Evaluating Noise Exposures of Rural Youth

Pilot Project Proposal for the Great Plains Center for Agricultural Health

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Executive Summary

The prevalence of noise-induced hearing loss is higher among farming populations than other occupations due in part to exposure to livestock and noisy machinery normally found on the farm. This common occupational illness is not fatal, but can seriously affect the quality of life for those affected. While hearing loss is mostly associated with farmers over 50 years of age, it is believed that hearing loss among farmers begins in early adolescence. The purpose of this study is to assess the noise exposures of farming and non-farming male adolescents in rural areas. With this information we hope to assess the knowledge of hearing loss and noise exposure among rural adolescents, as well as develop recommendations and procedures for a larger study to identify successful interventions to protect the hearing among this population.

Project Goals

The specific aims of this project are to:

- Measure the noise exposures of adolescents living in rural areas.
- Compare the exposures of adolescents living in rural areas who work on farms to adolescents in rural areas who do not work on farms.
- Assess rural adolescents' knowledge about the health hazards associated with excessive noise exposure and their use of personal protective equipment to reduce their exposure.
- Develop recommendations and procedures for creating a larger study to determine rural adolescents' noise exposures, their knowledge of hazards associated with noise, and to develop interventions to protect their hearing.

Background and Significance

Noise-induced hearing loss is one of the most common occupational illnesses. It is well known that farmers have a higher prevalence of hearing loss than other occupations because of their exposure to noisy machinery. Studies of rural, farming populations have found that about half of male farmers over age 50 have significant hearing loss (Lierle 1958; Plakke 1992). Studies have also indicated that children involved in farm work have an increased prevalence of hearing loss (Flamme 2005). Therefore, hearing loss in adult farmers may begin in childhood. The prevalence of hearing impairment among 18-27 year old rural Iowa males is over 40% (Mudipalli 1999), which indicates that by the time many rural males enter the workforce, they already have significant hearing impairments. For adolescents who have farm work experience, the prevalence of hearing impairment is over 50% (Broste 1989). This level of prevalence is substantially higher than the 12.5% national prevalence among children aged 6 to 19, estimated in the Third National Health and Nutrition Examination Survey (NHANES III) (Niskar 2001). The presence of permanent hearing impairment at a young age implies an equal or worse hearing impairment later in life.

Conventional wisdom holds that most of the hearing impairments observed in rural youth is due to excessive noise exposure. Noise levels produced by farm machinery (Simpson 1969; Solecki 1995; Holt 1993) and woodworking and metalworking machines (Roeser 1983) are sufficient to produce permanent hearing damage. Noise exposure during recreational activities is also a potential cause of hearing impairment. The sound levels produced by many recreational noise sources (e.g. snowmobiles, ATVs, firearms) are also sufficient to cause permanent hearing impairment (Axelsson 1981). People living in rural areas are more likely to engage in both farming and recreational activities that put them at risk for hearing impairment (Nondahl 2000).

Permanent hearing impairment has serious psychosocial consequences. Hearing impairment is associated with increased depressive symptoms, reduced feelings of mastery, reduced self efficacy, feelings of loneliness, reduced self-esteem, and smaller social networks (Bess 1998; Kramer 2002). Hearing impairments described as "mild" using conventional audiological nomenclature result in substantial disabilities and handicaps in the areas of speech understanding in noise and the ability to locate the source of a sound (Flamme 2001; Kramer 1996; Kramer 1998).

Despite known high levels of noise exposure, few people living in rural areas use hearing protection devices (Merchant 2001). Hearing conservation programs should address noise exposure, the use of hearing protection devices, noise labeling, non-noise risk factors for hearing impairment, and guidance in preventing hearing impairments (Noise and Hearing Loss 1990). Hearing conservation training should begin during childhood and schools represent a

logical place to conduct this training (Noise and Hearing Loss 1990; Chermak 1991;Niskar 2001).

