

HEARING CONSERVATION EDUCATION NEEDS ALONG THE SOUTHERN ARIZONA
BORDER

by

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As members of the Audiology Doctoral Project Committee, we certify that we have read the project prepared by Student Name, titled *Hearing Conservation Education Needs Along the Southern Arizona Border* and recommend that it be accepted as fulfilling the Audiology Doctoral Project requirement for the Degree of Doctor of Audiology.

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DEDICATION

I would like to dedicate this to my family, who live and raised me in a small border community and whose presence there makes it the center of my world.

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Abstract

Background: The purpose of this study is to better understand the need for hearing conservation education in rural and underserved populations, such as those along the Southern Arizona border. The project consists of reviewing data from a previous National Institutes of Health funded study, the clinical trial of the *Oyendo Bien* intervention, and reviewing previous literature to determine the depth and breadth of information available on hearing conservation education for adults. *Oyendo Bien* was a community program s in which members of the Santa Cruz County in Arizona learned about different topics regarding hearing from community health workers in collaboration with audiologists. Data was then gathered pertaining to the hearing history of the participants and to evaluate the effectiveness of hearing health education in this population.

Methods: The audiology doctoral project is a sub-study of *Oyendo Bien* and consists of analyzing different responses from questionnaires collected from the *Oyendo Bien* study.

Results: Data from the questionnaires revealed that participants were exposed to noise recreationally and vocationally. It also demonstrated that participants used nonconventional items to protect their hearing as well as conventional hearing protection.

Conclusion: These results, together with a lack of prior published research on hearing conservation education programs and resources for health education, demonstrated a need for greater hearing conservation education.

Background

Hearing loss is a common experience in the older adult population in the United States, Americans within the 60-69 years age range are the largest number of people with hearing loss in the population (Hoffman HJ, Dobie RA, Losonczy KG, Themann CL, Flamme GA., 2016). People can be congenitally born with hearing loss or can obtain it later in life due to different reasons such as illnesses, aging, or noise exposure. Typically, determining the etiology of hearing loss for older adults can be difficult since there is such a broad causation for hearing loss. Another component that makes etiology difficult to identify is that most hearing loss configurations are similar despite the origin of the hearing loss. For example, hearing loss typically caused by aging, is characterized by a sloping high frequency hearing loss. Similarly, noise induced hearing loss tends to follow the same configuration because both are characterized as damage to the cochlea. However, research in the past has demonstrated that noise-induced hearing loss can be preventable with the use of hearing protection. By using hearing protection, noise-induced hearing loss can be prevented or diminished.

Hearing conservation education can act as a medium to help diminish the consequences of noise exposure experienced recreationally or vocationally. Previous research has demonstrated that hearing conservation education helps promote the proper use of hearing protection (Chermak, & Peters-MaCarthy, 1991). However, not many resources exist that educate the general population about the impact of recreational noise exposure on hearing.

The purpose of this audiology doctoral project is to analyze the need for hearing conservation education in Santa Cruz county, a county located in southern Arizona along the border with Mexico. The current study acts as a sub-study from a larger community-based participatory research study titled *Oyendo Bien*. Santa Cruz county was the location for this

research because it is comprised of a large Hispanic/Latino population which previous research has demonstrated having hearing health care disparities (Ingram et al., 2016). Furthermore, noise exposure ranked as a top risk factor for hearing loss in the Hispanic/Latino population (Cruickshanks et al., 2015).

Several factors were used to determine the hearing conservation education need in this population. First, noise exposure and conservation data from the questionnaire that was delivered to the *Oyendo Bien* participants. Second, an analysis of existing policy regarding hearing conservation was completed. Finally, an investigation of available resources regarding hearing conservation education are reviewed. Together these results will be discussed in the context of policy in both the U.S and Mexico.

