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Factors Influencing Farmers' HPD Use

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Table of Contents

List of Terms and Abbreviations.....	3
Abstract	4
Significant Findings.....	4
Translation of Findings.....	4
Outcomes/Relevance/Impact.....	4
Scientific Report.....	10
Specific Aims	10
Background and Significance.....	10
Noise Exposure in Farming	11
NIHL in Farmers.....	11
Other Factors Contributing to NIHL among Farmers	11
Off-farm Employment	11
Lack of Regulation.....	4
Prevention of NIHL.....	4
HPD Use among Farmers	4
Interventions with Farmers	4
Theoretical Bases for Interventions to Prevent NIHL	4
The Predictors of Farmers' Use of Hearing Protection Model	4
Summary.....	4
Preliminary Studies	4
Design and Methods	4
Results and Discussion.....	4
Conclusions	20
Publications	21
Peer Reviewed Articles	21
Proceedings.....	21
Abstracts.....	21
Inclusion of Gender and Minority Study Subjects.....	22
Inclusion of Children	23
Materials available for other investigators.....	23
Final Financial Status Report	23
Final Invention Statement and Certification.....	23

List of Terms and Abbreviations

NIHL: Noise-induced hearing loss
HPD Hearing protection device

Abstract

Occupational Health and Safety Issue Addressed: Use of hearing protection among farmers in the upper Midwest.

Importance of the Problem: Farmers are exposed to hazardous noise from equipment and livestock and experience high rates of noise-induced hearing loss (NIHL), but their use of hearing protection devices (HPDs) is low

Approach: Telephone surveys of factors influencing predictors of hearing protector use were conducted with a disproportionate probability sample of farmers randomly selected from census lists from a four-state region in the upper Midwest. To describe farmers' personal experiences in using hearing protection, face-to-face interviews were conducted with a purposive sample of farmers who reported high frequency of use of HPDs.

Key Findings: Farmers overall demonstrated low (27%) hearing protector use when exposed to hazardous noise. Factors found to negatively influence use included barriers, inconvenience, and female gender. Farmers who were frequent users of HPDs were motivated to use protection by a desire for good hearing, as well as a way to avoid problems associated with noise exposure and NIHL. Many (although not all) had attempted to influence other farmers' use of hearing protection, especially family members. Most had developed methods to overcome problems with access and barriers to HPD use that other farmers frequently reported.

How Results Will Be Used: Findings from this study will be useful in the design of interventions to promote HPD use among farmers and reduce the level of NIHL among this high-risk and underserved worker group.

Highlights/Significant Findings

Farmers who were surveyed universally reported exposure to dangerous levels of workplace noise, but also reported low use of hearing protection (27% of time exposed to high noise). This rate of use is not likely to result in protection of hearing.

Analysis of survey results identified barriers, situational factors, and gender as statistically significant predictors of this health behavior. This finding is in contrast to that of a previous study of farmers, which found that interpersonal factors (as well as barriers and situational factors) were significant predictors of HPD use. Predictors in the current study, although differing from a previous study of farmers, were similar to those of other worker groups. The model correctly predicted 74 percent of cases, suggesting that the model was inclusive of many of the important factors affecting use of hearing protection.

Face-to-face interviews with farmers who were frequent users of hearing protection confirmed that they have frequent exposure to hazardous noise. These high-frequency users described their motivation to adopt protective behavior as avoiding hearing loss, noise annoyance, or tinnitus. Many tried to influence others' use of hearing protection, particularly family members. These farmers have developed a variety of methods to assure convenient access to hearing protectors when they are needed, and have developed effective techniques for overcoming common barriers to use of protection.

Translation of Findings

The low rate of HPD use reported here and in previous studies affirms the need to develop interventions to increase HPD use among farmers. Lusk, Kerr, Ronis, and Eakin (1999) have suggested that factors from this type of research can form the basis for and guide the development of educational interventions. The information generated in this study will be useful in identifying learning needs, and in designing general and tailored, model-based nursing interventions to increase hearing protector use among farmers. Lusk, Kerr, Ronis, and Eakin (1999) have suggested that findings from this type of research can form the basis for and guide the development of educational interventions that can be expected to increase use of HPDs. Selection of the factors most relevant to HPD use, and focusing on these as targets for change can be expected to enhance the effectiveness of future interventions. Increasing farmers' use of hearing protection can be expected to improve hearing health and contribute to improved safety and quality of life among farmers

Dissimilar to previous studies of other worker groups, benefits of use and self-efficacy of use were not found to be significant predictors of use (i.e., these factors did not separate users from non-users). Reasons for these differences are as yet unexplored, but may in part be related to farmers' more universal perceptions of benefits of use and self-efficacy of HPD use, separate from their of frequency of use. This lack of difference between users and non-users may suggest that farmers are contemplating change in their frequency of use (Prochaska, 1997). This finding is consistent with the finding that most participants are interested in increasing their use of HPDs. This finding suggests that as a group, farmers' attitudes may be receptive to interventions designed to increase their use of hearing protection.

Female farmers were found to have lower rates of HPD use than their male counterparts. Reasons for this difference are unclear, but may relate to female farmers' more frequent part-time status in operations, and resulting lower concern about risks of NIHL with short-term exposures. Future interventions should focus on this high-risk group.

Results of this study can be used to develop future interventions designed to increase HPD use and to decrease rates of NIHL among farmers.

Physicians, nurses and other providers caring for farmers can expect that nearly all their patients who are farmers experience intermittent hazardous noise exposure at work. Quality of care will be enhanced by inclusion of an assessment of the farmer's perception of his noise exposure and perceived susceptibility to hearing loss. An assessment of the farmer's HPD use will include the farmer's own individual perceived barriers to use and factors influencing the convenience and accessibility of HPDs at the farm work site.

Farmers' descriptions of behavioral methods used to overcome barriers to use and availability of hearing protectors are particularly valuable, as they suggest that some myths of HPD use may be dispelled by relating experiences of other farmers and inviting trials of use. Videorecordings of farmers' statements may be useful as testimonials for educating other farmers, as peers may be particularly influential for this worker group known to highly prize their autonomy and shun outside influence on their businesses.

