SCREENING FOR NOISE INDUCED HEARING LOSS IN AGRICULTURAL WORKERS AND FARMERS

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Screening for Noise Induced Hearing Loss in Agricultural Workers and Farmers

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

DOCTOR OF NURSING PRACTICE

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ABSTRACT

According to the National Institute for Occupational Safety and Health hearing loss is the third most prevalent condition after high blood pressure and arthritis in the United States (U.S.) (NIOSH, 2019). An estimated 22 million U.S. workers are exposed to hazardous noise, making noise induced hearing loss (NIHL) the second most self-reported occupational disease or injury. Although most industries are regulated by government organizations such as NIOSH and the Occupational Safety and Health Administration, agriculture does not fall under regulations and policies enacted through these groups. The incidence of hearing loss is high in farmers and agricultural workers, reflecting an increased need for screening. Unfortunately, even with the high prevalence of NIHL in farming populations, there is a gap in pragmatic screening techniques among care providers.

The purpose of this practice improvement project was to a) identify and screen rural North Dakota agricultural workers and farmers in central North Dakota at risk and/or suffering from NIHL; b)provide education related to prevention of noise induced hearing loss and the use of hearing protection devices (HPDs); and c) promote referral to an appropriate health care provider. The Hear X hearScreen audiometric tool was utilized to help establish routine screening in a rural healthcare clinic. The project included using a pre-survey demographics questionnaire, the Hearing Handicap Inventory-Adult questionnaire and the Hear X hearScreen audiometric tool. Using these screening tools individuals' perceptions of hearing loss were compared to their actual hearing loss in a rural clinic setting in Steele, ND.

Screening data revealed that 72% of participants indicated a perceived hearing loss. Upon completion of the Hear X hearScreen audiometric tool, 72% of these same participants tested positive for some form of hearing loss. Over 96% of participants indicated exposure to loud

noise greater than 85dB daily. All participants were provided with verbal and written information regarding the use of HPDs as well as a document listing audiology providers within 100-miles of the rural health clinic if they were interested in further testing or treatment.

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CHAPTER 1: INTRODUCTION

Background and Significance

According to the National Institute for Occupational Safety and Health (NIOSH), hearing loss is the third most prevalent condition after high blood pressure and arthritis in the U.S. (National Institute for Occupational Safety and Health, 2019). The NIOSH further defines the extent of the problem through surveillance measures. Their findings have concluded that an estimated 22 million U.S. workers are exposed to hazardous noise, making noise induced hearing loss (NIHL) the second most self-reported occupational injury (McCullagh & Ronis, 2015, NIOSH, 2019). While many industries are served by government organizations such as NIOSH and the Occupational Safety and Health Administration (OSHA), agriculture does not fall under regulations and policies enacted through these groups (Kan et al., 2017; McCullagh & Ronis, 2015; National Institute for Occupational Safety and Health, 1998). According to the U.S. Department of Agriculture (USDA) (2017), there are 2.04 million farms and ranches in the U.S. These farms and ranches employ millions of individuals who are being exposed to hazardous noise produced throughout the workday. Furthermore, many individuals within this population underestimate their exposure to harmful noise and may lack knowledge pertaining to NIHL prevention tactics such as the use of hearing protection devices. Due to the irreversible and permanent nature of NIHL, effects extend beyond the individual and can affect his or her emotional, social, and physical functioning and extend to his or her occupation, family, and community (National Institute for Occupational Safety & Health, 2018). Some decrease of noise exposure reduction has been seen with the development of new technologies for farming and agricultural practices; for example, the introduction of the soundproof cab on large equipment. But along with technology advancements has also come new processes and equipment that

produces more intense hazardous noise, such as hydraulic cattle shoots, grain vacs, or grain bin fans. Farmers and agricultural workers should be made aware of the different decibel levels that they are being exposed to when around equipment and/or animals that may be causing them to incur a hearing injury.

When discussing hearing loss, it is important to understand that NIHL is the only preventable type of hearing loss, with reduction of hazardous noise being the most effective prevention method (NIOSH, 2018, Trung et al., 2017). Unfortunately, noise reduction is often perceived as not practical in the agricultural sector due to long workdays and the continuous deviation in work tasks. As the incidence of hearing loss is high in farmers and agricultural workers, there is a compounded need for screening among this population. Unfortunately, even with the high prevalence of NIHL in these populations, there is a gap in the literature concerning the application of screening techniques among primary care providers (McCullagh & Frank, 2012).

Additionally, due to health disparities hearing health services, such as conservation programs and audiometric testing, may not be offered in rural areas. Farmers and agricultural workers are often located in rural areas where healthcare services may not be as accessible, and they may experience deficits before their risk for NIHL is identified. Health care providers working in these areas may also be limited due to time scheduled with patient visits that may not accommodate screenings especially if they are the only provider in the facility. Due to these barriers to screening in rural areas, there is a need for more feasible methods for identifying individuals at risk. Therefore, the utilization of a self-administered hearing questionnaire accompanied by a simple audiometric screening tool may be a simple, low cost opportunity to

screen high risk individuals, and to initiate a referral for further hearing evaluation (Louw et al., 2018; McCullagh, 2012).

Problem

As farmers and agricultural workers are frequently exposed to hazardous levels of noise, they are often placed at high risk for hearing damage. NIHL is a progressive, incurable, permanent injury that is typically characterized by loss of hearing at higher frequencies (McCullagh et al., 2016; WHO, 2015). Unfortunately, hearing deficits often go untreated and unnoticed in early stages, and individuals are often unaware of a deficit until the hearing loss is already moderate to severe (McCullagh et al., 2016). According to the World Health Organization (WHO), over 600 million people are at risk for NIHL globally, with 1/3 of those cases being attributed to hazardous noise exposure (Le et al., 2017). Hazardous noise is defined as noise greater than 85 decibels (dB) (i.e. tractor at idle speed) (NIOSH, 1998). Short-term exposure to noise above 85 decibels may cause temporary impairment and tinnitus, while long term exposure can result in permanent, irreversible hearing damage. The difference in short-term and long-term hearing loss will be discussed further in the literature review portion of the paper. Unfortunately, as a growing public health issue, the concept of NIHL remains neglected in the U.S.

When compared to other industries, agriculture has a high prevalence of hazardous noise exposure placing many farmers and agricultural workers at a higher risk for hearing loss (Choochouy et al., 2019). Technological advances as well as increased labor demands in the agricultural sector have amplified noise exposure and the potential for NIHL. In their 2019 report, the United States Department of Agriculture (USDA) estimated there to be 2,023,400 farms in the United States. These farms employ millions of employees nationwide that are

exposed to hazardous noise. According to 2021 State Agricultural Overview published by the USDA, North Dakota is home to an estimated 26,000 farming operations. Additionally, the USDA (2017) reported 96% of all farms and ranches were family owned; thus, along with farmers and agricultural workers, their families are most likely also exposed to hazardous noise. Although NIHL has been recognized as a preventable occupational disease, little has been documented about agricultural work settings to help decrease the prevalence of hearing loss caused by hazardous noise. Unlike workers in other occupations, systems to protect individuals from NIHL are not present in the agricultural setting because most farmers are not protected by NIOSH and OSHA regulation standards (McCullagh et al., 2016).

NIHL can negatively affect an individual's quality of life, including one's emotional and physical functioning, employment, and social life. Furthermore, along with being costly for the individual patient, NIHL creates additional healthcare costs in the form of workers' compensation claims and medical costs (McCullagh et al., 2016). All these things combined can create social and economic burdens on rural communities and families. Several federal agencies including Healthy People 2020, the National Institute for Occupational Health and Safety, and the National Institute of Health (NIH) recognize NIHL as a detrimental health concern and have made prevention a priority (McCullagh et al., 2016). Studies have shown an increasing need for services and programs to increase hearing protection use among agricultural workers and farmers (Strawbridge et al., 2017; Wallhagen et al., 2017; Zazove et al., 2020).

Farmers and agricultural workers are often exposed to hazardous noise produced by equipment and livestock. Many of these workers underestimate daily exposure to hazardous noise and have a knowledge deficit pertaining to how high decibel noise may contribute to permanent hearing loss. Unfortunately, HPDs are grossly underutilized within this population,

even when the detrimental health effects of hazardous noise are understood. Historically farmers have been their own safety specialists and solely decide what type of HPDs to use and when to use them. Prevention is key when discussing NIHL, making HPDs a crucial safety device within the agricultural sector. Unfortunately, even though it is well known that the use of HPDs can prevent NIHL, the use of these devices among farmers and agricultural workers is low (McCullagh et al., 2016). McCullagh et al. (2016), further discussed barriers that contribute to lack of utilization of HPD's within this population. Examples of barriers to use of HPD included the frequent changing of tasks throughout the workday and the need for intermittent protection due to changing noise exposure (McCullagh et al., 2016). Thus, based on the literature the use of HPD's serves as an effective preventative measure for NIHL, but are often underutilized by workers in the agricultural sector.

According to the United States Preventative Services Task Force (USPSTF), hearing screening measures promote early detection and treatment of hearing loss and can improve quality of life [United States Preventative Services Task Force, 2021]. Although the prevalence of NIHL is high, the frequency of hearing screening among providers remains low due to multiple barriers within the rural primary care setting (Zazove et al., 2020). There is a lack of literature pertaining to screening protocols and current hearing screening practices within the primary care setting. Currently, screening is heavily reliant on the patient's self-report of a concern or noted concern on an intake form. Understanding the prevalence of hearing loss is important so that barriers to hearing assessment in primary can be explored and criteria for screening individuals for NIHL in the primary care setting can be established (McCullagh & Frank, 2012).

Purpose Statement

The purpose of this practice improvement project is to a) identify and screen rural North Dakota agricultural workers and farmers in central North Dakota at risk and/or suffering from NIHL; b) provide education related to prevention of NIHL and the use of HPDs; and c) promote referral to an appropriate health care provider. Additionally, a reliable hearing screening tool will be utilized to help establish routine screening in a rural healthcare clinic.

Objectives

The following objectives will help guide this project:

1. Identify and screen rural North Dakota farmers and agricultural workers at risk or suffering from NIHL at an agricultural event and/or at a rural health clinic.
2. Provide and explain verbal and written results to participants at the time of screening based on their perceived hearing loss results vs. their actual hearing loss results.
3. Categorize participants based on their cumulative score from the Hearing Handicap Inventory-Adult screening tool (Appendix D) and results from the Hear X hearScreen audiometric screening tool and make a referral if appropriate.
4. Provide education to all participants on the health consequences of NIHL, the benefits of utilizing HPDs, and steps to help overcome barriers to protection devices using a participant handout.

CHAPTER 2: THEORETICAL FRAMEWORK AND LITERATURE REVIEW

Theoretical Framework

Health Promotion Model

Overview of the Health Promotion Model

According to Murdaugh et al. (2019) the revised health promotion model (HPM) serves as framework to predict health behaviors by integrating nursing perspectives and health behavior science. Using this model researchers can predict how individuals engage in health promoting behaviors, and how they interact with their personal and physical environments regarding their own health. The original HPM focused on the following factors: a) importance of health to the individual; b) in individuals perceived control of their health; c) their personal definition of health; d) their perceived health status and self-efficacy; e) perceived barriers and benefits to certain health behaviors; f) demographic and biological characteristics; g) behavioral factors; and h) situational and interpersonal influences (Murdaugh et al., 2019). With the revision of the model, three new concepts were added to the framework including commitment to a plan of action, activity related effect, and immediate competing demands and preferences. Additionally, the revised HPM also created three broad categories for the above factors, individual characteristics and experiences, behavior-specific cognitions and affect, and behavioral outcome. (Murdaugh et al., 2019).

Individual Characteristics and Experiences. Within this category individuals prior related behavior and personal biological, psychological, and sociocultural behaviors are examined.

Prior Related Behavior. Prior related behavior is an important aspect of this model as it can predict if an individual will participate in a behavior change intervention. Murdaugh et al.

(2019) explain how individuals health behaviors are directly influenced by habits. Habits strongly influence human behavior. As behaviors or habits continue to occur the stronger that behavior becomes. Correlations can be made when discussing health promotion behaviors. The more the health promoting behavior occurs, the stronger and more repetitive that behavior will become. Health promoting behaviors can be influenced by many factors including previously held perceptions related to benefits, barriers and self-efficacy. It is important that the above factors be investigated to ensure individuals can successfully engage in the health promoting behavior.

Personal Factors. Personal factors are categorized into the following groups: a) biological (age, body mass index); b) psychological (self-esteem, self-motivation, perceived health status); and c) sociocultural (race, ethnicity, acculturation, education, and economic status) (Murdaugh et al., 2019).

Behavior-Specific Cognitions and Affect. Another key component of the HPM is behavior-specific cognitions and affect. Variables within this component include a) perceived barriers and benefits; b) self-efficacy; c) activity-related affect; d) interpersonal influences; and situational influences (Murdaugh et al., 2019). These variables are an important part of the model in that they can be changed or revised through the intervention. Additionally, they aid in evaluation of project interventions.

Perceived Benefits of Action. Perceived benefits of action simply are what the individual believes the benefits will be of performing a certain behavior. As individuals better understand the positive benefits of an action, they will be more likely to continue to perform that same action (Murdaugh et al., 2019). For example, if an individual understands that exercise may prevent them from developing heart disease, they may be more likely to exercise.

Perceived Barriers to Action. According to Pender's HPM, barriers to action can include the following: a) if the individual views the behavior as time consuming; b) if the behavior change is costly; c) and if the behavior change may cause inconvenience to the individual (Murdaugh et al., 2019). Barriers further decrease the likelihood that an individual will commit to a plan of action and take part in the behavior change.

Activity-Related Affect. The concept of activity related affect includes components that determine if the individual will make a sustainable, long term change. And includes the concepts of emotional arousal to act, self-acting, and environment in which the activity takes place Murdaugh et al., 2019). It is important to remember that positive and negative outcomes greatly affect if a behavior will be repeated. When initiating a health promotion behavior change it is imperative that all positive and negative behavior outcomes are explored to ensure feasibility and sustainability of the behavior change.

Interpersonal Influences. Social support, modeling or learning through others, and social norms or the beliefs of others greatly affect how likely and individual will be to make a behavior change.

Situational Influences. Murdaugh et al. (2019) note that situational influences may directly or indirectly affect an individual's behavior. By examining potential situational influences one can determine what perceptions individuals may have regarding their options for change, and the characteristics of the environment in which the behavior change may take place. This is a crucial component of the model as situational influences can significantly affect an individual's likelihood of make a behavior change, and the future sustainability of that change.

Commitment to a Plan of Action. Commitment to a plan of action was added to the revised HPM. Its focus is to determine if a plan of action should be created. Murdaugh et al.

(2019) state that to assist individuals in taking action the plan should include a commitment to carry out the plan of action in a specific place, at a specific time, and that there should be proper identification of methods to begin, conduct, and reinforce behaviors.

Immediate Competing Demands and Preferences. Another addition to the revised HPM is immediate competing demands and preferences. Immediate demands can include things in which the individual has no control over, such as work or family responsibilities. Competing demands or demands that and individual does have control over. For example, eating fast food over healthy fruits and vegetables. According to Murdaugh et al. (2019), both immediate and competing demands represent a danger to the likelihood of an individual initiating a behavior change.

Behavioral Outcome: Health Promoting Behavior. The outcome of the HPM is a health promoting behavior. This health promoting behavior results in increased functional ability, and improved health and quality of life (Murdaugh et al., 2019).

Integration of the Revised Health Promotion Model

Nola J. Pender's Health Promotion Model (HPM) will be used to help guide the development and implementation strategies of this practice improvement project. (see Appendix G). Interventions for this practice improvement project will focus on behavior changes related to farmers and agricultural workers, more specific their perceptions and attitudes on hearing loss and the use of hearing protection devices in the agricultural sector. Multiple studies have utilized Pender's HPM as conceptual framework to help guide targeted interventions related to hearing loss in this population (McCullagh et al., 2016; McCullagh, 2011; McCullagh & Ronis, 2015; McCullagh et al., 2002; Rosemberg et al., 2015).

Individual Characteristics and Experiences. These criteria are important to identify in farmers and agricultural workers former related behaviors related to hearing conservation and the use of hearing protection devices. Historically, literature has shown lack of knowledge related to the harmful, irreversible effects of hazardous noise as well as suboptimal use of hearing protection devices in the agricultural sector (Humann et al.,2012; McCullagh, 2010; McCullagh et al., 2016). As previously noted, prior behaviors and habits can strongly influence an individual's decision to make a behavior change. To create an opportunity for a positive behavior change, results of the Hearing Handicap Inventory-Adult questionnaire and the Hear X hearScreen audiometry tool will be utilized to help educate participants on their perceived hearing loss versus their actual hearing loss. Additionally, education will be provided on hearing protection devices and other conservation methods and why they would be beneficial to the individual. Through this educational intervention, prior related behaviors and experiences may be influenced to create a sustainable habit which will increase in strength as the behavior is repeated. For this practice improvement project, personal factors are limited to those relevant to explaining or predicting a given behavior. Farmers and agricultural workers will be asked to rate their perceived hearing health prior to implementation of hearing screening methods.

Behavior-Specific Cognitions and Affect. In this category of the HPM perceived barriers and benefits to action and interpersonal and situational influences are explored. Each of these concepts are important to this practice improvement project as they can be altered and changed throughout the course of project interventions.

Perceived Benefits of Action. According to Rosemberg et al. (2015) perceived benefits of an action relate to how valuable the behavior change will be to the individual. By expanding knowledge about hazardous workplace noise and potential long-term negative health effects,

farmers and agricultural workers can make better hearing health choices. These choices could include utilizing noise reduction strategies and wearing appropriate HPDs. Benefits of these actions would include a decrease in risk for NIHL, the need for hearing assistive devices later in life, and decreased risks of co-morbidities associated with NIHL leading to higher quality of life and improved health outcomes. By screening farmers and agricultural workers for NIHL, awareness will be created about the participants current hearing loss risk and provide for an opportunity for patient teaching and education on the harmful levels of noise.

Perceived Barriers of Action. *P*erceived barriers are determined by how much the individual must "give up" and instances that would prevent the individual from making the behavior change (Rosemberg et al., 2015). Like perceived benefits, perceived barriers can be significant predictors of farmers and agricultural workers use of behaviors pertaining to their hearing health. Multiple barriers are noted when discussing hearing conservation and the use of HPDs in the rural population. Additionally, barriers related to screening in rural areas also create further obstacles to optimal hearing preservation and obtainment of knowledge related to hearing loss prevention methods. Some of the most common barriers noted with the use of HPDs are that they are uncomfortable and inconvenient, and that they cause interference when trying to hear and work with other people (McCullagh et al., 2011; Rosemberg et al., 2015). Other concerns pertain to the availability of different types of HPDs in the agricultural setting. Due to the nature of farming and agricultural work, tasks are changed frequently resulting in intermittent exposure to varying levels of hazardous noise, requiring different types of HPDs. Having to carry HPDs for each task being completed throughout the day presents a significant barrier to their use in agricultural work.

Interpersonal Influences. The use of HPDs and employment of hearing conservation strategies in privately owned farms and agricultural related businesses can be directly influenced by the expectations of others, an individual's social support, and through modeling or by observing others. As the use of HPDs is low throughout the entire industry, farmers and agricultural workers lack social support, modeling, and are most likely not held to any expectations related to the use of HPD use. If family members or co-workers do not think that hearing protection devices are important, the individual themselves may not find any value in wearing them either. Through the systemic change of attitudes and beliefs related to hearing loss and its additional health implications, family support and modeling for the use of HPD and hearing conservation methods may start to increase.

Situational Influences. Situational influences may play a roll the lack of hearing conservation efforts and non-use of HPDs by farmers and agricultural workers. Farm and agricultural work occur in a unique environment; tasks are continuously changing and there are many cases with no definite set schedule of tasks that are to be completed for the day as seen with other industries. As mentioned above, due to frequent changes in tasks the use of HPDs and hearing conservation methods can be difficult. Farmers and agricultural workers may be in multiple shops, grain bins, and tractors each day requiring them to carry HPDs on them or have a set at each different location. Changes in seasons also make the use of HPDs difficult, for example in the summer HPDs may be perceived as being uncomfortable during hot temperatures. Other situational influences that could affect the use of HPDs includes that farmers and agricultural workers may lack health insurance to cover the costs of screening, and they may lack the general knowledge related to the detrimental effects of hazardous noise. Additionally, due to geographic location, many rural healthcare clinics lack funding, have fewer resources, and deal

with much greater problems such as poverty. This creates limited access to health care for farmers and agricultural workers.

The Iowa Model of Evidence Based Practice

Overview of the Iowa Model of Evidence Based Practice

The Iowa Model of Evidence-Based Practice to Promote Quality Care will also be used to guide this practice improvement project (See Appendix E). Developed at the University of Iowa Hospitals and Clinics, the Iowa Model "serves as a framework to improve patient outcomes, enhance nursing practice, and monitor health care costs" (Taylor-Piliae, 1999, p. 357).

Topic Selection. The first step in the Iowa model is to choose a topic. This topic can be chosen by identifying problem and or knowledge focused triggers which indicate a practice change is needed. According to Brown (2014), problem focused triggers include issues that derive from financial data, risk management data, or the identification of a clinical problem. Whereas knowledge focused triggers focus on new research or implementation of new practice guidelines (Brown, 2014).

Team Assembly. Once a topic for the practice change has been chosen a team must be formed to create, execute, and evaluate practice change. This group should include interdisciplinary stakeholders chosen on their hypothesized contribution to the project. Once a team has been formed, members should then work to collect and analyze relevant literature related to the project topic (Brown, 2014).

Assembly of Research and Related Literature & Critique. Several criteria have been suggested to help determine if relevant research can be used for a practice change. Titer et al. (2001) suggest the following criteria be considered when conducting research: a) the type and quality of the research; b) if there are multiple studies with similar findings that support the

practice change; c) if the findings are clinically relevant; d) if the studies found are practical and relevant to practice; and e) if the studies found have similar sample characteristics. Within this step Brown (2014) suggests that the team should decide if there is enough pertinent evidence to support a practice change.

Piloting the Practice Change. The next step is piloting the practice change if applicable to the project. By piloting the intervention, the team can assure that goals and objectives are feasible, prior to initiation of the project. In this step baseline data is collected and outcomes discussed. Additionally, establishment of evidence-based practice guidelines, along with modification and evaluation of the project plan and outcomes should occur. A crucial component to the Iowa Model of Evidence Based Practice is continuous evaluation; even though the project may be implemented, ongoing evaluation of the intervention should take place (Brown, 2014). Lastly, as clinicians are prepared for a practice change, all barriers, constraints, and resources should be evaluated. The practice improvement project will be promoted throughout this step to encourage acceptance of the proposed change, and an implementation plan will be created.