Methods

Oyendo Bien Research Study

Oyendo Bien is a National Institutes of Health (NIH) funded research study conducted by the University of Arizona (R21/ R33 DC013681, PI: Marrone). The clinical trial of the *Oyendo Bien* outreach program was a randomized controlled trial (RCT) with a waitlist crossover design (clinicaltrials.gov registration NCT03255161). For the purposes of this sub-study, the results of the RCT will not be discussed but rather the data collected from pre-assessments before the delivery of the outreach program. The clinical trial study sought to fill a gap in knowledge regarding the effect of an aural rehabilitation program for older adults along the United States/Mexico border -- specifically the Nogales area of Santa Cruz County, Arizona. As mentioned previously, this population was of interest because previous research had demonstrated that hearing health disparities exist among Hispanic/Latino older adults in the United States, especially when compared to Whites (Nieman et al., 2016). Thus, the study would

also help to investigate the hearing needs of families who are affected by hearing loss in this rural community (Marrone et al., 2017). This study hypothesized that the *Oyendo Bien* outreach program would empower participants to manage their hearing loss via improved self-efficacy and advocacy behaviors. The program would also improve family communication behaviors in order to create a more supportive communication environment (Marrone et al., 2017).

Participants

Santa Cruz County is located in southern Arizona and has a population of about 40,000 people (US Census, 2010). In this community 95% of the population identifies as Hispanic/Latino. The median household income of the population is \$39,630 dollars (US Census, 2017). Within Santa Cruz County, Nogales, Arizona has a population of 20,837 and median income of \$28,238. The participants for the *Oyendo Bien* outreach program were recruited from the local community by community healthcare workers (CHWs). Participants were older than the age of fifty-five and primarily of Mexican or Mexican American descent. A total of 137 participants completed the pre-assessment, with a total of 94 females and 41 males. The data from 2 additional participants was not utilized due to the two participants not completing a pre-assessment. The participants were primarily from dyads that consisted of the main participant, who had a certain degree of hearing loss, and a close communication partner or partners. To be eligible in the clinical trial, at least one person in the dyad had to have hearing loss (defined for this study as greater than 25 dB HL by average of pure-tone thresholds at 1000, 2000, and 4000Hz). Some dyads consisted of both participants having hearing loss as discovered by hearing tests completed as part of the pre-assessment or self-identification of hearing loss by the communication partners.

Hearing Test Results

The results from the hearing tests were analyzed by averaging the pure-tone thresholds of all participants in the study. These results are reflected in Appendix A, which is a graph of the average hearing threshold (in dB HL) of all participants in the *Oyendo Bien* study. Appendix B is a chart of the average hearing thresholds of females who reported noise exposure. This data is displayed separately to demonstrate differences between females and the group as a whole. It should be noted that not all participants completed a hearing test, reducing the sample size from n=137 to n=131. Participant values are reflected in each of the figures.

Procedures

As part of the recruitment process, participants completed a pre-assessment questionnaire that was developed by the research group. In the development process of the pre-assessment, Sonia Colina, PhD, Professor in the Department of Spanish and Portuguese from The University of Arizona, together with the community healthcare workers in the *Oyendo Bien* project, collaborated on language mediation and functional translation to develop a questionnaire that was culturally appropriate for the population being investigated (Colina, Marrone, Ingram, & Sánchez, 2017).

For this doctoral project sub-study, a total of three questions regarding noise exposure plus the data from the initial hearing test were analyzed. Table 1 lists the questions pertinent to this sub-study in Spanish (as they were delivered to the participants) in the left and English in the right. The first question pertained to noise exposure at work, the second to noise exposure recreationally, and the third to hearing protection use. The questions were open ended, which meant the participant could respond ‘yes’ or ‘no’ and give a qualitative response as well.

<i>¿Ha trabajado en lugares ruidosos, como en la construcción, la minería, la agricultura, o las fuerzas armadas?</i>	<i>Have you worked in noisy environments, such as in construction, mining, farming, military?</i>
<i>¿Tiene algún pasatiempo como ir al tiro al blanco, ir a conciertos de música, usar motocicletas, escuchar música de un alto volumen?</i>	<i>Do you have any noisy hobbies like going to a shooting range, attending a concert, using motorcycles or listening to loud music?</i>
<i>¿Ha protegido sus orejas de ruidos excesivos?</i>	<i>Have you ever protected your ears from loud sounds?</i>

Table 1 lists the questions pertinent to this study from the pre-assessment questionnaire in Spanish (as they were delivered to the participants) in the left and English in the right.

