al., 1990). Furthermore, Yueh, Shapiro, MacLean, and Shekelle (2003) reviewed the effectiveness of and potential for adult/elderly hearing loss screening in a primary care setting. They stated that although the Whispered Voice Test is simple, it cannot be standardized and, instead, recommended self-assessment measures such as the Hearing Handicap Inventory for the Elderly-Screening (HHIE-S) or the use of an AudioScope® (Welch Allyn, Skaneateles Falls, NY, USA). While the HHIE-S is a subjective measure, an AudioScope can obtain objective data. An AudioScope is a combination tool, including both an otoscope and an audiometer that is capable of testing 500, 1000, 2000, and 4000 Hz at a level of 25 to 40 dB HL. This tool has been tested and has proved to exhibit exemplary sensitivity, specificity, and patient preference in quiet test environments. Because of the simplicity of these screening procedures, combined with the burden of disease posed by hearing loss, it is recommended that adult screenings become routine (Yueh et al., 2003). Currently, surveys of clinical practice show that although doctors acknowledge the impact hearing loss has on one's life, the majority do not engage in any screening activity with their patients due to time constraints, lack of compensation, and the existence of more threatening issues (Chou et al., 2011).

As previously mentioned, adults may also be routinely screened when placed in situations that put them at a higher risk for hearing loss. Locations such as industrial workplaces often use computerized audiometry to screen their employees. Although not a conventional method, automated audiometry has been utilized for years, with its earliest documentation in 1947. Due to the predetermined systematic steps that are utilized when conducting pure-tone audiometry, threshold searches through automation appear to be appropriate and applicable (Mahomed, Swanepoel, Eikelboom, & Soer, 2013). To determine the validity of automated threshold audiometry, Mahomed et al. (2013) conducted a review of the literature and meta-analysis to determine the accuracy of automated methods when compared to manual audiometry. After evaluating 29 studies highlighting computerized testing, the test-retest reliability of automated audiometry was found to be similar to test-retest reliability of a manual approach, with minimal variability between test sessions existing with either method. This proven accuracy of automated audiometric methods allows for the justification of its use in a variety of settings (Mahomed et al., 2013). Although not a new concept itself, automated audiometry has recently been applied to developing technology, furthering its application within the field.

New technology. Since screening procedures are the initial step in diagnosing a hearing loss and are designed to be simple, brief, and economical, they are traditionally done outside of a sound booth. Unfortunately, this often results in high ambient noise levels detrimentally affecting test results. In recent years, new technology has been developed to address this problem. Meinke, Norris, Clavier, and Flynn (2016) identified four main characteristics of a technologically advanced wireless headset that can be used to increase accessibility to screening opportunities. These included attenuation of ambient noise, validation, portability, and usability. In preliminary studies involving the Creare wireless headset prototype, it was found that this new technology provided an equal or higher level of attenuation when compared to ER3A insert earphone shallow insertion, ER3A insert earphone full insertion, and Sennheiser HDA200 circumaural earphones at .5-, 1-, 2-, 4-, and 8 kHz. In addition, it was explained that the headset is intended for use with mobile computer devices to allow for portability, which also aids in its ease of use

(Meinke et al., 2016). With these characteristics, the wireless automated hearing test system (WAHTS) is specifically designed for settings not normally conducive to audiologic testing. The creation of the WAHTS was specifically crafted with this goal in mind, which is evident when observing its design. To reduce high frequency sounds, the high attenuating ear cups are coated with polyurethane foam. In addition to attenuating qualities, the right earphone actually contains a wireless audiometer that uses a computerized algorithm to find threshold, working as an automated test system. Bluetooth capability then allows the connected iPad to start the test and collect the results through an app called TabSINT. The left earphone holds the system's rechargeable battery, making the system extremely portable. Closest to the ear lay a speaker and microphone, which are attached to the faceplate. Finally, the headband connecting the two ear cups utilizes a quick-fitting technology that minimizes friction and allows for a snug and accurate fit of the headset, completing the automatic and easy-to-use design (Meinke et al., 2016).

The validation of the wireless automated hearing test system in an industrial setting was further examined in detail in Meinke, Norris, Flynn, and Clavier's (2017) recent publication. In this study, the WAHTS was used to obtain air conduction thresholds at 500 to 8000 Hz for 20 participants in six conference or small meeting room locations. Hearing thresholds were also obtained through computerized audiometry in a mobile sound booth and values where compared. Untrained administrative employees controlled and operated the hearing tests administered through the WAHTS in an effort to verify usability. Results indicated that thresholds obtained through the use of the WAHTS were between 0.7 and 4.6 dB better than those obtained in s single-walled sound booth, with the greatest standard deviation occurring at 8000 Hz. In addition to its capability to function comparatively even outside of a sound booth, the WAHTS also received positive ratings in a usability survey that was administered to the untrained operators (Meinke et al., 2017).

Ambient noise standards. Since screening procedures typically take place outside of a sound-treated environment, it is recommended that ambient noise levels be monitored during testing and considered when interpreting results. Ambient noise levels that are exceptionally high have the potential to make the results unreliable by producing hearing thresholds that are elevated. This effect is known as masking (American National Standards Institute, 2008). Due to this potential for ambient noise to taint results, both the Occupational Safety and Health Administration (OSHA) and the American National Standards Institute (ANSI) have released standards regarding the maximum acceptable noise levels for test environments for specific earphone types. According to OSHA (2005) standard 1910.95 App D, titled Audiometric Test Rooms, noise levels in ambient test rooms should not exceed 40 dB SPL at 500 Hz (octave band center frequency), 40 dB SPL at 1000 Hz, 47 dB SPL at 2000 Hz, 57 dB SPL at 4000 Hz, and 62 dB SPL at 8000 Hz. The American National Standards Institute provides standards that are a bit more extensive, specifying different values for three separate test frequency ranges and earphone type. According to ANSI S3.1-1999 (R2008), the maximum permissible ambient noise levels (MPANLs) for a test frequency range of 500 to 8000 Hz with supra-aural earphones are 21 dB SPL at 500 Hz, 26 dB SPL at 1000 Hz, 34 dB SPL at 2000 Hz, 37 dB SPL at 4000 Hz, and 37 dB SPL at 8000 Hz. For a testing condition utilizing insert earphones in the same frequency range, the octave band MPANLs are 50 dB SPL at 500

Hz, 47 dB SPL at 1000 Hz, 49 dB SPL at 2000 Hz, 50 dB SPL at 4000 Hz, and 56 dB SPL at 8000 Hz. In addition to MPANLs, ANSI also specifies that measurements should be obtained with a Type I sound level meter and an octave or one-third-octave band filter (American National Standards Institute, S3.1-1999 R2008).

Hearing Screening in Developing Countries

Lack of conventional methods. Though not as well established as programs in the United States, the developing world has addressed the need for the implementation of hearing screening protocols. Nonetheless, barriers are still present due to limited resources. Olusanya et al. (2004) stated that universal newborn hearing screening protocols were thought to be unachievable as of 2004. Although hearing loss has the ability to diminish an individual's quality of life, the presence of poverty and fatal illnesses in developing countries make this non-fatal disorder seem inconsequential. Due to these financial and situational constraints, prevention is often the focus in these communities, leaving children who currently have hearing loss without a solution. Olusanya et al. (2004) aimed to identify some barriers that exist to newborn hearing screenings in these regions. First, it is debated whether the addition of newborn screening protocols would solve the problem of unidentified hearing loss. In the developing world, it is not uncommon that a large percentage of permanent hearing loss among children occurs after birth, as a result of other illnesses such as measles, meningitis, mumps, and ototoxic medications. Children may acquire these illnesses at any time, and there is no detection protocol that will identify all cases (Olusanya et al., 2004). Furthermore, many children in low-income countries are born in the home, outside of the healthcare system. Olusanya (2012) reported home births as being up to 95% of births in Ethiopia, 91% in

Somalia, 65% in Nigeria, 85% in Bangladesh and 82% in Nepal. These statistics create a concern that if a hospital-based system were to be put in place, the likelihood of screening children born at home would remain low. In addition, the creation of newborn screening protocols could be taxing on the healthcare system in two ways. First, it is proposed that false positives will occur in greater numbers due to outer-ear blockages and temporary middle-ear pathologies. False positives will lead to more referrals, crowding clinics that are already limited on time and money. Furthermore, the costs required to set up and follow through with a newborn hearing screening protocol are immense and may not even be considered by parents when other life-threatening diseases are a serious concern (Olusanya et al., 2004).

Despite all of these financial, cultural, and healthcare barriers, steps are being taken to make a change. Olusanya (2012) is a strong proponent in advocating for the involvement of pediatricians in the early identification process. She states, "Given that a high proportion of deliveries occur outside of hospitals, partnership with public health professionals is necessary for achieving a wider community impact" (Olusanya, 2012, p. 5). To succeed in achieving that societal impact, programs also need to be designed with specific communities in mind. Due to differing types of governments within each developing country, one universal program created by high-income countries will not suffice. The problem needs to be targeted from the inside out (Olusanya, 2012).

Taking a step in that direction, Moodley (2016) aimed to determine the status of diagnostic testing in South Africa by studying what procedures are currently in use. Although not focused on newborn screenings, insight on when and how these children are identified due to the lack of protocol is provided. In his study, Moodley (2016) evaluated the audiological reports of 230 children who were referred to early intervention programs in the providences of Gauteng, Kwazulu Natal, and Western Cape. Through descriptive statistical analysis and hypothesis testing utilizing a chi-square test, it was determined that services in these three regions are not adequate, as a full evaluation is not likely to be carried out. In addition, no difference was found in the quality of services among the private or public healthcare sectors. No consistent test-retest protocol was in place across the varying locations. Of the 230 children, 140 were tested with pure tone audiometry, while only 22 children had records of bone conduction testing. Various types of electrophysiologic testing were carried out on 171 of these children. In addition, noisemakers were used as a preliminary evaluation for 14 children whose ages ranged from 7 to 62 months. No tympanometric data were obtained for 18% of these children. With such sparse and inconsistent data, it has been proposed that further information needs to be obtained regarding the current diagnostic practices and obstacles (Moodley, 2016).

New technology. After careful evaluation of current cultural, medical, and community-based information, many propose that new technological advances, which are readily available in the developed world, could lead to better medical outcomes in underdeveloped nations. In an effort to break the existing barrier due to limited resources, research conducted by Peer and Fagan (2015) has been completed to assess the effectiveness of utilizing mobile devices as screening tools. This research on new technology is vital to developing future screening protocols. Although these mobile-based procedures are less expensive and, therefore, create an automatic appeal, it is important to verify that accessibility is not being traded for accuracy. Peer and Fagan

(2015) conducted a study at the University of Cape Town in South Africa evaluating the potential of the UHear app as a screening tool in the developing world. The UHear app has been created through a partnership between Unitron Hearing Limited (2015) and Apple and is available at no cost through iTunes. It functions on any touch device as a self-administered hearing test. In Peer and Fagan's study, the hearing acuity of 25 patients was tested using the app, coupled with Apple ear buds, in three different environments. Those environments included a waiting room, quiet room, and a sound-treated room. Audiometric results were then compared to the formal audiograms, which were completed less than two weeks prior to testing utilizing the app. All participants with a true PTA of 40 dB HL or greater were properly identified through use of the UHear app. The most accurate thresholds were obtained in the sound-treated condition and at frequencies above 1000 Hz (Peer & Fagan, 2015).

Due to the potential posed by smartphones to detect hearing loss as a screening tool, other researchers have also conducted studies to test the reliability of such devices in the international audiological community. Sandström, Swanepoel, Myburgh, and Laurent (2016) published a study that aimed to determine the accuracy of smartphone audiometry without the use of a sound booth for use in undeserved community health clinics. Two participant groups included 64 individuals who were tested using conventional audiometry in a sound booth, along with 30 others who were tested using conventional audiometry at a health clinic with no sound booth available. In the sound-booth setting, a GSI 61 clinical audiometer was paired with supra-aural earphones. In the health clinic setting, conventional audiometry was measured with the use of the KUDUwave audiometer (Sandström et al., 2016). The KUDUwave is a diagnostic audiometer connected to circumaural ear cups that sit over insert earphone transducers and include microphones to monitor ambient noise. Its validity outside of the sound booth had already been confirmed in a school environment before the 2016 study (Swanepoel, Maclennan-Smith, & Hall, 2013). During the Sandström et al. (2016) study, all participants also received a hearing test through the use of a smartphone application called hearScreen, which was validated in a previous study by Swanepoel in 2014. In this condition, all participants used a Samsung Galaxy S3 phone paired with commercially available supra-aural headphones calibrated to international standards. Thresholds obtained from each condition were compared and data were analyzed using a paired samples t-test. Normal hearing was termed as hearing thresholds better than or equal to 15 dB HL. Among the sound-booth participants, 86.6% of cases in which thresholds were found to be greater than 15 dB HL showed agreement (within 10 dB) between conventional and smartphone audiometry. Among participants who were tested in a health clinic, 92.9% of cases in which thresholds were found to be greater than 15 dB HL showed consistent results between the two methods. Through the collection of this data, Sandström et al. (2016) confirmed the validity of utilizing smartphone apps to screen for hearing loss in communities with limited resources.

Access to Services

Services in Developing Countries

With new technology available to make screenings more easily accessible, fewer individuals may have undetected hearing loss. Though this creates opportunity for more diagnoses to be made, identification is just the first step in the rehabilitation process. Unfortunately, the limited resources that served as a barrier to screening also serve as a barrier to follow-up service. In 1978, all WHO member countries approved the Declaration of Alma-Ata, declaring basic healthcare services as a primary human right. Unfortunately, this effort to provide the developing world with basic access to health services failed. Although this occurred for a multitude of reasons, two main factors included the unwillingness of developed nations to let developing communities take control, and the concurrent incidence of civil wars, HIV outbreaks, and natural disasters (Hall & Taylor, 2003). With these issues in mind, the economical and societal cost of starting, and maintaining multiple audiology clinics is not highly regarded in regions where other, more serious, circumstances are taking lives. In addition, the expense of a hearing aid for an individual may be a family burden with no financial assistance. Olusanya et al. (2014) reported that WHO's definition of an "affordable" hearing aid is one that costs no more than 3% of the country's per capita. At the time this recommendation was offered, 3% of India's per capita was 46 US dollars and Malawi's was 10 US dollars. Since hearing aids in the United States are sold for a few thousand dollars, these numbers suggest that making an affordable hearing aid for an underdeveloped nation would be difficult with little to no profit margin. Moreover, even at those seemingly low costs, many families would be unable to afford hearing aids (Olusanya et al., 2014). Additionally, in many regions of the developing world, limited access is not only due to money, but can also be attributed to a shortage of trained audiologists, lack of government support, limited awareness, embarrassment, and geographical distance from services (Appold, 2012). Due to the limited number of trained professionals residing in these regions, the most affordable decision for many families is to send their child to a school for the deaf (Olusanya et al., 2014). Although this may be a self-elected decision by some families in the United States, the problem herein lies in the fact that these families in underdeveloped nations do not have the comfort of making that personal choice.