Many farmers in this study cited the influence of others in their decision to adopt use of HPDs at work. Farmers, their families, and health care providers may profit from knowing they are influential in the adoption of this important protective behavior among family members and other farmers. Techniques that farmers reported as influential in changing their own or others' HPD use behavior included modeling HPD use, providing a supply of HPDs for others to use, and encouraging others to use.

Farmers who were frequent users of hearing protection described techniques they adopted to increase their use of hearing protectors. These techniques could be easily adopted by other farmers. Video recordings of farmers offering testimonials of their high frequency of use and techniques for increasing use may be useful in future interventions designed to increase farmers' use of hearing protectors.

Outcomes/Relevance/Impact

Although farmers experience frequent exposure to dangerous levels of workplace noise, they also report a low use of hearing protection (27% of time exposed to high noise). This rate of use is not likely to result in protection of hearing, and points to the need for development of programs to increase this protective behavior.

Factors that strongly influence use of hearing protectors in this worker group include barriers, situational factors, and gender. These factors can serve as the focus for the design of more effective interventions to increase farmers' use of hearing protectors.

Face-to-face interviews with farmers who were frequent users of hearing protection confirmed that regular use of hearing protectors, although infrequent, is entirely possible in the farm work environment. Some farmers have developed a variety of effective techniques for overcoming common barriers to use of protection. Audio-video recordings of farmers' testimonials generated as part of this project can be adapted for use in future interventions designed to increase farmers' use of hearing protectors.

Scientific Report

Farmers are exposed to hazardous noise from equipment and livestock, and experience higher rates of noise-induced hearing loss (NIHL) than their non-farming age cohorts (Lierle & Reger, 1958; Thelin, Joseph, Davis, Baker, and Hosokawa, 1983; May, 1990; Marvel, Pratt, Marvel, Regan, and May, 1991; Plakke and Dare, 1992). NIHL is permanent and negatively impacts the quality of life of the individual through increased safety risks, impaired communication, and disturbance in social and family interactions (Hetu, Getty, and Quoc, 1995). Although use of hearing protection devices (HPDs) is effective in preventing NIHL (Sataloff & Sataloff, 1993; Savelle & Toothman, 1987; Hong, Chen, & Conrad, 1998), their use among farmers is low (Hallet, 1987; Karlovich, Wiley, Tweed & Jensen, 1988; Broste, Hansen, Strand & Stueland, 1989; Pytko, 1990; Langford, Zurales, & Garrett, 1995; Engstrand, 1995, McCullagh, Lusk, & Ronis, 2002).

Using Pender's Health Promotion Model, McCullagh (2002) identified predictors of HPD use in a convenience sample of farmers. Factors from the model that were found to predict farmers' use of HPDs included interpersonal influences, barriers, and situational influences. Lusk, Kerr, Ronis, and Eakin (1999) have suggested that factors from this type of research can form the basis for and guide the development of educational interventions.

Specific Aims

The purpose of this program of research is to prevent NIHL in farmers through increasing use of HPDs. Although an earlier study identified predictors of the use of HPDs, it did not use a random sample, thus limiting generalizability. The study reported here used a randomly selected population-based sample of farmers to identify factors that affect farmers' use of HPDs.

The specific aims addressed in this study were to

1. Identify the predictors of HPD use among farmers (test the Predictors of Farmers' Use of Hearing Protection Model)
2. Describe farmers' personal experiences in a) successfully becoming HPD users, and b) influencing others' use of HPDs, and c) overcoming barriers to the use of HPDs.

In summary, farmers are high-risk and underserved in relation to their hearing health, resulting in high rates of disabling levels of hearing loss in this worker group. A need exists to develop interventions to increase HPD use among farmers. This study identified the specific factors that influence farmers' use of HPDs. These factors can be used to develop a future educational intervention that can be expected to reduce the rate of NIHL among farmers.

Background and Significance

Farm work is associated with frequent exposure to high noise and a high prevalence of hearing loss (Lierle & Reger, 1958; Thelin et al., 1983; Broste, et al., 1989; Marvel, et al., 1991; Karlovich, et al., 1988; Beckett, Chamberlain, Hallman, May, Hwang, Gomez, Eberly, Cox, & Stark, 2000). NIHL occurs when the ear is repeatedly exposed to loud noise. These changes result in decreased sensitivity to environmental sounds, usually beginning with frequencies near 4,000 Hertz and later extending to other frequencies (Henderson, & Hamernik 1985). NIHL usually develops insidiously, unnoticed by the affected person until it is more advanced. Loss of hearing is irreversible and progresses with continued exposure to noise. NIHL negatively impacts the quality of life of the individual through impaired communication, reduced self-esteem, impaired ability to interact with the environment, and disruption of intimacy (Suter, 2000). Tinnitus, or ringing in the ears, often accompanies NIHL and may result in sleep

disturbance, decrease in concentration and productivity, and disruption in interpersonal relationships (Themann, 1993).

NIHL is associated with a decreased ability to detect and localize audible warning signals and increased safety risks. In a population-based interview survey of 998 farmers aged 55 and greater, Browning, Truszczynska, Reed and McKnight (1998) found that farmers with self-reported hearing loss experienced a 60% increase in risk for injury. Further, farmers who reported difficulty with hearing but did not wear hearing aids had a fourfold increased risk for injury.

Noise Exposure in Farming

Marvel (1992) estimates that approximately 328,000 farmers are exposed to potentially hazardous noise levels through many of their work activities, such as operation of tractors, grain dryers, and chain saws. The Nebraska Cooperative Extension Service (Schnieder, 1991) reported that tractor operator exposures range from 75 to 109 dBA. Themann (1993) reported sound levels (dB) of common farm situations: tractors (74-112), grain dryers (85-110), combines (85-105), chain saws (77-115), and pig squeals (82-112). Noise levels (mean decibels) of selected farming activities among participants of the New York State Farm Family Health and Hazard Survey ranged from 76 to 83 dB (Beckett et al., 2000). Although some tractor manufacturers report sound levels of less than 85 dB in new models, the average age of tractors in use is between 15 and 20 years (Murphy, 1997). Furthermore, laboratory tests of sound levels of new tractors may not accurately reflect noise exposures of farmers in actual use. These noise levels exceed the 85 dBA level considered safe by OSHA, as well as safe levels identified by NIOSH and the American Conference of Governmental Industrial Hygienists. Although there is a lack of population-based noise dose studies among farmers, the prevalence of hearing loss and noise exposure reports in this group are indicative of noise exposure in this worker group. While more research is needed to measure noise exposures and to design engineering controls to reduce such exposure, this approach is beyond the scope of the current proposal. Instead, the proposed study assumes the presence of hazardous noise and focuses on promoting the use of hearing protection in this high-risk and underserved workforce. Farm work is characterized by long workdays, particularly during peak production season, resulting in longer noise exposures together with shorter noise recovery times, thereby increasing the potential for damage to hearing. A large proportion of farmers have been exposed to farm noise exposure since childhood (Kohar, 1996), resulting in an increase in the total lifetime exposure to the effects of noise, and an earlier onset of problems associated with noise exposure (Broste, et al., 1989).