Few school-based hearing conservation programs have been systematically evaluated. However, there is evidence to suggest that hearing conservation programs can be beneficial. Chermak and Peters-McCarthy (Chermak 1991) observed a 23% improvement in knowledge and attitudes regarding hearing protection in third and fourth grade students, measured 2 weeks after the administration of a hearing conservation program. In a subsequent study with fourth grade students, Chermak (Chermak 1996) found a 25% improvement in knowledge of hearing and noise-induced hearing impairment, measured 1 week after the administration of a hearing conservation program. Despite short follow-up periods, these studies demonstrate that students are able to learn about hearing and hearing protection

The Marshfield program (Knobloch 1998) was developed for use in adolescent agricultural populations. This program included classroom-style education, reminders or cues to action intended to motivate students to engage in hearing protection behavior, noise level assessments, convenient access to hearing protection devices, and hearing evaluations. These components were recommended by Royster and Royster (Royster 1990) for use in industrial hearing conservation programs. In a 3-year longitudinal study, this program increased the use of hearing protection devices in secondary school students from below 25% at baseline to a final level above 87%.

The development of the Marshfield program elements was informed by the Health Belief Model (Strecher 1997) and the Theory of Self-Efficacy (Bandura 1977). In the substantive area of hearing conservation, the Health Belief Model holds that, before engaging in behaviors intended to protect hearing, a person must perceive that he/she is susceptible to hearing damage, that hearing damage has severe consequences, and that the protective behavior will be beneficial. In addition, the person must also perceive few physical or social/psychological barriers to the activities of hearing protection, and be regularly reminded to protect their hearing. The supporting construct of the Theory of Self-Efficacy holds that the person must be confident that he/she has the ability to successfully implement hearing protective behaviors, before he/she will engage in these behaviors.

Through student ratings of program components, the investigators discovered that most influential aspect of the Marshfield program was the availability of free hearing protection devices, which could indicate that availability and cost of hearing protection devices constitute a substantial barrier to the implementation of hearing conservation procedures. *Cues to action* like annual hearing evaluations, mailings to participants, teacher influence, and classroom instruction also influenced students' use of hearing protection devices (Knobloch 1998).

Although the Marshfield program was very successful, it could be improved. One *cue to action* in the Marshfield program involved a student's ability to borrow a sound level meter to take home and measure the amount of sound produced by familiar noise sources. Although access to sound level meters influenced the use of hearing protection devices, the sound level meters were in short supply, and few students were able to access them. Additional *cues to action* are desirable. Labels describing the noise levels produced by machines in their own daily lives would be a regular reminder of noise exposure at the moment when such information is most needed and influential. Noise exposure data could come from simple sound surveys taken among study participants' and databases containing sound level measurements (e.g. data available from the Keokuk County Rural Health Study (Merchant 2001). These noise exposure

data could be used by the participants in estimating their daily noise exposure. Thus, this type of information could improve self-efficacy.

Project Design and Methods

Study Population: Subjects will be recruited from the Keokuk County Rural Health Study (KCRHS), a population based, prospective study of health status and environmental exposures of residents in one rural Iowa County, conducted within the University of Iowa's Great Plains Center for Agricultural Health. The eligible population will include male adolescents between the ages of 13 and 18 who are currently enrolled in the KCRHS. The adolescents participating in the study will be divided into two groups, those who work on a farm and those who do not.

Methods: This pilot study proposes to collect noise exposure measurements among male adolescents, 13 to 18 years in age that are enrolled in the KCRHS. The results of this pilot study will be invaluable in designing a larger study to determine rural adolescent noise exposures. In addition this study will be able to assess the knowledge among adolescents regarding hazards associated with noise and provide direction on the most effective interventions to protect their hearing. The following procedures will be carried out to complete this pilot effort.

Subjects will be randomly selected from those participating in the KCRHS, through which this pilot project will be administered. Because potential subjects are enrolled in the KCRHS we will know which parents have kids in our target age group and whether or not they work on a farm. Staff at the KCRHS will be classifying each eligible individual into the appropriate category and age group prior to being randomly selected. An initial recruitment letter and brochure will be sent to the parents of the eligible subject containing information about the purpose of the study and study procedures. The initial recruitment letter will be followed up with a phone call to the parents to answer any questions and to schedule a time for the researchers to visit. Consent from the parents and assent from the adolescent will be obtained at a face-to-face meeting with the researchers. Recruitment will come to an end once there are five subjects for each age group in the two subject categories (Table 1).