Implementation Strategies. A critical step to the Iowa model is providing a framework for project implementation strategies. In their article, Cullen and Adams (2012) provide application-focused guidance to coordinate, plan, and choose approaches for implementation of evidence-based practice changes. Through a four-phase method their model helps create strategies that raise awareness and interest, generate knowledge and dedication, encourage action and adoption of interventions, and integration and sustained use (Cullen & Adams, 2012).

Incorporation of the Iowa Model of Evidence Based Practice

The Iowa Model of Evidence Based Practice will be used as framework to help guide this practice improvement project.

Topic Selection. The topic for this practice improvement project, screening for NIHL in agricultural workers and farmers was identified through problem and knowledge focused triggers and the identification of a clinical problem. Problem focused triggers include that farmers and agricultural workers are exposed to harmful levels of loud noise, they may underestimate how harmful these levels are, they do not wear HPDs, they lack knowledge related to additional health consequences that hearing loss may cause, and do not undergo appropriate screening. Other problem focused triggers include that primary care providers lack knowledge related to hearing screening tools, there is a lack of routine screening protocols in the rural clinic setting, and possibly the lack of resources. This project also identifies knowledge focused triggers including the need for new practice guidelines related to screening by primary care providers in the clinic setting and establishment of OSHA guidelines in the agricultural sector.

Through the utilization of a hearing screening questionnaire and pure tone audiometry testing individuals' perceptions of hearing loss versus actual hearing loss will be explored. A collaboration will be made between Four Season's Wellness in Steele, ND, were hearing screening will take place, and the appropriate referrals made. A second screening event will be held during the Agricultural Awareness Night hosted by the North Dakota State University Extension Service: Kidder County and the Kidder County Farm Bureau. At the time of screening education will be provided to individuals on hearing health and the use of hearing protection devices.

Forming a Team. The second step in the Iowa model is the formation of a team. Four individuals were assembled to help the co-investigator develop, implement, and evaluate this practice improvement project. The team is composed of: a doctor of nursing practice (DNP) graduate student (co-investigator), a family nurse practitioner and graduate school faculty

member, Dr. Dean Gross (committee chair), a family nurse practitioner, Dr. Heidi Saarinen, a family nurse practitioner, Kerri Benning, family nurse practitioner, and a graduate school appointed faculty member, Dr. Daniel Friesner.

Assembly of Research and Related Literature & Critique. With the assistance of a health science librarian, a literature review was conducted of current clinical guidelines related to audiology screening practices, current workplace regulations, hearing loss prevention, barriers to use of hearing protective devices, and the social and psychological effects of hazardous noise and hearing loss in the workplace. After the literature review a determination was made that there is enough, relevant evidence on the topic of NIHL in agricultural workers and farmers that a change in practice is warranted. The project literature review did reveal that there are significant gaps in knowledge pertaining to NIHL in farmers and agricultural workers as well as lack of utilization of screening tools in primary care settings. Therefore, a need has been identified for improved knowledge pertaining to NIHL within the rural population as well the need for reliable screening protocols in rural primary care settings.

Design and Piloting the Practice Change.

Piloting the Practice Change. No piloting is needed as prior studies have demonstrated the validity of the screening tools being implemented.

Selecting Outcomes to be Achieved. Literature and research evidence, clinical guidelines, and the purpose of the project provided direction for selecting outcome indicators.

Short Term Outcomes. Short term outcomes included a) the provider and participants will become more aware of reliable, cost effective hearing screening methods to detect those at risk or suffering from NIHL; b) the participating family nurse practitioner will be provided with the skills, training, and tools to provide cost effective and reliable hearing screenings for patients;

c) participants and the provider will become more knowledgeable about the importance of hearing screening and the use of HPDs, d) all participants will be provided with verbal and written education about NIHL, general hearing health, and options for the use of HPDs; d) when warranted, participants will be provided with a recommendation for further audiometric testing.

Long Term Outcomes. If benefits to participants are achieved, then specific changes in the community may occur: a) a change of practice may be initiated at the rural healthcare clinic resulting in increased screening of individuals for hearing loss and referral as appropriate; b) participating members of the community will be provided with a reliable, cost effective tool to help identify individuals at risk and those suffering from NIHL; c) a behavior change among farmers and agricultural workers will take place resulting in better hearing heath practices and the use of HPDs; d) a contribution will be made to the knowledge base utilized by occupational health organizations to help promote industry wide best practice related to hearing health and HPD use; and e) awareness in the community will be raised pertaining to NIHL, hearing health, hearing screening opportunities, HPDs, and hearing enhancement devices.

Choose an Evidence-based Screening Tool and Audiometric Tool to Guide the Screening Methods of the Project. For this practice improvement project, the Hearing Handicap Inventory-Adult will be utilized. By using this hearing screening questionnaire, each participant's individual perceptions of hearing loss will be assessed. Individuals hearing will then be screened using the Hear X hearScreen audiometry tool. Using these two screening methods, individual's perceived hearing loss will be compared with their actual hearing loss, and individuals at risk and/or suffering from NIHL will be identified. Results from both tools will be compiled and disseminated at the time of the screening to the participant. Results will be explained to the individual along with the need for possible referral for further treatment.

Collecting Baseline Data. Baseline data will be collected from the primary care provider at Four Seasons Wellness on the current average number of individuals being screened for hearing loss at this specific site. Information will be retrieved on the clinic's health intake questionnaires and reviewed for any information on hearing loss collected at the time of check-in or new patient registration. Electronic health record strategies will also be explored to understand if any prompts or reminders are being used to promote hearing screening during yearly wellness visits. Data will be collected to improve understanding of the facilities current practices and need for reliable hearing screening methods to help provide their patients with high quality patient care

Prepare Provider to Promote Adoption. The practice improvement project will be promoted through communication with the primary care provider at Four Seasons Wellness in Steele, ND and presentation of a clear, concise plan of action. Evidence-based research and guidelines will be presented to the provider on a screening method for NIHL, and how early detection and referral of those at risk and or suffering from hearing loss can help promote hearing health in their practice. Additionally, step by step guidelines for a practice change in their clinic will be proposed, evaluated, and revised based on that primary care providers recommendations. Additionally, promotion of free hearing screenings at the Agricultural Awareness Night will be promoted through communication with the North Dakota State University Extension Service: Kidder County.

Develop a Localized Protocol. For this practice improvement project, farmers and agricultural workers 18 years and older will be screened using the Hearing Handicap Inventory-Adult and Hear X hearScreen audiometry tool. Both male and female participants will be included. Each participant will fill out a demographic form with their gender, age, occupation, if

they already have or wear a hearing assistance device, and answer questions pertaining to the amount of noise exposure they encounter on a typical workday. Once the demographic questionnaire is complete, individuals will then be given the Hearing Handicap Inventory-Adult questionnaire to fill out. Upon completion results will be tallied and a score assigned indicating if the individuals have any type of emotional or social handicaps due to hearing loss. Finally, participants will then be screened using the Hear X hearScreen audiometry tool. Results will be printed and given to the participant. Scores between the Hearing Handicap Inventory-Adult questionnaire and the HearX hearScreen audiometry test will be discussed with the patient and if needed information on possible referral for further audiologic testing. Informational flyers and brochures on hearing loss, and hearing conservation methods will be provided to each participant along with a list of audiology providers within a 100-mile radius.

Implementation Strategies. To support the implementation of the Hearing Handicap Inventory-Adult screening questionnaire and the Hear X hearScreen audiometry tool in a rural healthcare setting, a culture of evidence-based practices must be embraced by the primary care provider. To support the progression of the practice improvement project frequent communication with the clinic and primary care provider will be maintained. Strategies to promote implementation of this practice improvement project, provided by the Iowa Model's Implementation Strategies for Evidence-Based Practice will include creating strategies that raise awareness and interest, generating knowledge and dedication, encouraging action and adoption of interventions, and integration and sustained use (Cullen & Adams, 2012).

Creating Awareness and Interest. The co-investigator will distribute key evidence highlighting the advantages of the screening for NIHL in the rural healthcare clinic setting and

before/during the Agricultural Awareness Event and to evaluate the impact that can be made. Through personal conversations with the rural primary care provider interest will be created.

The *Steele Ozone and Kidder County Press* will be utilized to create awareness about the free hearing screenings at the rural healthcare clinic and the Agricultural Awareness Event. Informational flyers will be placed in local businesses and sites frequently visited by agricultural workers and farmers throughout Kidder County to promote free hearing screenings.

Building Knowledge and Commitment. In addition to hearing screening guidance in the rural healthcare setting, education will be provided to the rural health care provider and participants related to hazardous noise in the agricultural workplace. For both the provider and participant, education will focus on examples of harmful noise levels, the use of HPDs and their benefits, the long-term effects of NIHL, and other co-morbidities caused by the condition (handouts). The co-investigator will provide this knowledge in hopes of voluntary behavior changes such as noise reduction strategies or utilization of HPDs by the participants to help reduce their risk. Education focused on reliable evidence-based screening methods and their importance in primary practice will be given to the provider.

Promoting Action and Adoption. The co-investigator will demonstrate the usability and workflow of the hearing screening tool in a meeting with the nurse practitioner at the rural health clinic prior to the implementation of the project. The health care provider will be encouraged to make suggestions related to the screening questionnaire and workflow of the proposed practice change, and modifications will be made based on further discussion. Barriers to utilization will also be discussed and taken into consideration. To promote action and adoption of a behavior change, participants will be provided with education related to NIHL and its long-term detrimental effects on an individual's health. The use of HPDs will be discussed as well as the

individuals perceived barriers. Participants results will be reviewed/discussed, and, if warranted a referral will be made for the appropriate care.

Pursuing Integration and Sustained Use. To help promote integration and sustainability of screening methods in the primary care setting copies of the Hearing Handicap Inventory-Adult screening questionnaire will be given to the rural healthcare clinic in Steele, ND. Education will be provided on the importance of integrating this screening questionnaire into the clinics intake form and addressing the given information in the patient visit if warranted.

For participants, sustained use of HPD is a vital component of their hearing health and overall well-being. By relaying that the individuals perceived hearing loss may not be conclusive with their actual hearing loss, a positive behavior change could be made. Through the creation of knowledge related to the harmful long-term effects of noise we can expect that farmers and agricultural workers would want to help protect their hearing and prevent future problems.

Literature Review

An Overview of Sound and Hearing

To understand the topic of NIHL an understanding of the basic anatomy of the ear, its surrounding structures, and how sound travels through these structures to the brain is needed. As air molecules oscillate or move back and forth in substances such as water, air, or solid materials they create the sounds we hear (Johnson & Martin, 2010). It is often thought of that sound waves act as invisible air that ripples across space, like water rippling if a coin is dropped into the water. (Murphy & Harshman, 2012). As sound waves, which can also be thought of as vibrations, ripple back and forth they travel through the ear and are interpreted by the brain. In the brain, the primary and secondary auditory cortex play a vital role in deciphering these vibrations and allow the body to interpret and recognize the sound (Johnson & Martin, 2010).

Pathway of Sound

Sound waves travel through the air and enter the external ear which consists of the ear canal and pinna. When discussing hearing loss, focus is placed on the structures of the inner ear which consist of the vestibular system and cochlea. After traveling through the external ear, sound is directed through the ear canal to the middle ear also known as the tympanic membrane or ear drum (Johnson & Martin, 2010). As these waves continue to travel through the tympanic membrane, they meet the ossicles, also known as the three middle ear bones: malleus, incus, and stapes (Chen et al., 2020). Through a resonance effect, these vibrations are then transmitted from the stapes, a horseshoe shaped bone to the elliptical window attached to an organ called the cochlea.

The cochlea is a snail shaped fluid filled organ responsible for housing the Organ of Corti and hair cells that transmit sound impulses to the auditory nerve. Located within the cochlea, the Organ of Corti plays a very important role in the transmission of sound. The Corti houses both the inner and outer hair cells which play a vital role in the relaying of acoustic information and the amplification of sound-induced vibrations (Chen et al., 2020). Vibrations stimulated by the stapes create waves of fluid throughout the cochlea. These waves then stimulate hair cells to rise and fall. Perched on top of these hair cells are microscopic hair-like projections called stereocilia (National Institute on Deafness and Other Communication Disorders [NIDCD], 2014/2019). As these stereocilia start to move and bend, pore like channels at the tips of these follicles start to open. As these channels open, potassium and calcium flow into the cell creating an electrical signal or action potential. The auditory nerve then carries this electrical signal to the brain; the signal is translated into a sound that we understand and recognize (NIDCD, 2014/2019).

Hair Cells. A crucial component of the auditory system is the hair cells which line the inside of the cochlea. Through shearing forces on the stereocilia of the hair cells, sound can be perceived (Rabinowitz, 2000). When this shearing force becomes excessive, cellular overload can occur causing cell damage and death. NIHL occurs with this damage and death of hair cells, and unlike amphibian and bird hair cells, human hair cells do not regenerate (Le et al., 2017; NICDC, 2014/2019).

Character of Sound

Sound has three basic characteristics: a) loudness/amplitude; b) pitch/frequency; and c) timbre. These characteristics depend on the properties of the vibrating source, the medium through which sound travels, and on the initial force (Johnson & Martin, 2010).

Loudness (Amplitude). Loudness or the intensity of sound is measured by sound pressure levels in decibels (dB). Sound can travel through different mediums such as air, water, bone, and metal, but the propagation of the sound wave can be affected by the medium through which sound is traveling, causing a gain or loss in energy (Madison et al., 2014). Hazardous sound exposure and hearing loss is directly related to the intensity of sound and length of exposure. If the energy associated with the sound is too loud, or if that sound lasts too long sound will overstimulate hair cells and leave them in a flattened state (Penn, 2012). This will then interfere with nerve impulses sent to the brain. According to the NIDCD (2014/2019) prolonged or repeated exposure to sounds over 85 dB can cause progressive hearing loss. The longer the duration and higher the intensity of the noise, the greater the damage will be to the inner ear (Chen et al., 2020, Hong et al., 2013). The dB scale ranges from 0 dB to over 160 dB, which is the range from the softest sound an individual may be able to hear to that of a firework show (NIDCD, 2014/2019). Normal conversation produces a dB level on average of 50-60 dB,

whereas a combine harvester produces readings of 80-105dB (Murphy & Harshman, 2012; Smith, n.d.).

Frequency (Pitch). Frequency, also referred to as pitch is measured in hertz (Hz). Humans can hear sound produced at 20-20,000 Hz (Winters et al., 2005). Sound above 1,000 Hz is considered high frequency and sound below 1,000 Hz is considered low frequency (Winters et al., 2005). It is important to understand the term frequency as it plays a very important role in audiologic testing and diagnosing. High pitch sounds, such as a school bell or fireworks, correspond to high frequency vibrations. Conversely, low frequency sounds, like a bass drum or low keys on a piano, correspond to low frequency vibrations. Sounds can be intermittent like with a firework, or they can be continuous like the hum from the radiator of a piece of equipment. Continuous or constant sounds are thought to be more damaging since they do not provide adequate recovery time for the ear, although both types can cause hearing loss (Madison et al., 2014). Nevertheless, high pitch, low pitch, and constant or intermittent sounds can all be damaging to hearing depending on the length of exposure to the sound.

Timbre. Murphy and Harshman (2012), describe timbre as what make a sound recognizable and distinct, timbre is the perceived sound quality of a tone, sound, or note. Additionally, they note as objects start to move back and forth, they produce a fundamental, or base line frequency. Vibrations in various intensities and frequencies in addition to the fundamental frequency are called overtones. Overtones that are simple whole number multiples of the fundamental frequency we hear a musical tone. Inversely, random combinations of vibrations or frequency is called noise (Murphy & Harshman, 2012).

Equal-Energy Principle

"The equal energy principle effectively states equal energy will cause equal damage (in any given individual), such that similar cochlear damage may result after exposure to a higher level of noise over a short period of time as would occur after exposure to a lower level of noise over a longer period of time" (Le et al., 2017, p. 2). Winters et al. (2005), better describe this rule by noting that sound energy doubles every 3dB increase in level. They noted that 8 hours of exposure at 85db is equal to 4 hours exposure at 88dBA, or 16 hours at 82 dB. Thus, a safe level of 85dB can be reached in just 15 minutes at a decibel level of 101 (Winters et al., 2005).

An Overview of Hearing Loss

To better understand the dynamics of NIHL and why hearing loss is common in the agricultural sector, basic concepts of pathophysiology related to hearing loss should be discussed. Because frequency and intensity thresholds can vary, the definition of hearing loss is very dependent on the reference criteria used by the facility. However, the USPSTF (2021) supports the definition of mild hearing loss as the inability to hear frequencies associated with speech processing under 25dB, and moderate hearing loss under 40dB.

According to Chen et al. (2014) the disease process of NIHL can be linked to genetic and environmental factors. The researchers conclude that additional factors may also play a role in the severity of NIHL such as: a) age; b) chronic disease; c) smoking history, and d) utilization of ototoxic medications. Furthermore, they note that exposure to high levels of hazardous noise is the most common cause of permanent NIHL. (Chen et al., 2020). When discussing an individual's perceptions of NIHL additional factors should be taken into consideration as well.

According to the WHO (2015), exposure to long- and short-term, intense sound causes damage to the auditory system and can result in noise induced hearing loss. This loss can be slow

in onset but is progressive even after noise is removed (WHO, 2015). Damage to the cochlea occurs through mechanical destruction and intense metabolic activity at the cellular level (Le et al., 2017; WHO, 2015). As hair cells are exposed to hazardous noise, they begin to lose their ability to function due to a form of mechanical destruction. Furthermore, exposure to hazardous noise leads to increased energy requirements of the hair cells, leading to greater oxygen consumption. This demand for oxygen increases levels of free radicals in the cochlea causing cell death (WHO, 2015).

Threshold Shifts. According to the WHO (2015), exposure to loud sounds resulting in temporary hearing loss, or tinnitus, is called a temporary threshold shift. For example, an individual who has attended a rock concert or event with excessive noise, may experience a temporary threshold shift, causing short-term hearing loss (WHO, 2015). Le et al. (2017), note that hearing generally recovers 24-48 hours after this shift occurs and that the temporary hearing loss may go unnoticed by the individual. However, continued exposure can lead to more permanent hearing deficits. A temporary threshold shift coincides with temporary hearing loss; thus, the shift is a good early indicator of irreversible hearing loss (WHO, 2015). Conversely, prolonged noise exposure causes more gradual, irreversible damage to sensory cells, leading to a permanent threshold shift (WHO, 2015). Temporary threshold shifts are an important early indicator of hearing loss. Early identification of these temporary threshold shifts, and hearing deficits may help prevent further loss and additional co-morbidities.

Types of Hearing Loss

Sensorineural Hearing Loss. According to the American Audiology Academy [AAA] (2021) high frequency hearing loss, due to aging and noise exposure, is the most common type of sensorineural hearing loss, and results in permanent damage to the hair cells within the cochlea

(AAA, 2021). Sensorineural hearing loss occurs progressively over many years, thus making the loss difficult for individuals to self-diagnose. Other known causes of sensorineural hearing loss include presbycusis, Meniere's disease, and ototoxic medications, among others (American Speech-Language-Hearing Association [ASHA], (1997-2021a). The natural, progressive, and irreversible hearing loss among individuals 60-65 years of age is called presbycusis (WHO, 2015). Damage from noise is typically more detrimental to hearing loss than aging. As a result, cochlear degeneration from noise exposure early in life can cause the ears to be more vulnerable to presbycusis (WHO, 2015). Ototoxicity can occur with the use of different medications such as chemotherapeutic agents such as platinol, aminoglycosides, furosemide, salicylates, and quinine (Rabinowitz, 2000). Of other concern are ototoxic substances such as carbon monoxide, tobacco smoke, lead, mercury, and some nitriles and solvents (Michels et al., 2019). Meniere's disease can cause low frequency hearing loss, tinnitus, vertigo, and fluctuating progressive hearing loss (Rabinowitz, 2000). Treatment for these types of loss includes hearing aids and cochlear implants.

Conductive Hearing Loss. The second most common type of hearing loss is conductive hearing loss. This type of loss occurs when there is blockage of normal air conduction within the sound pathways. These blockages can be caused by pathological occurrences such as excessive wax production, a foreign body, or fluid in the middle ear due to infection (AAA,2021). Other causes can include poor eustachian tube function, benign tumors, congenital defects, and ear drum perforation (ASAH, 1997-2021b). Due to blockage or interruption of normal air conduction, this type of loss causes a decrease in volume and is noted with low tones and vowels. Basic treatment for this type of loss is removal of the blockage, medically or surgically.

Combined Conductive and Sensorineural Loss. The third most common type of hearing loss is also referred to as mixed hearing loss, and is both conductive and sensorineural loss combined. This type of hearing loss is also referred to as mixed hearing loss. As the 3rd most common type of hearing loss it combines both conductive and sensorineural loss. With mixed hearing loss there is some type of damage to the middle ear and interruption in conduction of nerve impulses to the brain. An example of this type of loss would be an individual who has noise induced hearing loss and develops an acute ear infection, or otitis media.

Gradients of Hearing Loss

There is currently no universal grading criteria or universally accepted scale of hearing loss (Michels et al., 2019). Some organizations have defined models for classifying the severity of hearing impairment. The American Speech-Language Hearing Association (1997-2021b) has established grading criteria for the degree of hearing loss. With this grading system audiologists can categorize patients with normal, mild, moderate, severe, and profound hearing loss. Because hearing loss is measured in decibels, these categories are defined by the average decibel level of hearing loss present.

The ASHA categorizes hearing loss into the following categories: a) normal hearing (up to 25dB); b) mild hearing loss (26-45dB); c) moderate hearing loss (41-70 dB); d) severe hearing loss (71-90 dB); and e) profound hearing loss (91dB or greater). Individual's with normal hearing can hear and understand speech in quiet and comfortable listening situations. Whereas an individual with severe hearing loss may need hearing aids to help hear high frequency sound. Additionally, they may have difficulties with conversational speech and using the telephone. The Centers for Disease Control and Prevention (CDC) model suggests normal hearing as less than or

equal to 25 dB, mild hearing loss (26-40dB), and moderate hearing loss (41-55 dB) (Michels, 2019).

Tinnitus

According to the CDC, 25 million Americans, or about 10% of the population, have experienced tinnitus that has lasted for five or more minutes in the last year. Tinnitus, comes from the Latin word “ring or tinkle” is the sensation of sound when there is none, and is often linked to noise induced hearing loss (American Tinnitus Association [ATA], (2019). Described as whistling, hissing, swooshing, clicking, or buzzing, tinnitus can be an early indicator of auditory injury (ATA, 2019; Chen et al., 2020).

