

Brief Report

Effects of a Low Intensity Intervention to Increase Hearing Protector Use Among Noise-Exposed Workers

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Background Farm operators experience exposure to high noise and high prevalence of noise-induced hearing loss, but use of hearing protection in this worker group is low. The purpose of this study was to test a brief intervention to increase farm operators' use of hearing protection.

Methods In this one-group pre- and post-test study, a random sample of 32 members of a farmers' organization was supplied a variety of hearing protectors. Participants received an assortment of hearing protectors by mail with manufacturer's instructions for use.

Results Mean pre-intervention hearing protector use when in high noise in this group was 23% (*SD* 29). Of the 32 participants, 27 (84%) were exposed to hazardous noise during the study period. Post-intervention mean use of HPDs was 64%, an increase of 41% ($t = 5.26, P < 0.000$).

Conclusion Results of this study suggest that overall, hearing protectors were acceptable to farm operators, and that a brief mailed intervention is feasible. *Am. J. Ind. Med.* 54:210–215, 2011. © 2010 Wiley-Liss, Inc.

KEY WORDS: hearing loss; noise induced; prevention; pilot projects; agricultural workers

BACKGROUND

An estimated 22 million workers are exposed to hazardous noise at work [Tak and Calvert, 2008]. Noise-induced hearing loss (NIHL) is among the most common work-related diseases, and the second-most self-reported occupational disease or injury [Conway et al., 1993]. Although difficult to estimate the numbers of workers involved in farming, the USDA estimates there are about

3,281,000 farm operators [USDA, 2007]. A farm operator is the person who runs the farm, making the day-to-day decisions [USDA, 2009].

Noise levels of common farm equipment are known to be high, and several recent studies [McCullagh, 1999; Beckett et al., 2000; McCullagh et al., 2002; McBride et al., 2003; Jenkins et al., 2007] document farmers' exposure to hazardous noise. In the only recent study involving direct noise measurement, mean noise levels of several common farm tasks were found to be well within the range considered to be hazardous (above 85 dB). These noise sources included tractors (91 dB), vacuum pumps (91.9 dB), bedding choppers (93 dB), and feed unloaders (90.4 dB) [Beckett et al., 2000]. Farmers often work extended work days, resulting in longer noise exposures, and greater risk of NIHL and other negative effects of noise [Murphy, 1992].

Self-reported measures of noise exposure among farmers are also high. In a convenience sample of 25 Kentucky farmers, 96% of participants reported exposure to hazardous

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Contract grant sponsor: NIOSH/Midwest Center for Agricultural Safety and Health; Contract grant sponsor: North Dakota Farm Bureau Foundation.

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Accepted 1 July 2010
DOI 10.1002/ajim.20884. Published online 18 August 2010 in Wiley Online Library (wileyonlinelibrary.com).

noise on the farm [Gates and Jones, 2007]. Based on NHANES data from 1999 to 2004, 1.5 million workers in agriculture (or 43.3%) report exposure to hazardous noise [Tak and Calvert, 2008].

Precise estimates of the prevalence of hearing loss among farmers are not available because the data are reported in summary form for several worker groups (i.e., farming with forestry and fishing) [Tak and Calvert, 2008]. Estimates of prevalence rates for NIHL among farmers vary greatly, and have been reported to be 17% [Thelin et al., 1983], 22% [Gomez et al., 2001], 38% [Stewart et al., 2003], 65% [Marvel et al., 1991], and 72% [Beckett et al., 2000]. In comparison studies, farmers were more likely to have hearing loss than non-farmers [Thelin et al., 1983; Marvel et al., 1991; Rabinowitz et al., 2005].

Noise-induced hearing loss is characterized by loss of hearing in higher frequencies. The condition is permanent and incurable, and typically progresses slowly and insidiously with continued exposure to high levels of noise. Most people are unaware that they are affected until it is already well progressed [Morata, 1995].