NIHL in Farmers

Compared to workers in other occupations, farmers have higher rates of NIHL. Thelin et al. (1983) found that 16% of farmers had hearing loss, compared to only 6% of a matched group of office workers. Broste et al. (1989) found that the prevalence rate of hearing loss among students involved in farming was twice that of non-farming students. Using an age and gender-matched control group, Marvel et al. (1991) found that farmers were more likely to have hearing loss than non-farmers, regardless of history of injuries, infections, and participation in noisy recreational activities. In a study of Wisconsin farmers, Karlovich et al. (1988) found that the hearing thresholds of farmers were comparable to industrial workers exposed to a 95 dBA, eight-hour, time-weighted average.

The rates of NIHL increase with age and years of experience in farming. In a study of randomly selected farmers, May (1990) found that the number of years experience in farming correlated with reductions in hearing that were not explained by confounding factors, including use of noisy recreational equipment. These findings were confirmed in a study of Iowa farmers

(Plakke and Dare, 1992), 10% of whom demonstrated a hearing handicap at age 30, progressing to 30% at age 40, and 50% at age 50. In a study of 106 male Canadian dairy farmers, Pfeiffer, Graham, Webb, Wilson, Rigington-Moss and Fisher-Ingram (1984) found that hearing thresholds were progressively higher by about four dB in each advancing decade of life.

Evidence of NIHL exists among farmers at an early age. High-frequency hearing loss characteristic of NIHL has been observed in farm children as young as 10 years (Langford et al., 1995), high school age (Broste, et al., 1989), and young adults age 20 (Karlovich et al., 1988) and age 30 (Plakke & Dare, 1992).

The quality of hearing ability studies among farmers is limited by use of non-representative samples, inconsistencies in the definition of hearing loss, lack of measurement of dose of noise received, lack of control for confounders (e.g., age, recreational noise exposure, and temporary threshold shift) and lack of longitudinally-designed studies that support causal relationships. Measurements of farmers' hearing abilities in many of the studies were also limited by non-standardized audiometric techniques. Only one study (May, 1990) specified that screenings were conducted by qualified personnel using a silent environment and an audiometer that met criteria set by the American National Standards Institute. Yet the consistency of findings across several studies over 50 years strongly suggests that hearing loss among farmers a) is greater than among non-farming age cohorts, b) follows a pattern characteristic of NIHL, and c) is associated with high noise exposures in a variety of farming tasks.

Other Factors Contributing to NIHL among Farmers

In addition to exposure to hazardous farm noise, farm work involves a variety of other risks to hearing health not commonly found in other occupations.

Worker Factors.

Because the farm workforce includes a diversity of workers (part-time farmers, seasonal hires, youth, and migrant laborers) many part-time or transient farmers may be less familiar with the farm operation and its safety procedures (including protection from noise) than stable full-time farmers. Further, the aging of the farm workforce (U.S. Department of Commerce, 1992, 1997) results in compounding the effects of NIHL with those of age-related hearing loss (presbycusis).

Off-farm Employment.

An increasing trend among farmers is to combine farming with off-farm work such a factory work that often includes noise exposure, thereby increasing the dose of noise and reducing recovery time that many farmers experience.

Lack of Regulation.

Regulations designed to protect industrial workers from the problems associated with noise exposure (e.g., OSHA Noise Standard, and OSHA Hearing Conservation Standard) are not present in the farm environment (National Coalition for Agricultural Safety and Health, 1988; Kelsey, 1991; Etherton et al., 1991, Murphy, 1997). Farmers also have greater variety in job tasks and often have economic constraints unique to their role as owner-operators. Similarly, safety programs are often weak or lacking in farm work settings due to economic constraints. As a result, farmers are less likely to have trained supervision, safety education, and worker unions on their farms to protect workers exposed to noise and other work-related hazards. For example, industrial employers often provide workers with a variety of HPDs from which to choose. Farmers working in small establishments without safety programs may not have examined the variety of hearing protection devices available or made a proper selection that fits

their various work activities. In addition, farm operators have a more active role in obtaining HPDs than most employees in industrial settings, including locating, selecting, purchasing, and making available HPDs to themselves and other farm workers.

Prevention of NIHL

The problem of NIHL has been identified as a priority by federal agencies. Healthy People 2010 (USDHHS, 2000) identified NIHL as the most common occupational disease. This consensus document includes an objective (28.18) aimed at reducing adult hearing loss in the noise-exposed public. In the National Occupational Research Agenda published by NIOSH, the problem of hearing loss was ranked as one of 21 research priorities (NIOSH, 1996). Healthy People 2010 includes a goal to reduce NIHL.

Hearing conservation programs are aimed at prevention of NIHL, halting the progression of NIHL, and identifying temporary hearing loss before it becomes permanent. The preferred method of prevention of NIHL is by reduction of noise exposure through use of engineering controls to reduce noise levels, or administrative controls to decrease exposure. Where these methods are inadequate or unfeasible, use of HPDs is recommended (NIOSH, 1996).

The effectiveness of HPDs in prevention of NIHL has been demonstrated in studies by Sataloff and Sataloff (1993), Savelle and Toothman (1987), and Hong, et al., (1998). In a study of 265 industrial workers exposed to hazardous noise over 7 to 13 years, Savelle and Toothman (1987) found essentially no change in hearing threshold among workers who used hearing protectors. Sataloff and Sataloff (1993) found that 36 employees in a noisy textile plant were protected from temporary threshold shift, despite exposure to noise levels of 89 to 104 dBA. Studying airport workers, Hong et al. found that continuous users of HPDs had significantly lower rates of hearing loss than the occasional users or nonusers.

