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Predictors of Use of Hearing Protection Among a Representative Sample of Farmers

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Abstract: Farmers experience higher rates of noise-induced hearing loss (NIHL) than workers in most other industries. We developed a model of farmers' use of hearing protection, and tested it with a random sample ($n = 532$) of farmers from the upper Midwest. Barriers to using hearing protection (e.g., difficulty communicating; $OR = .44$, $p < .003$) were negatively related to use. Greater access/availability of hearing protectors ($OR = 1.75$, $p < .010$) and male gender ($OR = .43$, $p < .019$) were positively related to use. The model correctly predicted use of hearing protection for 74% of the cases. Overall, farmers demonstrated low hearing protector use, and results were similar to those from previous studies of non-farm workers. Findings from this study will be useful in designing interventions to increase farmers' hearing protector use and decrease their rates of NIHL. Res Nurs Health 33:528–538, 2010

Keywords: hearing loss; agriculture; prevention and control; noise

Farmers are exposed to hazardous noise from equipment and livestock. They experience higher rates of noise-induced hearing loss (NIHL) than their non-farming age cohorts (Hwang et al., 2001) and have a higher prevalence of hearing loss than workers in most other industrial sectors (Tak & Calvert, 2008). Although use of hearing protection devices (HPDs) is effective in preventing NIHL (National Institute for Occupational Safety and Health [NIOSH], 2009), the use of HPDs among farmers is low (Carruth, Robert, Hurley, & Currie, 2007; Gates & Jones, 2007; Jenkins, Stack, Earle-Richardson, Scofield, & May, 2007; Schenker, Orenstein, & Samuels, 2002).

BACKGROUND AND SIGNIFICANCE

NIHL is irreversible and progressive with continued exposure to noise, negatively influencing people's quality of life through impaired communication, reduced self-esteem, impaired ability to interact with the environment, disruption of intimacy, and tinnitus (Carruth et al., 2007; Suter, 2001). The problem of NIHL has been identified as a priority by federal agencies and programs, including *Healthy People 2010* (United States Department of Health and Human Services, 2000) and NIOSH (1996).

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Noise Exposure and Hearing Loss Among Farmers

Farm work is associated with a high prevalence of hearing loss and hearing handicap. A large proportion (72%) of a representative sample of 185 farmers in New York State demonstrated high frequency hearing loss (Beckett et al., 2000). Over one-third (38%) of a convenience sample of farmers from Michigan had a hearing handicap, as determined by the Self-Assessment of Communication hearing handicap scale (Stewart, Scherer, & Lehman, 2003). This handicap could have been caused by exposure to noise or other ear problems.

Many common farm tasks involve exposure to high noise. Beckett et al. (2000) measured mean noise levels of several common farm tasks and found them to be above 85 decibels, which is considered by NIOSH to be hazardous. Based on National Health and Nutrition Examination Survey data, Tak, Davis, and Calvert (2009) estimated that 1.5 million workers in agriculture are exposed to hazardous noise.

Hearing Protector Use Among Farmers

Although NIHL is preventable through the consistent use of HPDs (NIOSH, 2009), the results from several studies from various geographic areas suggest that HPDs are rarely or never used by a majority of farmers (Carruth et al., 2007; Gates & Jones, 2007; Jenkins et al., 2007). The relationship between noise exposure and HPD use among farmers is not known.

McCullagh, Lusk, and Ronis (2002) identified several predictors of HPD use in a convenience sample of farmers from a farm trade show in the upper Midwest. Factors found to positively and significantly influence use of hearing protection included interpersonal influences (e.g, norms, modeling, and support for use), and access/availability. Access/availability includes convenience and access, as well as the presence of reminders to use hearing protection. Perceived barriers to hearing protector use (e.g., fear of not hearing equipment sounds and difficulty communicating with co-workers) were negatively and significantly related to hearing protector use. Although the study results helped to identify predictors for using HPDs, the use of a convenience sample limited generalizability of the findings.