NIHL affects physical and emotional functioning, social life, and employment. In addition, NIHL results in heavy social and economic burdens on families and communities from all ethnic and socioeconomic groups. In addition, persons with NIHL frequently experience tinnitus, and have increased safety risks due to difficulty hearing warning sounds [Hetu et al., 1995]. Monetary costs for NIHL are high, and include workers' compensation (for employees) and medical costs [NIOSH, 1996]. Importantly, hearing loss has also been associated with increased risk for injury among farmers [Choi et al., 2005].

Because NIHL is permanent and irreversible, treatment is limited to hearing aids for sound amplification. Most users find hearing aids expensive, unlike their natural hearing, and particularly unsatisfactory when there is background noise or when trying to focus on one speaker when there are other competing sounds [NIDCD, 2009].

Farmers are a unique population. Unlike workers in general industry, most farmers work in an OSHA-exempt, non-regulated workplace [Suter, 2009]. They are not protected by the OSHA Hearing Conservation Standard (i.e., noise level monitoring and a hearing conservation program for at-risk employees which includes audiometric testing, training, and provision of HPDs [Suter, 2009]. Also, because most farms in the US are small, family-run organizations, there is no labor advocacy for worker hearing health or work-based health programs [Murphy, 1992]. Farmers, unlike most workers, are "on their own" to determine when hearing protection should be worn, which types are suitable, where to purchase, and how much to pay for HPDs [Suter, 2009]. Because of this, many farmers may underestimate their exposure to noise hazards and consequences of noise exposure, and may not be

knowledgeable about NIHL prevention techniques. Even when the farmer is aware of noise exposure and the hearing health hazard it represents, s/he is less likely to have tried the types of hearing protection available to him or her, in order to select the ones that suit the individual best [McCullagh, 2009]. Unlike many positions in general industry, farm work is characterized by frequent changes in tasks and accompanying changes in noise exposure levels [McBride et al., 2003]. It is therefore unlikely that one type of hearing protection will suit any farmer for all of his work tasks.

Noise elimination is the most preferred method of prevention of NIHL. However, this approach is often not technically or economically feasible in the farm work environment [Murphy, 1992]. Although noise dosimetry has not been well studied in farming, proper use of hearing protectors is effective in reducing most workplace noise to safe levels, and their consistent use is effective in preventing NIHL [Savelle, 1987; Sataloff, 1993; Hong et al., 1998]. There are several types of hearing protectors marketed; the most highly used types are foam plugs, ear muffs, pre-molded plugs, and semi-aurals (also known as canal caps). There is no "best" type of hearing protection. Rather, the "best" hearing protector is the one the user prefers and will wear. Selection of type of HPD is highly individualized, and based on noise exposure as well as personal perception of comfort and convenience [NIOSH, 1996]. Several studies have examined HPD use among farmers [Carpenter et al., 2002; McCullagh et al., 2002; Stewart et al., 2003; Carruth et al., 2007; Gates and Jones, 2007; Jenkins et al., 2007]. In each study, use of HPDs in this noise-exposed group was too low to be considered effective.

Healthy People 2010 [United States, 2000] includes an objective addressing NIHL. It has been named as one of the 21 top research priorities for the century by NIOSH [NIOSH, 2009], and is included as a high-priority area in the National Agriculture, Forestry, and Fishing Agenda [NIOSH, 2009].

Pender et al. [2006] suggests that health promotion behavior is influenced by attitudes, beliefs, habits, behavior history, and personal factors (such as age and gender). A variety of factors based on this model have been found to be predictors of HPD use in multiple studies of workers, including farmers. These factors are included in the Farmers' Use of Hearing Protectors Model (Fig. 1), and served as a guide for the study. In a previous study [McCullagh et al., in review], this model was effective in predicting HPD use in 74% of cases.