Results

Questionnaire Responses

The first question which related to vocational noise exposure demonstrated that 38% (n = 52) of the participants had been exposed to loud noise at their workplace (refer to Figure 1 for a plot of these results). Fourteen percent (n = 17) of the participants responded ‘yes’ to performing an activity recreationally that exposed them to noise (refer to Figure 2 for a plot of these results). The third question pertaining to hearing protection use, was analyzed not only in the number of participants reporting whether they used hearing protection, but also analyzing what type of hearing protection they used. Thirty-one percent (n = 42) of the participants reported using hearing protection, however, this included conventional and unconventional forms of hearing protection.

Specifically, anything that was not an ear plug or hearing protection muffs was categorized as unconventional hearing protection. Some examples of unconventional hearing protection reported by the participants included: their hands, cotton balls, and paper napkins. Within those respondents reporting use of hearing protection, 57%(n = 24) reported using

conventional hearing protection (ear plugs or ear muffs); 29% (n = 12) reported using unconventional hearing protection; 10% (n = 4) reported using both; and Four percent (n = 2) did not report what they used to protect their ears.

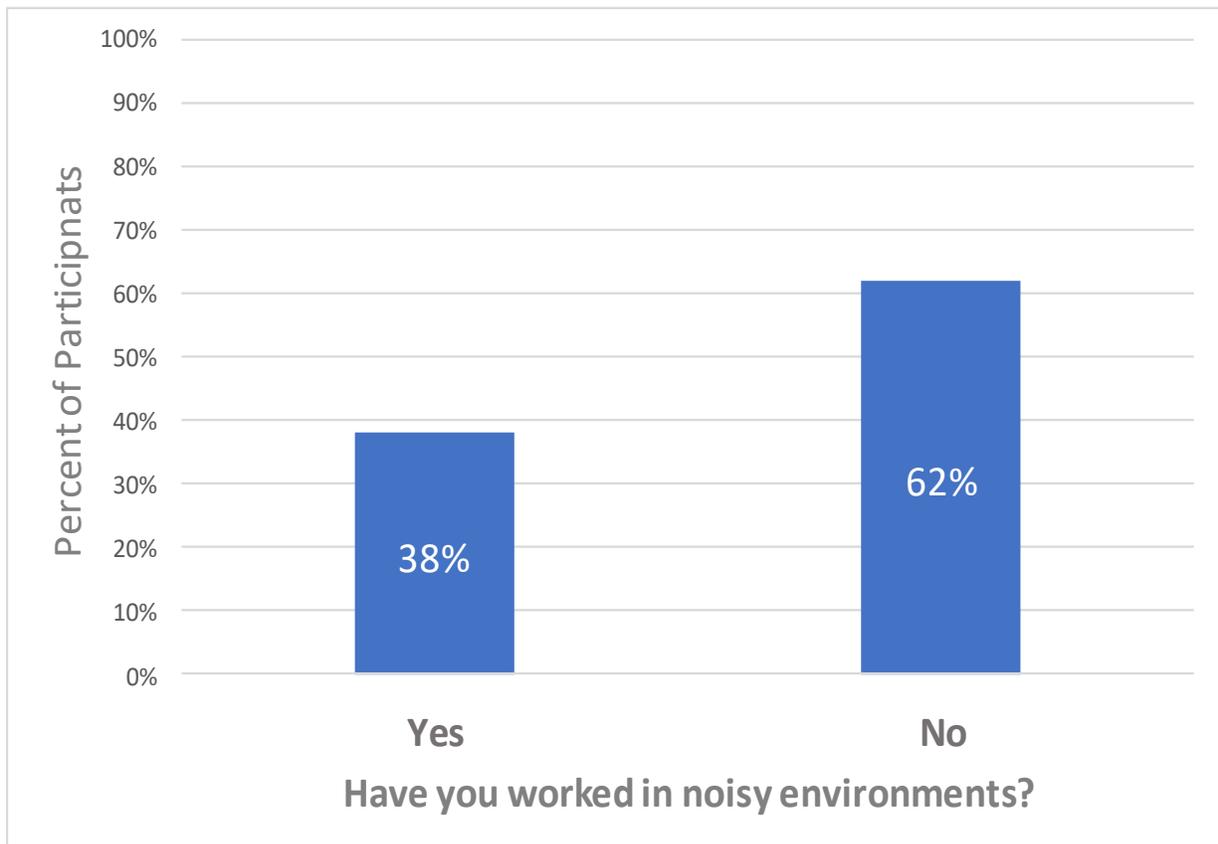


Figure 1 refers to the percentage of participants that reported having been exposed to loud noise at their workplace.

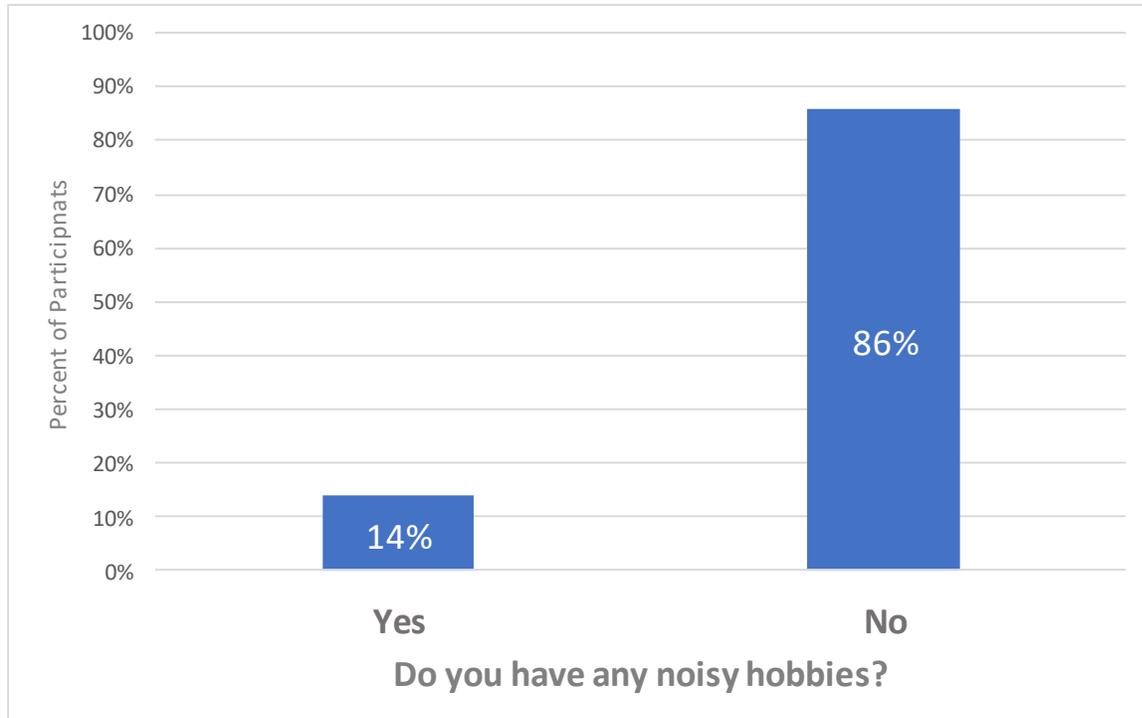


Figure 2 refers to the percentage of participants that reported having been exposed to loud noise recreationally.