HPD Use among Farmers

Although NIHL is preventable through the consistent use of hearing protection devices (HPDs), the results of several small studies from several geographic areas over the past decade suggest that farmers' use of this protective behavior is low (Hallet, 1987; Karlovich, et al., 1988; Broste, et al., 1989; Pytko, 1990; Langford, Zurales, & Garrett, 1995; Engstrand, 1995; Wadud, Kreuter, & Clarkson, 1998). In a study by McCullagh (2002), half of farmers reported a 0% use of HPDs, and overall percent of time of HPD use was too low (17%) to provide protection from NIHL. In all but one of these studies (Pytko, 1990), HPDs were reported as never used among a majority of farmers polled. The results of these HPD use studies are consistent with studies that show a high prevalence of NIHL in this population (Thelin, Joseph, D., Davis, W., Baker, D. & Hosokawa, 1983; Karlovich, et al., 1988; Plakke% Dare, 1992; Broste, et al., 1989). The low use of HPDs among this worker group points to a need to study this protective behavior.

Farmers are exposed to constantly changing noise hazards throughout the workday and through various seasonal periods. Therefore, their need for use of hearing protection may be variable throughout the workday and from season to season. Because most American farmers work on small family-run farms (Kelsey, 1994), the farm machinery operator may fear that use of HPDs may result in failure to hear subtle warning sounds and result in costly equipment damage and lost production time.

In surveys of farmers, factors influencing use of HPDs have been identified as male gender (Karlovich et al., 1988), practicality, and convenience (Wadud et al., 1998). Factors influencing use of HPDs have also been studied in other worker groups. Overall, several studies suggest that the following factors are predictors of HPD use across several populations of workers and using a diversity of conceptual frameworks: barriers-related factors (Ewigman, Kivlahan, Hosokawa, & Horman, 1990; Lusk et al., 1994; Melamed et al., 1996; Lusk et al.,

1997; Wadud et al., 1998), self-efficacy (Lusk, Ronis, Kerr, & Atwood, 1994; Rabinowitz, Melamed, Feiner, Weisber, & Ribak, 1996; Melamed et al., 1996; Lusk et al., 1997), and benefits of use-related factors (Lusk et al., 1994, 1997; Rabinowitz et al., 1996). Additional studies (Lusk et al., 1994, 1997) suggest that interpersonal modeling, situational influences, and personal factors may be predictors in some worker groups as well. Conclusions from several of these studies are constrained by the lack of use of conceptual models (Karlovich et al., 1988; Wadud et al., 1998), and lack of reporting of validity and reliability of instruments (Ewigman et al., 1990; Rabinowitz et al., 1996; Melamed et al., 1996; Wadud et al., 1998). Because the farmer studies were not model-based, there is a need to conduct studies designed to identify variables in predicting use of HPDs among farmers.

Interventions with Farmers

A review of several literature databases produced no published studies of effectiveness of interventions to reduce NIHL among farmers. There are few published intervention effectiveness studies addressing health behavior among farmers. In a survey of 280 Kentucky farmers, Morgan, Cole, Struttman, and Piercy (2002) examined methods of persuading farmers to adopt use of rollover protective structures. This survey found that narrative-based messages were more persuasive than statistic-based messages, consistent with similar studies in non-farmer groups by Baesler and Burgoon (1994) and Cox and Cox (2001).

Theoretical Bases for Interventions to Prevent NIHL

The usefulness of conceptual models to enhance the effectiveness of interventions to change health behavior is well recognized (Goldenhar & Schulte, 1994). Lusk, et al. (1999) have suggested that statistical analysis of predictors of the target behavior can be used as a basis for the design of an intervention.

Pender's (1996) Health Promotion Model was selected as the conceptual model for this study. Models based on the health promotion model have yielded high levels of prediction in previous studies of use of hearing protection in groups of construction and factory workers (Lusk, et al., 1994; 1997), and interventions based on the model have yielded improved levels of HPD use among factory and construction workers (Lusk, et al., 1994, 1997, 2003). The Health Promotion Model posits relationships between selected individual characteristics, cognitions, and affects to predict and explain health promoting behavior, such as exercise and stress management.

The Predictors of Farmers' Use of Hearing Protection Model

The conceptual framework for this study (Figure 1) is derived from Pender's (1996) revised Health Promotion Model and the results of previous empirical research in health protection behavior among farmers and other workers. The derived model uses selected cognitions and affects to predict and explain HPD use. A major aim of this study is to test the Predictors of Farmers' Use of Hearing Protection Model for its applicability to HPD use among farmers.