Availability and access to hearing protectors, as well as perceived barriers to hearing protector use were found to be significant predictors of hearing protector use in previous studies. However, purchase cost of hearing protectors was not found to be a predictor of use [McCullagh et al., 2002, in review]. In addition, farmers who are frequent users of hearing protection have been found to use methods to make these devices readily available at their farm operations

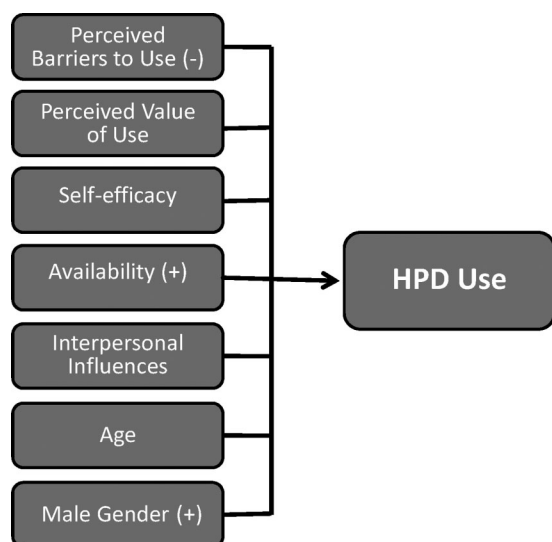


FIGURE 1. Farmers' use of hearing protectors model.

[McCullagh and Robinson, 2009]. The author hypothesized that providing a supply of hearing protectors of various types may result in increased frequency of hearing protector use.

The purpose of this study was to examine the effects of a model-based mailed intervention on farmers' use of hearing protectors. The specific aims of this feasibility study were to (1) test study procedures, and (2) compare pre- and post-intervention hearing protector use.

METHODS

Design and Sample

The study used a one-group pre- and post-test design to test the feasibility of delivering a brief mailed intervention to increase hearing protector use. This article describes the effects of the intervention as well as an analysis of the experience of the intervention delivery.

Procedures for the study were approved by the Institutional Review Board of the investigator's university. A random sample of farmers was obtained from membership lists of a statewide farm organization. Telephone calls were placed to the phone numbers provided. The investigator served as interviewer at both pre-test and post-test. The interviewer requested to speak with the person named as organization member. If this person was not available, then the interviewer asked to speak with a person at this number who met study inclusion criteria (such as a family member actively engaged in farm production who was at least 18 years of age). Farmers were selected for participation who were at least 18 years of age, active in production at least half-time (e.g., not solely in a management role), were willing to

trial an assortment of hearing protectors, and respond to a post-test. Following obtaining of informed consent, the investigator administered the pre-test. Pre-test measures included Farmers' Use of Hearing Protection Scale, questionnaire items (regarding history of use of hearing protection, hearing health information sources, and functional hearing ability), and demographic survey.

Participants received an assortment of free hearing protectors via mail during the production season, with manufacturer's instructions for use. The assortment included a variety of foam plugs (corded and uncorded), pre-molded plugs, one semi-aural headband with several replaceable of tips, and one pair of ear muffs. Participants were offered the entire assortment of hearing protectors (estimated retail value \$20) for continued use as a gift in acknowledgement of their time devoted to the project. Other costs of the study included telephone use, interviewer time, and time to assemble and mail hearing protectors.

The post-test was administered by telephone 2 months following delivery of the intervention. Post-test measures included the Farmers' Use of Hearing Protection Scale, and Comfort and Convenience Questionnaire. All responses were recorded by hand.

Measures

Farmers' use of hearing protection scale

Development of this scale is described elsewhere [McCullagh et al., 2002]. This scale consists of four items reporting the percentage of time that farmers actually used hearing protection when they were exposed to high noise at work settings: in the field, in the shop, with livestock, and at the grain-handling system. The instrument defines high noise as present whenever one had to raise one's voice to be heard by another person at a distance of 3 feet or less. A prior study [McCullagh et al., in review], found that farmers reported a wide range of frequency of use and experienced no difficulty using the instrument. The scale was scored as the average percentage use among settings in which the farmer reported being exposed to high noise. Alpha coefficient for this scale in a previous study was 0.89.

In a study comparing the validity of observed and self-reported HPD use [Lusk et al., 1995], self-report and observations were highly correlated (0.89), suggesting that self-report is an appropriate measure of HPD use. Also, the low reported use by farmers in previous studies demonstrates a low social desirability effect.