Discussion

Discussion of Results

Based on the data collected from this study it was evident that participants had been or are exposed to noise occupationally and/or recreationally. A total of 38% of the participants responded 'yes' to being exposed to noise occupationally. Although, there are now entities that oversee noise exposure regulations in the workplace both in the United States and Mexico, some of the regulations were not in place by the time our participants were already of working age. For example, the NOM-011-STPS was not enacted until 2002, thus the regulations and procedures specifically from this policy may not have applied to our participants who had been members of a workforce, in Mexico, for a good amount of time before the norm went into action.

Furthermore, 29% of the participants reported having used unconventional hearing protection. This demonstrates that the participants had some knowledge about the negative effects of noise but may not have had the access to conventional hearing protection or did not have the correct education regarding the importance of wearing appropriate hearing protection. The same could be the case with the 10% of participants who reported using both, conventional and unconventional hearing protection. However, the motives are unknown as to why some participants wore unconventional hearing protection. In addition, these motives are potentially different than those of the participants who chose to not wear hearing protection at all. A separate study analyzing the reasons why people in this community do not wear conventional hearing protection could help provide insight about the knowledge and mindset of hearing protection use.

As for recreational noise exposure, 14% of the participants reported being exposed to noise recreationally. An interesting insight from this data came from the analysis of the question that pertained to noise exposure recreationally. The question asked the participant to respond ‘yes or no’ if they had a history of recreational noise exposure, and the question provided some examples of common recreational activities that were noisy. These examples included “*going to a shooting range, attending a concert, using motorcycles or listening to loud music.*” The majority of the participants were older females, who due to the generational norms of their time may not have identified with any of the examples provided by the questions.

The same issue could apply to the occupational noise exposure question. A modification of the question which would have made it more inclusive would have been the addition of vocational examples that were applicable to women of that generation, such as sewing or working as a phone operator. The border of Santa Cruz County is known for having many *maquiladoras* which are factories in Mexico that are owned by foreign entities. Many women work in these *maquiladoras*, especially the *maquiladoras* that use sewing machines (Fernandez-Kelly, 2007). Moreover, it is important to note that, if the majority of the participants had been male, the results from the *Oyendo Bien* questions that pertained to noise exposure could have been different. The examples originally provided by the questions were activities that men of that generation were more likely to participate in, based on observation and discussion with community members.

These findings will next be considered in terms of national policies in the U.S. and Mexico on hearing conservation as well as on the availability of hearing conservation programs. The broader context of the sub-study includes consideration of the setting as a border community with three ports of entry. The participant demographics reflected this community, including

primarily individuals of Mexican American or Mexican descent as participants. Although participants' work histories were not formally measured in the current study, some participants reported work backgrounds or personal histories in both countries. This provides the rationale for review of hearing conservation policies that will influence employees in a border region.

Policy Analysis

In order to further determine the need for hearing conservation education, information about noise exposure policies was reviewed. There are entities such as the Occupational Safety and Health Administration (OSHA) which create and enforce standards that pertain to noise exposure in the workplace. OSHA is part of the of the United States Department of Labor, it regulates hazardous substances in the workplace, which includes noise (Arenas et al., 2014). OSHA has the authority over this area of labor because of the Occupational Safety and Health Act (Public Law 91-596), which was passed by the U.S. Congress in 1970.

One of the directives OSHA places upon employers, is to enact a series of obligations when the noise at their workplace reaches 85 dBA such as the enactment of a hearing conservation plan. In addition, the permissible noise exposure limit (PEL) for an 8-hour workday is 90 dBA in the United States (OSHA, 1970). As of 2008, OSHA released a new directive (PER 04-00-004) that gave specific requirements for establishing a hearing conservation program at the workplace. This included instructions for noise monitoring, audiometric testing, hearing protection, training and recordkeeping. Some of the most notable instructions are as follows: Baseline and yearly audiometric testing that includes frequencies 500, 1000, 2000, 3000, 4000, 6000, 8000Hz; Noise exposure training prior to beginning work and at least once a year thereafter; Noise measurement records for 2 years; and audiometric test result records for duration of employment. From an audiological standpoint, these directives given by OSHA for

hearing conservation fill the need for hearing conservation in the workplace. Nonetheless, OSHA only observes noise exposure occupationally while noise exposure can also exist recreationally. This flaw allows an average individual who has minimal noise exposure in the workplace but substantial recreational noise exposure to receive little to no, formal education that relates to hearing conservation.