The American Tinnitus Association (2019) describes tinnitus as not a disease process but rather a symptom of an underlying disease process. They state that common causes include hazardous noise, ototoxic drugs, medical conditions, trauma to the brain, sinus and barometric pressure, temporomandibular joint disorder, and/or obstruction in the middle ear (ATA, 2010). There is a strong correlation between tinnitus and hazardous noise exposure, and according to Chen et al. (2020), the degree of tinnitus may be associated with the severity of NIHL. According to the WHO (2015), tinnitus induced by hazardous noise exposure can be transient and serve as an early sign of hearing damage. There is no cure for tinnitus and treatment focuses on symptom relief. Like hearing loss, long term tinnitus can lead to anxiety, sleep disturbance, impaired concentration and communication, and depression (WHO, 2015). Since the prevalence of tinnitus is much higher amongst individuals exposed to hazardous noise (Trung et al., 2019), assessment is crucial in that patients experiencing this symptom are further screened for underlying hearing loss.

Screening for Hearing Loss

According to Zazove et al. 2020 hearing loss is the second most common disability in the U.S. Unfortunately, even with staggering statistical evidence supporting the detrimental long-term effects of hearing loss, hearing loss remains under diagnosed and under treated (Zazove et al., 2020). Currently, most recommendations focus on preventative screening for individuals 50 years of age and older (USPSTF, 2021; Walker et al., 2013). However, Walker et al. (2013) noted an increase in the prevalence of hearing loss in younger age groups due to different environmental causes such as hazardous noise exposure. They have concluded that these populations may benefit from routine simple hearing screenings in the primary care setting as well as occupational setting (Walker et al., 2013). Research shows that early screening and diagnosis of hearing loss is crucial to help reduce long term effects and additional co-morbidities of noise induced hearing loss (Louw et al., 2018).

Simple, cost effective screening methods can be used in the primary care setting. Some methods recognized by the USPSTF include the use of a screening questionnaire and basic clinical tests such as the watch tick test, finger rub, and whispered voice test (USPSTF,2021; Walker et al., 2013). The question “Do you have trouble with your hearing?” can also serve as a simple, valid, introductory screening for patients (Louw et al., 2018).

Stawbridge et al. (2017) compared four basic screening tests using a handheld audiometer. The researchers developed a protocol that included: 1) a direct question (Do you feel you have difficulty hearing?); 2) an indirect question (if anyone had told them they had trouble hearing); 3) the whisper test; and 4) the finger rub test. The Earscan 3 audiometer was utilized to test hearing at frequencies of 1,000, 2,000, and 4,000 Mhz at 25 dB and 40 dB. Based on the

results, the researchers concluded that the finger rub test had the highest sensitivity at 91%, followed by the direct question with a sensitivity of 89% (Strawbridge et al., 2017).

Another form of screening can be completed through pure tone audiometry. This form of screening uses an audiometer to test tones across the speech spectrum from 500-4,000 Hz with 4,000 Hz being the upper limits of normal hearing (Walker et al., 2013). The test is then rated as a pass or a fail. Individuals who do not pass this test will then be referred on for further diagnostic testing.

Unfortunately, studies have shown many of these affordable hearing screening methods are highly underutilized in the primary care setting (Strawbridge et al., 2017; Wallhagen et al., 2017; Zazove et al., 2020). Hearing loss can be insidious and progressive. Some individuals may have mild hearing deficits prior to becoming symptomatic, whereas others may be reluctant to reveal that they are already experiencing a hearing deficit. Thus, the utilization of screening methods for asymptomatic individuals that fall into mild to moderate risk categories is crucial.

Lack of screening in these settings may be attributed to multiple barriers experienced by patients and primary care providers. Farmers and agricultural workers may not have access to rural healthcare services. Additionally, they may lack health insurance to help cover screenings, lack general knowledge related to the detrimental effects of hazardous occupational noise, and may be reluctant to reveal that they may have a hearing deficit.

Primary care providers experience multiple barriers to screening. Despite the availability of screening methods these barriers include a) lack of time; b) lack of reimbursement; c) lack of awareness of audiologic services; d) knowledge deficits related to hearing loss; and e) the sense that there are more important clinical issues to attend to (Strawbridge et al., 2017; USPSTF, 2021). In their study, Wallhagen et al. (2017) reviewed the low rates of screening in primary care

settings, even with high-risk older adults. They found that 40-86% of primary care providers were not routinely screening patients due to the above barriers (Strawbridge et al., 2017, USPSTF, 2021). Even when individuals were screened and provided with a referral, they had misconceptions about the benefits of utilizing hearing aids (Wallhagen et al., 2017). Lack of hearing screening in the primary care setting represents a gap in the rural healthcare system when in contact with those patients at potential risk. All members of the health care team must work screen individuals at risk for hearing loss to help promote early detection and referral.

Utilization of a Questionnaire for Screening

Due to health disparities and barriers, implementation of hearing screening programs can be difficult. According to Louw et al. (2018) screening questionnaires represent a practical way to screen patients in the primary care setting. Self- reported hearing loss aids in early diagnosis and treatment. Screening questionnaires are simple and can be administered by any health care worker to aid in referral to the appropriate provider for diagnostic testing (Louw et al., 2018). Audiometric testing is the gold standard for hearing loss diagnosis; however, audiometric testing can be costly, timely, and requires certified staff. Implementation of screening in the primary care setting allows for referral of patients in need of further diagnostic testing, while potentially avoiding unnecessary referrals.

In a study by Wallhagen et al. (2017), researchers worked to create a quick, efficient protocol, which included a hearing screening questionnaire, educational session, and referral for further treatment. To help address hearing health knowledge deficits, the authors developed a trifold brochure, which included information on hearing loss. Details of the brochure included how hearing loss affects communication, the importance of addressing hearing deficits in early stages, the benefits of hearing amplification devices, and alternatives to hearing aids. Working

with two primary care clinics, patients 60 years and older who were coming into the clinics for routine visits, and who had not worn hearing aids for at least year were asked if they would like to take part in a hearing screening. Individuals who agreed to participate were then screened with the Inner Ear Scale Questionnaire to determine individuals perceived hearing loss. Once at-risk individuals were identified through the screening questionnaire an educational session was provided to participants whose questionnaire indicated they were high risk for hearing loss. Three-months post-session, participants were contacted to attain follow-up information. The researchers requested information regarding follow-through with their referral or any alternative changes the patient may have made (Wallhagen et al., 2017).

Out of 125 individuals screened, 94 tested positive for a possible hearing deficit. Sixty-seven individuals agreed to fully participate in the study. Once participants completed the screening questionnaire and educational session, results of the questionnaire were discussed. Out of the 67 individuals, 34 were referred on by their primary care provider, and 33 were not provided with a referral. Thirty-one out of these 33 non-referrals reported that their primary care provider did not discuss the results of their screening with them. Five out of the 33 non-referrals reported that they followed up with audiology services on their own based on the educational information the nurse provided them. Twenty-five out of the 34 cases that were provided with the referral accepted, four of the 34 referrals provided stated they would go on their own time, and five completely declined. After a three month follow up, the researchers found that 18/34 referrals did follow-up with professional audiology services. Of other importance was that 70% of the 67 participants reported making on alternative change to help improve their communication, and 24% made more than one change. Examples of alternative changes

implemented included using personal amplifiers or assistive devices for telephones (Wallhagen et al., 2017).

Wallhagen at al. (2017) noted that providers in the primary care setting face constant time demands due to seeing large volumes of patients. By developing a protocol that other members of the health care team can utilize, patients can be provided with effective, quick screening for hearing loss. This not only helps take some of the burden off primary care providers, but also helps provide high-quality healthcare. In this study, 52% of referred individuals followed up with professional audiological services. This number may have been even greater if the 33 non-referred individuals were provided with an actual referral from their provider. This study makes a number of valid points: a) screening questionnaires can be quick, efficient, and effective; b) education and resources provided to patients can be effective in promoting action; and c) lastly the study shows the need for additional provider education on the detrimental health effects of hearing loss and how providing a simple referral for further care could result in positive health outcomes (Wallhagen et al., 2017).

Screening Questionnaire Used for This Project

Another well-known, validated screening questionnaire is the Hearing Handicap Inventory for the Elderly (HHI-E). Developed by Ira Ventry and Barbara Weinstein in 1982, this was one of the first hearing screening questionnaires developed for clinical use (Cassarly et al., 2020; Ventry & Weinstein, 1982). This short questionnaire takes two minutes to complete and is the most well-known questionnaire for individuals over the age of 50. According to Neuman et al. (1990) the questionnaire can implicate a possible hearing deficit, as well as shed light on the emotional and social- situational effects that may be caused by the hearing deficit. These effects will not be seen on audiometric screening. This questionnaire was standardized for individuals

over the age of 65 until 1998, Nondahl et al. (1998) demonstrated higher accuracy in younger age groups (48-64 years old).

The HHI-E has since been modified for use in younger adults. In 1990 Neuman, Weinstein, Jacobson, and Hug. (1990), created a revised HHI-E known as the Hearing Handicap Inventory for Adults (HHI-A). This 25-item self-assessment questionnaire also included two subscales that investigate social-situational and emotional effects of hearing loss (Neuman at al., 1990). Questions within the scale were also modified to focus on occupational effects of hearing loss on individuals. The HHI-A consists of 13 emotional and 12 social-situational items that are then scored and tallied. Yes= 4 points, sometimes= 2 points, and no= 0 points. Scores are then rated on a scale indicating perceived handicap, 0= no handicap, 100= significant perceived handicap (Neuman et al., 1990). In their study, Neuman et al. (1990) sought to validate and assess audiometric correlations and psychometric adequacy of the revised and modified HHI-A. They found that the internal reliability, or Cronbach's alpha, to be 0.93 for the total scale. The Pearson product-moment correlations between the total scale and two subscales were high ($r = 0.84\text{-}0.96$) and statistically significant ($p<0.01$) (Neuman et al., 1990). Additionally, the standard error of measurement with the total HHI-A was six points (Neuman et al., 1990). Since its origination, the HHI-A's validity as a self-screening questionnaire has been further validated. Cassarly et al, 2020 also confirmed the validity and deemed the tool as a "strong unidimensional scale that can be used to quantify self-perceived hearing handicap for all ages" (Cassarly et al., 2020, p. 104). The HHI-A has become a very popular and well utilized screening questionnaire in healthcare. HHI-A offers a reliable, simple, cost effective way to screen individuals of all ages for possible hearing handicaps and deficits, promoting early referral and detection of hearing disease and secondary conditions.

Audiometry Screening Tool Used for This Project

As a hearing screening questionnaire can be useful in determining an individual's perceived hearing loss and provide indicators for the need for further testing, audiometry remains the gold standard for hearing loss assessment. Unfortunately, audiometry can be expensive and even more importantly, not available in rural areas. Although individuals may indicate the need for further follow up and referral, they may not have the financial or physical means of going to see another provider for their hearing loss concerns.

With the heightened need for technological advancements and tele-medicine, development of audiologic software and applications has sky-rocked (Tonder et al., 2017). There has been an increased demand for portable audiometers and smart phone-based hearing tests in the field of audiology. This addition of automated audiometry has allowed health care professionals other than audiologists, to provide screening and diagnostic audiometry with results comparable to manual audiometry (Tonder et al., 2017). Because of new hearing technology health care professionals can spend more time with patients on patient teaching and management options. An additional benefit, portable audiometers or smart phone-based hearing tests audiologic services can be provided in rural underserved areas.

In a review of current available hearing screening platforms Jayawardena et al. (2018) discussed HearX. HearX, a company located in South Africa has designed a mobile phone-based audiometer. This mobile based application has been gaining popularity amongst providers in the United States. The package includes a Samsung Galaxy A3 with built in software, Sennheiser HD280 Pro headphones and a carrying case. To be able to purchase the audiometry software, all equipment must be purchased from the company to ensure proper calibration. Software and equipment are required to be recalibrated yearly for a small fee. Data are saved onto the device

itself and then uploaded to the mHealth studio, a Health Insurance Portability and Accountability Act compliant cloud-based platform. HearX offers two software packages, the hearTest and hearScreen. hearScreen is a validated automated test that tests hearing at three frequencies at different thresholds. Limitations noted by Jayawardena et al. (2018) included that false positive results can occur in high noise settings and that the programs do not allow for bone conduction testing (Jayawardena et al., 2018).

In a recent study by Brittz et al. (2019) the clinical utility of the smartphone-automated hearTest pure tone audiometry tool was evaluated and compared with manual audiometry in an infectious disease clinic setting. Threshold comparisons were made between the hearTest application and manual audiometry. Individuals that were found to have high-frequency pure-tone average greater than 15 dB in either ear were considered to have hearing loss. 106 (53%) of participants were found to hearing loss with the smartphone audiometry testing, and 96 (48%) were found to have hearing loss with manual audiometry. Findings noted that a strong positive correlation of 0.76 to 0.79 was found between smartphone automated pure tone audiometry and manual audiometry, Findings found that 88.2% of thresholds corresponded within 10dB or less between the hearTest application and manual audiometry. This study concluded that the hearTest smartphone based pure tone audiometry in combination with properly calibrated headphones can provide reliable results and serve as a reliable tool in the clinic setting (Brittz et al., 2019).

Current Screening Guidelines

Current screening guidelines for hearing assessment in adults are vague and pertain in many instances only to older populations over the age of 60. Currently the USPSTF provides recommendations for infants and children but note that there is insufficient evidence to support routine hearing screening in adolescents and working aged adults. Additionally, the USPSTF

(2021) states there is insufficient evidence pertaining to the benefits and risks of screening asymptomatic adults 50 years and older, unless already diagnosed with a hearing deficit. Therefore, they make no recommendations for or against asymptomatic screening (USPSTF, 2021). The USPSTF does recommend that screening for NIHL should be completed within workplace conservation programs and according to occupational medicine guidelines. This allows adults covered under these workplace conservation programs to benefit from mandatory screening by organizations like OSHA and the U.S Department of Labor.

Unfortunately, this does leave a large gap of at-risk adolescents and adults in the general population not covered under government screening and regulation programs. Farmers and agricultural worker often fall into this at-risk population, as they are consistently exposed to hazardous noise, yet do not fall under guidelines set forth by government programs. The American Academy of Audiology (AAA) (2021) and the National Institute of Deafness and Other Communication Disorders (NIDCD) acknowledges that there is a gap in research making decisions difficult for the USPSTF to make any further recommendations. The AAA and the NIDCD both have noted in recent publications that they are working to help close these gaps through new funding and research (AAA, 2021, NIDCD, 2016). Both the AAA and American Academy of Family Physicians (AAFP) currently mirror USPTF recommendations (USPSTF, 2021). In contrast, the American Speech-Language-Hearing-Association (ASHA) recommendations state that individuals should be screened every decade up to 50 years of age, then every three years unless considered high risk for hearing loss (ASHA, 1997-2021b).

Diagnosis

There are different types of audiologic tests that can be performed to diagnose hearing loss. Pure tone audiometry is the gold standard for evaluating hearing loss both for screening and

diagnosis (Barbosa-Servidoni & Conterno, 2018). Diagnostic pure tone audiometry categorizes the severity of hearing loss at each frequency (Walker et al., 2013). This type of audiometry can confirm the softest sound a patient can hear at different frequency levels 50% of the time. The ASHA recommends that threshold search audiometry be performed using the Hughson-Westlake method. This method gives guidance on the different dB levels that should be presented to the patient and in what order (Walker et al., 2013).

Additionally, in order to differentiate between sensorineural and conductive hearing loss, bone conduction audiometry must be performed (Walker et al., 2013). Like the Rinne and Weber tests, bone conduction audiometry compares air and bone conduction. A mechanical device is used to transmit sound through the forehead and mastoid using vibrations (Walker et al., 2013).

After testing is complete, data are collected and interpreted in an audiogram. Diagnostic pure tone audiometry should be performed by a trained professional and audiometers and audiometric equipment must meet American National Standards Institute (ANSI) specifications. The AAA, American Academy of Otolaryngology- Head and Neck Surgery, and the ASHA each have different guidelines for the use and training of support personal to perform audiometry (Walker et al., 2013).

Unfortunately, even though these audiologic tests may not need to be performed by an audiologist, rather by trained personal, many times the equipment and testing programs are unavailable or very costly. Thus, making access to pure tone audiometry difficult in some areas throughout the country, especially in rural communities. Additionally, Kahn et al. (2017) found that numerous health disparities contribute to the lack of hearing screening programs and trained personal in rural areas. Disparities such as lack of funding, fewer resources, poverty, lack of health insurance, and limited access to healthcare contribute to poorer health outcomes for

members of these communities (Kahn et al., 2017). By providing cost effective hearing loss screenings, such as hearing loss questionnaires, in rural healthcare settings, high risk individuals can be identified and referred for appropriate follow-up. These simple screenings also offer an opportunity for patient teaching on general hearing health and hearing loss prevention. Patients may not have the financial means to pay for extensive audiological testing, but by providing education related to hearing loss and prevention methods, patients may adopt alternative methods to improve hearing and communication, as well as adopt better hearing health practices to help prevent further damage.

Current Noise Regulations in the Workplace

Although NIHL is permanent and irreversible it is preventable (Kardous et al., 2016). In the United States there are several organizations and regulatory bodies that work to help regulate occupational noise exposure and promote employee safety (NIOSH), 1998). With the passage of the Occupational Safety and Health Act of 1970, the NIOSH became the lead organization for setting recommendations and standards for hearing loss. According to the NIOSH's 1998 publication related to occupational noise, the recommended to limit noise exposure to 85dB, A-weighted, as eight-hour time weighted, using a three decibel exchange rate. Any exposure to noise over this level is considered hazardous (NIOSH, 1998). The NIOSH provides extensive guidelines for employers who institute hearing loss prevention programs based on the level of noise that their employees are exposed to. One important regulation is that individuals exposed to over 85dB within an eight-hour time weighted average (TWA) are required to wear hearing protection (NIOSH, 1998). Time weighted average is the average noise exposure that an individual has over an eight-hour time period. Also, of importance, if employees are exposed to more than 85dB in an eight-hour period they must be provided with audiology services including

a baseline and exit audiogram and yearly hearing threshold testing. Employers must also institute a hearing health training program and hold yearly continuing education sessions relating to hearing loss and prevention measures (NIOSH, 1998).

In 1970, the Occupational Safety and Health Act established the Occupational Safety and Health Administration (OSHA) within the United States Department of Labor as the enforcement agency for the safety of the American workforce. Current OSHA guidelines require certain industries to use engineering controls when the sound is over 90dB, and hearing protection with annual follow up when exposed to hazardous noise over 85dB (CDC, n.d.).

Noise Regulations in Agriculture

Although both the NIOSH and OSHA offer comprehensive occupational hearing loss prevention strategies for noise regulations in certain workforces, agricultural industries are not regulated by these organizations (NIOSH, 1998). In 2015, McCullagh and Ronis estimated that 1.5 million agricultural workers were exposed to hazardous noise. Additionally, they found that even though NIHL was high among farmers they continued to be underserved by programs and advocacy groups intended to prevent NIHL (McCullagh & Ronis, 2015). Due to the lack of advocacy provided by regulatory organizations, farmers and agricultural workers are at high risk for NIHL as well as knowledge deficits due to lack of educational programs. More specifically, farmers and agricultural workers are also affected by multiple health disparities. These disparities include a lack of knowledge related to hazardous noise exposure, underestimation of the value of HPDs, and unrealistic perceptions of actual hearing loss versus perceived hearing loss (Kahn et al., 2017).

The lack of hearing screening in rural healthcare facilities, in combination with knowledge deficits and the nonuse of use of HPDs, have created a serious health crisis within the

agricultural sector. Primary care providers and health care professionals must recognize this problem and work within their communities to screen, identify, and provide education to farmers and agricultural workers. Thus, implementation of hearing screening protocols and patient educational sessions should be considered to help improve hearing health, and consequently overall quality of life.

Negative Health Effects of Hearing Loss

Hazardous noise associated with hearing loss can have debilitating and life changing effects on an individual's health (Lusk et al., 2017). Hearing deficits not only create a communication handicap for those that suffer from the disease process, they can also lead to significant decreased quality of life and numerous psychosocial concerns (Powell et al., 2019). In a literature review by Trung et al. (2017) several consequences of NIHL were discussed. One of the most concerning consequences included the individual's loss of ability to communicate with the surrounding world. This loss of communication further contributes to increased social stress, depression, poor self-esteem, embarrassment, and the inability to maintain functional relationships. (Basner et al., 2014; Le et al., 2017; Lusk et al., 2017; Trung et al., 2017). These consequences are then intensified in many situations where excessive background noise may be present. In their literature review Trung et al. (2017) further discuss the increased risk of occupational injuries that can be caused by hearing loss.

Researchers found in a study by Giarard et al. (2015) a confirmed an increase in work related injuries and hospitalizations for every dB of hearing loss (Trung et al., 2017). In additional research, Neitzel et al. (2017) also found that workers suffering from hearing deficits may be placed at a greater risk for injury while working, they may miss work more frequently, and may have increased ratios of unemployment or underemployment. Other researchers have

also studied the long-term health consequences of hearing loss. According to Powell et al. (2019) hearing loss can have negative effects on overall wellness including interpersonal relationships, employment, and subsequent financial stability. Additionally, hearing loss may enhance negative emotions such as disappointment, anger, distraction, dissatisfaction, and helplessness among others (Lusk et al., 2017).

In addition to psychosocial concerns and occupational safety risks, hearing also can have non-auditory effects on the body. For example, noise has been associated with cardiovascular conditions such as coronary artery disease and hypertension (Kerns et al., 2018; Skogstad et al., 2016). Correlations have been made by researchers linking the bodies stress response to noise with increased heart rate and blood pressure, which can contribute to conditions like those mentioned above (Kerns et al., 2018; Skogstad et al., 2016). Hazardous noise has also been associated with health conditions such as tinnitus, hyperacusis, and insomnia (Basner et al., 2014). In other studies, Lin (2012) found correlations between hearing loss and risk for dementia. A two-fold risk for dementia was found individuals with mild hearing deficits and a five-fold risk for those with severe hearing loss (Lin, 2012). In 2017, The Lancet Commission on Dementia Prevention and Care also found further data confirming that midlife hearing loss was a risk factor in the development of dementia. Researchers found that even individuals with normal cognition, but baseline hearing impairment were at higher risk (Livingston et al., 2017). Significant research has been done on the harmful effects of hearing loss on an individual's social, emotional, and physical quality of life. This evidence highlights the importance of hearing loss screening, and prevention methods to helping decrease and individuals' risk for permanent hearing damage.

Noise Exposure in Agriculture

Hearing loss is a common health risk among many professions where workers are exposed to high decibel noise for long periods of time. In many industries noise levels are regulated through standards set by OSHA and NIOSH. However, the agriculture sector does not fall under regulations and standards set forth by these agencies, leaving farmers and agricultural workers to make their own hearing health decisions. Due to knowledge deficits related to hearing loss and the insidious nature of the disease, less attention is paid to the detrimental long-term effects of NIHL. Farmers and agricultural workers are exposed to high decibel noise sources such as tractors, chain saws, grain dryers, livestock activity, milking machinery, and squealing animals daily. Due to the high intensity of these noise sources, hearing damage starts to occur due to prolonged exposure such as noise greater than 85dB for more than eight hours (Williams et al., 2015).