Fortunately, some organizations and individuals are working to offer solutions in the realms of service delivery and education. Appold (2012) highlighted the work of Paige Stringer, who is the founder of the Global Foundation for Children with Hearing Loss. Though based out of Seattle, this nonprofit organization works in Vietnam to supply hearing aids and train teachers and medical professionals in the community. Partnerships with 35 schools for the deaf allow this organization to educate families while also offering support as their children develop language proficiency. In addition, donated hearing aids are fit on children who cannot afford them. Although the Global Foundation for Children with Hearing Loss use hearing aids manufactured by companies in the developed world, such as Phonak and Oticon, they also dispense Solar Ear hearing aids. These aids are created by an organization in São Paulo, Brazil and were designed specifically as a low-cost option for underdeveloped nations. Offered in one analog and three digital models, Solar Ear aids are rechargeable through light energy. Other low-cost methods being employed in these regions include basic sound amplifiers (Appold, 2012). Similar to this situation in Vietnam, non-government organizations such as Stringer's serve as the only opportunity for adequate access in many developing areas. In the Sanders et al. (2015) study, prevalence estimates were accompanied by data collected on service provisions in the Pacific Island nations. Aside from one screening program called Project HEAVEN and the Bayly Clinic in Fiji, most other clinical programs are reliant on professionals from New Zealand and Australia. Providentially, educational and support-based assistance is provided in the Pacific region from groups such as Loto Tamaufai or SENESE in Samoa. These organizations help to educate families not only about hearing loss, but also regarding other disabilities and how to advocate for children who present with them (Sanders et al., 2015). Though some help is being provided, the reduced amount of services present in these regions is representative of the underserved majority.

Services in the United States

Another concern when it comes to access is the availability of healthcare to immigrants when they move to the United States. Those individuals residing in developing countries, refugee camps, or other oppressive situations will often relocate to America in hopes of a better life. This improved quality of life is often linked to healthcare. Unfortunately, the mere presence of audiological services in the United States does not guarantee that they are accessible to the average immigrant. Betancourt, Green, Carrillo, and Ananeh-Firempong (2003) stated that inevitable demographic changes among the United States population in the coming years support the need for attending to racial and ethnic inequalities in healthcare. They determined that most cultural barriers in the healthcare system lie in its social construct. Individuals who are new to this country typically have more financial needs and lower levels of education than native citizens do. Along with a lack of health insurance and a possible language barrier, these factors may result in an individual not seeking out care due to an overall sense of fear. This fear may arise from unfamiliarity with the system, presence of differing medical and cultural views, or even anxiety regarding deportation for those who are undocumented. Furthermore, when these patients do seek care, the absence of an interpreter and multilingual informational material may result in a misunderstood diagnosis, treatment, and follow-up plan. It was reported that Spanish-speaking clients who interacted only with English-speaking physicians were more prone to missing dosages of medication and not showing up to doctors' appointments when compared to those provided with language-appropriate services. With these disparities in mind, an approach based on cultural competence is encouraged to serve minority populations more effectively in all realms of healthcare (Betancourt et al., 2003).

This move toward cultural acceptance is especially vital in a healthcare system, as even a general knowledge of differing beliefs may help steer professional recommendations in a direction of increased individualization for clients of different backgrounds. Rhoades, Price, and Perigoe (2004) stated "the high rate of immigration from developing countries, where hearing loss is more prevalent, is leading to a growing number of children with special needs that do not share the same culture of most auditory-based clinicians" (pp. 285-286). Management of diversity in clinical and educational settings needs to be mastered by audiologists, speech-language pathologists, deaf educators, and other professionals who may encounter hearing loss. It was reported that 80% of audiologists consider English to be their primary language. In addition, of all children with hearing loss in the United States, 49% of them identify as something other than Caucasian. These statistics led to the suggestion that professionals need to become increasingly aware of cultural, lingual, and financial differences among their clients (Rhoades et al., 2004).

Use of interpreters in audiological care. Part of becoming culturally aware is being cognizant of when an interpreter is needed and learning how to properly collaborate with one. According to ASHA, audiologists are responsible for advocating for the use of an interpreter for clients who need them. Selection of an interpreter should be based on the individual's proficiency in each language, prior experience, training and certification. The United States does not currently have many standards when it comes to the training and licensure of interpreters, yet organizations at the state level are developing for this purpose. In addition, the International Medical Interpreters Association offers certification and a code of ethical principles (ASHA, 2018a). Although audiologists may not choose specific interpreters, Rhoades (2008) suggested that audiologists meet with their assigned interpreters separately before the appointment in which their assistance is needed. During this time, it is important to briefly familiarize the interpreter with the content of the appointment. Although the interpreter is a professional in the area of cultural proficiency, their knowledge of audiology will vary. Commonly used terms, procedures, and goals of the appointment should be discussed. In addition, the interpreter should be warned not to give gestural clues during testing. During the appointment with the client, proper positioning is necessary. It is recommended that audiologists face and speak directly to the client. The interpreter should be positioned to the side and slightly behind the audiologist. In addition, the audiologist should use clear, non-figurative language. For the comfort of the client and ease of continuity, it is beneficial if the same interpreter is utilized at each session (Rhoades, 2008).

Immigration and Settlement of Refugees in the United States

Immigration Data

The United States is a multicultural melting pot. This requires professionals to become culturally competent and also culturally aware of their service population. The number of immigrants who reside in the United States is actively increasing. According to Zong and Batalova (2016), the population of people born abroad increased by 2.5% between the years of 2013 and 2014. Between 1970 and 2014, the size of the U.S. immigrant population steadily increased from 9.6 million to 42.4 million. In terms of proportion of immigrants to natural-born citizens, there has been an 8.6% increase since 1970 with 13.3% of the population being foreign-born in 2014. During 2014, the top five countries people emigrated from were India, China, Mexico, Canada, and the Philippines. While the immigrant population is flourishing across the United States, certain states have had more growth than others. From 2000 to 2014, California and Texas have had the largest absolute growth of their immigrant populations. In 2014, California, Texas, New York, Florida, and New Jersey had the highest number of immigrants. Yet when ranked by share of immigrants in relation to state population, the top five states were California, New York, New Jersey, Florida, and Nevada (Zong & Batalova, 2016).

In addition to the general immigrant population, there is also a growing number of refugees and asylees who seek freedom from persecution in the United States. According to the United States Department of Homeland Security (2016), 69,975 refugees arrived in the United States in 2014. Of those individuals, 17,501 came from Africa, 47,197 from Asia, 818 from Europe, 4,066 from North America, 252 from South America, and 141 from unknown locations. From individual countries, the United States admitted the most refugees from Iraq (19,769), Burma (14,598), and Somalia (9,000) (United States Department of Homeland Security, 2016). With crises present in many locations around the world, the United States government regulates refugee resettlement by location of origin. For the 2016 fiscal year, the admissions limit was set at 85,000, with 10,000 of those spots reserved for individuals from Syria. Additionally, 34,000 spots were allocated to East and South Asia, with concern mainly for Iraq and Burma (Zong & Batalova, 2016).

Languages, Healthcare, Education, and Workplace

With people immigrating to the United States from such a large variety of countries and circumstances, characteristics of daily living differ greatly. Although English is still the official language of the United States, only 79% of citizens over the age of 5 say that they speak only English in the home (Zong & Batalova, 2016). Of the 63.2 million people who report speaking another language, 62% speak Spanish, 5% speak Chinese, 3% speak Tagalog, 2% speak Vietnamese, French, Korean, Arabic, and German, and 1% speak Russian. In 2014, about 50% of the immigrant population over the age of 5 were classified as “Limited English Proficient,” meaning they claimed to speak English “not at all,” “not well,” or “well” (Zong & Batalova, 2016).

In terms of healthcare coverage, the Affordable Care Act has helped to decrease the number of uninsured immigrants. While the uninsured rate for native individuals only dropped from 12% to 9% between 2013 and 2014, the rate for immigrants decreased from 32% to 27%. Of the remaining individuals, about 27% had public coverage and about 53% obtained private policies (Zong & Batalova, 2016).

Education and workplace are also a characteristic that varies greatly across the immigrant population. Among all immigrants living in the United States in 2014 who were over 24 years of age, 29% had obtained at least a bachelor’s degree. This number is not far off from the 30% of native citizens who achieved the same. Unfortunately, a matching 30% of U.S. immigrants never graduated from high school or received their

GED. This disparity in education also leads to a variety of career options for the immigrant population. As of 2014, 26.7 million immigrants were employed in the United States. Those workers selected a variety of occupations including management, professional and related areas (30.3%), service industry (24.6%), sales (17%), natural resources, construction, and maintenance (12.9%), and production and transportation (15.2%).

Immigrants in Colorado

Statistics. Although not one of the top five states for immigration, Colorado is a location in which the foreign-born population is growing rapidly. According to the American Immigration Council (2015), immigrants made up 4.3% of Colorado's state population in 1990. By 2013, that number rose to 9.5%. The fastest growing ethnic group in Colorado is Latinos, with 1 in 5 Coloradans identifying as such (American Immigration Council, 2015). In addition to general immigration, Colorado has also been a new home for many refugees in recent years. According to the Colorado Office of Economic Security, during the 2015 fiscal year refugees and refugee-eligible populations came to Colorado from East Asia (821), Europe and Central Asia (74), Africa (680), Near East and South Asia (509), and Latin America and the Caribbean (166). Of these numbers, the greatest number of individuals reported Burma (610), Iraq (329), Somalia (290), Congo (223), and Nepal (194) as their country of origin (Colorado Office of Economic Security, 2015).

Services available. With refugee communities present in Colorado, certain government and community organizations have developed to ensure a smooth transition into American life. The Colorado Department of Public Health and Environment has created a Refugee Health Program in which all refugees and refugee-eligible populations receive a medical and mental health screening within 90 days of entry or verification of eligibility. Screenings take place at the Refugee Health Clinic in Aurora, Salud Family Health Center in northern Colorado, and Peak Vista Community Health Center's Myron-Stratton Clinic in Colorado Springs. During this health visit, refugees receive a physical exam, immunization updates, health education, and screenings for parasites, HIV, hepatitis B and C, and tuberculosis, and referrals as deemed necessary. No hearing screenings are routinely performed (Colorado Department of Public Health and Environment, n.d.).

In addition to initial medical screenings, multiple organizations exist to help with career searches, English classes, community involvement, and other services. The Lutheran Family Services of the Rocky Mountains has one of the largest refugee resettlement programs and offers refugees help with housing, case management, employment, community engagement, work-experience programs, school programs, and legal services (Lutheran Family Services, 2011). In addition, the African Community Center (ACC) offers similar services in the Denver area such as job-readiness training in its own thrift shop and youth programs to prepare refugee children for college (African Community Center of Denver, n.d.).

Lastly, the Immigrant and Refugee Center of Northern Colorado (IRC), located in Greeley, Colorado, offers holistic services in healthcare, immigration, legal assistance, finances, and education with a vision for a sustainable integration of all refugees into communities (IRC, n.d.). The Center utilizes the Comprehensive Adult Student Assessment (CASAS), which was created through the CASAS non-profit group. This organization has created assessments and corresponding curricular supports that are used by the local center to place students in the appropriate classes. These tests are widely used by many governmental and educational organizations (CASAS, 2018a). For the IRC, the assessments regarding English learners are the most pertinent. Comprehensive Adult Student Assessment skill levels for English Language Learners range from "Beginning ELL" at level A, progressing to "Proficient Skills" at level E (CASAS, 2018b). At the IRC, classes are organized from level one to five (A to E), and students test into the appropriate level at the start of each semester utilizing CASAS assessments.

With these local organizations willing to provide services and community engagement to refugees, Colorado can begin to properly care for those in need. For the local audiology community, this population cannot be overlooked. With the prevalence of global hearing loss existing mainly in developing countries and many refugees emigrating from regions of turmoil to Colorado, hearing health must be a consideration. The lack of hearing screenings as protocol for this population has the ability to lead to untreated hearing losses, making it difficult for individuals to integrate into the community.

Conclusion

Consequently, although hearing loss is a health issue that plagues every area of the world, its regional impact is imbalanced. Hearing loss in the developing world is both more prevalent and more likely to go undetected and untreated. When compared to developed nations, the financial constraints, shortage of trained professionals, additional life-threatening diseases, and a lack of protocol in the developing world create barriers that are difficult to overcome. These obstacles occur at every stage of the process, from identification to treatment. Fortunately, new technology has been developed that allows for audiological testing outside of a sound booth for these difficult-to-reach populations. These new advances along with increased clinical competence will allow audiologists to better serve these populations both at home and abroad.

CHAPTER III

METHODOLOGY

This study was designed to: (a) determine the feasibility of utilizing wireless technology to test the hearing of refugees and immigrants for the purpose of providing entry-level audiological care; and (b) identify patterns and trends in the hearing health of the immigrant community in northern Colorado. This chapter outlines the methodology used in the study.

Participants

The participants of this study included adult immigrants who reside in northern Colorado and currently utilize the services offered at a global immigrant and refugee center. Inclusion for participation in the study required all subjects to meet the following criteria: (a) be at least 18 years of age; (b) identify as a refugee or immigrant who has personally relocated to the United States; (c) be a non-native English speaker; and (d) be a native speaker of Somali, Burmese, Spanish, Karen, Karenni or Rohingya. There were no restrictions relating to country of origin or length of time since participants first immigrated to the United States. Participants included persons with all levels of self-reported hearing ability. Exclusion criteria for the study was applied to those who: (a) were unable to understand the test instructions; (b) lacked the dexterity to use touchscreen controls; or (c) presented with draining ears.