Moreover, the participants of this study were from a border community and based on the pre-assessment questionnaires, some reported having worked in Mexico as well. Mexico has their own version of OSHA which is called Secretaria del Trabajo y Prevision Social (STPS). They enact their policies based on the Mexican standard NOM-011-STPS, which allows them to regulate noise exposure at the workplace. The Mexican government based the standard from the OSHA Act which explains the many similarities between the two. For example, the PEL enacted by STPS is of 90dBA with an exchange rate of 3dB, which makes the guideline stricter than that of the United States (exchange rate of 5dB). Furthermore, as previously discussed, OSHA has specific requirements in regard to enacting a hearing conservation program at the workforce. Similarly the NOM-011-STPS gives recommendations for what a hearing conservation program should look like vocationally. However, the main difference is that while OSHA requires hearing conservation programs to follow their specific requirements the STPS only recommends that their hearing conservation program recommendations be followed.

In regard to our study, the NOM-011-STPS went into effect in 2002, by this time, the majority of our participants had already been working. This means that for several years into their employment the NOM-011-STPS had not been in effect. Furthermore, currently there exists a lack of research that investigates the enforcement of hearing conservation programs by employers in Mexico (Arenas et al., 2014). In the United States, this topic has been researched

somewhat further but some studies have shown that both employers and employees have not adhered to the policy and regulations set by OSHA (Saunders et al., 2010).

Discussion of Hearing Conservation Programs

An investigation of literature that pertained to hearing conservation education programs outside of the workforce was also completed. This was done to gain knowledge about the resources available to those who are exposed to noise outside of work. From this research it was discovered that hearing health social programs have shown to be effective as a form of audiological rehabilitation for older adults (Hickson et al., 2007). However, current research on hearing conservation education primarily exists for children and adolescents but not older adults (Saunders et al., 2010). The research about these programs for children and adolescents has indicated that hearing conservation programs are effective in promoting use of hearing protection and knowledge of consequences of prolonged noise exposure (Chermak et al, 1991; Neufeld et al., 2011). It would be beneficial for the older adult population in the United States if further research is conducted on hearing conservation education programs.

From this literature review, it is evident that more research needs to be conducted to understand the knowledge of noise exposure in populations similar to this one. This population is unique because it is comprised of a closely-knit community, experiences health disparities due to its rural location, and has an occupational history of citizens who have worked in two different countries at some point in their lives. Recreationally, the lack of resources and research in the area of hearing conservation education for those exposed to noise outside of work also demonstrates the need for education tailored to this population. In the pilot study leading up to the clinical trial, participants in post-program focus groups also raised the need for greater hearing conservation (Marrone et al., 2017), and additional information was added to the fifth

session of the program. In the future, it will also be important to analyze the clinical trial results for pre-post outcomes evaluation on hearing conservation. Finally, it will be important to analyze the trial data in terms of whether participants attended the fifth session of the *Oyendo Bien* program which has a focus on hearing conservation to see if this positively contributes to outcomes over time.