Table 1. Breakdown of sample days.

Subject Category	Age group at enrollment	Number of Subjects	Number of Sample Days for Round 1	Number of Sample Days for Round 2
Work on farm	13 & 14	5	5 x 2 = 10	5 x 2 = 10
	15 &16	5	5 x 2 = 10	5 x 2 = 10
	17 & 18	5	5 x 2 = 10	5 x 2 = 10
Do Not work on farm	13 & 14	5	5 x 2 = 10	5 x 2 = 10
	15 &16	5	5 x 2 = 10	5 x 2 = 10
	17 & 18	5	5 x 2 = 10	5 x 2 = 10
Total Sample Days			**60**	**60**

Adolescents for whom parental consent and assent has been obtained, and are enrolled in the study will be given a one-page pre-survey (Appendix A) at the face-to-face meeting with the researchers. The pre-survey is intended to collect information about activities that the subjects participate in, that may contribute to their noise exposure. In addition to being given the pre-survey, this visit will also be used to give instruction by the study investigators or staff members of the KCRHS on collecting noise monitoring data and keeping a daily log (diary) of their

activities. Specifically, students will be shown how to start and wear a noise dosimeter and provided a daily diary and instructed how to note their activities during the day.
The students will be told that they will receive the pre-calibrated dosimeters and diaries via Federal Express® on four randomly selected days over a six month period.

On the day after they receive the dosimeters, they are to start and begin wearing the dosimeters shortly before they begin their work and leisure activities. The dosimeters will record the noise exposure levels in dBA (data-logged every minute) and will provide a total noise dose level according to Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH) criteria. These data will be correlated with the various activities that the adolescent performed during the day. In addition to noting in their diaries what they did during the day, the subject will also be asked to note their use of any hearing protection devices or measures they took to reduce their noise exposure levels. After ten hours, the students will turn off the dosimeters and place them in a pre-addressed Federal Express® mailing envelop for return to the investigators. The investigators will download the noise exposure data from the dosimeters, code the diary information into a database for linking with the dosimeter data, and clean and re-calibrate the dosimeters for use by the next study subject.

We will use Quest NoisePro DL® dosimeters to measure noise exposure levels. These dosimeters are rugged and are designed for extensive use in harsh heavy-industry environments. They are light-weight (< 2 lbs) and should not significantly restrict the students' activities. The dosimeters will be calibrated before sending them to each study participant.

The participants will receive the dosimeter and diary kits on two selected dates between October and December 2007 (Round 1) and two selected dates between March and May 2008 (Round 2) for a total of four selected survey dates per study participant (Table 1). A total of 120 survey days will be obtained from 30 study subjects.

Data Analysis: A database of subject's noise exposure levels, activities, and use of protective measures will provide important information to help design a larger study. This data can be used to estimate the power of a larger study to detect true differences between the noise exposures among different groups of adolescents and describe their use of personal productive equipment. Descriptive statistics including means, medians, and variances of exposure levels and doses will be calculated for the two exposure groups. The levels in these groups will be compared using analysis of variance and pair wise comparison tests (Scheffe).

Implications for Future Studies
This project will produce information about the noise exposures, knowledge of risks, and use of protective measures by adolescents living in rural environments and involved in farm work. It will guide future intervention and education efforts to reduce the noise exposure of rural youths.

This pilot project, in conjunction with the Iowa Hearing Loss Prevention Project, will help initiate a larger study of the noise exposures and effectiveness of training efforts for young people living in rural, agricultural environments. The Iowa Hearing Loss Prevention Project is a study conducted by Dr. Flamme in the Iowa counties of Keokuk and Louisa, evaluating the effectiveness of two comprehensive hearing conservation educational programs, one for 7th graders and one for 4th graders, designed to enhance their awareness of noise hazards and increase their use of hearing protection devices.

The project produces information about the feasibility of using the noise monitoring equipment to measure the real-time noise exposures of adolescents and the practicality of recording their

activities and correlating them with noise exposures. This project may also suggest future intervention work to reduce adolescent noise exposures. The investigator has a history of successfully conducting field studies of agricultural workers and working with children.