In an Australian study by Williams et al. (2015), researchers sought to understand the magnitude of farmers exposure to hazardous noise. Visits were made to farming operations to monitor decibel level readings around common farming equipment. Noise measurements were taken during typical activities that were considered “noisy” on the farming operations. Readings were then summarized for each farm and correlated with appropriate exposure time limits for each reading. The current Australian Exposure Standard mimics that of the United States at 85dB. Decibel level readings of different machinery used on these operations included: a) tractors (72-99dB); b) Bobcat (83 dB); c) post hole digger (88 dB); c) grinder (90-102 dB); d) grain auger (85-98 dB); e) air compressor (82-90 dB); and f) generator (92 dB) (Williams et al., 2015). To help understand the significance of these dB readings, associations can be made between sound levels and non-agriculture activities. Johnson and Martin (2010) give examples of

different readings seen during common activities. For example, Rice Krispies crackling emits dB readings of around 30 dB, normal conversation gives off dB readings of around 60dB, a vacuum cleaner produces readings around 80dB, a leaf blower at 90 dB, crowd noise at a baseball game at 120 dB, and a jet taking off at 130dB (Johnson & Martin, 2010). Other common decibel readings include a music through headphones at maximum volume (avg 94-110 dB), a fireworks show (avg 140-160 dB), and a siren (avg 110-129) (NIDCD, 2018).

The Equal Energy Principle discussed earlier in this literature review is important to remember when discussing decibel level readings. The Equal Energy Principle describes the correlation between exposure time and intensity of the sound. Sound energy doubles every three decibels increase in level. Eight hours of exposure at 85dB is equal to four hours of exposure at 88 dB, or 16 hours at 82dB. The National Institute of Occupational Safety and Health (2018) further defines these noise limits and provides guidance on noise intensity levels and exposure time. They report that individuals will reach 100% of their daily noise dose: a) within eight hours at 85dB; b) within four hours at 88dB; c) within two hours at 91 dB; d) within one hour at 94dB; e) within 30 mins at 97 dB; and f) within 15 mins at 100dB (NIOSH, 2018). Therefore, one can see how quickly farmers and agricultural workers reach their daily noise dose as they are exposed to in many cases several high dB related activities during workdays that in many cases extend beyond the typical eight-hour workday.

In another study by Mead-Hunter et al. (2019) 42 grain and livestock operations in western Australia were studied to determine sources of hazardous noise and to determine worker exposure to hazardous noise. Sound level meters were used around equipment and tasks that were suggested to emit high decibel noise and personal noise dosimeters were placed on workers and monitored for four hours during a normal workday. Data were collected from harvesting and

seeding activities. Results concluded that 29% of workers were exposed to noise level readings of 80-84dB, placing them at increased risk for NIHL. Researchers found that many of these workers did not just work eight-hour shifts, many were exposed to multiple different sources of hazardous noise for up to 12-16 hours, exceeding recommended exposure levels. Seeding and spraying activities saw an even greater increase in exposure time as workers in many cases were putting in overtime hours during this season. 13% of operators during this season were exposed to noise levels greater than 85 dB within four hours, another 13% exceeded exposure limits within eight hours, and 40% would exceed limitations within a 12-hour shift. Dosimeters worn by individuals completing spraying and seeding tasks revealed that 21% of workers seeding and 17% of workers spraying were exposed to noise levels peaking over 140dB (Mead-Hunter et al., 2019).

Also discussed in this study was sheep shearing. Sheep shearing is an agricultural task that involves being in enclosed facilities working with tools that emit high decibel noise. Individuals working in close proximity to one another with shearing tools dramatically increasing the amount of noise exposure. Mead-Hunter et al. (2019) found that sheep shearing does pose a significant risk for hearing damage. Measurements indicated that the exposure standard of 85dB would be exceeded in just a mere 35-40 minutes. Dosimeter measurements recorded peak levels above 140dB, approximately ten dB levels above that of a jet airplane taking off (Mead-Hunter et al., 2019). Clearly, daily tasks associated with agriculture, pose a significant risk to hearing health of farmers and agricultural workers. To help create awareness and promote hearing loss prevention strategies it is imperative that education on tasks involving hazardous noise be provided for farmers and agricultural workers.

Hearing Loss Prevention in Agriculture

As farmers and agricultural workers are continuously exposed to hazardous noise throughout their workday, they are placed at a high risk for NIHL. Prolonged exposure to hazardous noise is the number one contributor to NIHL, a progressive, irreversible disease (Chen et al., 2020; McCullagh & Ronis, 2015). Treatment for NIHL is very limited and requires the use of amplification devices like hearing aids. For many individuals this type of treatment is expensive and unsatisfactory (McCullagh & Ronis, 2015). In addition, farmers and agricultural workers lack advocacy and noise regulation programs which further creates a knowledge deficit pertaining to the harmful effects prolonged exposure to hazardous noise. Fortunately, NIHL is completely preventable (NIDCD, 2018; WHO, 2015).

Noise elimination is considered the most effective prevention method for NIHL. Unfortunately, this is not possible in many industries, including agriculture. As complete noise elimination is not feasible within this populations, consistent use of HPDs as a secondary prevention method has been suggested as one of the best ways to help prevent NIHL in the agriculture sector (Chen et al., 2020; McCullagh & Ronis, 2015). In addition to HPDs, noise reduction, noise isolation, and reducing noise through engineering controls have also been suggested preventative measures.

Murphy and Harshman (2012) discuss hearing loss prevention methods such as noise reduction, isolation, and engineering controls. Researchers found that noise reduction within farming and agricultural operations can be achieved in many ways including: a) substituting damaged, loose, or unstable machine parts; b) consistent lubrication of parts to decrease friction; and c) through the utilization of larger engines that can work at lower speeds reducing noise levels (Murphy & Harshman, 2012). Noise isolation can be achieved by purchasing equipment

that has sound reducing cabs, and by making sure that windows and doors are tightly sealed (Murphy & Harshman, 2012). Due to the nature or work in the agricultural sector administrative controls may not be as effective. Administrative controls include that workers rotate workstations so that they are only exposed to loud noise for a certain period. Since many farmers and agricultural workers switch tasks so frequently this type of noise reduction may not be as effective.

Personal protective equipment (PPE) or hearing protection devices (HPD's) have many benefits and come in many different forms. Common HPD's include earmuffs, foam ear plugs, and custom fit ear plugs. According to McCullagh and Ronis (2015) there is no one "best" type of hearing protection, preference is given to what the individuals feels comfortable in and will actually use. In an article titled *CDC Grand Rounds: Promoting Hearing Health Across the Lifespan,* Murphy at al. (2018) state that HPD's if fitted and worn properly could reduce hazardous noise up to 30-40dB. This is a significant drop in the intensity of loud noise which could potentially help decrease the risk of NIHL in many settings where individuals are exposed to hazardous noise.

As many farms are small and family owned, they may lack resources and knowledge pertaining to the prevention of NIHL. McCullagh et al. (2002) discussed the significance of different interventions to aid in hearing loss prevention. They found that many farmers had knowledge deficits related to NIHL prevention measures and misjudged their exposure to loud noise (McCullagh et al., 2002; McCullagh & Ronis, 2015). Studies have shown that there is an immense need for education and services related to HPD use among agricultural workers and farmers, "and unlike some other worker groups, there is no ceiling effect limiting effectiveness of interventions" (McCullagh et al., 2002; McCullagh et al., 2016, p. S4).

In their 2016 study, McCullagh et al. (2016) evaluated three interventions created to promote HPD use among farmers and agricultural workers. Farmers (491) were assigned to one of five intervention groups. These intervention groups included: a) interactive web-based information with mailed assortment of HPD's; b) interactive web-based information only; c) static web-based information with mailed assortment of HPD's; d) static web-based information only; and e) mailed assortment of HPDs only (McCullagh et al., 2016). Interactive web-based information that was provided to participants included a model driven approach, participants could select topics they wanted to explore and choose how much time they spend within each module. An example used for these interactive web-based modules was the use of a sound meter which displayed noise in decibel readings and then played recordings of common noises heard in agricultural settings such as tractors and livestock. The static web-based intervention provided minimal interactivity, participants could view pamphlets and flyers presenting information on HPD use.

Lastly, various HPDs including earmuffs, roll down plugs, pre-molded plugs, and semi-aurals were mailed to selected participants along with written instructions for use. Outcome measures were looked at 6 and 12 months after the interventions were completed and relied on self-report of HPD use. Results concluded that the use of HPD's increased at the 6- and 12-month intervals in all intervention groups. The mean use of HPD at baseline was 29.5%, 6 months: 48.7%, and 12 months: 49.3%. Other findings included that there was no difference in HPD use between the interactive web-based intervention and the static web-based intervention. Utilization of HPD's was higher in the group receiving HPD's in the mail and the interactive web-based intervention. The greatest increase in HPD use was seen from individuals who received HPD's in the mail.

Results of this study correlate with a previous study by McCullagh et al. (2009) which found supportive findings concluding that barriers to HPD use can be overcome within the agricultural sector. This study also found that most agricultural workers and farmers are willing to increase their use of HPD's when being exposed to hazardous noise (McCullagh et al., 2016). By mailing HPD's to participants McCullagh et al. (2016) suggest that this may help address lack of awareness of the different types of HPD's as well as increase access to them on farming operations.

Conclusions drawn from this study suggest new methods that could be used for the prevention of NIHL in the agricultural industry. Specifically, addressing barriers to access and ease of HPD use, rather than completely focusing on educational approaches. Awareness is important and must be raised in the agricultural setting regarding HPD's and their availability (McCullagh et al., 2016). Additionally, education is needed on HPD technology and how to properly fit and wear HPD's. Education on HPD's is also imperative as well as the continued exploration of barriers contributing to the lack of HPD use in agricultural workers.

Barriers to Use of Hearing Protection Devices

Although HPD's are a simple, cost effective solution to help protect farmer and agricultural workers hearing, barriers to the use of these devices are encountered frequently in this industry. According to McCullagh and Ronis (2015) predictors of HPD utilization among this population indicate that farmers want to protect their hearing and are interested in learning more about HPDs. Using Pender's Health Promotion Model, they explored farmers perceived benefits of using HPD's, they found that farmers feel confident in using HPD's. They also noted positive relationships related to HPD use when discussing their individual's beliefs and attitudes towards their use (McCullagh & Ronis, 2015; McCullagh et al., 2002).

Although models may suggest that farmers and agricultural workers have positive attitudes towards the use of HPD's, barriers remain that have significantly reduced the utilization of these devices for hearing protection. One of the greatest barriers to HPD use in the agricultural setting is the frequent variations in work tasks, resulting in farmers and agricultural workers being exposed to multiple different levels of noise, numerous times throughout the day, resulting for the need for intermittent use of HPD's (McBride et al., 2003; McCullagh et al., 2016). McCullagh (2011) also notes that planning and applying interventions for farmers is difficult as "farm operators have a reputation for having a strong sense of autonomy and resistance to "outside" interference with their operations". In the United States agricultural operations are often geographically dispersed, solely owned and operated, and lack regulation from hearing protection advocacy groups (McCullagh, 2011).

McCullagh, in her 2011 study investigated the use of HPDs by farmers. The purpose of her study was to determine if HPD's were more readily available if farmers would utilize them more often. Availability of HPD's has been discussed as a barrier for many farmers and agricultural workers. Through collaboration with a local farm organization 32 participants were contact via telephone for pre and post-tests questions. The pre-test consisted of an invitation to participate and demographic data collection. Famers that agreed to participate where then mailed a gift of multiple HPD's including earmuffs, corded and uncorded foam ear plugs, semi-aural headband, and pre-molded plugs. Pre-test questions found that 22% of farmers used some type of HPD when exposed to hazardous noise. Post tests were then completed via phone two months after the participant received the HPD's. The Farmers Use of Hearing Protection Scale and the Comfort and Convenience Questionnaire were used post intervention to determine how often the HPD's were used when participants were working around hazardous noise. Hazardous noise was

defined as having to raise your voice to be heard by someone else who was standing three feet away. 84% of participants responded to the post-test questions. Posttest findings found an increase from 22%-66% in the number of participants using HPD after receiving the devices in the mail. An increase of 44% over pre-test numbers. This was a statistically significant finding ($p < 0.001$) even with the small sample size. Findings based on the Farmers Use of Hearing Protection Scale indicated that farmers and workers exposed to hazardous noise are influenced by perceived barriers as well as the availability of HPD (McCullagh, 2011).

In another study, Rosemberg et al. (2015) investigated rural and farm youths' perceptions of hearing conservation and the use of HPD's. 25 farm youth were recruited to participate in one of two focus groups. The Health Promotion Model by Nola J. Pender was used as a framework for focus group interviews establishing participants perceived benefits of HPD use, perceived barriers to HPD use, perceived self-efficacy in relation to using HPD, situational influences, and activity-related affect. Several misconceptions were found when discussing with participants the concept of NIHL. Many believed that NIHL would and could only affect them once they were older. Some believed that their risk of NIHL decreased as they were exposed to noise longer, as their ears just started to get "used" to the noise. None of the participants made any correlation between hazardous noise levels and permanent hearing damage. Barriers to the use of HPD's were discussed, stated barriers included that devices were uncomfortable, inconvenient, burdensome, and annoying. Youth were also concerned about safety and not being able to hear equipment or others around them. These discussions with youth highlight the need for education within this population, to help increase the efficacy of hearing conservation efforts and to provide accurate information regarding the use of HPD's. More importantly, adults have strong

interpersonal influences on these young individuals and can help reinforce the importance of hearing protection to prevent long term, irreversible hearing loss.

Conclusions

By better understanding the dynamics and pathophysiology of hearing loss, providers and patients can have a better understanding of the concept of NIHL, causes, and prevention methods. Amongst other industries, agriculture is ever-changing with many workers if not all agricultural workers exposed to hazardous levels of noise, placing them at high risk for NIHL. As shown by the literature, screening for hearing loss in rural healthcare settings is imperative to hearing conservation in farmers and agricultural workers. Simple, cost effective hearing screening questionnaires have been proven effective in determining risk levels in farmers and agricultural workers. With the use of these self-administered questionnaires opportunities are created for patient education on the permanent, irreversible effects of hearing loss as well as opportunities for referral for further audiologic testing. In combination the self-administered further screening with pure tone audiometry allow providers to understand an individual's perceived hearing loss vs. actual hearing loss. By making these correlations and disseminating results patients have increased awareness of the extent of their hearing loss and may be more compliant with HPD use to decrease their risk for further damage. There is significance with providers understanding health disparities commonly associated with agricultural workers and farmers in the rural healthcare setting and work to provide high quality care which includes hearing screening. Additionally, hearing conservation methods such as noise reduction and the use of hearing protection devices should be explored by providers and discussed with farmers and agricultural workers.

CHAPTER 3: METHODS

Project Overview

The purpose of this practice improvement project was to bring awareness to rural North Dakota agricultural workers and farmers about the harmful effects of hazardous noise. Provision of education on the importance of screening, improved hearing health practices, including the use of HPDs is an important component of this project. This project also served to a) identify and screen agricultural workers and farmers for hearing deficits; b) provide appropriate referrals for agricultural workers and farmers deemed at risk, and c) give rural primary care providers a cost effective, efficient, screening protocol. Participants were given the Hearing Handicap Inventory-Adults questionnaire to help determine their perceived hearing loss (see Appendix A). Post hearing screening participants' actual hearing was then tested using pure tone audiometry with the Hear X hearScreen audiometric tool. Results of these two tests were analyzed looking at individuals perceived hearing loss vs. actual hearing loss and disseminated to participants along with an educational packet on hearing loss prevention methods and a gift set of ear plugs or earmuffs.

Implementation Plan

Setting

The practice improvement project was proposed to take place at two locations in Steele, ND. Four Seasons Wellness is a private, rural healthcare clinic owned and operated by Mandy Rath, FNP and Mandi Mock, LPN. Four Seasons Wellness serves the Kidder County area, which consists of multiple rural farming communities. The estimated population of Kidder County was around 2,394 people covering about 1433 square miles. Communities included in Kidder County include Steele, Tuttle, Dawson, Tappen, Robinson, and Pettibone. Four Seasons Wellness

provides services to all members of the county. The county is largely devoted to agriculture. Many individuals own farms, or are employed by farms, ranches, and agricultural related business are seen in this facility, making Four Seasons Wellness an ideal location for this practice improvement project. Patients are frequently seen by appointment and occasionally by walk-in appointments. Recruitment, screening, and data collection took place at this location from August 2021 to January 2022.

In a second location, participants were to be recruited for screening during the 2nd Annual Agricultural Awareness Night, hosted at Pifer's Auction Building in Steele, ND in September 2021. The event was hosted by the North Dakota State University Extension Office: Kidder County and the Kidder County Farm Bureau. The goal of the Agricultural Awareness Night was to educate farmers, ranchers, and agricultural workers in the Kidder County area on farm safety measures, making this popular event a fitting recruitment setting for recruiting participants for a hearing loss prevention practice improvement project. Unfortunately, due to COVID-19 and scheduling changes, screenings were not able to take place at this event.

Participants

A convenience sample of farmers and agricultural workers was recruited for screening. The sample size goal was a total of 75 participants between the two locations. Participants were over the age of 18 and exposed to agricultural related noise (*e.g.,* farmer, rancher, mechanic, employee of agriculture related business, or family member/individual living on or exposed to agricultural noise). There were no restrictions on race or gender for this practice improvement project.

Protection of Human Subjects

This practice improvement project was conducted in accordance with North Dakota State University Institutional Review Boards policies. With this practice improvement project, men and women over the age of 18 could participate by completing the pre-survey demographics questions, the Hearing Handicap Inventory-Adult questionnaire, and by taking the hearScreen audiometric screening test. Participants received education on NIHL, the long-term effects, and the importance of using HPDs.

The possible risks associated with this practice improvement project were minimal and included possible emotional distress associated with receiving results of hearing loss. Proper referral to a hearing specialist was given to address any other concerns a participant may have. Risks were minimized by protection of private patient information by the co-investigator, and committee chair/committee.

For this practice improvement project participants were recruited at Four Seasons Wellness in Steele, ND through chart reviews. Flyers and newspaper advertisements were also used to help promote recruitment for hearing screenings. Participants were to be recruited at the Agricultural Awareness Night in Steele, ND. Participation was voluntary and no identifying data would have been collected from participants. There were multiple benefits of the proposed practice improvement project for participants including the following: a) participants may become more aware of a reliable, cost effective hearing screening method detecting those at risk or suffering from NIHL; b) participants should be more knowledgeable about the importance of hearing screening and use of HPDs; and c) participants were provided with verbal and written education about NIHL, general hearing health, and options for use of HPDs. Institutional Review Board approval was granted from North Dakota State University, (see Appendix A).

Recruitment

Rural Health Clinic

This co-investigator completed a chart review of social history for all patients scheduled in the rural health clinic each day that the co-investigator was in clinic during clinical rotations. Patients over the age of 18 and list an occupation related to agriculture were asked if they would like to participate in a free hearing screening. Those who agreed to participate were first asked to provide oral consent after reading through the consent form. (see Appendix O). They then were asked to completed a demographics questionnaire: a) age; b) gender; c) occupation (*e.g.*, farmer, rancher, agriculture related business employee, mechanic, or other); d) known exposure to loud noise; e) number of hours per day they are exposed to hazardous noise; d) perceived level of hearing loss (zero -four scale, zero being no hearing loss, four being significant hearing loss); and e) and if they wear hearing protection when exposed to loud noise (see Appendix C). After completion of the demographics questionnaire the participant was then taken through the hearing screening process.

Agricultural Awareness Event

Farmers and agricultural workers were to be recruited to the Agricultural Awareness Event by the NDSU Extension Service and Kidder County Farm Bureau. The Agricultural Awareness Event is an event that has been held for the Kidder County Agriculture Community the past few years. Farmers, ranchers, and agricultural workers from a variety of different backgrounds are invited to attend. Dinner is provided and topics pertaining to farm safety are typically discussed. In 2021, grain bin safety was the focus of the event.

The practice improvement project was to be listed as a booth on the Agricultural Awareness Event informational flyer provided by the NDSU Extension Service and the Kidder

County Farm Bureau. Event flyers promoting this practice improvement project and free hearing screenings were to be placed around the community at local businesses. In addition, the co-investigator intended on placing a small add in the *Steele Ozone and Kidder County Press* promoting the free hearing loss screenings offered at the event. The co-investigator was to have a booth set up at the event, along with an additional room for the Hear X hearScreen audiometry testing. Patients over the age of 18 and list an occupation related to agriculture were to be asked to participate in the Hearing Handicap Inventory- Adult questionnaire (see Appendix D) and Hear X hearScreen audiometric screening to measure actual hearing loss. Participants at the Agriculture Awareness Event who agreed to participate would be entered into a drawing to win one of 4 $25.00 gift cards to a local business. As stated previously, hearing screenings were not able to take place at this community event.

Resources

Resources needed for implementation of this practice improvement project at Four Seasons Wellness in Steele, ND included the following a) a partnership between the co-investigator and primary care provider (see Appendix I); b) Hearing Handicap Inventory-Adult questionnaire and pre-survey demographics questionnaire; c) Hear X hearScreen audiometric screening tool with calibrated headphones; d) folders with education handout, list of audiology providers within 100-mile radius of the rural health clinic, and a set of foam ear plugs; e) press release sent to *The Steele Ozone and Kidder County Press* to help promote recruitment for hearing screenings; and f) an educational flyer hung up at local businesses promoting recruitment for hearing screenings at the rural health clinic.

Resources needed for implementation of this practice improvement project at the Agricultural Awareness Event in Steele, ND included the following a) a partnership between the

co-investigator and the NDSU Extension Service- Kidder County and the Kidder County Farm Bureau (see Appendix H); b) Hearing Handicap Inventory-Adult questionnaire and pre-survey demographics questionnaire; c) Hear X hearScreen audiometric screening tool with calibrated headphones; d) folders with education handout, list of audiology providers within 100-mile radius of the rural health clinic, and a set of foam ear plugs; e) flyers promoting hearing screenings to be provided at the Agricultural Awareness Event to be distributed throughout the Kidder County community; f) Four- $25.00 gift cards to local businesses (drawn as door prizes for participants at the event).