Conclusion

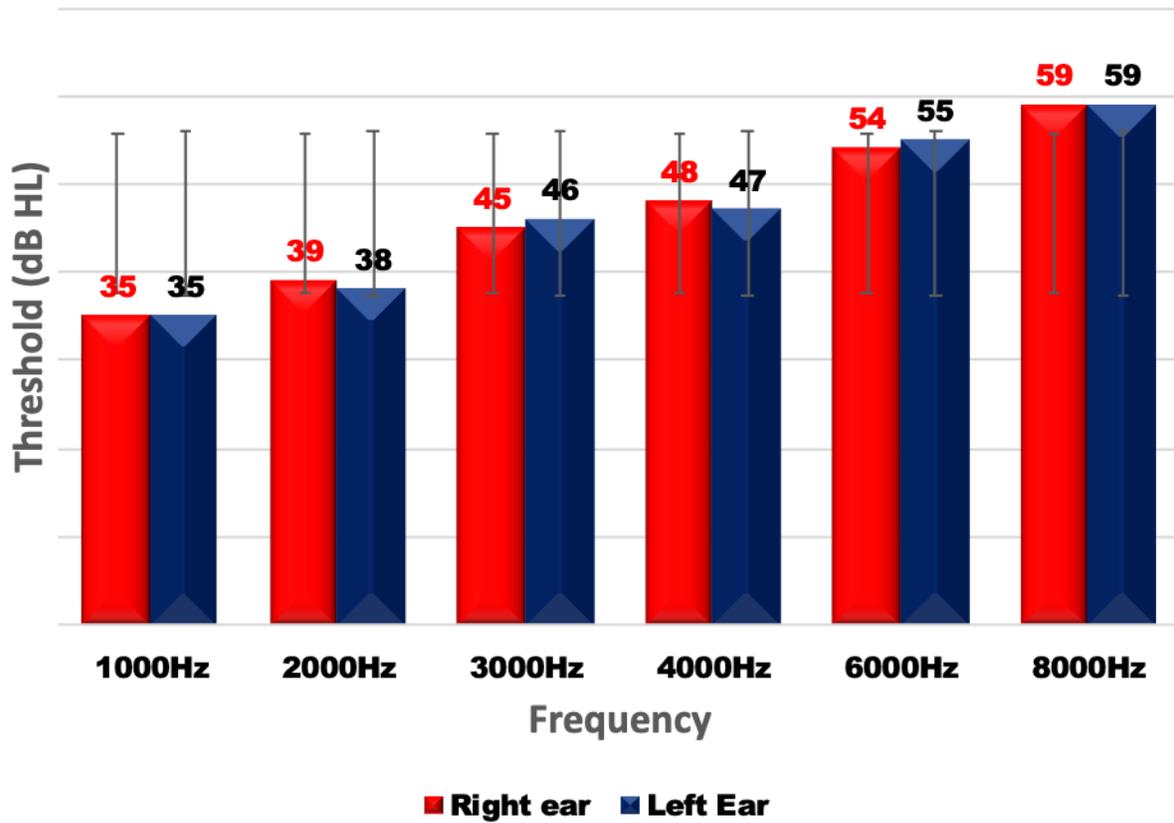
A series of factors helped determine the hearing conservation education need in this population. This population was particularly of interest because previous research had demonstrated the hearing healthcare disparities are existent in populations similar to this one. The factors analyzed for this population included the noise exposure and conservation data from the questionnaire that was delivered to the *Oyendo Bien* participants. Also, the policy that is in place for hearing conservation and an investigation of resources available to people about hearing conservation education.

Vocationally, it is evident that the need for hearing conservation education exists based on the lack of research in enforcement and the gaps in application of hearing conservation. Also, research has demonstrated that some employers and employees do not follow hearing conservation policies. In the current study there were also participants who utilized conventional and unconventional hearing protection, demonstrating that some participants had some knowledge about the topic but there was still some room for improvement and others did not know about proper hearing protection use.

Moving forward, in order to bridge the gap for the need of hearing conservation education, community hearing conservation programs may be a solution. Research has shown