Noise-induced hearing loss is one of the most common occupational problems in the US. Preventing hearing loss is one of the priorities cited by the National Occupational Research Agenda (NORA) of NIOSH.

Dissemination of Results
A manuscript will be drafted at the completion of this study detailing the study results and conclusions drawn. The manuscript will be submitted for publication to an appropriate per reviewed journal. The results will also be presented at professional conferences such as the American Industrial Hygiene Conference and Expo (AIHce) and the National Institute for Farm Safety (NIFS).

Evaluation Plan
The contribution of this pilot study will be evaluated in several ways. First, it will determine our ability to recruit adolescents 13 to 18 years of age to participate in our study (participation rate). It will also allow us to determine whether our study design can collect accurate, self-monitored noise exposure levels from participants over several randomly selected dates (study design compliance and expected data accuracy). The instrumentation (Quest NoisePro DL® dosimeters) may also be evaluated in this study to determine their durability, ability to maintain calibration, acceptance by study subjects, and reliability and validity of the sample data (instrumentation failure rate). Although this small study will not be able to statistically test exposure and behavior differences across the training-exposure groups, the data collected in this study can be used to estimate the sample sizes needed for a larger study, which can test these differences.

To ensure validity of our noise exposure measurements 1/3 of the subjects will be randomly selected and monitored simultaneously by the study staff with a second noise dosimeter. One day of monitoring will be done for each subject randomly selected, for a total of 10 sampling days for the evaluation. The exposures measurements from the two noise dosimeters will be evaluated to see if the measurements are comparable. Measurements which vary less than 10% will be considered valid.

Biosketch (See attached Biosketch for Michael Humann)
Michael Humann is currently a PhD student in the Department of Occupational and Environmental Health at the University of Iowa. He has over seven years of experience working in agricultural health and safety. His main research focus has been on noise exposures of agricultural workers in large scale swine confinement facilities. Michael also has 18 months of agricultural health and safety research experience specific to children, as a research specialist with the National Children's Center for Rural and Agricultural Health and Safety in Marshfield, WI.

Utilization of Center Facilities
This study utilizes the faculty, staff, and resources from the Great Plains Center for Agricultural Health (GPCAH), the Keokuk County Rural Health Study (KCRHS) and the Heartland Center for Occupational Safety and Health. Data collection, entry, and analysis will conducted at the Institute for Rural Environmental Health on the University of Iowa campus.

Timeline
This timeline reflects the relative amount of time that will be needed to complete study tasks.

Activity	Round 1			Round 2		
	Oct	Nov	Dec	March	April	May
Acquire and test sampling equipment and create diaries and field survey database						
Administer baseline exposure survey and recruit and train study participants (October – February)						
Conduct noise exposure surveys (Round 1)						
Conduct noise exposure surveys (Round 2)						
Code and analyze data						

Budget
The budget for this project includes the following expenditures:

Item	Cost
Equipment Calibration	$1400
Federal Express Mailing	$2580
Supplies	$170
GRA 25%	$5250
Recruitment	$3000
Travel	$1700
Total	**$14,100**

Equipment Calibration – Cost of calibrating six Quest Noise Pro dosimeters at $195 each and 2 two calibrators at $115 each.

Federal Express Mailing – Cost of mailing out dosimeters to each study subject, four times during the study period.

Supplies – General office supplies, printing and copying.

GRA 25% - Staff time required to recruit subjects, mail dosimeters, conduct evaluation and analyze data.

Recruitment - $100 for each subject to participate in the four days of sampling during the study period.

Travel – Travel expense (car + mileage) for maximum number of trips to Keokuk County to recruit subjects (30) and conduct evaluation of sampling procedures (10).

Plan for Continuing Reporting of Work
Mid-year and final reports will be submitted to the Great Plains Center for Agricultural Health as indicated in the request for proposals. The principal investigator will continue to maintain a relationship with the Great Plains Center for Agricultural Health after the completing of the project. Annual updates with be made to GPCAH staff on any publications, presentations, grants, etc that are a direct and indirect results of this study.

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