Implementation

In order to efficiently and effectively implement the practice improvement project, specific criteria were developed to help meet each project objective. North Dakota farmers and agriculture workers were voluntarily screened for hearing loss at Four Seasons Wellness in Steele, ND from August 2021- January of 2022. Additionally, farmer and agricultural workers were to be recruited for hearing loss screening at the Agricultural Awareness Event in Steele, ND in September of 2021. For both locations the protocol and steps for screening were the same. Through the utilization of the Hearing Handicap Inventory-Adult screening tool, participants perceptions of their hearing were assessed. Each participant was then screened using the Hear X hearScreen audiometric tool to assess actual hearing loss. After screening completion results were disseminated to the participant and discussed. Referral was provided to participants scoring mild handicap or above on the Hearing Handicap Inventory-Adult questionnaire screening tool. Each participant was given a directory of North Dakota audiologists within 100 miles. Additionally, handouts related to hearing health and hearing protection devices were placed in a folder for the participant and they were given a set of earmuffs or ear plugs by the co-

investigator for their participation. At the Agriculture Awareness Night each participant would have been entered into a drawing to win a one of four $25.00 gift cards to a local Steele business.

Budget

Table 1

Budget for the Proposed Practice Improvement Project

Item	Estimated Expense
Hear X Screening Software, Headset, and Tablet	$1042.00
Printed flyers for Agricultural Awareness Event	$10.00
100 soft ear plugs	$18.00
20 sets of muffs	$200.00
Poster board for educational booth at Agricultural Awareness Event	$15.00
Gift cards for door prizes	$100.00
Folders and Educational Materials x 100 participants	$100.00
Printed HHI-A questionnaires and results of Hear X pure tone audiometry testing	$20.00
Grand Total:	$1505.00

** This budget was covered solely by the co-investigator.

Outcomes and Plan for Evaluation

Each objective for this practice improvement project was evaluated thoroughly and the process described using a logic model (See Appendix F). Objectives for this project included the following: a) to identify and screen rural North Dakota farmers and agricultural workers at risk or suffering from NIHL at Four Seasons Wellness in Steele, ND and/or at the Agricultural Awareness Event held in September of 2021 in Steele, ND; b) explain results of the Hearing Handicap Inventory-Adult hearing screening tool and Hear X hearScreen audiometric testing at the time of screening and compare the individuals perceived hearing loss versus actual hearing loss; c) categorize participants based on their cumulative score and results from the audiologic screening tool and make a referral as appropriate; and d) provide education to participants on the health consequences of NIHL, the benefits of utilizing HPDs, and steps to help overcome barriers using a participant handout.

Outcomes

Short-term outcomes for the above objectives were as follows: a) increased awareness for agricultural workers, farmers, and rural primary care providers of a reliable, cost effective hearing loss screening method to detect individuals at risk or suffering from NIHL; b) provide skills, training, and tools that staff at a rural healthcare clinic can utilized to assist in hearing loss screenings for patients; c) increased knowledge pertaining to hearing screening and the use of HPDs; d) assist in referral for further audiometric testing if warranted; and e) provide verbal and written education pertaining to NIHL, general hearing health, and options for the use of HPDs.

Long-term outcomes for the above objectives included the following: a) a change of practice was initiated at the rural healthcare clinic, resulting in increased screening of individuals for hearing loss and referral as appropriate; b) the rural health clinic would be provided with a reliable, cost effective protocol to help identify farmers and agricultural workers at risk or suffering from NIHL, c) a behavior change would take place resulting in better hearing health practices and use of HPDs; d) a contribution will be made to the knowledge base utilized by occupational health safety organizations to help promote industry wide best practices related to hearing health and HPD use; and e) overall community awareness would be created pertaining to NIHL, hearing health, hearing screening opportunities, and hearing protection and enhancement devices.

Data Collection and Analysis

Data were collected from August 2021-January 2022. The Iowa Model of Evidence Based Practice and the Health Promotion Model by Nola J. Pender was utilized to help guide project analysis and evaluation. Data for this project were collected via the pre-survey

demographic questionnaire, the Hearing Handicap Institute- Adult hearing loss questionnaire, and the Hear X hearScreen audiometric testing.

Objective one for this practice improvement project was to identify and screen rural North Dakota farmer and agricultural workers at risk or suffering from NIHL at an agricultural event and/or a rural health clinic. Data collection for this objective included recruiting participants and noting the number of participants that have hearing screenings completed. Participants results for the pre-survey demographics questionnaire and Hearing Handicap Inventory-Adults questionnaire were then tabulated. By completing these two questionnaires the co-investigator was able to determine if individuals were at risk or had perceptions that they were suffering from NIHL.

Objective two for the practice improvement project was to categorize participants based on their cumulative score from the Hearing Handicap Inventory-Adult questionnaire and the Hear X hearScreen audiometric screening tool and make a referral if appropriate. Through the use of the Hear X hearScreen audiometric tool participants actual hearing was screened. He or she was given a result of normal hearing, slight hearing loss, mild hearing loss, moderate hearing loss, or severe hearing loss in one or both ears. Those scoring with mild to moderate hearing loss or above were provided with referral for further follow up. Data were tabulated in an excel spread sheet to help organize and report also the individuals perceived emotional and social handicaps that their hearing loss may be causing them.

Objective three for the practice improvement project was to provide and explain verbal and written results to participants at the time of the screening based on their perceived hearing loss versus their actual hearing loss results. Again, scores were obtained from the Hearing Handicap Inventory-Adult on the participants perceived emotional and social handicap. In

addition, scores were utilized from the pre-survey demographics questionnaire, specifically the question that asks them to rate their perceived hearing loss from zero (no hearing loss) to four (significant hearing loss). The data were entered into an excel spread sheet to help make conclusions at the completion of the project.

Objective four for the practice improvement project was to provide education to all participants on the health consequences of NIHL, the benefits of utilizing HPDs, and steps to help overcome barriers to utilization of HPDs using a participant handout. Data were collected on the number of participants that were provided with education after their hearing screening.

Conclusion

Utilizing the Iowa Model of Evidence Based Practice and Nola J. Pender's Health Promotion model framework for this practice improvement project was established. Through application of the Iowa Model of Evidence Based Practice step by step guidance was provided assisting in topic selection, team assembly, assembly of research and related literature, designing the practice change, choosing evidence based screening tools, collecting baseline data, and preparing a provider to promote adoption of recommendations determined by the project. In addition, implementation strategies were developed to help create awareness and interest in the project, build knowledge and commitment, promote action and adoption, and to pursue integration and sustained use.

Nola J. Pender's Health Promotion Model offered additional guidance for this project, investigating the health promotion behaviors of farmers and agricultural workers. This model served to establish prior related behaviors amongst the population, investigate perceived benefits and barriers to the proposed intervention and defined interpersonal and situational influences that may have impacted the outcomes of the practice improvement project.

Through integration of the Iowa Model of Evidence Based Practice and the Health Promotion Model project objectives were clearly defined and were accomplished with timely implementation of the project. Objectives for this practice improvement project focused on individuals at risk or suffering from NIHL as well as providers working in rural healthcare settings. Once objectives were initiated focus was placed on the purpose of this project, to decrease the risk of NIHL in agricultural workers and farmers. New protocols and hearing screening guidelines were presented to a rural healthcare clinic to prompt a change in practice related to the screening of individuals at risk for hearing loss. Lastly, and most importantly a simple hearing screening was provided to agricultural workers and farmers. These screenings helped create awareness about the detrimental, irreversible effects of NIHL and what effective prevention methods can be used to help prevent hearing loss.

CHAPTER 4: RESULTS

Results

Objective One

Objective one for this practice improvement project was to identify and screen rural North Dakota farmers and agricultural workers at risk or suffering from NIHL at an agricultural event and/or a rural health clinic. A total of 47 individuals were recruited and participated in this practice improvement project at the rural health clinic from August 2021 to January of 2022. Each of the 47 participants agreed to complete the pre-survey demographics questionnaire, Hearing Handicap Inventory-Adults questionnaire, and participate in the Hear X hearScreen audiometric hearing screening. There were no survey questions left unanswered and all responses were included in the final summary of the practice improvement project. Objective one of this practice improvement project was met.

Demographics

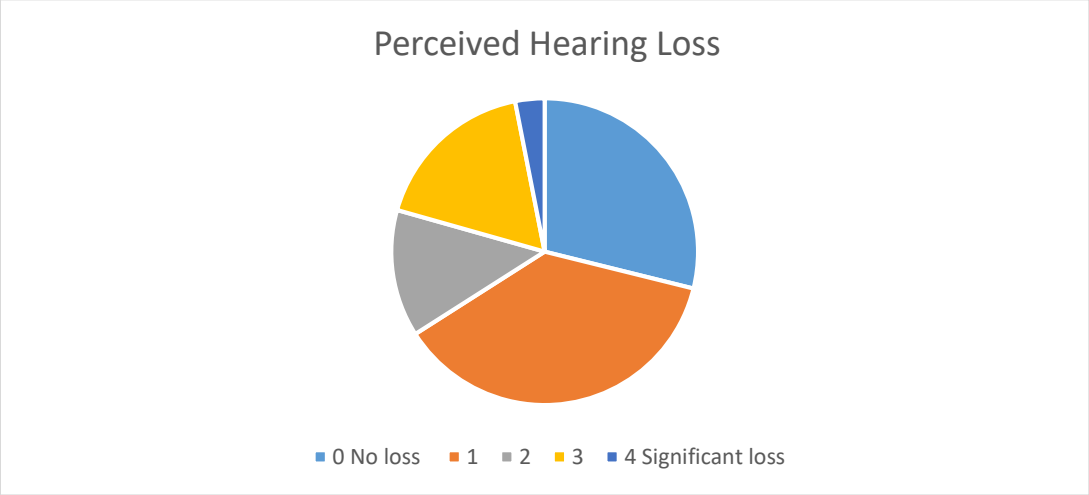
The purpose of the pre-survey demographic questions was to obtain demographic information about the participants including their gender, age, occupation, hearing protection use, hearing aid device use, perceived hearing loss, and perceived amount of noise exposure each day. There was a total of 47 individuals that participated in the practice improvement project, with 34 (72%) being male and 13 (28%) being female. The largest group of participants were between the ages of 32 to 48 years, making up 40% of the sample population. There were no participants between the ages of 18 to 25 years. Three (6%) of participants were between the age of 26 to 31 years, 13 participants (28%) were between the ages of 49 to 67 years, and 12 (26%) were 68 years of age or older.

Each participant was asked to list their occupation on the pre-survey demographics questionnaire. Fourteen participants (30%) chose both farmer and rancher. Nine (19%) choose exclusively farmer and four (8.5%) chose exclusively rancher. Ten (21%) of participants choose employee of an agriculture business and four (8.5%) chose mechanic. Six (13%) participants chose other and listed other occupations. Other occupations listed among these six individuals included wife of a rancher working on the farm part time, wife a rancher, veterinarian, and agricultural spray plane pilot.

After providing information on age, gender, and occupation participants were asked to provide information on their perceived level of hearing loss, HPD use, and level of noise exposure. Each individual was asked to rate their perceived level of hearing loss from zero to four. Zero indicating no loss and four indicating significant hearing loss. Thirteen (28%) participants indicated a zero or no hearing loss. Seventeen (36%) participants chose one, six (13%) participants chose two, eight (17%) participants chose three, and three (6%) participants chose a four indicating they perceived they had significant hearing loss. Overall, 34 (72%) of participants in this practice improvement project indicated that they have some form of hearing loss. Forty-five participants (96%) indicated they were exposed to loud noise over 85dB, 2 (4%) indicated they were not exposed to loud noise.

Figure 1

Perceived Hearing Loss



For participants that indicated a yes for noise exposure on the questionnaire, they were then asked about the hours per day that they were exposed to noise greater than 85dB. Twenty-nine (62%) participants noted noise exposure over 85dB for one to five hours per day, 14 (30%) participants indicated noise exposure over 85dB for six to 10 hours per day, and two (4%) participants indicated noise exposure over 85 dB for 11-15 hours per day. Two (4%) individuals noted no noise exposure during the screening process and therefore did not answer the question. No participants noted noise exposure for 16 to 20 hours or 20 to 24 hours. Two participants (4%) wore hearing aids, neither participant wore for the hearing screening. Forty-five (96%) participants wore no hearing aid or amplification device.

Table 2

Demographics of Participants

Characteristic	n (%)
Demographics	
Age (in years)	**n= 47**
18-25	0 (0%)
26-31	3 (6%)
32-48	19 (40%)
49-67	13 (28%)
68+	12 (26%)
Gender	**n= 47**
Male	34 (72%)
Female	13 (28%)
Occupation	**n= 47**
Farmer	9 (19%)
Rancher	4 (8.5%)
Farmer/Rancher	14 (30%)
Mechanic	4 (8.5%)
Employee of agriculture related business	10 (21%)
Other	6 (13%)
Perceived level of hearing loss	**n= 47**
0 No hearing loss	13 (28%)
1	17 (36%)
2	6 (13%)
3	8 (17%)
4 Significant hearing loss	3 (6%)
Hearing Protection Use	**n= 47**
All the time	0 (0%)
Most of the time	10 (21%)
Sometimes	20 (43%)
Never	17 (36%)
Noise Exposure > 85 dB	**n= 47**
Yes	45 (96%)
No	2 (4%)
Noise Exposure > 85 dB (hours per day)	**n= 47**
No noise exposure indicated	2(4%)
1 to 5 hours	29 (62%)
6 to 10 hours	14 (30%)
11 to 15 hours	2 (4%)
16 to 20 hour	0 (0%)
20 to 24 hours	0 (0%)
Hearing Aid/Amplification Device Use	**n = 47**
Yes	2 (4%)
No	45 (96%)

Objective Two

Objective two for this practice improvement project was to provide and explain verbal and written results to participants at the time of screening based on their perceived hearing loss versus their actual hearing loss results. Forty-seven participants completed the Hearing Handicap Inventory-Adult questionnaire and were screened using the Hear X hearScreen audiometric screening tool. Each questionnaire was scored and discussed with the participant. Results of the audiometric screening tool were printed off in the room for the patient to review with the co-investigator. Results of the Hearing Handicap Inventory-Adult questionnaire and the Hear X hearScreen audiometric screening tool were reviewed with 100% of the participants at the time of their screening. Objective two for this practice improvement was met.

Hearing Handicap Inventory - Adults Questionnaire Results

Each participant in the practice improvement project was asked to complete the Hearing Handicap Inventory-Adult questionnaire to assess their perceptions about their current level of hearing loss and the social and emotional handicap it may be causing them. Participants were asked to answer yes (4 points), sometimes (2 points), or no (0 points) for each question. Questions pertaining to the emotional effects of hearing loss were then scored and divided by 52. Questions pertaining to the social effects of hearing loss were then scored and divided by 48. The total number of points was then added together and divided by 100 to give a final handicap score. No handicap was noted for individuals scoring 0 to 16%. Mild to moderate handicap was noted for individuals scoring 17 to 42%, and significant handicap for individuals scoring 43% and above (see Appendix P).

Hearing Handicap Inventory Adult- Social Handicap Scores

The Hearing Handicap Inventory-Adult questionnaire evaluated individual's perception of social and emotional handicaps that their hearing problem may cause them. Each of the 25 questions on the questionnaire is preceded by an S for social, or E for emotional. Participants answer the question with a score of 4 (yes), 2 (sometimes), 0 (never). Scores were then tallied and divided by 48 for social, and 52 for emotional. A score of 0-16% indicates no handicap. A score of 17%-42% indicates a mild to moderate handicap, and greater than 43% indicates significant handicap.

Out of the 47 participants 26 (55%) scored between 0-16% indicating no perceived social handicap in relation to their hearing. Sixteen (34%) scored between 17-42% indicating a perceived mild to moderate social handicap, and five (11%) scored greater than 43 indicating a perceived significant social handicap when discussing their hearing.

Hearing Handicap Inventory Adult- Emotional Handicap Scores

Out of the 47 participants that evaluated their perceived emotional handicaps regarding their hearing 31 (66%) scored between 0-16% indicating no perceived emotional handicap. Twelve (25%) scored between 17-42% indicating a perceived mild to moderate emotional handicap. And finally, four (9%) scored 43% and greater indicating a perceived significant emotional handicap.

Perceived Hearing Loss versus Actual Hearing Loss Results

Each participant was asked to rate their perceived hearing loss with zero indicating no perceived hearing loss and four significant perceived hearing loss on the pre-survey demographics questionnaire. Once completed the participants actual hearing was tested using the Hear X hearScreen audiometric screening tool.

There were 13 participants that indicated zero, or no hearing loss on the demographic questionnaire. Of these 13 individuals 3 (23%) tested with normal hearing in both ears, four (31%) participants test revealed slight hearing loss, one (8%) participants test revealed normal hearing in their left ear and slight hearing loss in their right ear and one (8%) participants test revealed normal in their left ear and mild hearing loss in their right ear. One (8%) participant tested with mild hearing loss in both ears, and one (8%) participant tested with moderate hearing loss in both ears. Two (15%) participants that noted no perceived hearing loss on their demographic's questionnaire tested with moderate hearing loss in their left ear and mild hearing loss in their right ear. Of the 13 participants that indicated zero, or no perceived hearing loss a total of 10 (77%) had some form of hearing loss in both ears.

Seventeen participants indicated a perceived hearing loss of one on the pre-survey demographics questionnaire. Nine (53%) participants were screened and presented with normal hearing. One (6%) participants audiometric screening test showed slight hearing loss in the left ear, and normal hearing loss in the right ear. Five (29%) participants screening test revealed slight hearing loss in both ears. No participants screening test indicated mild hearing loss. One (6%) participant tested with slight hearing loss in the right ear, and mild hearing loss in the left ear and one (8%) participant tested with moderate hearing loss in the left ear and mild hearing loss in the right ear. Of the 17 participants that indicated a perceived hearing loss of one on their demographic screening questionnaire, eight (47%) participants Hear X hearScreen audiometric test revealed some form of hearing loss in both ears.

Seven participants rated their perceived hearing loss at a two on the pre- survey demographics questionnaire. Of these seven participants one (14%) participant tested with normal hearing. Three participants (43%) tested with slight hearing loss in both ears, one (14%)

tested with mild hearing loss in both ears. One (14%) participants Hear X hearScreen results indicated normal hearing in their left ear, and mild hearing loss in their right ear. Finally, one participant tested with moderate hearing loss in their right ear and slight hearing loss in their left. Of the seven participants that indicated a perceived hearing loss of two on their demographic's questionnaire, six (86%) presented with some form of hearing loss on the Hear X hearScreen audiometric tool.

Eight individuals indicated on the demographic's questionnaire a perceived hearing loss of three. Zero of the participants screening test revealed normal hearing in both ears. One (13%) individual tested with slight hearing loss in the right ear and normal hearing loss in the left. One (13%) participants Hear X hearScreen test indicated mild hearing loss in both ears, four (50%) participants indicated moderate hearing loss in both ears, and two (25%) individuals screening test indicated mild hearing loss in the right ear and moderate hearing loss in the left ear. Of eight individuals that indicated a perceived hearing loss of three on their demographic's questionnaire, eight (100%) tested with some form of slight to moderate hearing loss on the Hear X hearScreen audiometric tool.

Finally, three participants indicated a four or significant hearing loss on their demographic's questionnaire. Of the three participants, none tested with normal hearing. One participant's screening indicated slight hearing loss in both ears. One participant tested positive for slight hearing loss in their left ear, and mild hearing loss in their left ear. And finally, one participant tested positive for moderate hearing loss in both ears. Of the three (100%) participants that indicated a 4 or significant hearing loss on their demographics questionnaire all three presented with hearing loss in both ears on their Hear X hearScreen audiometric test.

In conclusion, out of the 47 individuals participating in the practice improvement project, 34 (72%) indicated some form of perceived hearing loss with 45 (96%) being exposed to loud noise over 85dB. Forty-seven individuals were screened for hearing loss with the Hear X hearScreen audiometric tool and 34 (72%) tested with some form of actual hearing loss. Thirteen (28%) participants had normal hearing in both ears.

Objective Three

The third objective for this practice improvement project was to categorize participants based on their cumulative score from the Hearing Handicap Inventory-Adult questionnaire and provide referral if appropriate. Due to the amount of noise exposure noted from most participants pre-survey demographics questionnaire, each individual was given a handout with a list of all audiologists within a 100-mile radius of the clinic in Steele, ND. Forty-Five (96%) participants indicated exposure to noise over 85dB daily. Conversations were held discussing each participants noise exposure and each individual was encouraged to reach out to any of the audiologic specialists listed the handout if they have any further concerns or questions. Seventeen (35%) participants scoring with mild or moderate hearing loss on the Hear X hearScreen audiometric tool were given a stronger recommendation to reach out to a provider for further work up, assessment, and education. No individuals tested with severe hearing loss. Objective three of the practice improvement project was met.

Objective Four

The final objective for this practice improvement project was to provide education to all participants on the health consequences of NIHL, the benefits of utilizing HPDs, and steps to help overcome barriers to using protection devices using a participant handout. All participants were provided with an educational handout (see Appendix: L) as well as verbal education on the

health consequences of NIHL, benefits of using HPDs, and steps to help overcome barriers to using HPDs. Each participant was provided with a pair of foam ear plugs, and every tenth individual was provided with a set of earmuffs. Objective four of the practice improvement project was met.

CHAPTER 5: DISCUSSION AND RECOMMENDATIONS

Summary

The purpose of this practice improvement project was to identify and screen North Dakota farmers and agricultural workers at risk or suffering from NIHL. Farmers and agricultural workers have been frequently exposed to hazardous noise. Unfortunately, many are not aware of the level of their exposure or of the risks associated with NIHL.

The practice improvement project included a total of 47 farmers, ranchers, and agricultural workers who were asked about their perceived hearing loss using a demographics questionnaire and the Hearing Handicap Inventory- Adult questionnaire. The co-investigator was quickly able to determine if the participant felt they were experiencing some form of hearing loss and to what extent the loss was affecting their emotional and social aspects of daily living. Participants were asked to rate their perceived hearing loss on a scale of zero (no perceived loss) to four (perceived significant hearing loss). Overall, 72% of participants indicated that they had some form of hearing loss.

Along with perceived hearing loss, participants were asked about their noise exposure and their HPD use. Participants were asked if they were exposed to noise greater than 85dB and for what duration of time. Of the 47 participants, 96% noted exposure to noise greater than 85dB anywhere from one to sixteen hours per day. Additionally, 36% of participants indicated never wearing hearing protection, 43% reported only wearing HPDs, sometimes and 21% reported wearing HPDs most of the time. No participants indicated wearing HPDs all the time.

In addition to the demographic questionnaire and Hearing Handicap Inventory-Adult questionnaire participants' actual hearing was screened using the Hear X hearScreen audiometric tool. The audiogram results were printed for the participant and reviewed with every participant.