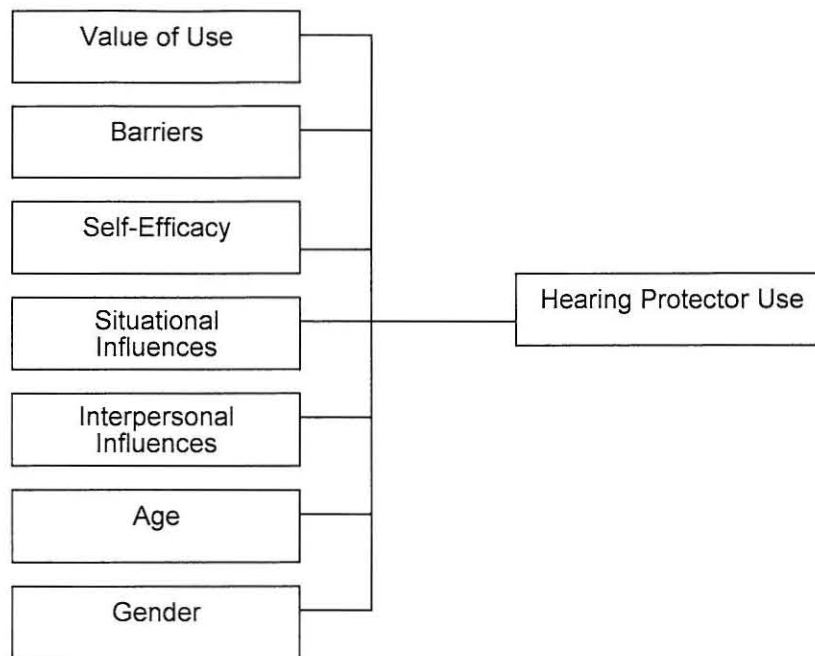


Figure 1. Predictors of Farmers' Use of Hearing Protection Model

Summary

Farmers are at high risk for NIHL, owing to their occupational exposures to hazardous noise and low use of HPDs. In addition, these high-risk workers are underserved by hearing preservation programs. A limited number of studies have examined protective behavior, and specifically HPD use among workers, including farmers. Although identified by different labels, several of the reviewed studies of protective behavior among farmers and other worker groups identified similar concepts as predictors. Several studies suggested that attitudes and beliefs (especially benefits and barriers) may serve as predictors for many of these behaviors. Limitations of these studies included the lack of use of a conceptual model and use of convenience samples. Using models of health behavior to explore the cognitive and attitudinal reasons for farmers' use of hearing protection will serve to inform future interventions aimed at increasing HPD use.

Preliminary Studies

Study 1. Study of Factors Influencing HPD Use among Farmers

A study was designed using the Pender Health Promotion Model to create and test instruments to measure cognitive and attitudinal factors affecting farmers' use of HPDs. Existing instruments designed to measure concepts from the Health Promotion Model among workers in industry and construction were modified for use with farmers through interviews, validity testing, and reliability testing. Interviews with farmers revealed important themes underlying their use of hearing protection, and several adaptations of the parent instrument were made to accommodate unique features of farm work (e.g., workers' ownership of the business, lack of hierarchical organizational structure, transient noise exposure, and exposure to weather).

Following a process of initial testing and further instrument modification, the resulting scales were used with a convenience sample of 139 farm show participants. The relationships of HPD use predictor scales to HPD use were in the expected direction, lending support to the validity of the scales. The scales did not exhibit ceiling or floor effects, and internal consistencies of most scales (Benefits of Use, Barriers to Use, Self-Efficacy of Use, and Interpersonal Influences on Use) were in the acceptable range (alpha coefficient $>.70$). Alpha coefficient for the situational influences scale was slightly lower, at $.64$. Regression analysis using the model generated in the study explained 48% of the variance in HPD use in the sample.

Use of the scales in the Farmers' Use of Hearing Protection Model identified three concepts (interpersonal support, barriers, and situational influences) as statistically significant ($p<.05$) predictors of HPD use, correctly predicting 77% of the cases. The results of this study, together with previous research (Melamed et al., 1996; Rabinowitz et al., 1996; Wadud et al., 1998; Lusk et al., 1994, 1997; Parrot et al., 1996; Peterson et al., 1994), suggest that these concepts are important factors affecting workers' HPD use.

The small, nonprobability convenience sampling approach used in this study limited the generalizability of results. Farmers who participated in the study may be more likely to be those who felt concern or interest in their hearing, resulting in a bias toward favorable attitudes about HPD use. Level of HPD use was measured by self-report, and may be subject to recall and social desirability biases. However, based on the low reported use and non-use, there is little concern about a social desirability effect. Further, a previous study by Lusk, Ronis, and Baer (1995) showed that blue-collar workers' self-reported use of HPDs was highly correlated with observed use. Among farmers, self-report can be expected to be at least as valid due to the absence of demand characteristics found in industrial settings.

Study 2. Examination of Feasibility of Alternative Hearing Screening Methods

The National Institute for Deafness and Communication Disorders developed a functional ability questionnaire to assess people's need for medical examination of their hearing. While the use of a self-administered questionnaire may offer a simple, low-cost opportunity to assess the hearing health of farmers, the validity of this questionnaire was not established. A study by McCullagh (2002) compared the results of audiometric screening and the NIDCD questionnaire in identifying hearing impairment. Data were collected from 103 farmers at a regional farm show. In this study, the 10-item questionnaire had an overall internal consistency reliability of $.85$ as measured by Cronbach's alpha. In a multiple regression analysis, only 2 of the 10 questionnaire items were good predictors of hearing loss, but the shortened 2-item questionnaire had low sensitivity (42%), suggesting that the questionnaire would not identify many respondents with hearing loss. Farmers participating in the study showed high rates (43%) of hearing loss. Results of this study do not support the use of a screening questionnaire and affirm the need to provide hearing health services to this worker group, including prevention education and screening audiometry alone or in conjunction with a functional ability questionnaire.

Importance of Findings for Proposed Study

The previous studies provide essential foundation for the proposed study. The Farmers' Hearing Protection Study demonstrated the validity of instruments for use in the proposed study and the feasibility of conducting a similar study with a random sample of farmers. The results of the Alternative Screening Methods Study affirm the high rate of hearing loss in this population and the accompanying need for hearing conservation services for this high-risk worker group. Conducting the proposed study with a random sample will allow generalizability of results, build

on the earlier identification of factors relevant to HPD use in this worker group, and gain input from farmers about ways to influence farmers' use of HPDs.

Design and Methods

This cross-sectional study was conducted in two phases:

- 1) telephone surveys to a random sample of Midwest farmers to identify factors related to farmers' use of hearing protection by testing the Farmers' Use of Hearing Protection Model. This phase of the study resulted in a hypothesized model of HPD use among farmers.
- 2) a series of interviews with a purposive sample of farmers to explore personal experiences of HPD use among farmers.

Phase 1. Identification of Predictors of HPD Use

Setting and Sample.

Prior to the collection of data, procedures for collection of data using telephone interviews were reviewed and approved by the researcher's university IRB. After obtaining informed consent, scales were administered to a group of farmers by telephone. Participants who were younger than age 18, did not speak English, and were active in farming operations fewer than 20 hours per week were excluded.