Factors influencing the use of HPDs have also been studied in other worker groups, including factory and construction workers. Although NIHL and low use of HPDs remains problematic, the most recent studies of factors influencing the use of HPDs are now more than a decade old. The small number of studies on this topic in the past 10 years exposes the need for studies examining predictors of hearing protector use.

The following factors have been found to be predictors of HPD use across several populations of workers using multiple conceptual frameworks. Workers who did not perceive barriers (e.g., interference of HPDs with work tasks) reported higher use of HPDs (Lusk, Ronis, & Hogan, 1997; Ronis, Hong, & Lusk, 2006; Wadud, Kreuter, & Clarkson, 1998). A positive relationship was found between HPD use and self-efficacy (Lusk, Ronis, & Hogan, 1997; Melamed, Rabinowitz, Feiner, Weisberg, & Ribak, 1996; Rabinowitz, Melamed, Feiner, Weisberg, & Ribak, 1996). Lusk, Ronis, and Hogan (1997) also found that, when workers perceived the use of HPDs as having benefits, such as prevention of NIHL and protection of their inner ear, they had higher rates of HPD use. Findings from other studies suggest that use of hearing protection by others (such as co-workers and supervisors), availability of hearing protection, and personal factors such as influence of supervisors and co-workers may be predictors in some worker groups as well (Lusk, Ronis, Kerr, & Atwood, 1994; Ronis et al., 2006). Additional factors found in other studies of factors influencing farmers' use of HPDs include perceptions of practicality, convenience (Wadud et al., 1998), and concern about the stress that hearing loss would exert on family (Gates & Jones, 2007). Overall, barriers and self-efficacy were found to be predictors of HPD use among workers in most studies; fewer researchers found other factors (such as perceived benefits of HPD use, availability of HPDs, and influence of supervisors and other workers) to be predictive.

The prevalence of high noise exposure among farmers and low use of HPDs are consistent with the high rates of NIHL in farmers. Together, these factors pointed to a need to study use of hearing protection among farmers. The purpose of this study was to identify the predictors of HPD use among a population-based, randomly selected sample of farmers in the upper Midwest.

Theoretical Bases for Interventions to Prevent Noise-Induced Hearing Loss

The conceptual framework for this study (Fig. 1) was derived from two sources: Pender, Murdaugh,

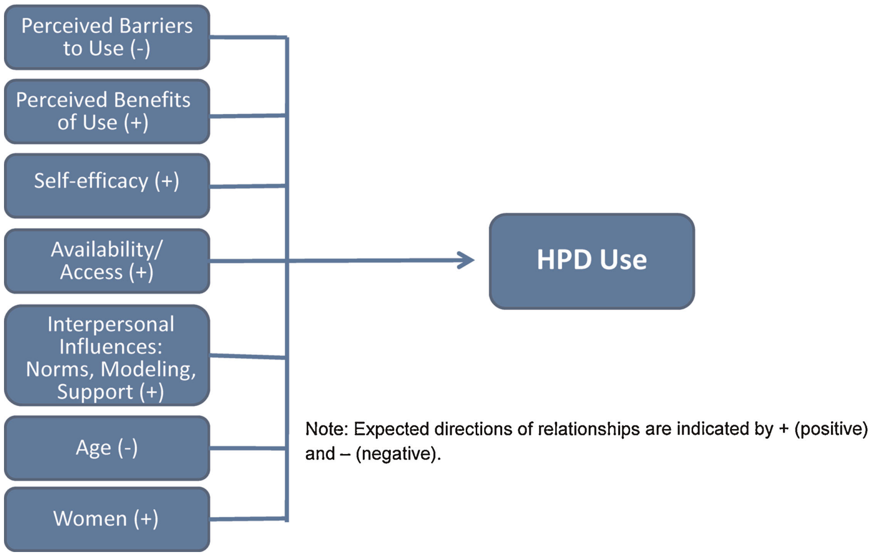

FIGURE 1. Predictors of farmers' use of hearing protection model.

and Parsons' (2010) revised health promotion model, and the results of previous empirical research about health protection behavior among farmers and other workers (Lusk, Ronis, & Hogan, 1997; McCullagh et al., 2002). The health promotion model uses selected attitudes and beliefs such as perceived barriers, perceived self-efficacy, and interpersonal factors (such as norms, modeling, and support of others) to predict and explain health behavior. Our predictors of farmers' use of hearing protection model (McCullagh et al., 2002) builds on work by Lusk and colleagues, who used Pender's model to develop a model of use of hearing protection among factory workers (Lusk et al., 1994).