Materials and Instrumentation

Audiometric Equipment

All audiometric testing was done with the Creare wireless automated hearing test system, which was designed for use in settings where a sound booth is unavailable. The headset is equipped with a wireless audiometer, located in the right ear cup, which searches for threshold by utilizing an algorithm pertaining to the modified Hughson-Westlake technique. Pure-tone stimuli occur in a pulsed manner, with three short-duration pure tones produced for each stimulus presentation. Paired with an Android tablet through Bluetooth technology, an app called TabSINT was used to collect and store results. TabSINT is an app created by Creare and pairs to the wireless headset and manages test protocols for the headset audiometer. At the start of the testing session, the researcher entered participant information into a form on the app. Once the headphones were properly placed on the participant's head, the tablet was given to the subject and the test began when the listener selected "begin test." During the test, the participant responded to the stimulus by tapping his or her finger within the touch-screen response box displayed on the tablet screen. Once results were obtained at each test frequency, the app generated a corresponding audiogram to display on the screen. All data were saved to a password-protected web-based database (Meinke et al., 2017).

Sound Level Meter

To calculate acoustic measurements of ambient noise levels, a Quest Type II Sound Level Meter, Model 2900, with an OB-300 one-third octave band filter was used to measure ambient noise levels prior to testing each participant. Calibration of the sound level meter was conducted with a Quest Model QC-10/QC-20 acoustic calibrator.

Interview Instruments

Two separate interviews were conducted with each participant. The first, given before audiometric testing, was comprised of hearing health questions (Appendix B). Questions for this interview were adapted from the National Health and Nutrition Examination Survey audiometry questionnaire as well as the University of Northern Colorado Audiology Clinic case history report. The second interview, administered after hearing testing, focused on the participant's overall testing experience (Appendix C). Statements regarding comfort and usability were provided, and participants were asked to rate their level of agreement on a 5-point Likert scale. Numbers and visual representation in the form of smiley faces were made available for the participant to identify their level of agreement due to a known lack of literacy skills among this population. Both interviews were conducted with the help of interpreters who were fluent in the participants' native languages.

Interpreters and Translated Material

Due to the demographic of the testing population and the presence of multiple languages, interpreters were utilized to help communicate consent of the participants. They were also utilized to interview, debrief, and address any questions or concerns from participants.

Procedure

Institutional Review Board approval was granted for both a pilot and a main study (Appendix A). Following this approval, the study was carried out following the subsequent procedures.

Pilot Study

Prior to the start of data collection, a small pilot study was conducted to test the interview materials and familiarize the interpreters with testing procedures. Participants of the pilot study were comprised of the interpreting staff at the refugee center. One participant was recruited per target language to verify ease of translation and cultural sensitivity. Participants underwent the same processes utilized for the main study, with the addition of a reflection survey (Appendix E). This survey was designed to gain insight into any foreseeable complications and make necessary revisions. Information gathered from these surveys was reviewed and utilized to adapt materials as per interpreter recommendations.

Test Environment and Ambient Noise Measurements

All testing occurred at the community refugee center. This facility was located in the educational wing of a church building, on the third floor. Testing was performed in quiet areas, as far away from classroom noise as possible. Windows were kept shut during testing to minimize outdoor road noise. Utilizing the Quest 2900 Type II sound level meter, ambient sound pressure levels (SPL) were recorded in dBA at 125, 250, 500, 1000, 2000, 3150, 4000, 6300, and 8000 Hz. Measurements were obtained in the location in which the participant was seated both before and after the hearing test was completed. Ambient noise levels were recorded in a logbook and later transferred to an electronic spreadsheet. Recorded levels were subsequently compared to the maximum permissible ambient noise levels set forth by the American National Standards Institute for the test frequency range of 500-8000 Hz utilizing supra-aural earphones (ANSI S3.1-1999 [R2013]) to examine threshold validity.

Hearing Health Survey

Once written consent forms were completed with the help of interpreters, participants were given a hearing health interview in their native language, also through the use of an interpreter. This interview gathered information regarding demographics, hearing healthcare history, self-reported hearing status, and communication challenges. The questions were accompanied by answer choices or required a short response to minimize time, address education levels, and facilitate translation. A copy of the hearing health interview can be found in Appendix B.

Otoscopy

Following completion of the hearing health interview, the researcher performed otoscopy. Both ears were viewed with a Welch Allyn otoscope and the amount of cerumen present in the ear canal was recorded as clear, partially occluding, or fully occluding. The researcher did not attempt to remove the any cerumen. In addition, any abnormalities of the pinna (outer portion of the ear), the ear canal, or the tympanic membrane were noted.

Audiometric Testing

Subsequent to the otoscopic exam, the researcher entered the participant ID into the tablet and read the set of pre-written instructions (Appendix F). The interpreter verbally translated the instructions sentence by sentence. When complete, the participant was given the headset to put on, and the tablet to begin the test. The wireless automated hearing test system was programmed to test the following frequencies: 500 Hz, 1000 Hz, 2000 Hz, 3000 Hz, 4000 Hz, 6000 Hz, and 8000 Hz. A practice test at 1000 Hz was conducted with each participant. In the event that the listener was having visible difficulty (i.e., responding too often or not at all) or had a question, the test was paused, and the researcher and/or interpreter re-instructed the participant. Once conditioned to respond in the appropriate manner, participants then completed the automated test in each ear.

The interpreter was only employed during the audiometric test procedure if warranted by listener-initiated questions. These interactions were tallied and recorded by the researcher. At the conclusion of the hearing test, thresholds were recorded and uploaded to a secure password-protected cloud via the TabSINT and the Android tablet device.

Technology Usability Interview

Subsequent to audiometric testing, participants responded to a brief interview detailing their experience with the testing procedure, comfort with interpreter and translated material, and any additional input. Responses were obtained via a Likert scale utilizing a combination of graphics (smiley faces) and corresponding text that was verbally translated. A corresponding copy can be viewed in Appendix C.

Post-Test Ambient Noise Measurements

Following the audiometric testing, the researcher obtained a second recording of ambient sound pressure levels (SPL) at the location of the participant. Measurements were taken at the same frequencies as the pre-test recordings to monitor and evaluate any extreme changes in ambient noise that may have occurred.

Listener Debriefing

For the purpose of this study, a hearing loss was classified as a speech frequency pure tone average (.5-, 1-, 2-, and 4 kHz) of 25 dB HL or greater in either ear. Every participant had their results briefly explained to them with the help of the interpreter. All participants who were in need of follow-up care were given a handout indicating a recommendation for a referral for further evaluation (Appendix G). If a referral was warranted, the participant also received a list of local otolaryngologists and audiologists from whom they could schedule a full diagnostic hearing evaluation or receive cerumen removal services. After follow-up was suggested to appropriate participants, the researcher inquired about the likelihood of his or her pursuing follow-up services via two verbal interview questions that were communicated through an interpreter. Copies of these questions can be found in Appendix D.

Analysis

At the conclusion of data collection, a descriptive analysis was employed to examine outcomes. The hearing health interview responses were summarized with frequencies of responses to each question. In an effort to determine the current access to hearing healthcare in the immigrant community, the number of participants with self-reported hearing loss who had already sought out treatment versus the number of individuals who had potential unidentified hearing loss were evaluated. For those who had a pre-documented hearing loss, it was also noted if care was obtained in the country of origin or in the United States. For those who had not accessed care, barriers to such care were determined. In addition, self-reported hearing loss was compared to the objective audiometric results. The percentage of people with hearing loss was calculated and compared among countries of origin, age, and sex. Commonalities among perceived effects of hearing loss were determined. In addition, the contribution of hearing loss when assimilating into American culture was evaluated based on participant responses.

Audiometric thresholds were categorized in the following ways and compared to national prevalence rates in the United States. In terms of objective threshold measurements, the primary outcome measure was a speech frequency pure tone average (0.5-, 1-, 2-, and 4 kHz) of 25 dB HL or greater in one or both ears. In addition, prevalence of high frequency hearing loss was also considered by calculating number of participants with a high frequency PTA (3-, 4-, and 6 kHz) of 25 dB HL or greater. Hearing impairment was further categorized by severity utilizing speech frequency PTA values in the following manner: (a) mild (25-40 dB HL); (b) moderate (41-55 dB HL); (c) moderately severe (56-70 dB HL); (d) severe (70-90 dB HL); or (e) profound (91+ dB HL). Test validity was also reviewed in the context of ambient noise levels that may or may not influence threshold measurements.

Participant responses to the usability interview were utilized to ascertain the WAHTS ease of use and evaluate the feasibility of providing entry-level care in a non-traditional healthcare setting using the technology. A summary of the questions asked by participants regarding the technology use was also compiled.

CHAPTER IV

RESULTS

Pilot Study Outcomes

Five participants who were also interpreters were recruited for the pilot study, one for each language listed in the inclusion criteria (Somali, Karenni/Karen, Spanish, Burmese, and Rohyinga). All five participants had normal hearing, which established that there should be no hearing-related limitations when serving as an interpreter. All responses to the hearing health interview were negative for any indication of hearing or ear-related complaints, and the post-test technology usability survey indicated that all five participants were comfortable with the use of the WAHTS and the tablet computer.

When analyzing the pilot reflection survey, the inability for some words to be directly translated was a common trend across languages. These words/phrases included “cochlear implant,” “trauma,” “heredity,” and “lawn care equipment.” These words were paired with alternative synonyms and/or explanations based upon interpreter suggestions when editing the surveys prior to the start of data collection. With regard to the best way to display the Likert scale, three out of the five interpreters thought the combination of graphics and verbal translations would be the clearest and, therefore, this method was implemented in the study. Another notable suggestion included adding “fast rate of speech” to reasons for not accessing medical care. This idea was offered by an interpreter due to a potential difficulty understanding English when native speakers talk fast, even if a participant is fairly fluent in that language. In the survey this was added to the language barrier choice (i.e., language barrier/fast rate of speech). In addition, giving information about insurance or payment plans to participants was also proposed. During the debriefing, participants received a brief description of which clinics accepted various forms of insurance and/or payment. Following the pilot study, the interviews were revised as described above for use in the main study.

Participants for the Main Study

Twenty-five individuals who were currently accessing services offered by the global refugee center gave consent for involvement in the study. Of those 25, only 20 followed through with participation. Following data collection, test data were analyzed for 19 subjects. One participant's test results were excluded from the study due to inconsistent responses that prevented the WAHTS from converging at a single threshold level at 500, 4000, 6000, and 8000 Hz in the left ear and at 500, 2000, 3000, and 8000 Hz in the right ear. Hearing thresholds that were recorded presented an atypical configuration that further suggested poor test reliability. Qualitative data obtained from this individual were also excluded from analysis due to the incomplete hearing test. It should be noted that the participant did self-report hearing loss, as well as tinnitus, and this may have contributed to the observed difficulty in understanding the hearing test instructions and/or providing consistent responses.

Of the remaining 19 individuals recruited for the study, 57.9% (n = 11) were female and 42.1% (n = 8) were male. Participant ages ranged from 22 to 76 years with 68.4% (n = 13) under 60 years of age and 31.6% (n = 6) over 60 years of age. English language proficiency levels varied, yet the majority (84.2%) of participants were currently placed in CASAS level two or below. The length of time since immigrating to the United States ranged from 7 months to 10 years with 63.2% (n = 12) of individuals residing in the U.S. for 4 years or less, and 36.8% (n = 7) for 5 years or more. Languages spoken included Karenni, Rohingya, Somali, and Spanish; countries of origin were comprised of Burma, Somali, Karenni State-Union of Myanmar, Bangladesh, and Mexico. Figure 1 provides a summary of the participant demographics.

Language	**Sex**		**English Level**						**Length of Time in U.S. (years)**				**Age (years)**					
	Male	Female	0	1	2	3	4	5	0-<2	2-4	5-9	10+	18-30	31-40	41-50	51-60	61-70	70+
Karenni	5	1	3	2	1				1	2	3					1	2	3
Rohingya	3		1	1				1	1	2			1		1		1	
Somali		9	5		2	2			3	3	1	2		5	1	3		
Spanish		1		1							1					1		
TOTAL	8	11	9	4	3	2	0	1	5	7	5	2	1	5	2	5	3	3

*Figure 1***.** Demographic summary information.

Ambient Noise Levels

Wireless hearing test data were collected in three acoustically diverse rooms at the refugee center. All of the testing occurred on the third floor of an older brick and stone building located in northern Colorado. Two of the rooms used for testing were classrooms (used for English language classes) with tables and chairs, linoleum flooring, painted plasterboard walls, and windows along one side of the room. Another room utilized was the interpreters' office. This room was used with only one participant in the afternoon after classes had concluded. The office was a large room with eight desks around the perimeter and a large conference-style table in the middle. Similar to the classroom, the walls were plasterboard, and there were windows along one wall. The last space used for testing was a stairwell connecting the second and third floors of the building. This stairwell also had windows on one side and linoleum flooring. Two walls were plasterboard, and the other two were made of stone. It was located at the back of the building, and two heavy doors separated this space from the hallways at the top and bottom of the stairs. Air conditioning (AC) units were turned off during the testing in the classrooms, and the stairwell did not have an AC unit. The mean ambient noise measurements can be seen in Table 1.

Table 1

Mean Ambient Noise Levels Compared to ANSI S3.1-1999 (dB SPL)

	Frequency (Hz)						
Testing Space	125	250	500	1000	2000	4000	8000
Classroom 1 (n = 8)	41.1	36.5	33.0	26.6	23.4	16.0	13.5
Stairwell (n = 9)	39.7	36.3	31.6	26.5	21.1	13.6	12.8
Classroom 2 (n = 1)	28.2	26.7	16.3	16.2	11.9	11.6	11.6
Office (n = 1)	34.3	34.9	36.9	33.8	28.8	19.3	13.2
Grand Mean	39.4	35.8	31.6	26.4	22.0	14.8	13.0
ANSI S3.2 (Supra-Aural 125-8000 Hz)	35.0	25.0	21.0	26.0	34.0	37.0	37.0
ANSI S3.1 (Supra-Aural 500-8000 Hz)	49.0	35.0	21.0	26.0	34.0	37.0	37.0

Utilizing a t-test, the pre- and post-test ambient noise measurements were compared, and no significant differences were noted. Therefore, a grand mean at each frequency was used for comparison to the ANSI Standards. This comparison resulted in mean noise levels that exceeded ANSI S3.1 standards for supra-aural earphones at 125 Hz, 250 Hz, 500 Hz, and minimally at 1000 Hz (ANSI, S3.1-1999 R2013). However, when testing only 500 to 8000 Hz (as was done in this study), modified values can be used which result in noise levels considerably exceeding the standard only at 500 Hz, and minimally at 250 and 1000 Hz. Comparisons between rooms were not computed due to small sample sizes in some test locations.