Power Analysis/Selection of Sample Size. The sample size for this study (750) was selected by a trade off between statistical power and logistic difficulties including cost based on power analyses using methods of Cohen (1988). The research design included oversampling of Hispanics and racial minorities; analyses will adjust for this oversampling. Although the data collection organization has had response rates of up to 86%, we have assumed a response rate of 70%, which is more typical of surveys. The survey design is an attempt to survey 650 whites (yielding 346 males and 109 females) and to oversample Hispanics and racial minorities, attempting to survey 100 (and achieving samples of 53 males and 16 females per group). The result is a sample of over 64 per group for males, females, Hispanics, and ethnic minorities. This will provide more than 80% power to compare these groups to others by chi-square tests of association or t-tests (Cohen, 1988) to detect medium sized effects of group. Note that the power is equivalent when testing medium-sized effects using either dichotomous or continuous measures.

Variables and Instruments.

The variables for the study are based on the Farmers' Use of Hearing Protection Model and include cognitive and affective factors that are specific to the behavior of HPD use. The instruments measuring the concepts from the theoretical model, together with their corresponding reliability coefficients and correlations with HPD use in the convenience sample of 167 farmers are described in Table 1. Internal consistency for each scale is reported using Cronbach's alpha and by theta coefficients. Theta is a special case of Cronbach's alpha (Carmines & Zeller, 1979). Development of these scales included pretest, revision, and review for construct validity by an expert panel (McCullagh, 2002).

Table 1. Scale Means, Standard Deviations, Coefficients Alpha, Theta, and Correlations with HPD Use (n=167)

	Mean	SD	Alpha	Theta	Pearson r
HPD Use ^a	17	27	b	b	b
Barriers ^c	3.07	.81	.87	.89	-.56**
Value of Use ^d	86	14	.83	.85	.08
Self-Efficacy ^c	2.60	.63	.72	.76	.14
Situational Influences ^c	3.12	1.03	.64	.66	.36**
Interpersonal Norms ^e	2.30	.44	.73	.75	.01
Interpersonal Modeling ^f	2.18	.73	.64	.68	.33**
Interpersonal Support ^g	1.43	.42	.72	.73	.34**

**p<.01. ^a percent of time of use (0-100); ^b not measured; ^c Rating scale (1=strongly disagree; 6=strongly agree); ^d Visual analog scale (0-100). ^e Rating scale (1=not at all; 3=a lot) ^f Rating scale (1=never; 4=usually). ^g Rating scale (1=never; 3=often).

Behavior-Specific Cognitions and Affects

Perceived Barriers to Action ("Barriers") are imagined or real preconceptions concerning the unavailability, inconvenience, expense, difficulty, or time-consuming nature of a particular action (Pender, 1996, p. 69). The instrument to measure farmers' barriers to use of hearing protection was derived from one used by Lusk et al (1997) to measure this concept among factory workers. The 13-item, 6-point rating scale had an internal consistency (alpha coefficient) of .87 and was significantly and negatively related to HPD use in a previous study of farmers (McCullagh, 2002).

Perceived Benefits of Action (Benefits) are mental representations of the positive or reinforcing consequences of a behavior. Benefits of HPD use will be measured using the Value of Use of Hearing Protection Scale. The Value of Use Scale was derived from one by Lusk and colleagues for use with factory (Lusk et al., 1994) and construction workers (Lusk et al., 1997). The scale consists of five visual analog items designed to measure the degree of importance of such concepts as "keep out noise" and "protect my hearing." The scale had an internal consistency reliability coefficient (alpha) of .83 and was positively related to HPD use in a previous study of farmers (McCullagh, 2002).

Perceived Self-Efficacy is a "judgment of personal capability to organize and execute a particular course of action" (Pender, 1996). The Self-Efficacy in Use of Hearing Protection Scale consists of a 6-item, 6-point rating scale derived from one developed by Lusk et al. (1994). In a previous study of farmers (McCullagh, 2002), the internal consistency reliability coefficient (alpha) for this scale was .72, and perceived self-efficacy was positively related to HPD use.

Situational Influences, as defined by Pender (1996), represent the individual's perception of environmental factors as they affect health behavior. The scale had an internal consistency reliability coefficient (theta) of .66 in a previous study of farmers, and was significantly and negatively related to HPD use (McCullagh, 2002). Subsequent revisions to the scale resulted in an alpha of .82 in a convenience sample of farmers.

Interpersonal Influences represent the individual's perceptions of the behaviors, beliefs or attitudes of others. Lusk et al. (1997) have operationalized this concept in three subscales: Interpersonal Norms, Modeling, and Support. The alpha coefficient for the Interpersonal

Influences Scale in the farmer sample was .78; administration of the scale showed significant and negative relationship to HPD use (McCullagh, 2002).

Individual Characteristics and Experiences

Demographic characteristics relating to farmers were collected using a form designed for this study. Items included primary product produced, occupational role, age, and gender.

Dependent Variable

Use of Hearing Protection was measured by self-report. In a study comparing the validity of observed and self-reported HPD use, Lusk and Kelemen (1993) found that self-report and observations were highly correlated (.89), suggesting that self-report is an appropriate measure of HPD use. Alternatives to self-report, such as observer or supervisor report, are not feasible in this population due to geographic dispersion and small average operation size. In addition, it was anticipated that farmers would feel even more free to report HPD non-use than the factory workers, as most farmers are not mandated to use HPDs by regulation or policy.

The Use of Hearing Protection Scale was developed for use among farmers and consists of four items reporting the percentage of time that workers 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 provides a definition of high noise. In a prior study (McCullagh, 2002), farmers reported a wide range of frequency of use and no difficulty using the instrument.

Data Collection Procedures

A representative sample of farmers for telephone surveys were randomly selected from U.S. Department of Agriculture (USDA) Agricultural Statistics Service census lists from a four-state region in the upper Midwest (Minnesota, Montana, North Dakota, and South Dakota). The USDA Statistics Service was selected for conducting telephone surveys based on its sole access to complete lists of farmers in this region, confidentiality of the farmer list, and its record of success in returning completed health surveys. Its list of farmers served as the sampling frame for this study; the sample includes adult principal farm operators who report that they normally have at least \$1000 in sales from agricultural products and their partners (others who share in decision-making for the operation). After obtaining informed consent, structured interviews were conducted using USDA Agriculture Statistics Service interviewers and computer-assisted telephone interviewing software. USDA interviewers are experienced in telephone data collection and were trained by the researcher for this project. Interviewers recorded results of surveys directly onto a microcomputer for later transfer to SPSS for analysis.

Data Analysis Procedures.