Demographic survey

Questions were presented regarding the participants' primary farm product produced, years experience in farming,

occupational role, age, and gender. Mailing address was verified.

Analytic Strategy

Objective data from the written record were entered into SPSS, version 16 for analysis. Subjective data were transcribed and analyzed using Microsoft Word to assist with data organization and reduction.

RESULTS

Telephone contacts were made with a total of 89 farm households in the upper Midwest during the 2008 growing season. Of these, 46 (52%) were eligible. Primary reason for ineligibility was retired status; others were done with production for the season ($n = 2$) or active in production less than 20 hr per week ($n = 2$). Of eligible contacts, 32 (70%) agreed to participate. Of 32 pre-test participants, 27 (84%) were exposed to hazardous noise during the study period and provided post-test data.

The mean age of participants was 50 years, and mean number of years experience in farming was 27. Most (90%) identified themselves as managers. Three-quarters (75%) primarily produced crops; the remainder produced livestock. Participant demographics are summarized in Table I.

Test of Study Procedures

The study was conducted in partnership with a statewide farm organization. Following a request to the board of the organization, the organization supplied a list of members randomly selected from the membership roles. The organization also supplied a cell phone for study use. Most (90%) telephone numbers supplied by the organization were found to be working numbers. Calls to the number provided resulted in contact with an eligible participant about half (52%) of the time. Initial calls to prospective participants and follow-up calls to participants required multiple attempts

TABLE I. Participant Demographics

Characteristic	
Mean age (years)	50 (SD 10)
Mean years farming	27 (SD 11)
Men	27 (90%)
Role	
Manager	29 (90%)
FT paid	2 (6%)
PT paid	1 (3%)
Primary product	
Crop	24 (75%)
Livestock	8 (25%)

(range = 1–11). There was a high level of receptivity (70%) among eligible farmers to the invitation to participate. Pre-test telephone calls (i.e., invitation to participate, administration of informed consent, and data collection) lasted between 20 and 30 min and proceeded without difficulty.

An assortment of hearing protectors was packaged into standard mailers along with a copy of the informed consent form. The assortment included several foam plugs (corded and non-corded), one or more sets of pre-molded plugs (corded), one set of semi-aurals with several replacement tips, and one set of ear muffs. Products represented a variety of manufacturers. None was returned undeliverable. Follow-up telephone calls to a subsample of participants verified receipt of the mailed packages.

Post-test data were collected 2–3 months after delivery of the intervention. The majority (84%) of study participants supplied post-test data. The remainder was not exposed to hazardous noise during the study period due to unusual growing conditions that season. Post-test data collection lasted between 15 and 20 min and proceeded without difficulty.

A large proportion (70%) of eligible contacts was receptive to the invitation to participate. Excluding participants who were not exposed to loud noise during the study period, 100% of participants supplied post-test data.

Comparison of Pre- and Post-Intervention Hearing Protector Use

On pre-test, participants reported use of hearing protectors (all types combined) 22% of the time they were exposed to loud noise. On post-test frequency of use of hearing protection was 66% overall, an increase of 44% over pre-test ($P < 0.001$).

Of the 28 participants, 24 increased their use. Statistical comparisons of persons who increased use with those who did not increase use by age and other factors were very low powered. For example, in comparing two groups of 4 persons versus 24 persons (not increased versus increased) the t -test had 14% power to detect a medium-sized difference. A medium-sized effect is one visible to the naked eye, so clinically important [Cohen, 1992].

Four of the 25 managers did not increase their use, while all of the remaining participants (21 managers, 2 full-time, and 1 part-time employee) increased use. The mean age of those who increased their use was 50.5 years, while age of those who did not increase their use was 45.5, but the difference between these was non-significant by t -test. Mean years in farming was 27 for those who increased their use, and 25 for those who did not increase use; this difference was also non-significant by t -test.

Distribution of use by type of hearing protector changed over the course of the study. On pre-test, most farmers

reported using foam plugs; on post-test use of semi-aurals and muffs increased by 22% and 27%, respectively.