Our model (McCullagh et al., 2002; Fig. 1) includes the attitudes and beliefs hypothesized to influence HPD use among farmers. The following concepts were predicted to have relationships to use: (a) perceived barriers to the use of HPDs, (b) perceived benefits of use of HPDs; (c) self-efficacy of use of HPDs; (d) access/availability of HPDs; (e) interpersonal influences, specifically, perceptions of norms, modeling, and support for use of HPDs by other farmers and family members; (f) age, and (g) gender. Model concepts predicted to have a negative relationship to use include barriers and age; perceived benefits of use, self-efficacy, access/availability, interpersonal influences, younger age, and female gender were all predicted to have a positive influence on use.

The farmers' use of hearing protection model performed well in a previous study using a convenience sample of farmers from a farm trade show in the upper Midwest (McCullagh et al., 2002), predicting 78% of the variance in HPD use. To expand understanding about the use of HPDs, the farmers' use of hearing protection model was tested in the study reported here using a randomly selected representative sample of farmers.

RESEARCH DESIGN AND METHODS

Setting and Sample

The study was approved by the relevant university institutional review boards and the U.S. Department of Agriculture (USDA) National Agricultural Statistics Service. To identify a sample for survey, we used the USDA census lists of farmers from a four-state region in the upper Midwest (Minnesota, Montana, North Dakota, and South Dakota). The lists include gender, race, and ethnicity data; those data were used to design the sampling frame for this study (USDA, 2009). The USDA has sole access to complete lists of farmers in this region.

The sample of farmers for this study was randomly selected from the USDA list, with over sampling for women, non-whites, and Hispanics. This sample included adult resident farmers who reported normally having at least $1,000 in sales from agricultural products. As most farming operations in the United States are family-owned and operated, household members who were active in farm production were also eligible for inclusion in the study. Consequently, the sample included farm owners or farm household members active in farming. The participating states were selected based on similarity of agricultural profile, including products, production methods, and types of farm ownership. Primary farm products of this region include grains, row crops (e.g., corn, soybeans, and potatoes), and beef cattle. Production of these farm products is accomplished primarily through technology and mechanization, rather than labor-intensive hand-picking methods required for some other crops (e.g., apples, cucumbers, peaches).

Data collectors telephoned 1,173 farm households from the population of 171,064 farmers in the database. These data collectors administered the 65-question survey to those farmers who agreed to participate. This sample size was based on the goal of retaining at least 500 participants and having at least 80% power to detect an odds ratio of 2 (considered medium large) in a logistic regression analysis, controlling for other predictors with a squared multiple correlation of up to .3 with the focal predictor. A relatively large proportion of contacted farmers did not meet eligibility criteria, primarily due to spending fewer than 20 hours per week in production. When we screened the potential participants we discovered that many farmers listed in the National Agricultural Statistics Service database derived their farm income from renting land or from government conservation programs, rather than producing farm products. Of the 1,173 farm households contacted, 43% did not include a household member who met eligibility criteria, leaving 664 (57%) eligible. Of those households with an eligible farmer, 554 (83%) agreed to participate (110 persons or 17% refused). A total of 22 participants did not respond to all questions posed by the data collectors, leaving 532 surveys for analysis. Of these, 309 respondents answered 75% or more of the survey questions, and 391 answered 50% or more of the questions.

Variables and Instruments

The following instruments were used to measure the concepts from the theoretical model: (a) Farmers' Perceived Barriers to HPD Use, (b) Farmers' Perceived Benefits of HPD Use, (c) Farmers' Self-Efficacy of HPD Use, (d) Farmers' Access/Availability of HPDs, (e) Farmers' Interpersonal Norms Influencing HPD Use, (f) Farmers' Interpersonal Modeling of HPD Use, and (g) Farmers' Interpersonal Support for HPD Use. These instruments, together with their corresponding Cronbach's α coefficients in the current sample, are described in Table 1. As detailed elsewhere (McCullagh et al., 2002), development of these instruments included pretesting, revisions, and review for content validity by an expert panel.