Nevertheless, when the average attenuation of the WAHTS is subtracted from the measured ambient noise levels at each frequency, these levels were all within maximum permissible ambient noise levels (MPANLs) (Meinke et al., 2017). In addition, no individual pre- or post-test measurements indicated noise values too high to obtain reliable thresholds with the Creare WAHTS, as per attenuation values documented in Table 5 of Meinke et al. (2017, p. 18). Therefore, ambient noise in all four testing locations was sufficiently attenuated to enable testing down to 0 dBHL at all test frequencies. Detailed data may be reviewed in Appendix K.

Interpreting Services and Content

The necessity of interpreter presence for the acquisition of qualitative and quantitative data presented with some notable findings. During data collection, only one interpreter was available for most languages. Benefits of this included that the interpreter became very familiar with the testing procedures and translation occurred with ease. However, scheduling proved to be more difficult as the appointment time needed to be coordinated for all three parties (researcher, participant, and interpreter). Data for 17 subjects were obtained through traditional interpreting, with the material being translated directly from English to the participants' native language. The remaining two participants' data were acquired through the use of two interpreters; the questions were translated from English to Burmese and then Burmese to Karenni. This occurrence took place due to an unexpected extended absence of our Karenni interpreter.

Identical instructions for the hearing test were translated orally into the participant's native language via the interpreter in a sentence-by-sentence format. A total of 47.4% (n = 9) of participants did not ask for any clarification of the verbal instructions and completed the test with only the information that was given to them at the onset. Five individuals clarified with a question before the test began (e.g., which ear will I hear it in first?). Four subjects required a single re-instruction after the test began, and one required two re-instructions. It was observed that most individuals that required one re-instruction only needed the reinforcement of visual cues to understand (e.g., "beep beep beep" followed by a tapping motion). The most common error observed was the tendency for participants to tap multiple times in correspondence with the number of tones presented. However, this is a common occurrence, even with tests given in a person's native language, and simple re-instruction typically solved this mistake.

Audiometry and Otoscopy

Otoscopy

Otoscopy was performed on a total of 38 ears. Otoscopic findings revealed 33 ears with clear canals and visible tympanic membranes. Two ears presented with partially occluding cerumen. An additional three ears had various abnormalities such as increased redness (suggestive of infection/inflammation) and unidentifiable structural irregularities. Though noted, the abnormalities did not warrant medical referral on the basis of observations alone. However, some individuals with abnormal otoscopic findings were referred for other reasons. Further observation was made that two ears were characterized by elongated ear lobes, which was possibly related to cultural ritual.

Hearing Threshold Levels

Fourteen subjects (73.7%) completed the audiogram in both ears at all test frequencies. One Somali participant decided to conclude the test partway through testing the second ear due to an expressed "fear of harmful electricity," despite reassurance that testing was safe. This occurrence might be attributed to having lived in the U.S. for only eight months and being generally unfamiliar with technology.

For four participants (21.1%), the WAHTS failed to converge at one or more test frequencies. In these instances, if the missing frequency was part of the pure tone average (PTA) calculation (.5, 1, 2, and 4 kHz), a three-frequency PTA was utilized to determine hearing status.

Some individuals had thresholds that exceeded the output limits of the audiometer. This mostly occurred at 6000 and 8000 Hz. For these frequencies, the threshold was identified at the next highest 5 dB step above the output level of the WAHTS at that frequency. In these instances, the threshold was at least this poor, with the possibility for it to be even worse than labeled.

For this study, hearing loss was defined as a speech frequency pure tone average (PTA) (0.5-, 1-, 2-, and 4 kHz) of 25 dB HL or greater in one or both ears. Hearing thresholds for the 19 participants indicated that 52.6 % (n = 10) of individuals presented with hearing loss in at least one ear, representing a total of 17 of 38 ears with hearing loss. Thirty percent (n = 3) of participants with hearing impairment had unilateral losses, and 70% (n = 7) had bilateral losses. Of those individuals, 60% (n = 6) were male and 40% (n = 4) were female.

The participants with hearing loss were from four of the five geographical regions represented in the study. Two were natives of the Rohingya cultural group, two were from Somalia, five were from the Karenni State, and one was from Mexico. Age ranges of individuals with hearing loss ranged from 47 to 76, with 40% falling between 40-59 years of age and 60% over 60 years of age. Of the 17 total ears with hearing loss, 9 were classified as mild, 5 as moderate, 1 as moderately severe, and 2 as severe. Level of hearing acuity can be viewed per ear by participant in Table 2. High frequency hearing loss, defined as a high frequency PTA (3-, 4-, and 6 kHz) of 25 dB HL or greater, was found in 57.9% (n = 11) of participants. Based on air-conduction audiometric configurations, seven individuals would likely benefit from bilateral hearing aids and two additional participants would qualify as unilateral hearing aid candidates assuming these hearing losses were not medically correctable.

Table 2

Speech Frequency Pure Tone Average (0.5-, 1-, 2-, and 4 kHz) in dBHL and Severity Classification

Participant No.	Right Ear	Left Ear	Right Ear Severity	Left Ear Severity
201	6	6	Normal	Normal
202	39	44	Mild	Moderate
203	38	52	Mild	Moderate
204	25	8	Mild	Normal
205	23	29	Normal	Mild
206	8	3	Normal	Normal
207	35	60	Mild	Moderately severe
208	46	25	Moderate	Mild
209	8	13	Normal	Normal
211	9	8	Normal	Normal
212	4	9	Normal	Normal
213	9	8	Normal	Normal
214	41	41	Moderate	Moderate
215	11	18	Normal	Normal
216	11	10	Normal	Normal
217	75	80	Severe	Severe
218	10	9	Normal	Normal
219	33	35	Mild	Mild
220	19	35*	Normal	Mild

Note. Severity of hearing loss was categorized utilizing the Speech Frequency PTA in the following manner: (a) mild (25-40 dB HL); (b) moderate (41-55 dB HL); (c) moderately severe (56-70 dB HL); (d) severe (70-90 dB HL); (e) profound (91+ dB HL).
*Data at 2k for participant 215 and 4k for participant 220 was found utilizing interpolation due to system error in recording that threshold.

Mean hearing thresholds of all 19 participants showed a general trend of borderline normal low-frequency hearing and reduced hearing acuity in the higher frequencies (above 1000 Hz). In general, right ears had better hearing than left ears, particularly in the high frequencies (above 3000 Hz). The average hearing sensitivity among the participants is displayed in a composite audiogram (Figure 2) and represents a normal, sloping to mild high-frequency hearing loss in the right ears and a normal, sloping to moderate high- frequency hearing loss in the left ears.

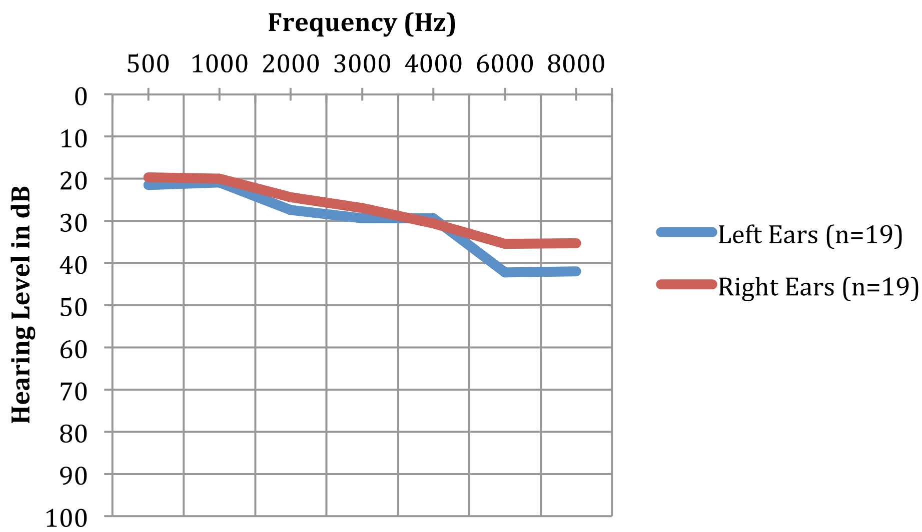

Figure 2. Mean hearing thresholds of all participants (n = 19).

Mean thresholds derived from the 17 ears (n = 10 participants) with hearing loss show a greater difference between right and left ears. Right ears display better hearing sensitivity than the left ears at all frequencies above 1000 Hz. Figure 3 exhibits the mean hearing thresholds for subjects with hearing loss. The audiometric configuration can be described as sloping from mild to moderately-severe in the right ears and mild sloping to severe in the left ears.

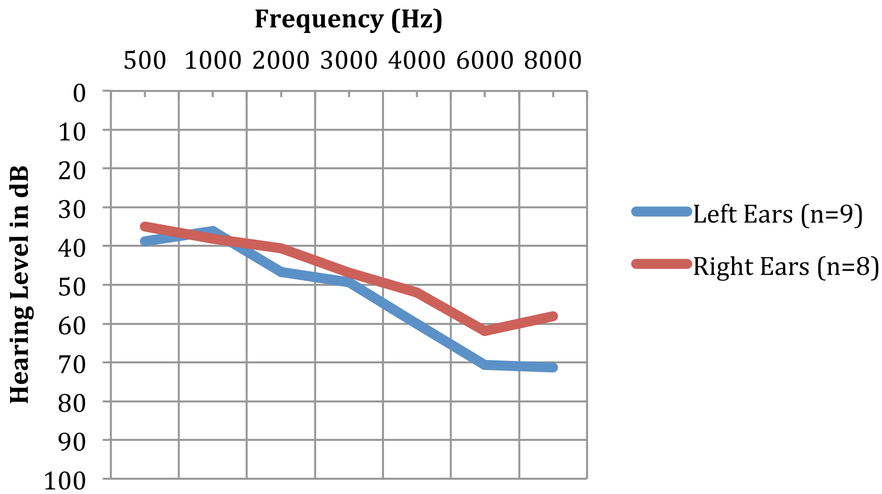

Figure 3. Mean thresholds of ears with a >25 dBHL PTA.

The prevalence of hearing loss found within this immigrant population is much greater than what has been found in the general U.S. population when comparing data obtained from this study to Lin et al.'s (2011) data collected from the National Health and Nutritional Examination Survey between 2001 and 2008. Using the same criteria for hearing loss, Lin et al. (2011) found 12.7% of those ages 12 or above to have bilateral hearing loss in the speech frequencies. That number increased to 20.3% when unilateral hearing loss was included. More recently, Hoffman, Dobie, Losonczy, Themann, and Flamme (2017) reported a prevalence of 14.1% among 20- to 69-year-olds, suggesting a declining occurrence of adult hearing loss (either unilateral or bilateral) in the United States when compared to previous years. Although representative of a much smaller sample size, the prevalence of 36.8% with bilateral hearing loss and 52.6% with unilateral or bilateral hearing loss found in this immigrant population is higher than expected when compared to recently calculated U.S. national prevalence rates. Percentage of participants with hearing loss in the current study represents a point prevalence of hearing loss within this specific immigrant population at a refugee and immigrant center in Northern Colorado. Although it should not be projected to represent the whole population, the amount of hearing loss discovered is noteworthy. Table 3 illustrates exact data from the NHANES study conducted by Lin et al. (2011) age matched to the data obtained from this immigrant population.

Table 3

Prevalence of Speech-Frequency Hearing Loss in Adults

Age (Years)	NHANES Prevalence	Immigrant Community in Northern Colorado Prevalence (Current Study)
20-29	3.20%	0% (0 out of 1)
30-39	5.40%	0% (0 out of 5)
40-49	12.90%	100% (2 out of 2)
50-59	28.50%	40% (2 out of 5)
60-69	44.90%	100% (3 out of 3)
70-79	68.10%	100% (3 out of 3)

Note: NHANES prevalence obtained from "Hearing Loss Prevalence in the United States" by F. Lin, J. Niparko, and L. Ferrucci, 2011, *Archives of Internal Medicine, 171*(20), 1851-1853.

Follow-Up Care

Eleven individuals were directed to follow-up care with either an audiologist and/or an otolaryngologist. Seven individuals were referred for a full hearing evaluation simply due to the presence of symmetric hearing loss, bilaterally. The remaining 4 individuals were given recommendations to see an otolaryngologist due to asymmetric hearing loss and/or unilateral tinnitus. Of the 11 individuals advised to seek medical care, 10 indicated that they planned to follow-through with the recommendations that were given to them. The other stated that transportation and uncertainties surrounding insurance coverage would likely prevent follow through. All 11 participants stated that if they were to attend a follow-up appointment, they would want an interpreter to accompany them, and 1 individual added that interpreter support would likely be needed to schedule the appointment as well.

Hearing Health Interview Conclusions

Self-Reported Hearing Status

Among the 19 participants that completed the hearing health interview, 63.2% (n = 12) answered that their hearing was either excellent or good. The remaining 36.8% (n = 7) indicated some level of difficulty with hearing in at least one ear. Detailed data can be viewed in Figure 4. Of the 7 individuals with self-reported hearing loss, 6 were male and 1 was female. One hundred percent (n = 7) of the participants who self-reported hearing loss had audiograms with elevated thresholds either in the speech frequencies or high frequencies. Speech-frequency hearing loss was confirmed in 6 individuals who self-reported hearing loss during the pre-exam interview. High-frequency hearing loss was confirmed in the other individual with self-reported hearing loss. Forty percent (n = 4) of individuals with speech frequency hearing loss did not report any difficulty hearing. Two of those individuals had unilateral mild hearing losses; 1 had mild hearing loss, bilaterally; and the other presented with moderate hearing loss, bilaterally.