By completing questionnaires that assessed perceived hearing loss and through completion of the audiometric screening participants perceived hearing loss was compared with their actual hearing loss. This portion of the project was very influential; the findings helped facilitate conversations about the risk associated with hazardous noise exposure and the importance of prevention methods to prevent hearing injury or minimize further injury. Of the 47 individuals that indicated zero or no perceived hearing loss, 77% tested with some form of hearing loss with the audiometric screening tool. The seventeen participants who indicated a one, or minimal hearing loss on their demographic questionnaire, 47% tested with some level of measurable hearing loss with the audiometric screening tool. Overall, of the 72% (34 participants) that indicated some form of perceived hearing loss on their demographic questionnaire, 72% (34 participants) tested with some level of measurable actual hearing loss.

After screening was completed through questionnaires and the audiometric screening tool, education was provided to 100% of participants. Education focused on a) how sound travels into and through the ear; b) how hazardous noise can damage the ear; c) how the use of hearing protection devices can help prevent hearing injury and further damage for those already experiencing loss; and d) other risks associated with NIHL. Information on referral to an audiologist was discussed with each of the individuals presenting with exposure to high levels of noise exposure in case they would have any questions about further screening or treatment options. In addition to a written handout, individuals screened with mild to moderate loss unilateral or bilaterally were highly recommended to follow up with an audiologist.

Each of the 47 participants were given a folder with a copy of their audiogram results, a list of audiology providers within 100 miles of the rural health clinic, and a handout from Texas A & M University on NIHL prevention methods and associated risk factors. A set of foam ear

plugs were provided to each participant in their folder and a set of earmuffs were given to every 10th participant participating in the project.

Discussion

Objective One

Objective one for this practice improvement project was to identify and screen North Dakota farmers and agricultural workers at risk of suffering from NIHL at an agricultural event and/or a rural health clinic. Four Seasons Wellness a rural health clinic in Steele, ND was utilized for hearing screenings and patient education for this project. Steele, ND is a rural farming community and is the county seat of Kidder County. The rural clinic offers services to a little over 2,000 residents that reside in the county. Currently, hearing screenings are infrequently performed at Four Seasons Wellness. If concerns are presented to the provider a small handheld audiometer is used to screen the individual and referral made if necessary, with the closest audiologist to Steele, ND being a minimum of 50 miles away. Kidder County is primarily a farming community, home to many farmers, ranchers, and agricultural workers making the clinic an ideal location for this practice improvement project. Unfortunately, the literature has shown that rural areas, like Kidder County, typically lack healthcare services such as audiometric screenings. Many rural health care providers lack the time and resources to implement routine hearing screenings in this population in efforts to help prevent and identify NIHL.

Through the utilization of the pre-survey demographic questionnaire, Hearing Handicap Inventory-Adult questionnaire, and the Hear X hearScreen audiometric tool, 47 voluntary participants were screened at the rural healthcare clinic. Individuals were recruited through chart reviews completed by the co-investigator during clinical rotations at Four Seasons Wellness. Unfortunately, this did not produce the desired number of willing participants for the project as

only about 15 participants were initially identified. More effective routes of recruitment for the project included the use of informational flyers placed at the clinic and around the community, recruitment by word of mouth, as well as through social media posts made by the clinic. Three screening days were utilized, and individuals interested in hearing screening through the above methods were invited to come to the clinic for their free hearing screening.

A noteworthy finding is that the actual screening took about 30 minutes per participant which was significantly longer than the 15 minutes expected in planning of the implementation of the project. An additional unexpected finding was that the Hear X hearScreen tool also took slightly longer to complete than expected. For those with normal hearing the test took about three to four minutes, and for those with mild to severe hearing loss five to seven minutes. Education with the participants also took longer than expected. The co-investigator lives in the community and participants liked to visit and ask questions after the completion of their visit. Due to this time increase the co-investigator was not able to screen as many participants as expected during the times that were available for screening at the clinic. An additional obstacle was that many of the individuals coming into the clinic for visits that met the criteria in many cases did not have additional time to stay for a hearing screening. Farmers and agricultural workers have very busy and variable work schedules and even getting them into the clinic for their original appointment can be difficult. In conclusion, time was a major factor, as what was originally anticipated to take less than 20 minutes took closer to 45 minutes resulting in less opportunity to screen as many participants as anticipated.

Another barrier during this practice improvement project was that hearing screenings where not able completed at the Agricultural Awareness Event which was scheduled at Pifers Auction & Realty in Steele, ND in September of 2021. Due to a significant number of COVID-

19 cases in the community and other factors the event was moved by the NDSU Extension Service Kidder County and Kidder County Farm Bureau to February of 2022 and to a different location. Due to the extension of the date and change in venue the co-investigator in consultation with the committee chair opted not to complete hearing screenings during the event. The new location was not only delayed but did not have a realistic area that would allow for minimal background noise, and then events scheduled changed to include live entertainment which would have significantly impacted the opportunity for effective hearing screenings to be completed.

With the implementation of this project all willing participants were screened for NIHL. Upon completion of screening using both the questionnaires and the audiometric tool measures the results reflected 72% of participants tested with some form of actual hearing loss ranging from a slight to moderate deficit. Additionally, 96% of participants indicated that they were exposed to loud noise greater than 85dB ranging anywhere from one to sixteen hours per day. Although screenings were not able to be completed at the Agricultural Awareness event the original objective of this project was to screen individuals at a rural clinic and/or an Agricultural Awareness event. Objective one was met for this project by identifying these individuals at risk and or suffering from noise induced hearing loss by screening them at the rural healthcare clinic.

Objective Two

Objective two for this practice improvement project was to provide and explain results to participants at the time of screening based on their perceived hearing loss versus their actual hearing loss results. The rural agricultural population may lack knowledge related to the long-term effects of hazardous noise exposure and may not understand that the levels of noise exposure they are being exposed to are causing them long term permanent damage. NIHL is a

slow, progressive condition and unfortunately, many individuals may not know they are experiencing deficits until the damage has already occurred.

By providing written and verbal results to the participant at the time of screening, the co-investigator was able to show individuals their perceived hearing scores versus what their actual hearing loss as assessed with the Hear X hearScreen audiometric tool. Only two participants reported having prior consultation with audiometry and wore hearing aids for their deficits. For several participants the results of the audiometric test confirmed the assumptions of their perceived hearing loss, and others were very surprised to find that they may have perceived their loss as low but their actual hearing loss revealed a mild to moderate loss in one or both ears. For some being able to see a graph that showed the decline in their hearing was eye opening and many had additional questions about the hearing loss report. Objective two was met as all of the participant's questionnaire results and audiometric test results were reviewed with each participant at the time of screening.

Objective Three

Objective three focused on categorizing participants based on their cumulative score on the Hearing Handicap Inventory-Adult questionnaire and results from the Hear X hearScreen audiometric tool and make a referral if appropriate. Although the objective was met, this objective presents some challenges for this population specifically in rural communities. Variation of work tasks and work schedules within this population make getting them to and from additional healthcare appointments difficult at times. The nearest audiologist is 50 miles from the rural healthcare clinic in Steele, ND. Encouraging those testing with mild to moderate deficits, which should have some follow up if interfering with their daily life, can be difficult. Additionally, if hearing aids or amplification devices are warranted, they are often very

expensive and not covered by insurance. These points exemplify the importance of this project and screening processes from the screening results. Early screening for those at risk or suffering from NIHL remains key to early prevention.

With this practice improvement project 96% of participants indicated they have exposure to noise greater than 85dB through the day. Due to this statistic, each participant indicating some form of hazardous noise exposure was given a sheet with audiology providers within a 100-mile radius in the case that they would want further testing or have any further questions or concerns about their exposure levels. Those with mild to moderate hearing deficits were provided stronger verbal recommendations for follow up if they would start to have more concerns or like to seek out some treatment options.

Objective Four

Objective four for this practice improvement project was to provide education to all participants on the health consequences of NIHL, the benefits of utilizing HPDs, and steps to overcome barriers to protection devices using a participant handout. All participants were provided with verbal and written education and given a folder with a handout from Texas A & M University Extension Service. The hearing loss handout provided education on decibel level readings on different types of farm equipment and noise produced by various farm tasks. The handout also discussed the length of time that an individual can be exposed to a certain decibel level of noise before it becomes harmful to their hearing. Many of the participants were not aware of simple things such as a riding lawn mower which can produce decibel readings over 100dB, thus damaging hearing in just under seven minutes. Also discussed in the hearing handout were the harmful long-term effects of hazardous noise and how prevention measures can help decrease the risk of injury or further damage. NIHL can not only create a communication

barrier for these individuals but hearing loss can lead to increased social stress, poor self-esteem, depression, embarrassment, and the inability to maintain relationships with friends and family.

Different types of HPDs were also discussed and how they decrease hazardous noise levels by up to 20dB if worn properly. Each participant was given a set of foam earplugs and every tenth individual was given a set of earmuffs provided by the co-investigator for their participation in the hearing screenings. Objective four for this practice improvement project was met. Education was provided to each participant who was screened for hearing loss at the rural healthcare clinic.

Recommendations

The project has the potential to be replicated and/or implemented into practice in rural healthcare clinics. Therefore, additional recommendations are a key component for success in future projects evaluating hearing loss. Future implementation should include the collection of more demographic information including but not limited to barriers to HPDs use, the likelihood that a participant will start using HPDs after the results of their screening are presented to them, if they have had a previous audiometric test performed, and if they are using HPDs, what type of HPDs they are using.

Investigators planning future hearing screenings should anticipate additional time be provided for screening and education. During data collection 15 minutes was allotted for the completion of questionnaires, audiologic screening, and patient education. Time allotment should be increased to 30 minutes per participant to provide enough time for patient education and questions after the screening. Screening with the Hear X hearScreen tool in addition to the completion of the demographic's questionnaire and the Hearing Handicap Inventory-Adult questionnaire took an estimated 15 minutes. Printing of the results of the audiologic screening

tool as well as discussion on the education handout took up to an additional 15 minutes depending on the extent of the questions asked by the participant. Consideration should be given to only have participants fill out the demographic questionnaire and not use the Hearing Handicap Inventory-Adult questionnaire prior to the audiology screening.

A change in location from the rural health clinic for hearing screenings if COVID-19 and/or other illness exposure needs to be limited. Due to the current pandemic, along with seasonal winter virus, assessing healthy patients in a rural health clinic where ill patients are also being seen was not ideal. If the clinic was large enough and participants could be guided to a room instead of sitting in a waiting room the change could limit illness exposure. During the project assessment, a mask mandate at the clinic would have provided for a safer environment for everyone.

The process of recruitment of participants should also be evaluated. Farmers and agricultural workers should be recruited through direct verbal recruitment, newspaper articles, flyers, and social media posts. The rural health clinic was seeing about five to seven patients per day. Chart reviews revealed a limited number of patients that would be eligible for the hearing screenings. Lengthening the screening time at the clinic may be warranted or decreasing the goal of the sample population.

An agricultural event should work for a hearing screening project, although due to COVID-19 the site was not ideal for this practice improvement project. Future hearing screening projects anticipating to complete screenings at a rural agricultural event should find an event without a formal dinner, entertainment, or scheduled speakers to allow for increased participation at the hearing booth. An example could include a farming vendor show that had a space that should provide a quiet space for screenings.

A limitation of this practice improvement project was that to complete the Hear X hearScreen audiometric screening the area where the screenings takes place must minimize background noise. Ensuring that the location selected for screenings has an area where background noise can be limited would be key to providing screenings at both an agricultural event as well as at the healthcare clinic.

Dissemination

The practice improvement project findings will be disseminated through a poster presentation May 4th, 2022 at North Dakota State University. A 3-minute video summarizing the practice improvement project will also be completed and submitted the North Dakota State University graduate school as part of dissertation requirements. After approval by the Graduate School a copy of the dissertation will be provided to the nurse practitioner at Four Seasons Wellness in Steele, ND and results as well as the validity of the Hear X hearScreen tool will be discussed. The co-investigator also has plans to submit to a manuscript agricultural related magazine called *Top Producer* as well as the *Journal of Industrial Medicine*. The co-investigator will also work with the local North Dakota State University Extension Office to provide a summary of the results collected throughout the course of the practice improvement project as well as information that can be distributed to Kidder County farmers and agricultural workers.

Strengths and Limitations

A limitation of this practice improvement project was the limited size of 47 participants. The goal for this project was a n = 75. Also, the sample lacked gender diversity with 72% of participants being male. This practice improvement project was also implemented in one setting which limited the number of participants in the project. Due to COVID-19 and rescheduling of the Agricultural Awareness Night until February of 2022 and to a different venue, screenings

were not completed as planned at the community event. Increasing the number of rural healthcare clinics and or communities, the outcomes and data collected during the practice improvement project would have been strengthened.

An additional limitation was that in order to properly complete the Hear X hearScreen audiometric screenings the patient needed to be in a quiet room with little to no background noise. Although the calibrated headphones were sound canceling, mild to moderate background noise could have affected the ability of the participant to hear the tones being played throughout the screening. Lack of a quiet environment limits the number of potential sites where this tool could be implemented.

The length of time to complete the questionnaires, audiometric screening, and participant education was considered a limitation for both the co-investigator and the participants. Agricultural workers and farmers are typically very busy individuals; therefore, getting them to take 30 minutes out of their day for a hearing screening may have been difficult. Time limitations also created difficulties when participants coming in for clinic visits were asked about completing a hearing screening. Some individuals did not have an additional 30 minutes for screening on top of their appointment time. Additionally, answers to the demographic questionnaire and Hearing Handicap Inventory-Adult could have been subject to bias, as participants may have wanted to satisfy the co-investigator with their answers.

This practice improvement had many strengths that contributed to the project success. Through project completion individual participants were provided with an accurate, effective, cost-efficient screening tool to identify individuals at risk and or suffering from NIHL. By completing this project at a rural healthcare clinic, providers at the clinic also received education

about the screening tools and their ability to provide cost effective, accurate screenings for the patients seeking care at Four Seasons Wellness in Steele, ND.

An additional strength of this project included the education provided to 47 participants on NIHL, how hearing loss occurs, and how hearing loss can be prevented. Many individuals screened had only slight to mild hearing loss after completion of testing with the audiometric screening tool. By identifying these individuals as well as moderately impaired individuals the co-investigator was able to educate them on preventative measures. By providing information and education in these early stages participants can start practicing preventative measures that could help them from further detrimental losses later in life. One strength of the Hear X hearScreen audiometric hearing screening is that the tool provided simple, easy to read results that were printed and handed to the patient during their screening visit. Results can then be discussed, and the participant can ask questions about their scores as well as any identified hearing loss. The ability to show participants the results of an audiogram and provide them with a visual was exceptionally helpful especially in this population.

Additionally, the practice improvement project allowed the co-investigator to compare patients' perceived level of hearing loss with their actual level of hearing loss using the audiologic screening tool. Since NIHL is insidious and progresses very slowly, hearing loss usually goes unnoticed in the early stages. Assessment is crucial so that individuals exposed to loud noise greater than 85dB for long periods of time are given proper education and screening to help prevent progression of hearing injury.

Conclusion

The main purpose of this practice improvement project was to identify and screen rural North Dakota farmers and agricultural workers that may have been at risk or suffering from

NIHL. NIHL a progressive, incurable condition that in many instances goes unnoticed until the damage is permanent. Treatment options have been very limited and are usually very costly, leaving many of these individuals to live with their hearing impairment without any form of assistive device.

As the agriculture sector lacks any regulation pertaining to limits on hazardous noise exposure or on the use of HPDs the community lacks advocacy groups focused on hazardous noise reduction and the use of HPDs. Additionally, hearing screenings for agricultural populations in rural healthcare systems are limited due to lack of providers, lack of time, and lack of resources allowing many individuals to fall through the cracks when assessing hearing health.

Farmers and agricultural workers frequently lack knowledge related to the intensity of sound associated with different work tasks as well as the amount of time that can be spent on that work task before hearing injury can occur. They also may lack knowledge regarding the importance of wearing hearing protection devices that could decrease their risk of hearing loss.

By utilizing a demographics questionnaire, the Hearing Handicap Inventory- Adults questionnaire and the Hear X hearScreen audiometric tool farmers' and agricultural workers' hearing were screened in a rural health clinic. Individuals at risk for NIHL were easily identified with the simple use of a paper questionnaire taking only a few minutes to complete. Hearing was then further assessed with the Hear X hearScreen tool giving an accurate assessment of their actual hearing. The co-investigator was easily able to provide vital information to those at risk and or suffering from NIHL on prevention measures such as the use of HPDs as well as information on a referral for further assessment.

Health promotion and injury prevention is a crucial component of this practice improvement project. By utilizing tools that are efficient and cost-effective, the participants were provided with hearing test results and needed education information which could help decrease their risk of a hearing injury or help prevent worsening of a current hearing loss. The conclusions from this project supports the need for hearing screenings for farmers and agricultural workers in the rural primary care setting. A tool as simple as the demographic questionnaire or the Hearing Handicap Inventory- Adult questionnaire should be used in the clinic setting to screen individuals for noise exposure and possibly hearing loss. In conjunction with these tools the Hear X hearScreen audiometric screening tool can provide quick accurate results for each patient. With quick results, education can be provided for the patient at the visit about the harmful effects of noise exposure and prevention methods such as the use of HPDs. Referral by primary care providers to an audiologist can be made for those testing positive for hearing impairments on the screening tool.

The choice to screen and assess individuals for hearing loss is based on the provider's judgement. The co-investigator strongly recommends that nurse practitioners educate themselves on the risk factors of NIHL for not only the agricultural sector but for occupational health as well. There are numerous different professions that are exposed to loud noise. The screening tools in this project can be adapted to provide screenings for other professions. In addition, nurse practitioners should be aware of different hearing screening tools available for detecting individuals at risk. Providers at rural health clinics are in the best position to identify individuals that would benefit from screening. By providing hearing screenings in the rural health clinic, nurse practitioners can assist in finding individuals at risk for NIHL and provide vital education on prevention measures including the use of hearing protection devices.

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APPENDIX A: IRB APPROVAL

NDSU NORTH DAKOTA STATE UNIVERSITY

08/31/2021

Dr. Dean A Gross
Nursing

IRB Approval of Protocol #IRB0003777, "Screening for Noise Induced Hearing Loss in Agricultural workers and farmers"

Co-investigator(s) and research team:

- Dean A Gross
- Erin Lynn Dewitz

Approval Date: 08/31/2021
Expiration Date: 08/30/2024
Research site(s): The practice improvement project is proposed to take place at two separate rural North Dakota locations. Four Seasons Wellness is a private, rural health care clinic owned and operated by Mandy Rath, FNP and Mandy Mock, RN, located in Steele, North Dakota (ND). (See attached letter of support). Four Seasons Wellness serves the Kidder County area, which consists of multiple rural farming communities. Many individuals own farms, or are employed by, farms, ranches, and agricultural related business are seen in this facility, making Four Seasons Wellness an ideal location for this practice improvement project. Patients are frequently seen by appointment and occasionally by walk-in appointments. Recruitment, screening, and data collection will take place at this location from August 2021 to January 2022. In a second location, participants will be recruited for screening during the 2nd Annual Agricultural Awareness Night, hosted at Pifer's Auction Building in Steele, ND in January of 2022. The event is hosted by the North Dakota State University Extension Office: Kidder County and the Kidder County Farm Bureau. (See attached letter of support). The goal of the Agricultural Awareness Night is to educate farmers, ranchers, and agricultural workers in the Kidder County area on farm safety measures, making this popular event a fitting recruitment setting for recruiting participants for a hearing loss prevention practice improvement project.
Funding Agency:
Review Type: Expedited category # 4,7

The above referenced protocol has been reviewed in accordance with federal regulations (Code of Federal Regulations, Title 45, Part 46, *Protection of Human Subjects*).

Additional approval from the IRB is required:

- Prior to implementation of any changes to the protocol.
- For continuation of the project beyond the approval period. A task will automatically generate for the PI and Co-PI 8 weeks prior to the expiration date. To avoid a lapse in approval, suspension of recruitment, and/or data collection, a report must be received, and the protocol reviewed and approved for continuation prior to the expiration date.

Other institutional approvals:

- Research projects may be subject to further review and approval processes.

A report is required for:

- Any research-related injuries, adverse events, or other unanticipated problems involving risks to participants or others within 72 hours of known occurrence.
- Protocol Deviations
- Any significant new findings that may affect risks to participants.

Thank you for cooperating with NDSU IRB procedures, and best wishes for a successful study.

RESEARCH INTEGRITY AND COMPLIANCE
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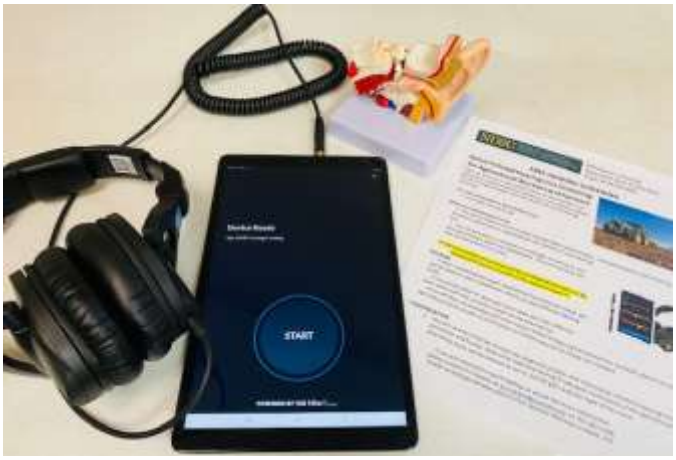
APPENDIX B: EXECUTIVE SUMMARY



EXECUTIVE SUMMARY

Introduction

In the United States noise induced hearing loss (NIHL) is a significant problem in farmers and agricultural workers. NIHL can negatively affect an individual's quality of life, including their emotional and physical functioning, employment, and social life. Many individuals within this population underestimate their exposure to hazardous noise and may lack knowledge related to the importance and use of hearing protection devises (HPDs). Unfortunately, as HPDs are a well-known prevention method utilization within this population is low. Farmers and agricultural workers encounter numerous barriers to use of HPDs during their workday which further discourages the use for prevention. In addition, this population also lacks knowledge related to effective screening measures. Early screening is a crucial component of early detection and treatment of individuals at risk or suffering from NIHL and allows opportunities for further education about prevention measures.

Purpose

The purpose of this practice improvement project was to a) identify and screen rural North Dakota farmer and agricultural workers at risk or suffering from NIHL at an agricultural event and/or at a rural health clinic; b) provide education related to prevention of NIHL and use of HPDs; and c) promote referral to an appropriate health care provider. Additionally, a reliable hearing screening tool will be utilized to help establish routine screening in a rural health clinic.