Reliability estimates for five of the instruments using Cronbach's α coefficients were .70 or above, a reliability estimate that is considered to be satisfactory for beginning research (Devellis, 2003). However, the Farmers' Interpersonal Norms ($\alpha = .63$), Interpersonal Modeling ($\alpha = .49$), and Interpersonal Support for HPD Use ($\alpha = .69$) instruments had α coefficients of less than .70.

Independent variables: Behavior-specific attitudes and beliefs. Perceived barriers to action are imagined or real preconceptions concerning the inconvenience, expense, difficulty, or time-consuming nature of a particular action (Pender et al., 2010). The Farmers' Perceived Barriers to Use of HPDs instrument was derived from an instrument used to measure perceived barriers to HPD use among factory workers (Lusk, Ronis, & Hogan, 1997). The instrument consists of a 13-item, 6-point Likert scale. The scale response options included *strongly agree*, *moderately agree*, *slightly agree*, *strongly disagree*, *moderately disagree*, and *slightly disagree*. An even number of response items was purposefully chosen to avoid neutral responses. A sample item from this scale is, "Wearing hearing protectors interferes with getting my farm tasks done." This item was significantly and negatively related to HPD use in a previous sample of farmers (McCullagh et al., 2002).

Perceived benefits of using HPDs are mental representations of the positive or reinforcing consequences of a behavior (Pender et al., 2010). This concept was measured using the Farmers' Perceived Benefits of Use of Hearing Protection instrument. This instrument was derived from similar instruments by Lusk et al. (1994) for use with factory and construction workers (Lusk, Ronis, & Hogan, 1997). The Farmers' Perceived Benefits of Use of Hearing Protection instrument consists of five-items (e.g., "keep out noise" and "protect my hearing") rated on a 10-point Likert scale ranging from *slightly important* to *highly important*. The scale was positively related to HPD use in a previous sample of farmers (McCullagh et al., 2002).

Perceived self-efficacy is evaluation of ability to organize and carry out a particular course of action

Table 1. Instrument Means, Standard Deviations, and Alpha Coefficients

Instrument	Number of items	Range of scores (actual)	Alpha coefficient[a]	Mean for total group[b]	*SD*	Users of HPDs mean scores	Non- users of HPDs mean scores
HPD use[c]	4	0–100	.89	27.50	34.63	48.5	0
Barriers to HPD use[d]	13	1.0–5.6	.81	2.61	0.81	2.37	3.01
Benefits of use of HPDs[e]	5	1.0–10.0	.82	8.88	1.29	9.12	8.49
Self-efficacy of HPD use[f]	11	1.8–6.0	.75	4.43	0.81	4.57	4.06
Availability of HPDs[g]	11	10.0–6.0	.81	4.07	1.12	4.47	3.44
Interpersonal norms influencing HPD use[h]	4	1.0–4.0	.63	2.33	0.45	2.42	2.26
Interpersonal modeling of HPD use[i]	2	1.0–4.0	.49	2.50	0.80	2.69	2.19
Interpersonal support for HPD use[i]	4	1.0–3.0	.69	1.41	0.42	1.52	1.31
Age	1	22.0–84.0	[k]	52.81	11.51	51.57	52.71
Gender[l]	1	[k]	[k]	[k]	[k]	[k]	[k]

[a]Alphas based on current study, $n = 532$.
[b]Scale means were computed as means of the items (with reverse scoring as appropriate).
[c]HPD = Farmers' hearing protection device (HPD) use scale; percent of time of use (0–100); 43.2% report zero use; 56.8% report some use.
[d]Farmers' barriers to HPD use rating scale (1 = *strongly disagree*; 6 = *strongly agree*).
[e]Farmers' benefits of HPD use rating scale (1 = *slightly important*; 10 = *highly important*).
[f]Farmers' self-efficacy of HPD use rating scale (1 = *strongly disagree*; 6 = *strongly agree*).
[g]Farmers' availability of HPD rating scale (1 = *strongly disagree*; 6 = *strongly agree*).
[h]Farmers' interpersonal norms for HPD use rating scale (1 = *not at all*; 3 = *a lot*).
[i]Farmers' interpersonal modeling of HPD use rating scale (1 = *never*; 4 = *usually*).
[i]Interpersonal support for use rating scale (1 = *never*; 3 = *often*).
[k]not applicable to this scale.
[l]Males were more likely to use HPDs than females.