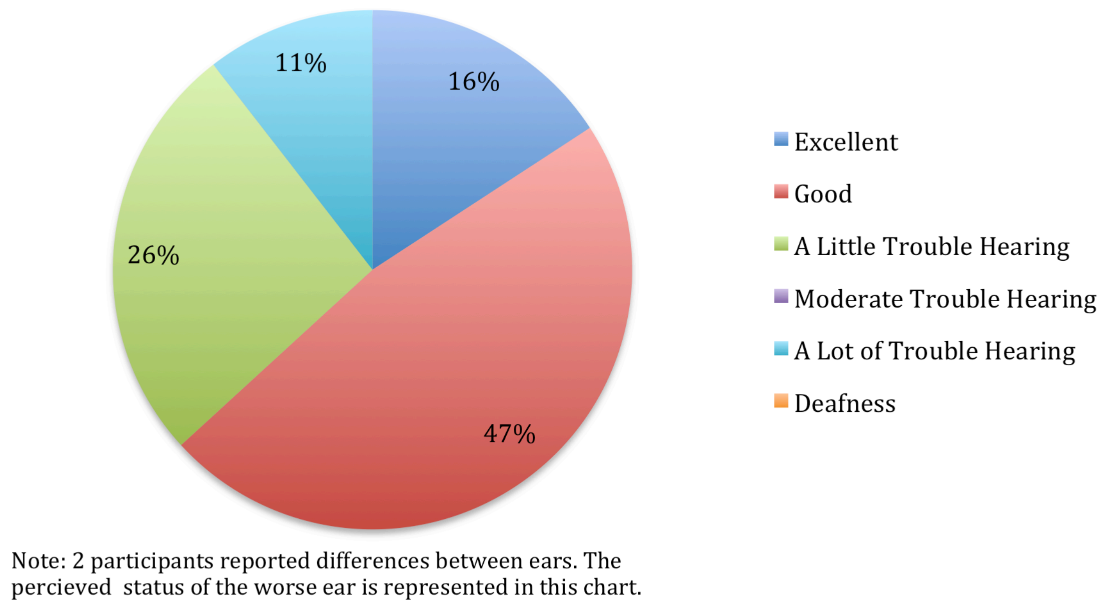

Figure 4. Self-Reported hearing status (n = 19).

Impact of Hearing Loss

The most common negative impact of hearing loss related to the inability to learn in general, or to specifically learn the English language. Six of the seven individuals (85.7%) with self-reported hearing loss indicated this as a way in which hearing loss impacts their life. The next most prevalent impact of hearing loss was on relationships, with 57.1% (n = 4) of those with perceived hearing loss indicating a negative impact in this area. In addition, 57.1% (n = 4) also indicated difficulty accessing medical care due to their hearing loss, though two of those four responded that that difficulty was also due, in part, to financial and/or language reasons. When asked in what situations they had difficulty hearing, the only notable trend was that 42.9% (n = 3) reported trouble hearing in their classes at the center, which may have included English learning or citizenship.

Access to Hearing Care

To evaluate access to hearing care in this population, tallies were taken of participants who had previously had their hearing tested and/or hearing loss treated. It was reported that 63.2% (n = 12) had previously had their hearing tested. Eleven of those individuals had this test completed in the United States, either at work for regulatory purposes (noise exposed) or at the doctor's office. One participant had their hearing tested in Thailand. Since these individuals had recently immigrated to the United States during their adult life, these data indicate that most participants spent the majority of their life without a hearing check before immigrating.

In addition to simply getting their hearing tested or screened, 36.8% (n = 7) participants had previously sought medical help for hearing-related issues. Out of the remaining 12 subjects, 9 reported that they did not seek help because they had no concerns, 2 were unfamiliar with the geographical area they currently resided in and/or felt uncomfortable with the language barrier, and 1 reported financial concerns.

From the group of individuals with hearing loss present (either speech or high frequency), 45.5% (n = 5) had previously had their hearing tested. Only 27.3% (n = 3) of those individuals had gone to see a doctor for hearing or related problems. A summary of this association can be viewed in Table 4. When asked about hearing aid usage, only one individual reported the use of a personal sound amplification device (not a hearing aid) that was acquired from the Internet.

Table 4

Need for Medical Care vs. Level of Care

Participant No.	HL Present?	Hearing Tested/Screened?	Professional Care Sought?
201	No	No	No
202	Yes	Yes	No
203	Yes	Yes	No
204	Yes	No	No
205	Yes	Yes	No
206	No	Yes	No
207	Yes	Yes	Yes
208	Yes	No	No
209	No	Yes	Yes
211	No	Yes	No
212	No	Yes	Yes
213	No	Yes	Yes
214	Yes	No	No
215	Yes	No	Yes
216	No	Yes	No
217	Yes	Yes	No
218	No	Yes	Yes
219	Yes	No	No
220	Yes	No	Yes

Noise Exposure

A positive history of hazardous noise exposure (recreational or occupational) was reported by over half of the participants (57.9%, n = 11). Six of those individuals presented with hearing loss of some degree. Six participants (31.6%) reported having a job at which they were exposed to excessive noise levels. All of those individuals were employed at the same local meatpacking facility. Five individuals (26.3%) noted a history of exposure to firearm noise, four due to recreational hunting and one due to war-related weapon noise. Three of those five individuals presented with asymmetric hearing loss.

Past Medical History

Various questions regarding participants' medical history were also asked during the hearing health interview. Responses to these questions did not raise concern when analyzed as a group, though the detailed data can be viewed in Appendix I.

Technology Usability

The post-test interview was completed to gather information regarding the participants' subjective impressions of the WAHTS technology and the hearing test procedure. Interviews were completed with 18 participants. One participant was reluctant to stay and complete the survey after discontinuing the hearing test as previously mentioned due to concern regarding potential electrical harm from wearing the WAHTS, despite researcher reassurances. Although the survey was presented as a 5-point Likert scale, the results were collapsed into a 3-point scale (1-3). This decision was made due to the observed difficulty many participants had when making a decision between *agree/strongly agree* and *disagree/strongly disagree*. The majority of the participants would respond with *yes* or *no* at first, and the interpreter further clarified the question and response options. It is unclear whether this complication was due to the language translations or the participant's unfamiliarity with the nuances of a Likert response scale.

For continuity of plotting outcomes in a positive direction, two questions were reversed coded due to the inverse nature in which they were asked. This coding change was made prior to condensing the scale from 5 to 3 points. Mean values for patient responses regarding headset usability and test logistics can be in viewed Figures 5 and 6.

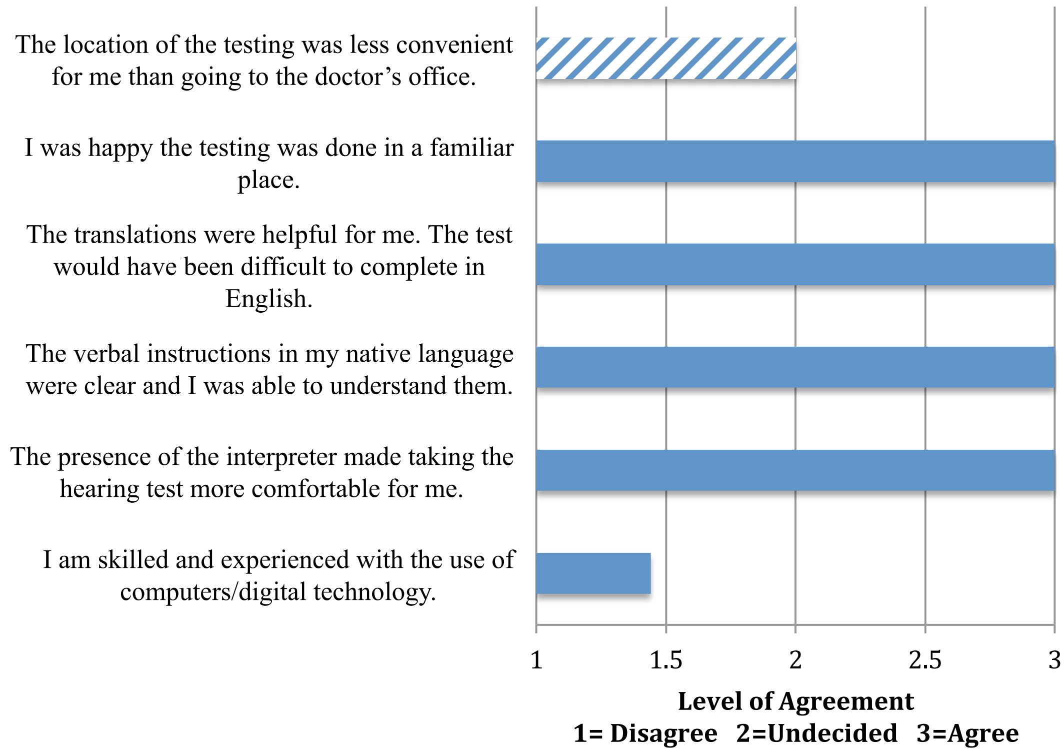

Figure 5. Averaged 3-point Likert responses to logistical statements. Patterned bars indicate responses that were reverse coded for continuity with display direction for positive outcomes.

Headset Usability

The first set of questions focused on the usability of the wireless headset. Overall, participants expressed a general level of comfort with the technology that was used. Mean Likert values fell between 2.5 and 3 on the questions that focused on this outcome and can be viewed per individual question in Figure 6.

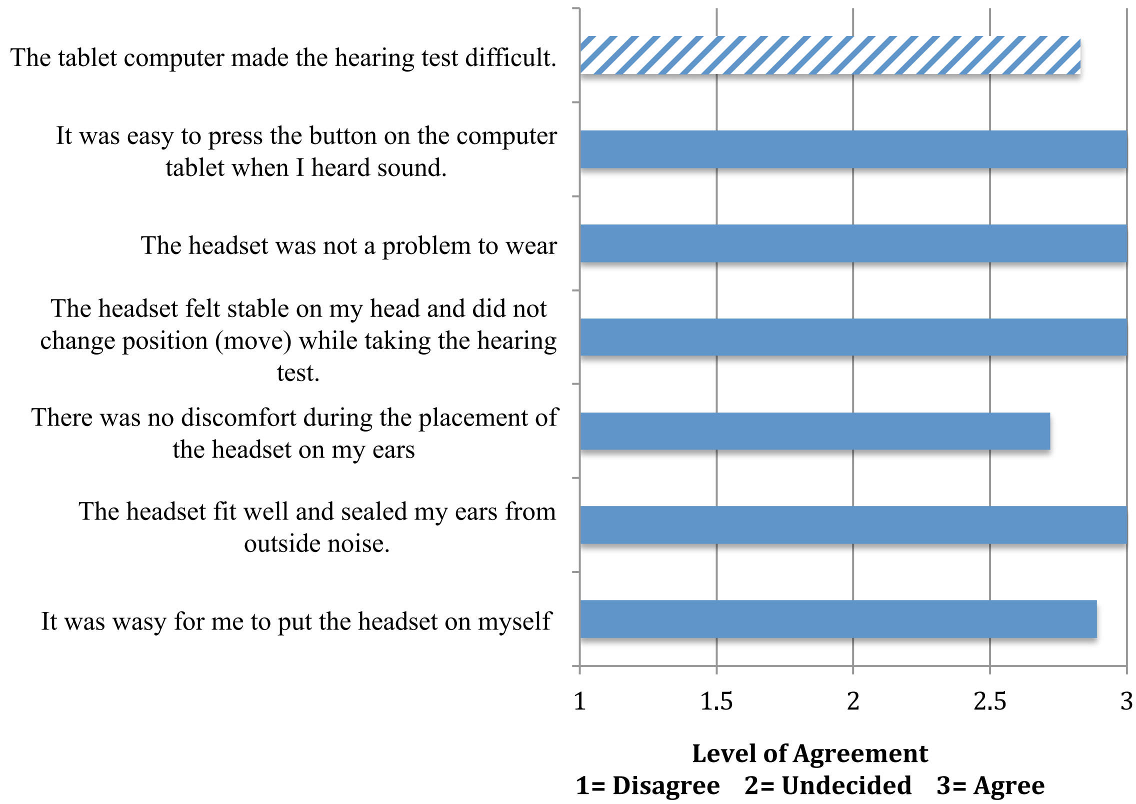

Figure 6. Averaged 3-point Likert responses to technology statements. Patterned bars indicate that responses were reverse coded for continuity with display direction for positive outcomes.

Hearing Test Logistics

The second set of questions focused on the logistics of the hearing testing experience (translations, interpreter presence, location of the testing, and user experience). High levels of agreement were identified relating to interpreter presence, instructions in the native language, and testing being conducted in a familiar place. However, mixed responses were obtained when asked if the location was less convenient than going to the doctor's office. Individuals that thought it was less convenient were evenly dispersed among those who took the test in the classroom or in the stairwell.

Possible explanations for this include scheduling complications in relation to class times or limited bus schedules with stops at the refugee center.

Lastly, the majority of individuals noted a lack of personal computer/technology skills. Despite the limited experience the most participants had with computer-based technology, they found the WAHTS easy to use. This response pattern indicates that use of this technology is feasible to implement in low-resource settings where individuals are neither familiar nor comfortable with technological equipment.

Summary

Overall, the results offered insight into the research questions presented. Results of the testing suggested a point prevalence rate in this specific community of 52.6% with hearing loss in at least one ear. Most individuals with hearing loss present were able to self-report their condition, as 60% of individuals with speech frequency hearing loss indicated some level of difficulty. No participants with normal hearing self-reported hearing loss. The majority of participants had not had a hearing test until arriving in the United States. Once present in the U.S., most have had a hearing screening and/or test, yet few with hearing loss have sought rehabilitative options. During this study, the WAHTS technology proved to be a feasible means of bringing entry-level care into the adult immigrant community, regardless of the individual's primary language. The majority of participants completed the test with only the information that was given to them during the pre-determined instructions or with an additional clarifying question prior to the start of the testing. Response patterns regarding the subjective usability of the headset indicated simplicity of use in this immigrant population with respect to technology level and comfort. However, the need for verbal translations during the process was strongly supported by patient report.

CHAPTER V

DISCUSSION

The results of this study offer some interesting considerations for the future of hearing screening, evaluating, and treating the immigrant and refugee population in the northern Colorado region of the United States. This chapter provides an overview of the implications for these results.

Technological Implications and Enhancements

The WAHTS headset proved to be feasible to use, despite the language barriers present in the Somali, Karenni, Rohingya, and Spanish refugee/immigrant populations. The majority of participants were able to complete the hearing test with minimal difficulty and reported high levels of comfort with the use of the WAHTS device. This finding suggests that it will be possible to use this automated hearing test equipment among the larger non-English speaking population in the United States to screen and/or monitor hearing status. The WAHTS headset may also be a useful screening tool in low-resource areas globally using untrained and/or minimally trained personnel. Previous studies found that untrained personnel in the industrial setting can easily operate the WAHTS device (Meinke et al., 2017). These two findings can be considered together to suggest the possibility of utilizing the automated computerized table-based equipment in low and middle-income regions. In these areas, the prevalence of trained audiological staff is scarce, yet mobile device users were found in abundance with subscriptions reaching 72 per 100 inhabitants in 2010. Therefore, mobile health solutions show promise for successful healthcare delivery in settings with insufficient resources (The World Bank, 2012).