In addition to quantitative data, farmers offered comments about their overall experience with the hearing protectors; these were nearly all positive. Many indicated that they were very pleased with their experiences with the assortment of hearing protectors, have become more aware of the need to protect their hearing, and find they were using hearing protection more often than prior to the study.

DISCUSSION

The proportion of farmers reporting high-noise exposure, and low rate of use of hearing protectors reported on pre-test is consistent with previous studies. However, despite this acknowledged high level of noise exposure and low rate of hearing protector use, there are few reports of interventions aimed at this worker group. This information points to the need for development and testing of new interventions. In general, farm operations in the US are (a) geographic dispersed, (b) large in number but employing few persons, (c) independently owned and operated, (d) lacking regulation or labor organization advocating for hearing protection. In addition, farm operators have a reputation for having a strong sense of autonomy and resistance to “outside” interference with their operations. For these reasons, designing and implementing interventions for this worker group is challenging.

The findings of the study reported here are consistent with those of Gates and Jones [2007]. These investigators conducted a non-equivalent control group study of farmers (17 experimental, 8 controls), providing individual, family and group education, on-site farm noise exposure assessments, placement of hearing protectors on the farms by study personnel, and mailed reminder messages. These interventions resulted in a significant increase in hearing protector use (as measured by 7-point Likert scale) at 1 month, but not at 2 months. In contrast to the Jones and Gates study, the study reported here used a randomly selected sample and was less intensive, but showed a significant increase in hearing protector use (as percent time) after 2 months. It is encouraging to note that the less intensive (and perhaps less costly) study resulted in a significant change in hearing protector use. More cost-effective approaches are needed in agricultural health and safety program, due in part to the multiple challenges to program delivery mentioned above.

Although the sampling framework included a high proportion of non-working numbers and ineligible persons, the recruiting method yielded a satisfactory number of participants with reasonable effort. Initial calls to prospective participants and follow-up calls to participants required multiple attempts. However, a high proportion of eligible contacts volunteered for the study and completed post-tests, making participation highly satisfactory. The mailed sampler

of hearing protectors worked well as an incentive, as it did not require additional costs to the study, and informal subjective feedback from participants about it was positive.

The partnership with the farm organization was highly effective in accomplishing study aims. The organization supported the study in two important ways. First, the organization provided material support in the form of funds to conduct the study as well as use of a telephone for data collection. Second, the organization board endorsed the study and agreed to supply names and contact information of members for use in recruitment. The investigator believes that the introduction of the study to prospective participants as a collaborative between the university and the farm organization was highly influential in members agreeing to participate.

The increase in mean use of HPDs of 40% was higher than expected. This increase was statistically significant, even though the sample size was small. This finding suggests that overall many farmers are receptive to efforts to increase their use of HPDs.

The intervention was designed to modify farmers’ attitudes and beliefs about hearing protection, based on the Predictors of Farmers’ Use of Hearing Protection Model. This model has shown that overall, farmers use of hearing protection is influenced by their perceived barriers to use of hearing protection as well as the availability of hearing protectors. The intervention may have decreased common barriers to HPD use such as comfort and convenience. It also may have increased availability by providing a greater number of HPDs for strategic distribution to locations in the farm operation where noise exposure was most likely.

Many farmers have reported fear of not being able to communicate with coworkers and fear of not hearing equipment sounds when using HPDs. These fears are conceptualized as Barriers to HPD Use in the Model. Although the intervention reported here did not address this barrier, it was modestly successful in increasing HPD use. This finding suggests that the cumulative number of barriers to HPD use may be more important than the presence of any single type of barrier in modifying this health behavior. Future studies with larger sample sizes are needed to affirm this.

The post-test was completed 2–3 months following the intervention. This relatively short post-test timing may partially explain the relatively high increase in use of HPDs. Future effectiveness studies should include post-test measures after a longer elapsed time from intervention, perhaps 6–12 months.

ACKNOWLEDGMENTS

This study was supported by NIOSH, the Midwest Center for Agricultural Safety and Health, the North Dakota Farm Bureau Foundation, and the 3M Corporation.

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