(Pender et al., 2010). The Farmers' Self-Efficacy of HPD Use instrument consisted of a six-item, 6-point rating scale derived from the scale developed by Lusk et al. (1994). Response scale options were *strongly agree* to *strongly disagree*. A sample item from this scale reads, "I know how to use my hearing protection so that it works effectively." In a previous sample of farmers (McCullagh et al., 2002), perceived self-efficacy was positively related to HPD use.

Situational factors, as defined by Pender et al. (2010), represent the individual's perception of environmental factors affecting health behavior. The seven-items composing the related Access/Availability scale include measures of the convenience and availability of the hearing protector supply; they are rated using a 6-point scale with response scale options of *strongly agree* to *strongly disagree*. A sample item from this scale reads, "The supply of ear plugs on the farm is not close to where they are needed." (This sample item was reverse scored, so that higher scores on the instrument indicated greater availability and access.) The Farmers' Access/Availability of HPDs instrument was significantly and positively related to HPD use in a previous sample of farmers (McCullagh et al., 2002).

Interpersonal influences on health behavior represent the individual's perceptions of other peoples' behaviors, beliefs, or attitudes regarding the use of HPDs. Lusk, Ronis, and Hogan (1997) operationalized and tested this concept using three subscales: Interpersonal Norms, Interpersonal Modeling, and Interpersonal Support. The three interpersonal instruments—Norms, Modeling, and Support—used in the current study showed positive relationships to HPD use in a previous sample of farmers (McCullagh et al., 2002). The three subscales (Interpersonal Norms, Modeling, and Support) were included in the analysis as separate variables in the study.

Interpersonal norms include the respondents' beliefs about how much other people (e.g., family members, friends, co-workers) think the respondents should wear hearing protection. The Farmers' Interpersonal Norms for HPD Use instrument used a four-item, 3-point scale to measure this concept. A sample item from this scale is, "How much do you believe other farmers think you should wear hearing protection when you are in a high-noise work environment?'' The scale response options were *not at all*, *sort of*, and *a lot*.

Interpersonal modeling is how much respondents believe that family members and other farmers use hearing protection when exposed to noise. The Farmers' Interpersonal Modeling of HPD Use instrument consisted of a two-item, 4-point scale. A sample item from this scale is, ''How much do you think other farmers wear hearing protection when exposed to high noise?'' The scale response options were *never*, *usually not*, *about half the time*, and *usually*.

Interpersonal support refers to encouragement or praise from family, friends, co-workers, and supervisors about the respondents' use of hearing protection. The Farmers' Interpersonal Support for HPD Use instrument consisted of a four-item, 3-point scale. A sample item from this scale is, ''How much do other farmers encourage or praise your use of hearing protection?'' The scale response options were *never*, *sometimes*, and *often*.

Dependent variable: HPD use. Use of hearing protection was measured by self-report. In a study of construction workers, there was a 92–99% concordance between observed and self-reported HPD use (Griffin, Neitzel, Daniell, & Seixas, 2009), suggesting that self-report is an appropriate measure of HPD use. Further, based on the low reported use of HPDs among samples of farmers (Carruth et al., 2007; Gates & Jones, 2007; Jenkins et al., 2007), there was little concern about a social desirability effect. Among farmers, self-report can be expected to be at least as valid due to the absence of demand characteristics found in industrial settings, such as mandates, policies, and regulations for use.