Since this was the first time the technology was utilized with a non-English speaker, there are future opportunities to enhance the tablet messages/software. These might include utilizing an instruction animation depicting both the expected stimulus and the appropriate response (the three beeps and the subsequent tapping of the screen), allowing for additional practice before the testing starts and perhaps creating a method to directly notify the operator when an individual is having difficulty converging at a single threshold level. In the current software, this information is given only at the conclusion of the test. This is especially important in situations where a language barrier is present due to the higher probability of miscommunication. Additionally, Bluetooth connection is occasionally lost throughout the test procedure, and manual reconnection is often necessary. There is a need to notify the operator of the Bluetooth signal drop without having to watch the listener's screen (e.g., an audible alert from the table for the operator to hear). The current lack of an alert could be problematic if the headset were to be utilized in a mass screening setting when one operator might be assigned to multiple listeners.

Implications of Interpreting Outcomes

For nearly half of the participants, the predetermined written instructions were a sufficient means to complete the test when translated verbally. Oftentimes, the interpreters made a "beep beep beep" sound and gestured the tap on the tablet for the listener to supplement the written instructions. To make the directions completely understandable to the majority of participants, some future modifications are suggested. First, it is highly recommended that interpreters be personally familiar with the test requirements and utilize gestures when explaining the task. Next, it should be explicitly stated that participants will hear a series of beeps, but they should only tap the tablet a single time for each set.

For use in a setting where interpreters may be unavailable, it may be feasible for listeners to watch/listen a pre-recorded video of the translated instructions on the tablet prior to the test. This would allow both the spoken test instructions to be heard in their native language and permit them to watch a demonstration of the desired response when tones are presented. A future study would be required to assess the practicality of this proposed pre-test instruction method.

Cultural Considerations

Dress

Aside from the need for translated material, testing of this population calls for the test operator to be aware of cultural considerations. During the testing procedure, some women (mainly those of the Somali cultural group) were required to remove head-coverings for correct placement of the headphones. Somali women traditionally cover their heads with either a *shash* (a special scarf) or a *garbasaar*, which drape over the entire upper-body and typically are not removed in the presence of men (other than their husband). For this study, most female participants removed just the top layer of the garment that revealed their ears and were able to leave on the bottommost layer that fit snuggly around their hair. Some of these participants were comfortable with the male interpreter present in the room during this process, and others were not. In situations in which the participant was uncomfortable with male presence, the translated instructions were given first, and then the garment was removed and headset put on after the interpreter had left the room (Figure 7). If this wireless system is utilized in the future in similar populations, it may be important for a female operator to be available to accommodate cultural values.

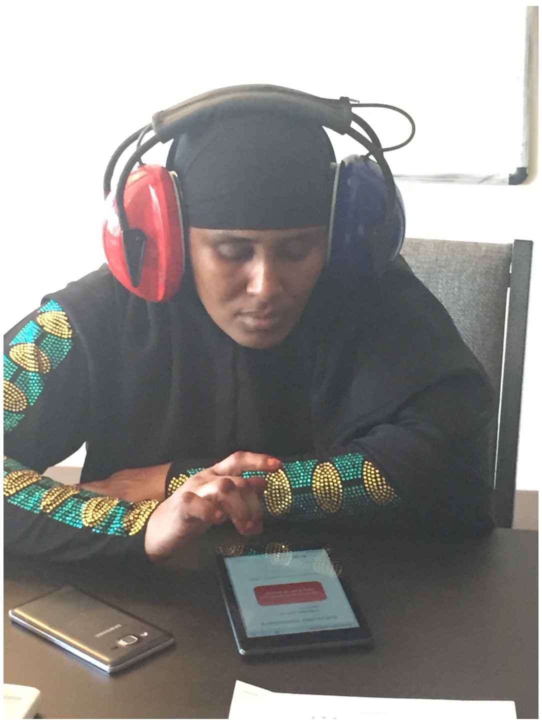

Figure 7. Participant removed top layer of garment, exposing ears, and left on the bottom layer, which fit tightly around the hair. (Picture taken with permission and IRB approval.)

Time Schedules

Another consideration noted when testing this population was the difference in how cultural groups perceive time. A challenge in this study was the act of setting up an appointment time and having the participants adhere to it. Twenty-eight initial appointments were made through the course of data collection based on volunteer interest, 25 of which consented. Fifteen (53.6%) of those appointments needed to be rescheduled at least one time, with some of these hearing tests not occurring until the third scheduled time. Eight (28.6%) individuals never followed through with participation at all (5 of these participants had already consented, while 3 had not). This occurrence may be attributed to differences in planning behavior and cultural norms. It has been documented that planning behavior is influenced by culture and societal norms (Reinecke, Nguyen, Bernstein, Näf, & Gajos, 2013). These differences in values across cultures should not be mistaken as thoughtlessness. Additionally, many participants had recurrent difficulty arranging transportation, coordinating bus schedules, addressing work conflicts, and/or securing childcare, which were the underlying reasons for missed appointments. Being mindful of these cultural differences and barriers to care is important when working with a multi-cultural population. Flexibility and a willingness to reschedule appointments will be important to build into screening/testing programs.

Misinformation/Educational Needs

Regardless of the technique, equipment, and location utilized for screening, an important consideration when working with this population is the need for education regarding hearing health. It was noted throughout the data collection phase of the study that many of the participants did not have a clear understanding of hearing care or testing procedures. Multiple individuals expressed a lack of knowledge regarding proper methods of cleaning their ears. Along with this came an obvious desire to learn. Misunderstanding was also observed in a single participant who reported the cause of his hearing loss to be water that got in his ears while swimming. Though it is possible that he was referring to otitis externa or “swimmers ear” that he contracted at some point in his life, it was not the cause of his current hearing loss as per otoscopic findings.

Technological misunderstanding was expressed in one participant who voiced concern that the headset was dangerous and feared that the electricity would go through her head. Despite reassurance, this unease prevented the participant from completing the procedure. After this occurrence, another woman from the same cultural group mentioned that her friend told her the procedure was “scary.” This informal spread of misinformation did not interfere with the other subjects’ participation in this case. However, when working with the refugee and immigrant population in the United States, it may be important to consider the basic information needs of the target group, and how information spreads among close-knit members in the community. It is, therefore, important that educational programs be implemented to promote the spread of correct information that does not further limit access to hearing healthcare for these individuals.

In recent years, health education and promotion have become a well-known method of achieving important objectives in the realm of global public health. While this is applicable to the population at large, it is known that behavioral health risks are higher in low-income and underprivileged cultural groups (Glanz, Rimer, Viswanath, & Orleans, 2008). As more resources for health education are offered to immigrant communities, the topic of “hearing” must not be ignored. Information about personal ear care, prevention, early warning signs of hearing loss, professional care, and treatment options need to be disseminated into the community. It is suspected by the World Health Organization that appropriate education is a strong force in the prevention of global hearing loss (Appold, 2012). Hearing health education, in general, has specifically been proven to have the ability to increase knowledge and induce behavior change in the youth population with respect to prevention of noise-induced hearing loss (Griest, Folmer, & Martin, 2007).

Additionally, behavior-change techniques have been successfully utilized with adults to prevent smoking or reduce the spread of AIDS in high-risk areas (Glanz et al., 2008). It is time that hearing health education becomes commonplace in at-risk populations for both adults and youths to reduce personal burden and allow for better access within local immigrant/refugee populations.

Implications of Noise Exposure

Another support for health-based education in this group is the high self-reported levels of noise exposure. The majority of the noise exposure described by this population was due to occupational noise. While refugees are eligible for employment at arrival to the United States, those with limited literacy skills face challenges when it comes to finding jobs that are not entry-level (Capps et al., 2015). The Bureau of Labor Statistics (2017) reported that foreign-born workers are more commonly employed in service, production, transportation, material moving, natural resource, construction, and maintenance occupations when compared to native employees. Therefore, employment in industrial settings is not uncommon. Inopportunely, these jobs put these individuals at higher risk for noise-induced hearing loss. Data collected by Masterson et al. (2013) compared the prevalence of noise-induced hearing loss across different industries in the U.S. and revealed the largest risk to be in the occupations of mining, manufacturing, and construction (all of which have a high percentage of foreign-born employees). Fortunately, individuals working these jobs should be enrolled in some type of hearing conservation program if such noise levels put them at risk. However, the same limitations with language and communication may make the training difficult and program effectiveness limited (Wakefield & Meinke, 2011). Less commonly reported in the group studied, but still a concern for the refugee population overall, is previous exposure to war-related noise which could potentially contribute to auditory disorders as well.

Impacts of Hearing Loss

With the high prevalence of hearing loss found in this population, it is important to address the reported effects of this condition as it relates to immigrant and refugee groups. The various reports regarding an inability to learn effectively and the difficulty hearing in classroom situations pose as a potential problem to an individual trying to learn English since this process relies on a person's ability to hear the sounds of the new language and reproduce them. In a discussion regarding children with conductive hearing loss trying to learn English as a second language, Aithal, Yonovitz, and Aithal (2008) explained how the ability to hear speech is crucial not only to the development of spoken language, but also to its written form. If a student is unable to hear the individual sounds of speech, they are likely to have decreased phonological processing skills, leading to a low level of reading proficiency and, ultimately, academic difficulties. In reference to the adults in the current study, it is comprehensible that these same obstacles apply. Therefore, the reports of ineffective learning and trouble hearing in class are concerning in this population striving to assimilate into new communities. However, these negative psycho-social impacts are consistent with what would be expected with the degrees of hearing loss found, as even a mild hearing loss can lead to difficulty acquiring knowledge in a classroom setting. In a study conducted by Most (2004), it was found that children with minimal hearing loss performed worse in academic settings than children with more severely impaired hearing thresholds. Presumably, this occurrence is due to a lack of intervention for the children with mild hearing losses (Most, 2004). There is a lack of intervention among this immigrant population as well, regardless of the severity of their hearing loss. Therefore, it is comprehensible that hearing loss strongly affects the ability of these individuals to learn in a classroom setting without amplification devices or systems. Though the participants in the current study were all adults, both classroom and incidental learning are currently a large part of their daily lives as they are in all in the process of adapting to U.S. culture. Beyond classroom learning, the participants reported other negative impacts of hearing loss, such as difficulty with relationships and trouble accessing medical care. These challenges may also limit the acculturation process. The majority of participants were not yet citizens, but expressed plans to pursue that designation in the future. Unfortunately, an undocumented hearing loss has potential to impact an individual's ability to be granted citizenship, as there is a speaking portion of the testing. This portion of the assessment is created to assess both expressive and receptive English language skills (U.S. Citizenship and Immigration Services, 2017). However, it would not be uncommon for someone with hearing loss to have communication breakdowns that could easily be misinterpreted as a lack of comprehension. Those with a documented disability (such as a hearing loss) can receive accommodations under Section 504, but it is important that these individuals are aware of that possibility and learn to be advocates for themselves. Consequently, education regarding hearing loss should be implemented not only at the level of the English-learning students, but also for the teachers and staff at these community-based centers. These individuals may be critical in terms of connecting and facilitating the immigrants/refugees with hearing loss to healthcare and support services and accommodating hearing-impaired students within the classroom and beyond.

Access to Hearing Care and Resources

In this study, only one individual reported receiving a hearing test in another country. Every other individual that had ever had a hearing test reported it as being completed in the United States, typically at work or at a physician's office. This survey outcome suggests limited access to screening procedures in the various underprivileged regions in which these individuals originated.

The majority of participants have had their hearing screened in the United States since immigrating. This finding indicates an increase in access to medical care for this population since arriving in this country. Over one-third of the individuals had even received care beyond a screening and sought out hearing healthcare from a medical professional. Among those who had not visited a doctor, most reported their reasoning being a lack of concern. Though financial and linguistic apprehensions were expressed as barriers to care, they were not found to be as large of obstacles as one might imagine (specifically when it comes to hearing healthcare).

The greatest barrier to hearing healthcare for this population appears to be at the treatment stage. While a little more than half of the participants presented with hearing loss, only one participant (10%) had ever tried any type of amplification device. Although hearing aid use in general is typically low, research surveying 13,018 U.S. residents suggested that 30.2% of individuals with self-reported hearing loss own a hearing aid (Abrams & Kihm, 2015). Therefore, it seems that there are additional barriers to rehabilitative care among the refugee and immigrant population when compared to the general U.S. population. More research will be needed to understand the reasons for this situation. Regardless, it is important that resources are provided to community-based centers in an effort to limit any potential barriers for this population. These may include information about local clinics to access care as well as regional and national funding sources for hearing aids.

Study Limitations and Future Directions

Limitations of this study include a small sample size and a small representation of cultural groups, which was restricted by the availability of interpreters. With a larger group of individuals from each cultural group, stronger trends may have been seen. In addition, more reliable comparisons could have been made across cultural groups. Lastly, participation in this study was voluntary and based on personal interest, so these individuals may not be representative of their peers in other immigrant/refugee communities within the U.S.

Further technology advancement could be done with the WAHTS and research conducted to test the feasibility of incorporating video-recorded instructions for a broader representation of multi-lingual populations. Incorporating videotaped instruction into the WAHTS has the potential to create opportunities for its use in screening programs. Especially, for programs without access to an interpreter in the U.S., and in low-income regions of the world. Future qualitative research is needed with this population to determine barriers to treatment and potential solutions or systems to facilitate overcoming these barriers. Finally, exploration of the effects of hearing loss in adults learning a new language may further contribute to our understanding of how to best accommodate hearing-impaired students in adult-education classrooms.