Phase I used a correlational descriptive approach to examine relationships among behavior-specific cognitions, affects, and use of hearing protection. Mean frequency of HPD use was dichotomized into non-use (0% mean use, coded zero) and ever-use (>0% mean use coded 1). Data were analyzed using SPSS to compute descriptive statistics and reliability estimates, and Stata to conduct properly weighted logistic regression analyses. Logistic regression analyses were conducted first including only those who answered 75% or more of the questions on each scale and then including those who answered 50% or more of the questions on each scale. These two analyses were conducted because in the first analysis the number of cases excluded due to missing data was substantial. This was traced to a defect in response scale wording where the response of "does not apply" was accepted but needed to be scored as missing. Both comparisons of the means and standard deviations of the two versions of each scale and comparisons of the results of these two logistic regression analyses were

very similar so only the analyses with the 75% completion rate are presented in detail. Prior to the logistic regression analysis linear regression was used just to test for collinearity among the predictors. The highest variance inflation factor (VIF) was only 1.934 so collinearity was not a problem.

Phase 2. Identification of Farmers' Personal Experiences

Setting and Sample

A purposive sample of farmers was recruited for interviews by personal contacts and displays at selected commodity and other farmer group meetings (e.g., North Dakota Farm Bureau, North Dakota Farmers Union) in Minnesota, Montana, North Dakota, and South Dakota. Participants were excluded who were younger than age 18; did not read, write and speak English; and were active in farming operations fewer than 20 hours per week. A modest cash honorarium was offered as an incentive for participation. Interviews were video recorded, and continued until interviews ceased to provide new information and informants confirmed previously identified salient points.

Data Collection Procedures

An interview guide was designed for use in this study. Semi-structured items were designed to encourage farmers to describe personal experiences in a) successfully becoming HPD users, b) influencing others' use of HPDs, and c) dealing with barriers to use of HPDs. Testing and refinement of the interview guide and video recording procedures was accomplished with a small group of local farmers. Following successful completion of this refinement phase, farmers were recruited for interviews. After obtaining informed consent, interviews were conducted by the researcher. Video recording of interviews was done by a media specialist.

Data Analysis Procedures

Video recordings of all informant interviews were transcribed for analysis by a panel consisting of the author and a second nurse-researcher experienced in NIHL prevention. The panelists extracted and coded significant statements that pertained directly to HPD use, with attention to messages that a) directly recommend actions to influence HPD use, b) implicitly suggested methods of influencing HPD use, or c) provided testimonials regarding HPD use. The panel met to resolve any discrepancies in agreement in coding and to discuss issues regarding analysis.

Results and Discussion

Phase 1

The study recruited a disproportionate probability sample of farm workers in four states (Minnesota, Montana, North Dakota, and South Dakota), oversampling females and minority group members. The survey was conducted by telephone and many producers were deselected in order to oversample by gender and ethnicity. In total 1173 households were called, but only 554 were selected and consented to participate. Twenty-two of these terminated the interview early, leaving 532 who actually completed interviews and could be included in analyses.

Predictor variables other than the demographics included Perceived Barriers to Use, Perceived Benefits of Use, Self Efficacy for Use, Availability of Hearing Protection Devices, Norms for Hearing Protector Use, Modeling of Use, and Support for Use. Each of these was assessed by a multi-item scale with reliability as shown in Table 2.

Table 2. Scales Used as Predictors of Use of Hearing Protection Devices

Scale Name	Number of Items	Range of Scores	Mean	Alpha
Barriers to Use	13	1-6	2.61	.812
Benefits of Use	5	1-10	8.88	.824
Self Efficacy for Use	11	1-6	4.43	.750
Availability of Hearing Protection Devices	11	1-6	4.07	.809
Norm for Use	4	1-3	2.33	.633
Modeling of Use	2	1-5	2.50	.493
Support for Use	4	1-3	1.41	.686

The mean age of participants was 52.1 years (SD =11.5). Years farming had a mean of 28.8 (SD=13.1). Most were men (71%; 365/516) and non-Hispanic white (85%; 439/516). When weights were applied to this analysis to counter the effects of oversampling of women and minorities these percentages came to 91% men and 98% non-Hispanic white, closely matching the distribution in the population of farmers in these four states.

On average, farmers reported use of HPDs 27.5% of the time they were exposed to high noise (SD=34.6). A majority (56.8%; 247/435) had ever used HPDs. Of these who reported ever using HPDs, their mean use when exposed to high noise was 48.5% of the time (SD=33.1).

Logistic regression analysis was conducted using Stata software predicting use of HPDs from demographics and other predictor variables while accounting for the disproportionate sampling by gender and ethnicity. To obtain good coverage of females and minority group members both of these groups had been oversampled. As anticipated, correcting for the oversampling by weighting increased the standard errors for tests in the overall sample. Results are summarized in Table 3.

Table 3. Survey Logistic Regression Results Predicting Any Use of HPDs

Any Use	Odds ratio	Linearized Std. Err.	t	p> t	[95% Conf. Interval]	
Barriers	0.44	.12	-3.01	.003*	0.26	0.75
Benefits	1.09	.16	0.55	.581	0.81	1.45
Self Efficacy	1.25	.33	0.87	.387	0.75	2.09
Availability	1.75	.38	2.60	.010*	1.15	2.67
Norm	0.87	.41	-0.29	.775	0.35	2.21
Modeling	1.26	.30	0.96	.338	0.78	2.01
Support	1.47	.67	0.84	.401	0.60	3.61
Female	0.43	.15	-2.36	.019*	0.21	0.87
Minority	0.66	.32	-0.85	.396	0.25	1.73
Age	1.00	.01	-0.30	.765	0.97	1.02

* p<.05

The logistic regression model predicting whether a person ever used HPDs while adjusting appropriately for the unequal selection probabilities was highly significant $F(10, 299) = 4.34, p<.001$. Three of the predictor variables were significant predictors of use. High perceived barriers was associated with less likelihood of using (OR=0.44, $p=.003$). High availability of HPDs was associated with higher likelihood of using (OR=1.75, $p=.010$). Females were less likely than males to use HPDs when in high noise (OR=0.43, $p=.019$). Though the obtained p values differed a bit, exactly the same effects were significant and the directions of the significant relationships were the same in analyses using more subjects by allowing a scale score based on as few as 50% of items answered $F(10, 381)=5.63, p<.001$.