Project Design

A convenience sample of 47 individuals were asked to participant in the practice improvement project. Participants completed a demographics questionnaire, the Hearing Handicap Inventory-Adult questionnaire, and then screening using the Hear X Hear Screen audiometric tool. Individuals perceived hearing loss verses their actual hearing loss was discussed during the visit. Verbal education was provided on hearing prevention measures such as the use of ear plugs as well as a pamphlet for individuals to take home. Referral was given for individuals reporting high noise exposure who were seeking further testing, and for those testing with mild to moderate hearing losses on the Hear Screen exam. Each participant was given a sheet with a list of audiology providers within a 100-mile radius of the rural healthcare clinic in Steele, ND.

Results and Conclusion

- Overall, 72% of participants indicated a perceived hearing loss. Upon completion of the Hear X Hear Screen audiometric tool, 72% of these participants tested positive for some form of hearing loss.
- 96% of participants indicated exposure to loud noise greater than 85dB daily.
- 36% of participants indicated no HPD use, 47% reported using HPD sometimes, and 21% reported wearing HPD most of the time. Zero participants reported wearing HPDs all the time.

Recommendations

- Include additional demographic information such as previous hearing examinations, barriers experienced with HPD use, and the likelihood that the individuals will start using HPD after their screening.
- Allot additional time for the hearing screening process up to 30 minutes. Or consider use of only the demographic questionnaire.
- When considering locations for hearing screenings ensure that a quite area can be provided for the audiologic hearing screening minimizing background noise.

APPENDIX C: PRE-SURVEY DEMOGRAPHIC QUESTIONNAIRE

Pre- Survey Demographic Questionnaire

Age Range: (circle):

18-25 26-31 32-48 49-67 68+

Gender (circle): Male Female

I am a currently employed/retired (choose all that apply):

Farmer Mechanic

Rancher Employee of a agriculture related business

Other:(please specify)

Are you exposed to loud noise over 85dB? (circle): Yes No

Duration per day (hours)	Sound level dB	Examples of noise source at sound levels
8	90	Tractor, combine, or ATV
6	92	Tractor or combine
4	95	Tractor, grain grinding, combine, or air compressor
3	97	Tractor, combine, or shop vacuum
2	100	Tractor, pigs squealing, or table saw
1 1/2	102	Tractor, combine, or riding lawnmower
1	105	Tractor, combine, chickens, or irrigation pump
1/2	110	Tractor or leaf blower
1/4	115	Chainsaw

Table retrieved from:
https://m.farms.com/news/hearing-loss-and-protection-for-agricultural-producers-134688.aspx

If so, how many hours a day are you exposed to loud noise? (circle one):

1-5 hours 6-10 hours 11-15 hours 16-20 hours 20-24 hours

What is your level of hearing loss (circle):

0 1 2 3 4

No hearing Loss Significant hearing loss

Do you wear hearing protection when being exposed to hazardous noise? (circle one)

All the time Most of the Time Sometimes Never

Do year wearing hearing aids or use any type of hearing amplification device? (circle): Yes No

APPENDIX D: HEARING HANDICAP INVENTORY- ADULTS

Weill Cornell Medicine
Hearing & Speech Center

Hearing Handicap Inventory Adults (HHIA)

Initials: _____Age: _____Date: _____

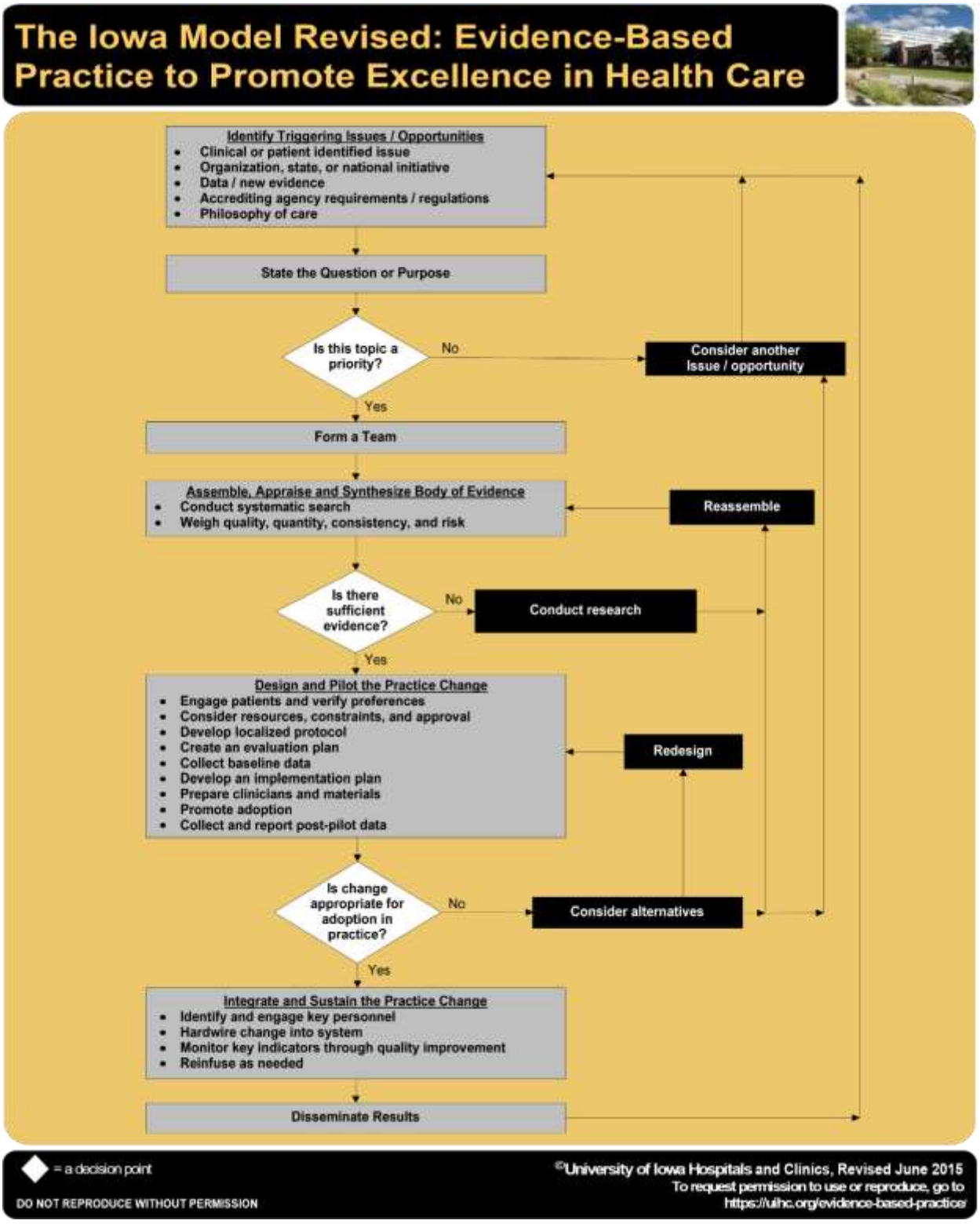
		Yes (4)	Sometimes (2)	No (0)
S-1	Does your hearing difficulty make you use the phone less often than you'd like?			
E-2	Does your hearing difficulty make you feel embarrassed or out of place when you are introduced to strangers?			
S-3	Does your hearing difficulty make you avoid groups of people?			
E-4	Does your hearing difficulty make you touchy?			
E-5	Does your hearing difficulty make you feel frustrated or unhappy when talking to people of your family?			
S-6	Does your hearing impairment cause any other difficulties when you go to a party or social meeting?			
E-7	Does your hearing difficulty make you frustrated when talking to work mates?			
S-8	Do you feel hearing difficulties when you go to the movies or the theater?			
E-9	Do you feel harmed or down because of your hearing difficulty?			
S-10	Does you hearing impairment cause difficulties when you visit friends, relatives or neighbors?			
S-11	Does your hearing difficulty cause you problems to hear/understand work mates?			
E-12	Does your hearing difficulty make you nervous?			
S-13	Does your hearing difficulty make you visit friends, relatives or neighbors less often than you'd like to?			
E-14	Does your hearing difficulty make you argue or fight with your family?			
S-15	Does your hearing difficulty cause you trouble to watch TV or listen to the radio?			
S-16	Does your hearing difficulty make you go out shopping less often than you'd like to?			
E-17	Does your hearing difficulty make you annoyed or unhappy?			
E-18	Does your hearing difficulty make you prefer to be alone?			
S-19	Does your hearing difficulty make you want to talk less to the people in your family?			
E-20	Do you think that your hearing difficulty reduces or limits your personal or social life somehow?			
S-21	Does your hearing difficulty cause you trouble when you are in a restaurant with family or friends?			
E-22	Does your hearing difficulty make you feel sad or depressed?			
S-23	Does your hearing difficulty make you watch less TV or listen to the radio less often than you'd like to?			
E-24	Does your hearing difficulty make you feel embarrassed or less comfortable when you talk to friends?			
E-25	Does your hearing difficulty make you feel isolated or left aside within a group of people?			

Total # of Points for **Social**_____/ 48= _____ Total # of Points for **Emotional**____/ 52= ____

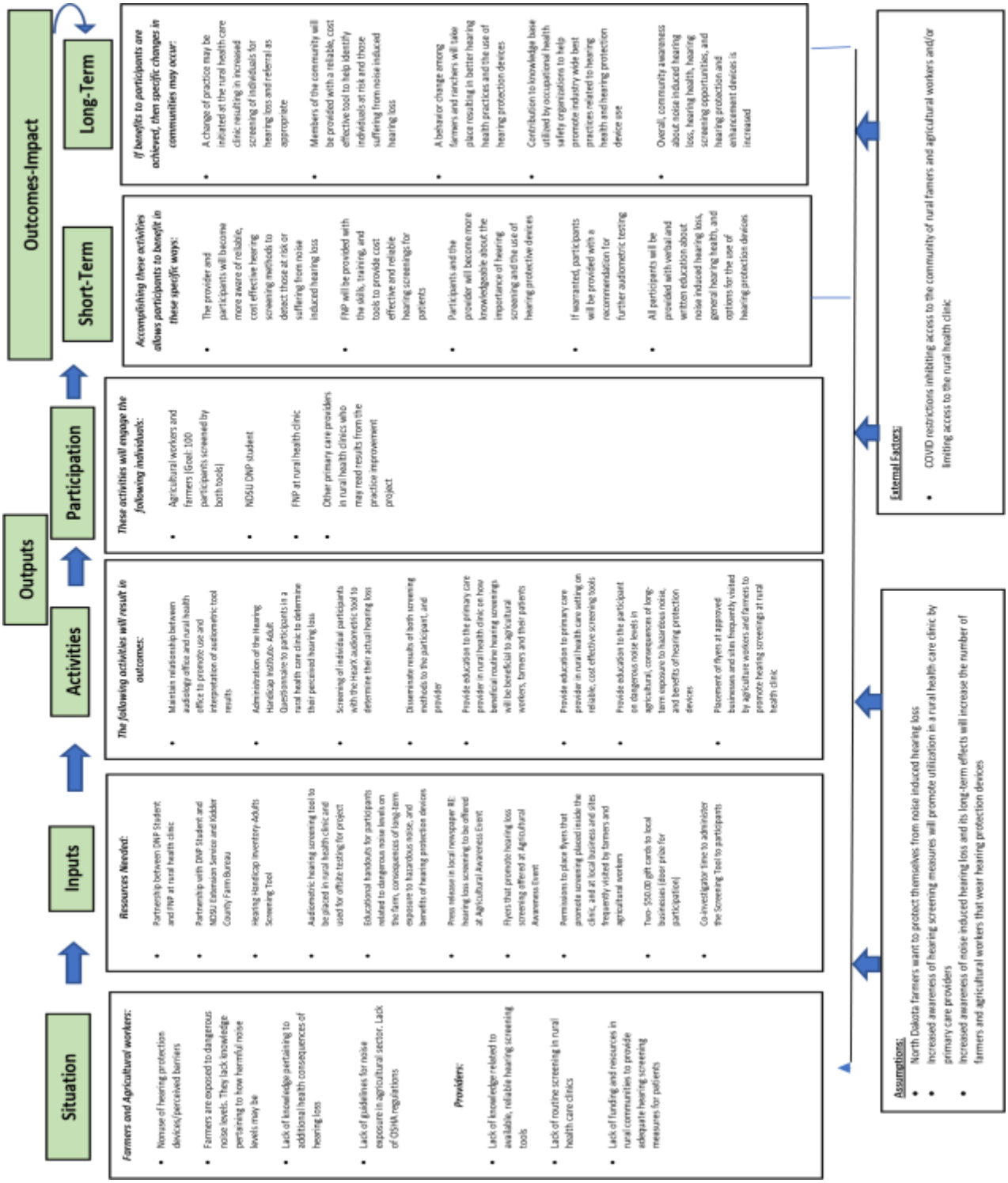
0-16% = **No Handicap**

18-42%= **Mild to Moderate Handicap** 44% + = **Severe Handicap**

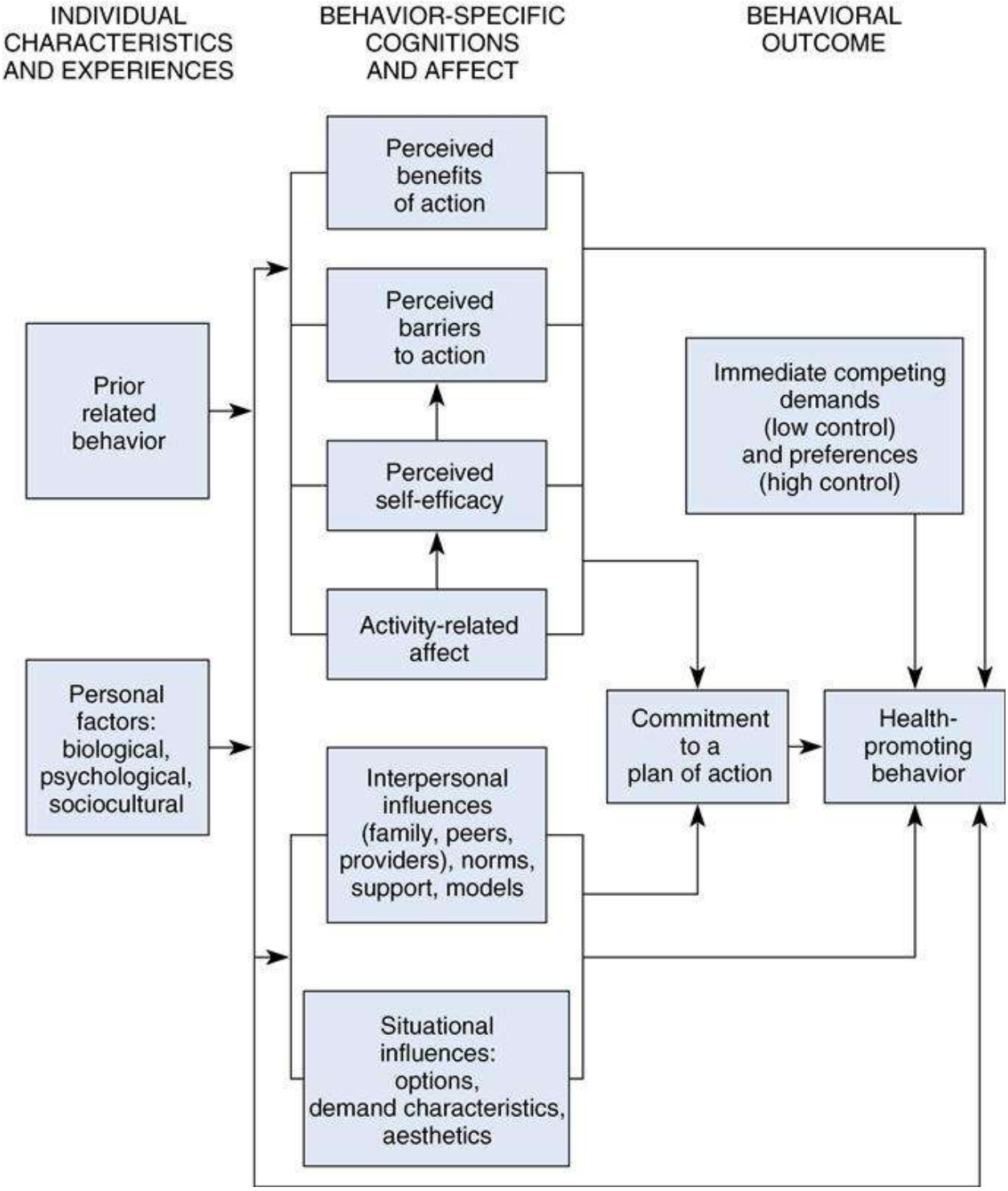
APPENDIX E: IOWA MODEL OF EVIDENCE BASED PRACTICE



APPENDIX F: LOGIC MODEL



APPENDIX G: HEALTH PROMOTION MODEL



APPENDIX H: NDSU AGRICULTURE AWARENSS NIGHT LETTER OF SUPPORT

NDSU | EXTENSION
KIDDER COUNTY

May 14, 2021

NDSU Institutional Review Board
NDSU Department 4000
PO BOX 6050
Fargo, ND 58108-6050

To whom it may concern.

This letter is to indicate the intent of NDSU Extension Kidder County to collaborate with NDSU Nursing student Erin Dewitz's dissertation project, "Screening for Noise Induced Hearing Loss in Agricultural Workers and Farmers."

NDSU Extension partners with Kidder County Farm Bureau and local emergency responders to hold a fall Agriculture Safety Awareness Evening in September, 2021 in Steele, ND. We give Erin permission to set up a display table for education on the risks of hearing loss while using farm equipment and conduct voluntary screenings and evaluations for farmers that attend this event.

I am aware of Erin's intent to use the Hearing Handicap Inventory- Adults to assess individuals' perceptions of hearing loss and then the HearX audiology tool to screen actual hearing of participants. Participants of the Farm Safety Awareness Evening will be encouraged to participate, but participation is voluntary.

I am also certified through the NDSU CITI Program Course for Human Research, Human Subjects: Extension Agents 1 – Base Course, Record ID: 41902247, expiration, March 30th, 2024. A completion certificate can be provided if needed.

We look forward to working with Erin in this excellent farm safety educational experience.

Sincerely,

Penny Nester
Agriculture and Natural Resourced Agent
NDSU Extension – Kidder County

North Dakota State University
NDSU EXTENSION | KIDDER COUNTY
Courthouse | 120 East Broadway | PO Box 110 | Steele ND 58482-0110 | 701.475.2672 | Fax 701.475.2207
NDSU.KidderExtension@ndsu.edu | www.ag.ndsu.edu/kidde-countyextension | www.ag.ndsu.edu/extension

APPENDIX I: FOUR SEASONS WELLNESS LETTER OF SUPPORT

Four Seasons Wellness
110 W Broadway Ave
PO Box 397
Steele, ND 58482
P: (701) 475-4488 F: (701) 540-6379

5/24/2021

To whom it may concern;

This letter is to indicate the intent of Four Seasons Wellness to collaborate in Erin Dewitz's practice improvement project; "Screening for Noise Induced Hearing Loss in Farmers and Agricultural Workers". The project will start in August of 2021 and end May of 2022. I am aware of Erin's intent to use the Hearing Handicap Inventory- Adult hearing questionnaire and Hear Screen audiometric tool to screen patients to identify individuals at risk or suffering from noise induced hearing loss.

Sincerely,
Mandy Rath, FNPc
Mandy Rath, FNPc

APPENDIX J: NEWSPAPER ADVERTISEMENT

Attention

Farmers and Agricultural workers:

Are you interested in a free hearing screening? If you previously or currently work on a farm, ranch, or in an agricultural related occupation, you may qualify for a free hearing screening and educational session on hearing loss prevention measures.

Hearing loss is permanent and, in many cases, irreversible, so take advantage of this free screening to find out what you can do to help decrease your risk of noise induced hearing loss.

Individuals must be over the age of 18 to participate.

Screenings take about 25 minutes and include a paper questionnaire and screening with an audiologic screening tool.

Please contact Erin Dewitz at 701-361-5298 or erin.dewitz@ndus.edu to schedule your free hearing screening today!

APPENDIX K: PERMISSION TO USE IOWA MODEL

Get Outlook for iOS

From: Kimberly Jordan - University of Iowa Hospitals and Clinics <survey-bounce@survey.uiowa.edu>
Sent: Wednesday, January 27, 2021 9:27:07 AM
To: erin.dewitz@outlook.com <erin.dewitz@outlook.com>
Subject: Permission to Use The Iowa Model Revised: Evidence-Based Practice to Promote Excellence in Health Care

You have permission, as requested today, to review and/or reproduce *The Iowa Model Revised: Evidence-Based Practice to Promote Excellence in Health Care.* Click the link below to open.

The Iowa Model Revised (2015)

Copyright is retained by University of Iowa Hospitals and Clinics. **Permission is not granted for placing on the internet.**

Citation: Iowa Model Collaborative. (2017). Iowa model of evidence-based practice: Revisions and validation. *Worldviews on Evidence-Based Nursing, 14(3), 175-182. doi:10.1111/wvn.12223*

> In written material, please add the following statement:
> *Used/reprinted with permission from the University of Iowa Hospitals and Clinics, copyright 2015. For permission to use or reproduce, please contact the University of Iowa Hospitals and Clinics at 319-384-9098.*

Please contact UIHCNursingResearchandEBP@uiowa.edu or 319-384-9098 with questions.

Reply
Forward

APPENDIX L: EDUCATIONAL FLYER HEARING PROTECTION

AgriLIFE EXTENSION
Texas A&M System

HEARING LOSS PROTECTION FOR AGRICULTURAL WORKERS

David W. Smith, Extension Safety Program

Farm environments and farm equipment can be quite noisy. Tractors, machinery, and animal confinement areas are common sources of loud noise. An agriculture worker exposed to this noise over an extended period of time is more likely to develop serious hearing loss. Knowing the typical sound levels of various sources of sounds will help you to recognize hazardous situations and take precautions to prevent hearing damage.

TYPICAL NOISE LEVELS

Sound is measured in decibels, designated as dB(A), using a tool called a decibel meter. The decibel meter can be used to identify those noise sources that exceed a safe level. The decibel level chart illustrates the typical noise levels from various sources. For example, while a tractor at idle speed produces about 85 decibels, a tractor at work will produce up to 100 decibels. According to the Occupational Safety and Health Administration, sounds of 85 decibels or higher can damage hearing.

As a general rule, the permissible safe noise exposure decreases as sound levels increase. For example, without adequate hearing protection, a farmer operating a tractor at work (typically generating 100 decibels), may begin to experience hearing loss after only two hours. With each 5-decibel increase, the "safe" exposure time is cut in half.

DID YOU KNOW?

It is common for a farmer to lose hearing in one ear faster than the other. Typically, one ear is facing the tractor exhaust or loud towed machinery more than the other as he or she frequently looks back toward the working equipment.