Summary

Use of the WAHTS in the refugee and immigrant population proved to be a feasible means of providing entry-level hearing healthcare. With some modifications, it may be possible to utilize this equipment to screen for hearing loss in low-resource areas amongst multi-lingual populations. Compared to recent data, the population tested was found to have a relatively high prevalence of hearing loss. While any individual with hearing loss may face communicative challenges, it may be especially difficult for these immigrants/refugees who are in the process of learning a new language and trying to assimilate into a new culture. Additionally, these individuals are likely acquiring employment in a location that further puts them at risk for hearing loss. Most individuals with hearing loss identified a problem, yet few had taken rehabilitative steps. In the future, education regarding hearing, hearing loss, available care, and advocacy will be important factors to consider when working with this population in the United States. Further investigation is needed in this community to broaden the applicability of the WAHTS headset in global, multi-lingual populations, in addition to exploration regarding impacts of hearing loss on adult language learning and cultural assimilation.

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APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

UNIVERSITY OF
NORTHERN COLORADO

Institutional Review Board

DATE:	April 7, 2017
TO:	Jennifer Ruths, B.A.
FROM:	University of Northern Colorado (UNCO) IRB
PROJECT TITLE:	[1039431-1] Application of Wireless Audiometric Testing System at a Refugee Center with a Multi-lingual Population
SUBMISSION TYPE:	New Project
ACTION:	APPROVED
APPROVAL DATE:	April 7, 2017
EXPIRATION DATE:	April 7, 2018
REVIEW TYPE:	Expedited Review

Thank you for your submission of New Project materials for this project. The University of Northern Colorado (UNCO) IRB has APPROVED your submission. All research must be conducted in accordance with this approved submission.

This submission has received Expedited Review based on applicable federal regulations.

Please remember that informed consent is a process beginning with a description of the project and insurance of participant understanding. Informed consent must continue throughout the project via a dialogue between the researcher and research participant. Federal regulations require that each participant receives a copy of the consent document.

Please note that any revision to previously approved materials must be approved by this committee prior to initiation. Please use the appropriate revision forms for this procedure.

All UNANTICIPATED PROBLEMS involving risks to subjects or others and SERIOUS and UNEXPECTED adverse events must be reported promptly to this office.

All NON-COMPLIANCE issues or COMPLAINTS regarding this project must be reported promptly to this office.

Based on the risks, this project requires continuing review by this committee on an annual basis. Please use the appropriate forms for this procedure. Your documentation for continuing review must be received with sufficient time for review and continued approval before the expiration date of April 7, 2018.

Please note that all research records must be retained for a minimum of three years after the completion of the project.

If you have any questions, please contact Sherry May at 970-351-1910 or Sherry.May@unco.edu. Please include your project title and reference number in all correspondence with this committee.

Thank you for your patience with the UNC IRB process. The first reviewer, Dr. Montemayor, has provided approval with no requests for modifications or amendments. Subsequently, I reviewed your materials and see that they are are very thorough and clear. No additional materials or amendment/modifications are required.

The protocols and documents are now approved and you may proceed with participant recruitment and data collection.

Best wishes with your research and don't hesitate to contact me with any IRB-related questions or concerns.

Sincerely,

Dr. Megan Stellino, UNC IRB Co-Chair

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within University of Northern Colorado (UNCO) IRB's records.

APPENDIX B

HEARING HEALTH INTERVIEW

Audiology & Speech Language Sciences

Hearing Health Interview

Participant # ____________________________________
Age______________________________

English Proficiency Level (assigned by the GRC) ________
Native Language __________________

General Information:

1. How long have you lived in the United States? _________________

2. Where is your home country? ______________________

3. Have you taken the citizenship test? ________
    Have you had any difficulty with the test? __________

    Do you think any of the following contributed to that difficulty? Please respond yes or no:

    English Proficiency   Hearing difficulty   Vision difficulty

    Lack of Preparation   Test difficulty

History of Noise Exposure:

1. Have you ever had a job, or a combination of jobs, where you were exposed to loud sounds or noise for 4 or more hours a day, several days a week? (loud means so loud you must speak in raised voice to be heard.)**
   Yes   No
   If yes, what type of work or workplace? ______________________________

2. Outside of a job, have you ever been exposed to very loud noise or music for 10 or more hours a week? This is noise so loud that you have to shout to be understood or heard 3 feet away.**
Yes   No
    What type of noise? Please respond yes or no to the following:
    Farming   Power tools   Music/Concerts   Sporting Events   Lawn Care Equipment (such as a lawnmower)   Other

3. Firearms may be used for target shooting, hunting, or in the military. Have you ever used or been exposed to firearm noise for any reason?**
Yes No
What type of noise? Please respond yes or no to the following:
Target shooting, Hunting, Military, Traumatic noise/War

Medical History:

1. Have you had earaches or drainage from your ears?
Yes (Which ear? Right, Left or Both) No

2. Have you ever had three or more ear infections? Please include infections you may have had as a child.** Yes (Which ear? Right, Left, Both) No
At what age was your last ear infection? ___________

3. Have you had any type of ear surgery? Yes (Which ear? Right, Left, Both) No
Please specify: ______________________

4. Have you ever experienced dizziness/vertigo? Yes No

5. Have you had any head trauma/ severe head injury? Yes No

6. In the past 12 months, have you been bothered by ringing, roaring, or buzzing in your ears or head that lasts for 5 minutes or more?** Yes No

7. Have you ever taken any medicines that you felt caused hearing loss or made your hearing worse than usual? Yes No

Hearing History:

1. Does anyone in your family have hearing loss that is not related to age? Yes No

2. Have you ever had your hearing tested? Yes No
If yes, where was it tested? (United States, home country, other)

3. Have you ever seen a medical doctor for hearing problems?

Yes

Do you know what type of doctor? Options include:
Ear Nose & Throat Doctor Family Physician Audiologist Not Sure

Where? United States /Home Country /Other Country

No

What has prevented you from doing so? Please respond yes or no to the following:

No Concerns Finances Language barrier/Fast rate of speech

Unfamiliarity with the area Other: ______________________

4. I am going to list 6 statements. Which best describes your hearing ? **

I would describe my hearing without a hearing aid or other listening device as:

- Excellent
- Good
- A little trouble hearing
- Moderate Hearing Trouble
- A lot of trouble hearing
- Deafness

If the participant responded "Excellent or Good" interviewer will "skip" questions 5-10.

5. How long have you experienced difficulty hearing? __________

6. What do you feel is the cause of your hearing loss? Some options may include:

Age Heredity/Family History Illness Noise Exposure
Traumatic Incident Don't Know

7. Have you ever worn a hearing aid or cochlear implant (will describe if necessary)? Yes No

8. Do you feel like hearing loss impacts your life in any of the following ways? Please respond yes or no:

I have difficulty learning English

I feel isolated from my new community

I have difficulty accessing medical care

It negatively affects my employment

It negatively affects my relationships

It negatively affects my learning

9. Do you have difficulties hearing in any of the following situations? Please respond yes or no:

Restaurants

In Class

At Work

During times of worship

Movies

Telephone

Doctor appointments

Shopping

10. Any additional ways in which you feel that hearing loss has impacted you:

____

____

____

11. Anything else you would like to tell us about your ears or hearing?

____

____

____

** Adapted from 2015-2016 NHANES Audiometry Questionnaire

APPENDIX C

TECHNOLOGY USABILITY INTERVIEW

UNIVERSITY OF NORTHERN COLORADO

Audiology & Speech Language Sciences

Technology Usability Interview

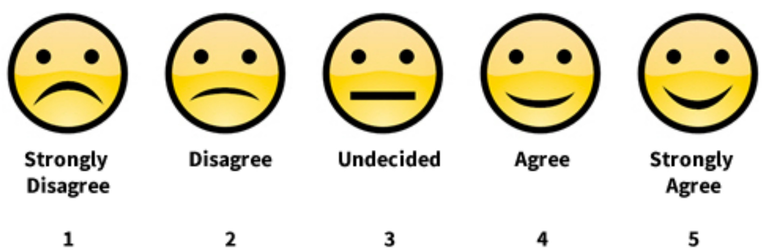
Participant # _______

Thank you for helping with our research project. Below are a few brief questions to help us learn more about the new equipment we are developing for hearing testing, as well as your experience with the test procedures today.

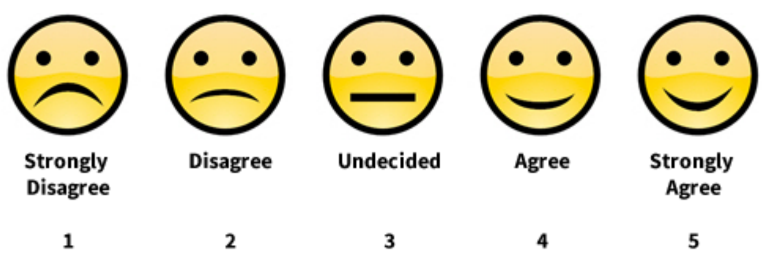
Please point to the appropriate response (1, 2, 3, 4, 5 or the corresponding smiley faces) for each statement that best describes your feelings and/or opinions.

1 = Strongly Disagree 2 = Disagree 3 = Undecided 4 = Agree 5 = Strongly Agree

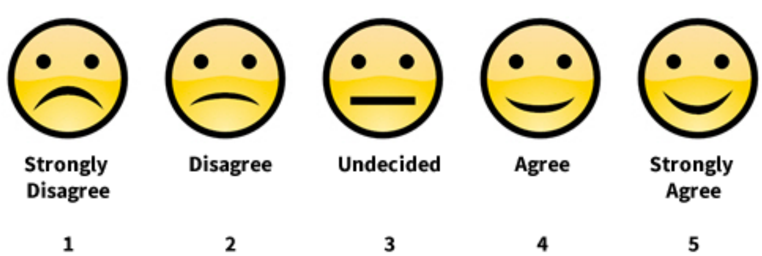
It was easy for me to put the headset on myself.



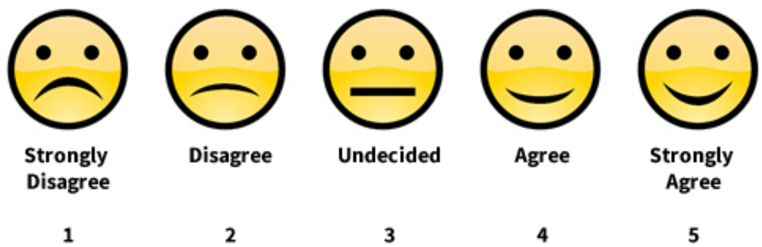
The headset fit well and sealed my ears from outside noise.



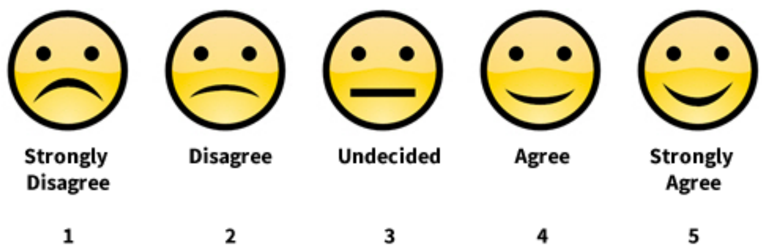
There was no discomfort during the placement of the headset on my ears.



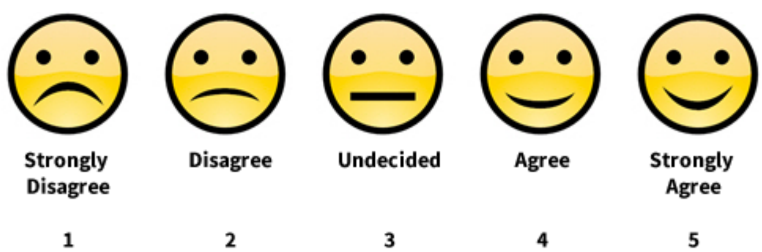
The headset felt stable on my head and did not change position (move) while taking the hearing test.



The headset was not a problem to wear.



It was easy to press the button on the computer tablet when I heard sound.



The tablet computer made the hearing test difficult.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

I am skilled and experienced with the use of computers/digital technology.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

The presence of the interpreter made taking the hearing test more comfortable for me.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

The verbal instructions in my native language were clear and I was able to understand them.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

The translations were helpful for me. The test would have been difficult to complete in English.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

I was happy the testing was done in a familiar place.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

The location of the testing was less convenient for me than going to the doctor's office.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

Are there any additional comments or feedback you can offer related to your testing experience and potential follow-up?
Are there additional comments or feedback you can offer related to the use and functionality of this wireless hearing test device?

Thank You

APPENDIX D

FOLLOW-UP INTERVIEW QUESTIONS

Follow-up Interview

The following questions will be asked to any participant for whom follow-up is recommended. All questions will be asked via the interpreter.

1. Do you plan to follow through with the follow-up services that were recommended today?
    a. If participant responds “no” or “maybe”: What do you feel will prevent you from doing so?
2. If you attend a follow-up appointment, do you want an interpreter to accompany you?

APPENDIX E

PILOT STUDY REFLECTION SURVEY WITH RESPONSES

Audiology & Speech Language Sciences

Pilot Study Reflection Survey

Hearing Health Survey/Interview

1. Do the questions translate well into the foreign language that you will be interpreting for? If not, which questions, and what would be a better way to ask them?

Somali	All the questions translated well
Karenni	Yes
Burmese	Some words cannot translate in direct meaning, therefore we used our own translation
Rohingya	Yes, well.
Spanish	They are easy to translate, other than some very specific words

2. Are there any questions that were culturally insensitive? If so, which questions, and what would be a better way to ask them?

Somali	None of the questions were insensitive
Karenni	None
Burmese	Not at all
Rohingya	No
Spanish	None that I thought

3. Do you foresee any additional complications with the survey/interview?

Somali	No
Karenni	No
Burmese	No
Rohingya	Survey & tests should not be done at the same time
Spanish	No, it seems straightforward, which is good for refugee populations

Wireless Hearing Test

1. Are the instructions clear when translated into the foreign language that you will be interpreting for? If not, what changes could be made?

Somali	The instructions were perfect
Karenni	Yes
Burmese	It's perfect
Rohingya	Yes, clear
Spanish	Yes, they are

2. Any other suggestions or foreseeable problems regarding the hearing test?

Somali	No suggestions
Karenni	Nothing
Burmese	If the test is long, someone may lose concentration
Rohingya	Time and place will be very important to set up/schedule.
Spanish	None

Technology Usability Survey

1. Do the questions translate well into the foreign language that you will be interpreting for? If not, which questions, and what would be a better way to ask them?