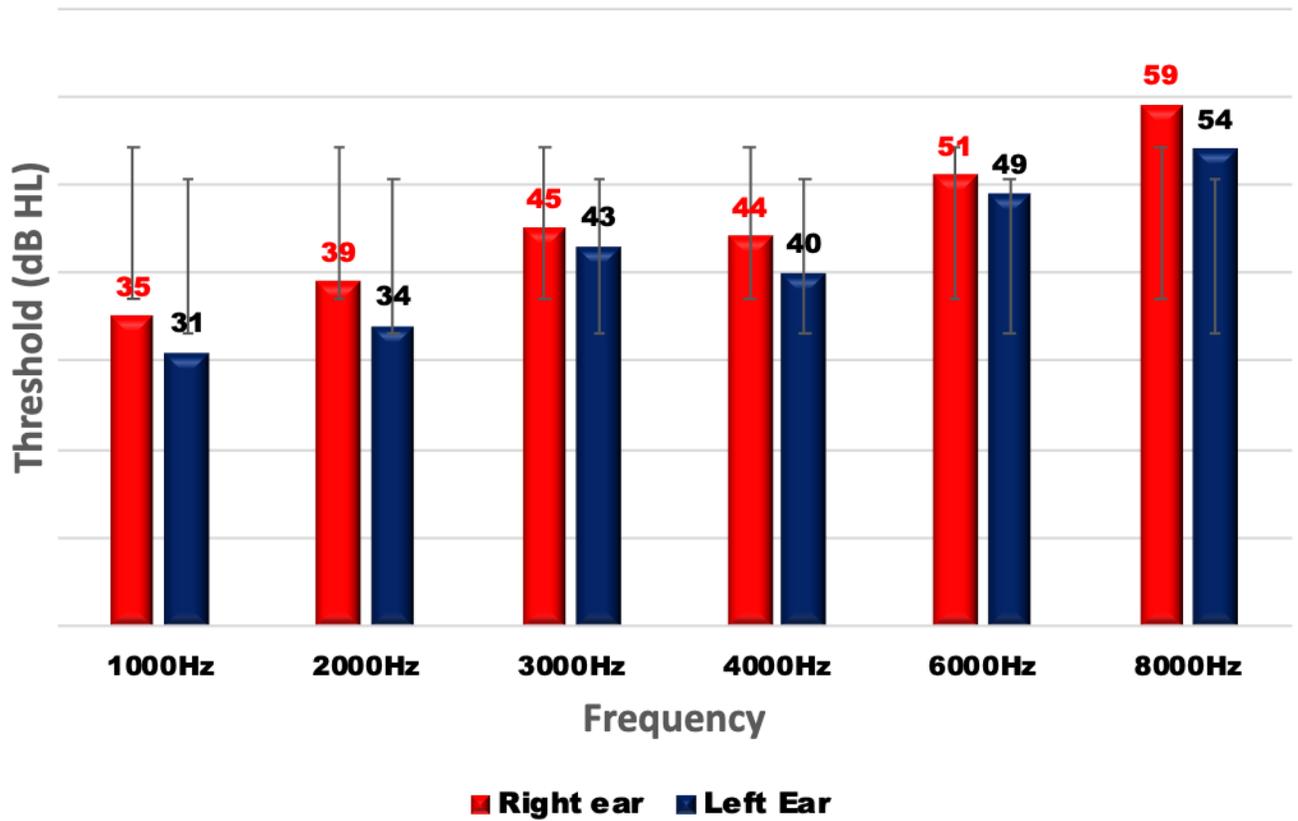
that hearing health social programs, such as the one delivered by *Oyendo Bien*, are an effective form of hearing health information delivery. The creation of a program that would focus on hearing protection and conservation could potentially fill this need in the southern Arizona communities. To further assist in the conservation of hearing from noise exposure, it would be beneficial for agencies such as OSHA and STPS to create incentives that would increase motivation of employers and employees to follow appropriate hearing conservation measures across environments. Using these types of strategies would then ensure that people who are exposed to noise, both vocationally and recreationally, have access to hearing conservation education and the motivation to preserve their hearing.

APPENDIX A – Average Hearing Thresholds of Oyendo Bien Participants (n=131)



Appendix A contains a graph of the average hearing thresholds (in dB HL) of the participants in the *Oyendo Bien* study

APPENDIX B – Average Hearing Thresholds of Female Oyendo Bien Participants (n=91)



Appendix B contains a graph of the average hearing thresholds (in dB HL) of the female participants in the *Oyendo Bien* study

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