DECIBEL LEVEL CHART

Decibel	Sound
0	Lowest sound audible to the human ear
30	Crickets, distant frogs, whisper
40	Kitten meowing, songbirds, distant dog bark
50	Refrigerator running, babbling stream, quiet empty barn
60	Average conversation level
70	Chicken coop, busy restaurant. At this level, noise may begin to affect your hearing if exposed over a long period of time.
80	Tractor idling, barn cleaner, conveyors, elevators. These noises can damage hearing if exposed for more than eight continuous hours.
90	Tractor at 50 percent load, blower, compressor, combine. As noise levels increase, the "safe" exposure time decreases; damage can occur in less than eight hours.
100	Tractor at 80 percent load, pig squeal, power tools. Even two hours of exposure can be dangerous. With each 5-decibel increase, the "safe time" is cut in half.
120	Tractor at full load, bad muffler, old chain saw. The danger is immediate.
140	Gunshot, backfire, dynamite blast. Any length of exposure time is dangerous. At this level, the noise may actually cause pain in the ear.

SAFETY ISSUES

Agricultural workers rely greatly on their ability to hear in order to detect machinery operation problems. For example, experienced mechanics can detect *missing* or misfiring in engines. Tractor operators operating hay balers rely upon sound pitch and sound variations in drive chains as a signal that it's time to oil or lubricate mechanical parts.

The ability to hear is essential for agricultural workers who rely upon verbal communication to avoid placing themselves or coworkers in danger. This is especially important when coworkers share hazardous tasks such as harvesting, loading, and conveying field crops.

Brief periods of excess noise have only minor effects, such as tinnitus (ringing or buzzing in your ears) or muffled hearing for a few hours after leaving work. Repeated exposure to loud noise may cause permanent hearing loss. First, you may have trouble hearing high-frequency sounds like phones ringing or high pitched voices. Next, you may lose speech frequencies, consonants, and then vowels. Finally, all verbal communication, including television, radios, and phone conversations may be difficult to hear.

Exposure to elevated noise is known to cause other health problems. It can cause fatigue, tension, and nervousness. It can also increase pulse rate, increase blood pressure, and narrow blood vessels. Over time, these conditions can stress the heart.

HEARING PROTECTION

Hearing protection is designed to reduce noise exposure to a safe level. Two types of protection, acoustical muffs and ear plugs, are most common. Acoustical muffs are placed over the ear to provide a sound barrier to the entire ear. Because they do not block out all sound, conversation for instruction or safety purposes can still be heard. Ear muffs will generally reduce decibel levels by 20 to 30 decibels.

Ear plugs are made to fit inside the ear canal, and come in formable or preformed designs. Formable plugs are compressed and placed inside the ear canal where they expand to fit. Preformed plugs come in many sizes and must be selected to fit the individual's ear. Ear plugs typically reduce decibel levels by 26 to 33 decibels. Ear muffs and ear plugs worn together can add another 3 to 5 decibels of protection.

NOISE REDUCTION TIPS

To reduce noise exposure levels on the farm:

- Keep machinery and equipment well lubricated
- Replace defective mufflers and exhaust parts
- Don't use "straight pipe" exhausts for tractors or any other engines
- Enclose noisy machine components
- Build acoustic barriers to loud machines
- Limit the duration of elevated noise exposure
- Stay away from noise when you don't need to control or tend the equipment
- Purchase power tools and equipment such as chain saws and lawnmowers that have built-in noise reduction systems.

Anyone experiencing hearing difficulty should get a hearing test so existing problems can be identified and monitored.

OSHA HEARING CONSERVATION STANDARD

Employers are required by law to implement a "Hearing Conservation Program" if the noise exposure meets or exceeds an eight-hour time-weighted average of 85 decibels [29 CFR 1910.95(c)].

APPENDIX M: AUDIOLOGY PROVIDERS

Audiology Providers

John Togen, Audiologist
Mid Dakota Clinic
401 N 9th St
Bismarck, ND 58501
701-530-6094

Karen Jacobus, Audiologist
Mid Dakota Clinic
401 N 9th St
Bismarck, ND 58501
701-712-4500

Joseph Ness, Audiologist
Mid Dakota Clinic
401 N 9th St
Bismarck, ND 58501
701-530-6000

Debra Arneson- Thilmony, Audiologist
Sanford Hearing Center
225 N 7th St
Bismarck, ND 58501
701-323-6000

Brady Ness, Audiologist
Sanford Hearing Center
Coal Country CHC Beulah
225 N 7th St
Bismarck, ND 58501
701-323-6000

Krystal Lee Mann, Audiologist
Sanford Hearing Center
715 E Broadway Ave STE 110
Bismarck, ND 58501
701-323-8922

Amanda Leddige, Audiologist
Sanford Hearing Center
715 E Broadway Ae Suite 110
Bismarck, ND 58501
701-323-8921

Lee D Gronhovd, Audiologist
Sanford Meical Center
222 N 7th St
Bismarck, ND 58501
701-323-6000

Shelly Grossman, Audiologist
Sanford Medical Center
222 N 7th St
Bismarck, ND 5850

Amy Anderson, Audiologist
Sanford Hearing Center
715 E Broadway Ave
Bismarck, ND 58501
701-323-8922

Jessica Mclindsay, Audiologist
Prairie Sea Hearing Center
3000 N 14th St FL 3
Bismarck, ND 58503
701-805-8057

Kristin Horner, Audiologist
Prairie Sea Hearing Center
3000 N 14th St Fl 3
Bismarck, ND 58503
701-805-8057

Marissa Marieleese, Audiologist
Jamestown Regional Medical Center
2422 20th St SW
Jamestown, ND 58401
701-952-4800

Melissa Ollie, Audiologist
701 3rd St NW
Jamestown, ND 58401
701-252-3850

Douglas Schauer, Audiologist
Sanford Hearing Center Jamestown
701-252-4100
Sanford Hearing Carrington Clinic
701-652-3200
Sanford Hearing Valley City
701-845-4955

APPENDIX N: RECRUITMENT FLYER

NDSU NORTH DAKOTA STATE UNIVERSITY

NDSU School of Nursing Department
2670, PO Box 6050 Fargo, ND 58108-6050

Noise Induced Hearing Loss Screening for Agricultural Workers and Farmers

If you are a farmer or agricultural worker or have worked in an agricultural related profession sometime in your lifetime having and are 18 years of age and older, you may qualify for a free hearing screening.

You will not be able to participate if you:

- Are under the age of 18.

What you will be asked to do:

- You will be asked to fill out a paper demographics questionnaire, informed consent, and a hearing inventory questionnaire regarding your perceptions of your hearing loss.
- You will be asked to complete an audiologic screening of your hearing utilizing a tablet and headphones. The entire process will take an estimated 15 minutes.

*****All information you provide will be confidential and will not be shared with anyone outside of the research team*****

SESSIONS

- After completing the paper questionnaires mentioned above you will be asked to wear headphones which will play different hearing tones.
- You will be asked to raise your hand when you hear different tones which will help provide a report of your hearing loss.
- You will then be provided with information related to hearing loss prevention methods specific to the agricultural sector as well as information on further referral for follow up if needed.

COMPENSATION

- You will receive a free set of foam ear plugs and a folder with information related to hearing loss prevention and further referral for additional testing if indicated.

If you are interested in participating, or would like more information, please contact Erin Dewitz at erin.dewitz@outlook.com or 701-361-5298. Health screenings will take place at Four Seasons Wellness in Steele, North Dakota

APPENDIX O: ORAL CONSENT FORM

School of Nursing
Aldevron Tower 540
Dept. #2670, P.O. Box 6050
Fargo, ND 58108-6050
(701) 231-7395

Screening for Noise Induced Hearing Loss in Farmers and Agricultural Workers

This study is being conducted by: Dr. Dean Gross, Assistant Professor of Practice, Dean.Gross@ndsu.edu, 701-231-8355; and Erin Dewitz, DNP Student, erin.dewitz@outlook.com, 701-361-5298.

Key Information about this study:

This consent form is designed to inform you about the study you are being asked to participate in. Here you will find a brief summary about the study; however, you can find more detailed information later in the form.

- **Purpose of the study**: The purpose of this practice improvement project is to a) identify and screen rural North Dakota agricultural workers and farmers in central North Dakota at risk and/or suffering from noise induced hearing loss; b) provide education related to prevention of noise induced hearing loss and the use of hearing protection devices; and c) promote referral to an appropriate health care provider.
- **Inclusion Criteria:** Farmers and Agricultural Workers over the age of 18 years old.
- **Exclusion Criteria:** Individuals < 18 years of age, individuals who do not speak English.
- **Risks:** Potential risk for emotional distress due to unknown hearing loss. Proper referral to specialist will be provided to address further concerns.
- **Benefits:** Increased knowledge pertaining to individuals' perceptions of hearing loss vs. their actual hearing loss. Increased knowledge pertaining to hearing loss prevention measures for agricultural workers and farmers exposed frequently to hazardous noise. Increased knowledge related to the proper use of hearing protection devices which could decrease the risk
- **Time commitment:** Approximately 15 minutes
- **Compensation:** The study will cover the cost of an audiometric hearing screening. Each participant will be given a pair of foam ear plugs for participating along with educational materials related to hearing loss prevention. Participants at the Agricultural Awareness Event will have the chance to win 4- $25.00 gift cards to a local business.
- **Privacy Concerns:** Privacy will be maintained via use of NDSU equipment and storing all information on a password-protected personal computer. No personal information will be

shared with any individuals not directly involved in the study. Information collected on paper forms will be logged into a password-protected personal computer accessible only to members of the study team.

Why am I being asked to take part in this study?

You are a current farmer or agricultural worker over the age of 18.

What will I be asked to do?

You will be asked to review this consent form and verbally consent to participating in this hearing screening. The hearing screening will consist of completion of the written demographic and hearing questionnaire. Once completed an audiometric tool will be utilized to screen your actual hearing loss. Headphones will be placed on your head and you will be given a tablet. The tablet will ask you a few questions as different audiometric tones are played. Once completed your results from both the questionnaire and the audiometric tool will be discussed. Verbal and written education will then be provided on hearing loss prevention strategies including the proper use of hearing protection devices. For participants that testing indicates a possible deficit, they will be given a list of audiologic providers within a 100-mile radius for further follow up.

Where is the study going to take place, and how long will it take?

Hearing screenings will take place at Four Seasons Wellness in Steele, ND and at the NDSU Extension Service & Kidder County Farm Bureau Agricultural Awareness Night in September of 2021.

What are the risks and discomforts?

Potential risk for emotional distress due to unknown hearing loss. Proper referral to specialist will be provided to address further concerns.

It is not possible to identify all potential risks in research; however, reasonable safeguards have been taken to minimize known risks. If new findings develop during the course of the study which may change your willingness to participate, we will tell you about these findings.

What are the expected benefits of this study?

Individual Benefits:

1. Participants will be more aware of a reliable, cost effective, hearing screening method to detect those at risk or suffering from noise induced hearing loss.

2. Participants will be more knowledgeable about the importance of hearing screening and use of hearing protection devices.

3. Participants will be provided with recommendations for further audiologic testing if warranted.

4. Participants will be provided with verbal and written education about noise induced hearing loss, general hearing health, and options for the use of hearing protection devices.

Societal: Overall, community awareness related to noise induced hearing loss, hearing health, hearing screening opportunities and hearing protection devices will be increased.

Do I have to take part in this study?

Your participation in this study is your choice. If you decide to participate in the study, you may change your mind and stop participating at any time without penalty or loss of benefits to which you are already entitled.

What are the alternatives to being in this study?

Instead of being in this study, you may choose not to participate.

Who will have access to my information?

Only Dean Gross and Erin Dewitz will have access to identifiable information. Privacy will be maintained via the sole use of NDSU equipment and keeping all identifiable information on a password-protected personal computer. Information collected from paper forms will be logged into a password-protected computer accessible only to the primary and co-investigators.

Once all information has been collected, data will be merged with those of other participants in the study. Data collected will not be associated with any personal information or shared with anyone not directly involved in the study. If you decide to withdraw from the study before it is completed, we will remove your information, shred all physical documents from your participation, and no additional information will be collected.

Can my participation in the study end early?
You may choose to stop your participation in the study at any time, for any reason.

Will I receive any compensation for participating in the study?
The study will cover the cost of a hearing screening. You will receive a free pair of foam ear plugs as well as education pertaining to hearing loss prevention.

What happens if I have abnormal results during the hearing screening?

If you are injured during the course of this study, you should contact Dean Gross at 701-231-8355. you require further management of abnormal results, must be provided by you and your third-party payer, such as private health insurance or Medicare. This does not mean that you are releasing or waiving any legal right you might have against the researcher or NDSU as a result of your participation in this study.

What if I have questions?

Before you decide whether you'd like to participate in this study, please ask any questions that come to mind now. Later, if you have questions about the study, you can contact Dean Gross at 701-231-8355 or Dean.Gross@ndsu.edu, or Erin Dewitz at 701-361-5298 or erin.dewitz@outlook.com.

What are my rights as a study participant?

You have rights as a study participant. All research with human participants is reviewed by a committee called the *Institutional Review Board (IRB)* which works to protect your rights and welfare. If you have questions about your rights, an unresolved question, a concern, or complaint about this study you may contact the IRB office at 701.231.8995, toll-free at 855-800-6717 or via email (ndsu.irb@ndsu.edu).

Documentation of Consent:

You are freely making a decision whether to be in this practice improvement project. Participating in this hearing screening indicates that:

1. you have read and understood this consent form
2. you have had your questions answered, and
3. you have decided to be in the project.

You will be given a copy of this consent form to keep.

_____ _____

Signature of researcher explaining study Date

_____

Printed name of researcher explaining study

APPENDIX P: ANSWERS TO HEARING HANDICAP INVENTORY_ADULT QUESTIONNAIRE

Question S- 1. Question S-1 asked: "Does a hearing problem cause you to use the phone less often that you would like?" Two (4%) indicated that yes, a hearing problem caused them to use the phone less often than they would like. Three (6%) individuals indicated sometimes, and 42 (90%) individuals indicated that their hearing problem did not cause them to use the phone less often than they would like.

Question E-2. Question E-2 asked "Does a hearing problem cause you to feel embarrassed when meeting with new people?" Four (9%) participants indicated yes that a hearing problem caused them to feel embarrassed when meeting new people. Nine (19%) indicated sometimes, and 36 (72%) indicated that their hearing problem did not cause them to feel embarrassed when meeting with new people.

Question S-3. Question S-3 asked participants "Does a hearing problem cause you to avoid groups of people?" Four (9%) individuals answered yes, a hearing problem does cause them to avoid groups of people. Nine (19%) indicated sometimes, and 34 (72%) noted that a hearing problem did not cause them to avoid large groups of people.

Question E-4. Question E-4 asked participants "Does a hearing problem make you irritable?" Three (6%) indicated yes that a hearing problem did make them irritable. Eleven (23%) indicated that sometimes a hearing problem made them irritable, and 33 (71%) indicated no, a hearing problem did not make them irritable.

Question E-5. Question E-5 asked participants "Does a hearing problem cause you to feel frustrated when talking to members of your family?" Five (11%) indicated yes, that a hearing problem caused them to feel frustrated when talking with members of their family.

Twelve (25%) indicated that sometimes a hearing problem caused them to feel frustrated when talking to members of their family and 30 (64%) indicated that a hearing problem did not cause them to feel frustrated when talking to members of their family.

Question S-6. Question S-6 asked participants "Does a hearing problem cause you difficulty when attending a party?" Nine (19%) indicated yes, a hearing problem causes them difficulty when attending a party. Thirteen (28%) participants indicated that sometimes a hearing problem causes them difficulty when attending a party, and 25 (53%) indicated no, a hearing problem does not cause them difficulty when attending a party.

Question S-7. Question S-7 asked participants "Does a hearing problem cause you difficulty hearing/understanding co-workers, clients, or customers?" Four (9%) indicated that a hearing problem did cause them to have difficulty hearing/understanding their co-workers, clients, or customers. Nineteen (40%) of participants indicated that sometimes a hearing problem causes them difficulty hearing/understanding co-workers, clients, or customers. Finally, 24 (51%) of participants indicated that no- a hearing difficulty did not cause them to have difficulty hearing/understanding co-workers, clients, or customers.

Question E- 8. Question E-8 asked participants "Do you feel handicapped by a hearing problem?" One (2%) participant indicated that yes, they felt handicapped by a hearing problem. Six (13%) individuals noted sometimes they felt that their hearing problem caused them to feel handicapped and 40 (85%) indicated that a hearing problem did not make them feel handicapped.

Question S-9. Question S-9 presented the question "Does a hearing problem cause you difficulty when visiting friends, relatives, or neighbors?" One (2%) of participants indicated yes, a hearing problem causes them difficulty when visiting with friends, relatives, or neighbors. Fourteen (30%) participants indicated that sometimes their hearing problem causes them

difficulty when visiting friends, relatives, or neighbors and 32 (68%) indicated that a hearing problem did not cause them to have difficulty when visiting with their friends, relatives, or neighbors.

Question E-10. Question E-10 asked participants "Does a hearing problem cause you to feel frustrated when talking to coworkers, clients, or customers?" Two (4%) participants indicated that a hearing problem does cause them to feel frustrated when talking to coworkers, clients, or customers. Sixteen (34%) of participants indicated that sometimes their hearing problem made them feel frustrated when talking to co-workers, customers, and clients, Lastly, 29 (62%) noted that a hearing problem did not make them feel frustrated when talking with coworkers, and clients.

Question S-11. Question S- 11 asked participants "Does a hearing problem cause you difficulty in the movies or theatre?" Three (6%) participants indicated that a hearing problem does cause them to have difficulty in the movies or in a theatre. Seven (15%) indicated that sometimes their hearing problem caused them to have difficulty in the movies or in a theatre. Finally, 29 (62%) indicated that a hearing problem did not cause them to have difficulty in the movies or at a theatre.

Question E-12. Question E-12 asked participants "Does a hearing problem cause you to be nervous?" One (2%) participant acknowledged that a hearing problem causes them to be nervous. Two (4%) indicated that sometimes a hearing problem caused them to be nervous, and 29 (62%) indicated that a hearing problem did not cause them to be nervous.

Question S- 13. Question S-13 asked participants "Does a hearing problem cause you to visit friends, relatives, or neighbors less often than you would like?" No participants indicated yes, that a hearing problem caused them to visit friends, relatives, or neighbors less often than

they would like. Three participants indicated that it sometimes causes them to visit less often, and 44 (94%) indicated that a hearing problem does not cause them to visit friends, relatives, or neighbors less often.

Question E-14. Question E-14 asked participants "Does a hearing problem cause you to have arguments with family members?" Three (6%) noted yes, a hearing problem does cause them to have arguments with their family members, six (13%) indicated that sometimes their hearing problem causes them to have arguments with their family members, and 38 (81%) chose no, that a hearing problem did not have them to visit friends, relatives, or neighbors less often.

Question S-15. Question S-15 asked participants "Does a hearing problem cause you difficulty when listening to TV or radio?" Six (18%) individuals indicated that a hearing problem sometimes causes them difficulty when listening to the TV or the radio, 19 (40%) indicated that their hearing problem does cause them difficulty when listening to the TV or the radio. And finally, 47% (22 individuals) stated that a hearing problem does not cause them to have difficulties when listening to the TV or the radio.

Question S-16. Question S-16 asked participants "Does a hearing problem cause you to go shopping less often than you would like?" Zero participants answered yes. One (2%) participant indicated that sometimes a hearing problem caused them to go shopping less often than they would like, and 46 (98%) indicated no, a hearing problem did not cause them to go shopping less often then they would like.

Question E-17. Question E-17 asked participants "Does any problem or difficulty with your hearing upset you at all?" Two (4%) participants indicated that yes, that their problem or difficulty with their hearing does upset them. Thirteen (28%) of participants indicated that

sometimes their problem or difficulty with hearing does upset them, and 32 (68%) indicated that no, a problem or difficulty with hearing does not upset them.

Question E-18. Question E-18 asked participants "Does a hearing problem cause you to want to be by yourself?" One (2%) participant indicated that yes, their hearing problem does cause them to want to be by themselves. Three (6%) individuals indicated that sometimes a hearing problem causes them to want to be by themselves. Forty-three (92%) of participants indicated that a hearing problem does not cause them to want to be by themselves.

Question S-19. Question S-19 asks participants "Does a hearing problem cause you to talk to family members less often than you would like?" Two (4%) individuals noted that their hearing problem does cause them to talk to family members less often than they would like. Two (4%) participants indicated that sometimes their hearing problem causes them to talk to family members less often than they would like and 34 (92%) participants indicated that a hearing problem does not cause them to talk to family members less often than they would like.

Question E-20. Question E-20 asked participants "Do you feel that any difficulty with your hearing limits or hampers your personal or social life?" Three (6%) individuals answered yes, difficulty with their hearing limits or hampers their personal or social life. Ten (21%) participants indicated that sometimes difficulty with their hearing limits or hampers their personal or social life. Finally, 34 (73%) indicated that difficulty with their hearing did not limit or hamper their personal or social life.

Question S-21. Question S-21 asked participants "Does a hearing problem cause you difficulty when in a restaurant with relatives or friends?" Seven (15%) participants indicated that a hearing problem does cause them to have difficulty when in a restaurant with relatives or

friends. Sixteen (34%) of participants indicated that a hearing problem does not cause them difficulty when in a restaurant with relatives or friends.

Question E-22. Question E-22 asked participants "Does a hearing problem cause you to feel depressed?" Zero participants noted that their hearing problem causes them to feel depressed. Two (4%) participants indicated that sometimes their hearing problem causes them to feel depressed. Forty-five (96%) indicated that a hearing problem did not cause them to feel depressed.

Question S-23. Question S-23 asked participants "Does a hearing problem cause you to listen to TV or the radio less often than you would like?" Two participants (4%) indicated that a hearing problem does cause them to listen to TV or radio less often than they would like. Two (4%) participants indicated that sometimes a hearing problem causes them to listen to TV or the radio less often than they would like. Forty-three (92%) individuals noted that a hearing problem does not cause them to listen to TV or radio less often than they would like.

Question E-24. Question E-24 asked participants "Does a hearing problem cause you to feel uncomfortable when talking to friends?" Zero participants indicated that a hearing problem causes them to feel uncomfortable with friends. Eight (17%) participants indicated that sometimes a hearing problem causes them to feel uncomfortable when talking with friends and 39 (83%) participants indicated that a hearing problem does not cause them to feel uncomfortable when talking to friends.

Question E-25. Question E-25 asked participants "Does a hearing problem cause you to feel left out when you are with a group of people?" Three (6%) indicated that a hearing problem does cause them to feel left out when they are with a group of people. Thirteen (28%) participants indicated that sometimes they feel that a hearing problem causes them to feel left out

when they are with a group of people and 31 (66%) indicated that a hearing problem did not cause them to feel left out when they are with a group of people.