Somali	The questions translated well
Karenni	Yes
Burmese	Yes (via verbal confirmation)
Rohingya	Yes
Spanish	These were probably the easiest to translate

2. Which way do you think is the best way to display the answer choices/scale?
   a. Graphics only
   b. Graphics + Translated words read to the participant
   c. Only translations

Somali	Only Translations
Karenni	Graphics & Translations
Burmese	Graphics & Translations
Rohingya	Graphics Only
Spanish	Graphics & Translations

3. Why did you choose the above answer?

Somali	They always prefer translations
Karenni	It was easy for me
Burmese	They are not familiar with these tests & equipment, so both are needed to explain
Rohingya	This is way more clear for the uneducated people
Spanish	Many can read in their native language, but many cannot. So graphics would help the person identify without reading

4. Do you think there are any other important questions that we consider asking participants about their experience?

Somali	I can't think of any other questions
Karenni	None
Burmese	No
Rohingya	Methods of cleaning the ears should be introduced during the session
Spanish	No Response

5. Do you have any additional concerns regarding this survey/interview?

Somali	No
Karenni	No
Burmese	No
Rohingya	No
Spanish	No Response

Overall Experience

1. Any other last suggestions/opinions?

Somali	None
Karenni	No Response
Burmese	We will need to explain the test to people who have no experience
Rohingya	No
Spanish	Add info on insurance or payment plans

APPENDIX F

VERBAL INSTRUCTIONS FOR HEARING TEST

We will now begin the hearing test. This is a self-administered test. Once you put the headphones on you can press the blue button on the bottom-right side of the screen to begin the test. The tablet will then begin to test your hearing at different pitches and loudness levels. It will start in your left ear and then will automatically switch to your right. Every time you hear the beeps, tap the red button in the center of the screen. If you have any questions during the test procedure, you may ask the interpreter and/or the researcher. We will now begin the test- place the red earphone over your right ear and the blue earphone over your left ear and tap the blue button on the bottom to begin when you are ready.

APPENDIX G

DEBRIEFING/REFERRAL FORM

UNIVERSITY OF NORTHERN COLORADO

Speech-Language Pathology and Audiology Clinic
Gunter Hall, Room 0330 | 1828 10th Ave Greeley, CO 80631 | Greeley, Colorado 80631

The following individual had otoscopy performed, and had their hearing tested as part of an Au.D. Graduate research study using new wireless headset technology.

Participant: ___________________________________ Date: ________________

Observations from this study resulted in the following referral status:

❑ No concerns at this time

❑ **Cerumen Removal:** You have earwax that is blocking your ear canal. It is recommended that you be seen by a physician to have the excess earwax removed.

Wax Status:	**Left Ear**	**Right Ear**
Clear	☐	☐
Partially Occluded	☐	☐
Fully Occluded	☐	☐

❑ **Audiologist Referral:** You are having difficulty hearing certain sounds. It is recommended that you be seen by an Audiologist for:

- ☐ A full hearing evaluation
- ☐ Other:____

❑ **Ear, nose and throat (ENT) Referral**: It is recommended that you see an ENT doctor for the following:

- ☐ Medical exam
- ☐ Cerumen impaction
- ☐ Hearing loss
- ☐ Other:____

If you have any questions regarding the research study or this referral, please feel free to contact Jen (student clinician/researcher) at 516-637-1710 or alle4276@bears.unco.edu

APPENDIX H

TECHNOLOGY USABILITY INTERVIEW RESPONSES

Chart of Technology Usability Interview Responses

Question	Agree	Undecided	Disagree
It was easy for me to put the headset on myself.	94.40%	0%	5.60%
The headset fit well and sealed my ears from outside noise.	100%	0%	0%
There was no discomfort during the placement of the headset on my ears.	83.30%	5.60%	11.10%
The headset felt stable on my head and did not change position (move) while taking the hearing test.	100%	0%	0%
The headset was not a problem to wear.	100%	0%	0%
It was easy to press the button on the computer tablet when I heard sound.	100%	0%	0%
The tablet computer made the hearing test difficult.	83.30%	16.70%	0%
I am skilled and experienced with the use of computers/digital technology.	16.70%	72.20%	11.10%
The presence of the interpreter made taking the hearing test more comfortable for me.	100%	0%	0%
The verbal instructions in my native language were clear and I was able to understand them.	100%	0%	0%
The translations were helpful for me. The test would have been difficult to complete in English.	100%	0%	0%

Question	Agree	Undecided	Disagree
I was happy the testing was done in a familiar place.	100%	0%	0%
The location of the testing was less convenient for me than going to the doctor's office.	44.40%	11.10%	44.40%
Are there any additional comments or feedback you can offer related to your testing experience and potential follow-up?	Two participants commented that they were happy with the experience. All others had no comment.		
Are there additional comments or feedback you can offer related to the use and functionality of this wireless hearing test device?	One participant said the headset was too large. All others had no comment.		

APPENDIX I

HEARING HEALTH INTERVIEW--MEDICAL QUESTION RESPONSES

Hearing Health Interview

Chart of Medical Question Responses

Question Asked	Percent of Participants Responding "Yes"
Have you had earaches or drainage from your ears?	26.3% (5/19)
Have you ever had three or more ear infections? Please include infections you may have had as a child.	15.8% (3/19)
Have you had any type of ear surgery?	5.3% (1/19)
Have you ever experienced dizziness/ vertigo?	15.8% (3/19)
Have you had any head trauma?	15.8% (3/19)
In the past 12 months, have you been bothered by ringing, roaring, or buzzing in your ears or head that lasts for 5 minutes or more?	26.3% (5/19)
Have you ever taken any medicines that you felt caused hearing loss or made your hearing worse than usual?	0% (0/19)

APPENDIX J

HEARING THRESHOLD RESULTS BY PARTICIPANT

Participant ID	L 1000 Hz Best	L 2000 Hz	L 3000 Hz	L 4000 Hz	L 6000 Hz	L 8000 Hz	L 500 Hz	R 1000 Hz Best	R 2000 Hz	R 3000 Hz	R 4000 Hz	R 6000 Hz	R 8000 Hz	R 500 Hz
201	5	10	5	5	5	0	5	5	5	5	10	5	15	5
202	40	45	40	55	70	75	35	40	40	40	55	65	55	20
203	50	65	DNC	DNC	DNC	DNC	40	35	40	30	40	40	50	35
204	10	5	10	5	30	20	10	20	25	35	30	40	40	25
205	25	25	30	40	60	60	25	20	25	20	25	40	50	DNF
206	5	0	15	5	5	0	0	5	15	0	5	10	0	5
207	60	50	60	65	80	75	65	40	15	45	50	75	55	35
208	10	30	30	50	80	75	10	40	45	50	55	80	75	45

209	10	10	15	15	15	15	15	5	10	5	5	5	15	10
211	0	20	5	5	15	15	5	5	10	-5	15	10	10	5
212	5	5	15	15	25	30	10	0	0	5	10	20	25	5
213	10	5	10	10	10	15	5	5	10	5	10	MR	MR	10
214	25	50	65	65	80	75	25	25	50	60	65	75	75	25
215	5	25	25	35	60	60	5	5	15	25	25	40	40	0
216	10	15	-5	5	5	0	10	10	10	5	15	0	0	10
217	80	75	80	85	80	75	80	75	70	80	80	80	75	75
218	10	5	5	10	25	30	10	10	10	10	10	30	45	10
219	35	40	40	DNC	35	60	30	30	40	35	40	40	40	20

220	0	40	50	65	80	75	EE	5	20	30	35	50	45	15
AVG	20.8	27.4	27.5	31.5	42.2	41.9	21.4	20	23.9	25.3	30.5	39.2	39.4	19.7
NORMAL HEARING AVG	7	10	10	11	19.5	18.5	7.5	9.1	11.8	9.5	15	21	24.5	7.5
HEARING LOSS AVG	36.1	46.7	49.4	60.7	70.6	71.3	38.6	38.1	40.6	46.9	51.9	61.9	58.1	35

KEY	DNC- Did Not Converge
	Upper Limit. Threshold May Be Worse At This Frequency
	EE- Equipment Error. No Threshold Recorded
	Threshold Interpolated Due to Equipment Error
	DNF- Did Not Finish Test

APPENDIX K

AMBIENT NOISE RESULTS BY PARTICIPANT

Chart of Ambient Noise by Participant

	Ambient Noise Level in dB SPL																	
Participant ID	Pre 125 Hz	Pre 250 Hz	Pre 500 Hz	Pre 1000 Hz	Pre 2000 Hz	Pre 3150 Hz	Pre 4000 Hz	Pre 6300 Hz	Pre 8000 Hz	Post 125 Hz	Post 250 Hz	Post 500 Hz	Post 1000 Hz	Post 2000 Hz	Post 3150 Hz	Post 4000 Hz	Post 6300 Hz	Post 8000 Hz
201	37	39.2	30.9	30.3	25.3	21.6	19.1	14.1	14.4	35.6	34.3	29.9	30.7	27.1	19.3	19.1	14.7	15.5
202	36	33.9	30.1	27.7	23.6	20.5	18.9	12	14.2	35.8	34	25.1	23.7	20.5	16.3	18.4	13.4	12.7
203	35	35.7	36.5	33.9	29.2	23.1	19.9	17	13.6	33.6	34	37.3	33.7	28.3	22.9	18.6	14.8	12.7
204	49.4	40.6	34	30.2	25	16.4	15.4	12.3	13.6	45.9	38	37.5	23.7	17	11.7	14.3	12.3	13.8
205	40.4	36.2	32.8	26.2	21.4	16.6	14.8	13	12.7	41.2	37.2	37	32.6	18.9	15.2	14.8	15.2	13.4
206	37	35.5	35.3	21.7	28.4	19.9	14.3	12.8	12.9	36.2	37.8	36.7	22.1	25.7	16.5	12.5	11.7	12.7
207	47.3	35.4	35.3	27.5	26.5	15.5	14.5	15.4	12.7	42.4	35.8	35.7	32.9	25.9	22	16.6	14.2	16.4
208	41.6	35.1	36	27.7	26.5	18.7	17.1	12.2	12.7	41.2	33.8	36.5	26.9	26.3	21	18.5	13	12.7
209	50.6	43.4	27.9	22.2	18.1	17.7	13.9	12.8	12.7	40.4	33.7	26.3	19.1	16.6	13.5	13.5	12.8	12.7
211	31.7	29.3	26.2	24.9	18.1	13.6	16.6	11.7	12.7	33.4	26.4	27.3	25.2	18.6	13.5	11.9	11.7	12.7
212	42.4	33.1	28.4	22.7	21.4	12.1	11.8	11.7	12.7	35.3	30.6	33.4	24.9	18	13.5	12.5	11.8	15.6

213	46.3	39.3	34.6	22.9	23.3	16.3	12.7	11.6	11.6	41.7	33.8	29.7	20.6	16	14.9	12	11.6	11.6
214	40.9	38.8	30.7	23.6	18.3	15.9	13.3	12.7	12.7	42.8	34.9	30.7	30.5	23.5	14.6	11.1	11.7	12.7
215	34.5	40.8	34.9	31.1	27.1	21.1	24.7	14.8	12.7	39.1	43.7	35.9	31.7	29.4	26.6	13.9	12.8	12.7
216	41.9	38.4	29.2	25.5	20	15	13.7	11.7	12.7	40.6	37.9	34.3	29.1	27.4	14.7	12.5	12.5	12.7
217	42.9	42.2	39.5	32.4	25.4	15.7	16.4	17.6	16.9	36.9	38.2	33	30.7	25.1	16.7	14.4	11.7	12.7
218	25.7	26.8	15.5	17.1	11.6	11.6	11.6	11.6	11.6	30.6	26.5	17.1	15.3	12.2	13.6	11.6	11.6	11.6
219	40.6	35	27.2	26.1	17.1	11.6	11.6	11.6	11.6	41.8	36.4	29.8	23.6	15.6	14.3	11.6	11.6	11.6
220	41.8	36.4	29.8	23.6	15.6	14.3	11.6	11.6	11.6	39.5	38.4	32.8	27.3	18.9	14.7	11.6	11.6	11.6
AVG class 1 (n=8)	42.4	37.4	32.8	26.7	24.4	18.4	16	13.1	13.2	39.8	35.6	33.1	26.5	22.3	16.9	16	13.4	13.7
AVG office (n=1)	35	35.7	36.5	33.9	29.2	23.1	19.9	17	13.6	33.6	34	37.3	33.7	28.3	22.9	18.6	14.8	12.7
AVG class 2 (n=1)	25.7	26.8	15.5	17.1	11.6	11.6	11.6	11.6	11.6	30.6	26.5	17.1	15.3	12.2	13.6	11.6	11.6	11.6
AVG stair well (n=9)	40.3	37	31.2	25.9	20.7	15.1	14.7	12.8	12.8	39	35.6	31.9	27.1	21.4	15.9	12.4	11.9	12.7

T- TEST RESULTS COMPARING MEAN PRE- AND POST- TEST AMBIENT NOISE LEVELS									
	125 Hz	**250 Hz**	**500 Hz**	**1000 Hz**	**2000 Hz**	**3150 Hz**	**4000 Hz**	**6300 Hz**	**8000 Hz**
P-VALUE	0.102	0.045	0.442	0.661	0.514	0.901	0.077	0.328	0.796

APPENDIX L

REFERRALS MADE

Chart of Referrals Made

Participant	Resulting Referral
202	Full Hearing Evaluation
203	Full Hearing Evaluation and/or ENT for hearing loss
204	Hearing Evaluation to connect to care (mild loss)
207	ENT- HL, unilateral tinnitus, History of medical problems
208	ENT- HL, asymmetric HL
210	ENT- HL, reported unilateral and beating tinnitus on occasion
214	Full Hearing Evaluation
215	Full Hearing Evaluation
217	Full Hearing Evaluation
219	Full Hearing Evaluation
220	ENT- HL, unilateral tinnitus

APPENDIX M

FOLLOW-UP INTERVIEW RESPONSES

Chart of Follow-Up Interview Responses

Participant	Do you plan to follow through with the services that were recommended today?	IF NO-- what will prevent you from doing so?	If you attend a follow-up appointment, do you want an interpreter to accompany you?
202	Yes		Yes
203	Yes		Yes
204	No	Do not have a car, unsure about insurance	Yes
207	Yes		Yes
208	Yes		Yes, needs it
210	Yes		Yes
214	Yes		Yes
215	Yes		Yes, & needs help making appointment
217	Yes		Yes, Family or Friend would come
219	Yes		Yes
220	Yes		Yes