Phase II

A purposive sample of adult, English-speaking farmers in North Dakota, South Dakota, and Minnesota (n=20) who reported high frequency of HPD use was selected for face-to-face interviews. Participants were recruited during a variety of trade and commodity meetings in the upper Midwest. Although recruitment of participants for on-camera interviews was anticipated to be potentially problematic, the P.I. enjoyed excellent participation with farmers. Participants who met selection criteria were passionate about their use and were eager to share their beliefs about HPD use, to be interviewed on camera, and to allow the researcher to release recordings of their interviews to researchers, farmers, and others.

Analysis of transcripts showed that farmers have frequent exposure to hazardous noise. Farmers described their motivation to adopt protective behavior as originating from their desire to prevent losing their good hearing, to prevent extension of their hearing loss, or to avoid the annoyance of loud noise. Many reported insight into the experience of living with hearing loss through their experience with a close family member or other farmers who have experienced NIHL, or having become aware of their own hearing loss. Many farmers were motivated to use HPDs in an effort to avoid a future of living with the negative consequences of NIHL, especially loss of communication ability and tinnitus. Many farmers reported trying to influence others' use of HPDs, particularly their children and other family members, through verbal persuasion and providing a supply of HPDs for their use. These farmers have developed a variety of methods to assure convenient access to HPDs when they are needed, and have developed effective techniques for overcoming common barriers to protection. A summary of codes generated by the analysis of the transcripts appears in Table 4.

Table 4. Interview Analysis: Code Compilation

1) Our jobs are loud	3) How I manage
a) Demo	a) This works for me
b) Products	i) Strategies: on hand
c) Noise	ii) My use: plugs
d) Recreational noise	iii) My use: muffs
2) Noise and hearing	iv) Access
a) I use hearing protection	v) Buying them
i) Acknowledge use	b) Barriers? What barriers?
ii) Induction	i) Barriers: general
b) How did that happen?	ii) Barriers: communication
i) Influence: role models	iii) Barriers: equipment sounds
ii) Influence hearing loss	c) Our future
(1) Mine	i) Too late smart
(2) Others	ii) Value
iii) Influence benefits	4) Other codes
iv) Influence annoyance	a) Warnings
v) Influence: other	b) Futility
vi) Influence I did it myself	c) Benefits
c) Pay it forward	d) Barriers
i) My influence	e) Values
ii) My family	f) Situational influences
iii) My kids: concern for youth	g) Interpersonal influence
iv) My employees	

Conclusions

The study identified factors that affect farmers' use of HPDs. This information will be useful in identifying learning needs, and in designing general and tailored, model-based nursing interventions to increase hearing protector use among farmers. It is expected that the effectiveness of future interventions can be enhanced by selecting the most relevant factors that have been shown to influence HPD use among groups of farmers, and focusing on these as targets for change. Increasing farmers' use of hearing protection can be expected to maintain normal levels of hearing, preserve hearing among farmers who have already experienced NIHL, and reduce the proportion of farmers experiencing NIHL at each age level. Resulting improvement in hearing protector use and hearing health can be expected to contribute to improved safety and quality of life among farmers.

Compared to a previous study using a convenience sample, use in the previous sample was slightly lower (17%), and significant predictors differed slightly (i.e., interpersonal influences, barriers, and situational factors).

This study also described farmers' personal experiences in successfully becoming HPD users, influencing others' use of HPDs, and overcoming barriers to the use of HPDs. Video recordings of farmers' own reports of these personal experiences were created. This information will provide input into the design of, as well as serve as a potential source of, personal testimonials for a future educational program designed to increase HPD use among farmers.

Publications

Peer Reviewed Articles

McCullagh, M. & Robinson, C. [in review]. Too late smart: Farmers' adoption of self-protective behavior in response to exposure to hazardous noise. *AAOHN Journal. Reports on the results of the interviews of farmers' experiences as users of hearing protection.*

McCullagh, M. & Ronis, D. [in review]. Predictors of use of hearing protection among a representative sample of farmers. *Nursing Research. Reports on the results of the results of model testing to identify predictors of farmers' use of hearing protection.*

Proceedings

McCullagh, M. [2008]. Using Client Narratives to Understand Adoption of Self-protective Behavior. Healthy People for the Healthy World, Bangkok, Thailand, June 25-27, 2008. *Reports on generation and analysis of videotaped interviews with persons who have adopted a health behavior.*

Abstracts

McCullagh, M. [2008]. Adoption of self-protective behavior among US farmers. American Public Health Association Annual Meeting, San Diego, CA, November, 2008. *Reports on motivations, influencing behavior, and overcoming barriers to hearing protector use.*

McCullagh, M. & Robertson, C. [2008]. Too late smart: Farmers' adoption of self-protective behavior in response to exposure to hazardous noise. MNRS 2008 Annual Conference, Indianapolis, Indiana. *Reports on results of analysis of videotaped interviews and insights into overcoming barriers and influencing others' use of hearing protection.*

Inclusion of Gender and Minority Study Subjects

Enrollment by Ethnic and Racial Categories

Ethnic Category	Females	Males	Unknown Gender	Total
Hispanic/Latino	2	4	0	6
Not Hispanic or Latino	145	353	0	498
Unknown ethnicity	7	11	10	28
Ethnic Category: total of all Subjects	154	368	10	532
Racial Categories				
American Indian/Alaska Native	17	41	0	58
Black or African American	0	1	0	1
White	128	311	0	439
Unknown	9	15	10	34
Racial Categories: total of All Subjects	154	368	10	532

Inclusion of Children

This study included persons under the age of 21 who meet the inclusion criteria of having at least \$1000 of income from farming. Persons under the age of 18 were excluded, owing to challenges of obtaining parental consent for participation by telephone.

Materials available for other investigators

Aggregate quantitative data resulting from this study, as well as videotaped interviews with selected farmer-participants are available to be shared with other investigators. This material is accessible by contacting the principal investigator.

Final Financial Status Report

A Final Financial Status Report is submitted separately by

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Final Invention Statement and Certification

A Final Invention Statement and Certification (HHS-568) is submitted separately by

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