The Farmers' Use of Hearing Protection instrument was developed expressly to be used with farmers and consisted of four items to reflect the percentage of time that farmers reported using hearing protection when they were exposed to high noise at selected farm work settings: in the field, in the shop, with livestock, and at the grain-handling system. The instrument defined high noise as present whenever someone had to raise his or her voice to be heard by another person at a distance of 3 feet or less (Lusk et al., 1999). Hearing protection use was described as using hearing protectors, such as ear plugs or muffs. In a prior study (McCullagh et al., 2002), farmers reported a wide range of use of hearing protection and experienced no difficulty using the instrument. In this study, the instrument was scored as the average percentage among settings in which the worker reported being exposed to high noise.

Individual characteristics and experiences. Information regarding demographic characteristics of farmers was collected using questions designed for this study. Items included age, ethnicity, gender, primary product produced, farming role (e.g., operator, full time or part time paid employee), years experience in farming, and gender.

Data Collection Procedures

Farmers were recruited for participation by telephone. The surveys were administered by specially trained USDA National Agriculture Statistics Service data collectors using computer-assisted telephone interviewing software, which guides the data collector through a carefully constructed survey algorithm based on participant responses. The data collectors were experienced in this method, and each demonstrated the ability to use the survey guide in a practice session prior to data collection.

Calls were placed to selected telephone numbers in the National Agriculture Statistics Service database, usually a farm residence. Data collectors asked to speak with the farmer associated with the telephone number; if this person was not available, then the data collector asked to speak with another household member (another farmer) who met study inclusion criteria. Only one farmer per residence was selected for inclusion. Persons who were younger than age 18, did not speak English, or were active in farming operations fewer than 20 hours per week were excluded. No potential participants were excluded base on the requirement to speak English; this was probably due to the very small population of non-English speaking residents in this region (CensusScope, n.d.). As an incentive for participation, four $50 retail gift certificates were awarded via a lottery; gift recipients were randomly selected from the list of participants who completed the full survey.

After screening for inclusion criteria and obtaining informed consent, data collectors asked farmers the questions from the instruments. Questions about HPD use were preceded by questions about attitudes and beliefs about HPD use. These questions were followed by demographic questions and an opportunity to provide additional comments about HPD use.

Data Analysis

A correlational, descriptive design was used to examine relationships among behavior-specific attitudes, beliefs, and use of hearing protection. Due to the highly skewed distribution of HPD use, linear regression analysis techniques were not appropriate. Consequently, mean frequency of HPD use was dichotomized into non-use (0% mean use, coded zero) and ever-use (> 0% mean use, coded 1), and data were analyzed using logistic regression. SPSS (version 16) was used to compute descriptive statistics and reliability estimates, and Stata (version 9) was used to conduct properly weighted logistic regression analyses, accounting for the oversampling of women, non-whites, and Hispanics.

Prior to the logistic regression analysis, linear regression was used to test for collinearity among the predictors. The highest variance inflation factor (VIF) was only 1.934. The possible range of the VIF is from one to positive infinity; a value of less than five indicates no collinearity (Kutner, Nachtsheim, & Neter, 2004). Initially, logistic regression analyses were conducted including only those respondents who answered 75% or more of the questions on each instrument, resulting in the exclusion of 126 cases. Due to the substantial number of cases excluded in this analysis, a second analysis was conducted including those individuals who answered 50% or more of the questions on each scale, resulting in the exclusion of 44 cases. The large amount of missing data was traced to response scale wording. We allowed a *does not apply* response option to many items; in subsequent analyses these responses were recoded as missing, as *does not apply* could be interpreted as missing data. We regard the decision to allow the *does not apply* response as a flaw in our study that we will correct in future research. Fortunately, the similarity of the two analyses (including those who responded to 75% and 50% of scales) suggested that this factor did not have an important effect on our results.) Both the comparisons of the means and standard deviations for the two versions of each scale and the comparisons of the results for these two logistic regression analyses were very similar; only the analyses with the 75% completion rate are presented here.

RESULTS

Sample demographics are summarized in Table 2. On average, farmers reported the use of HPDs < 30% of the time when they were exposed to high noise (Table 1). Further, only 56.8% had ever used HPDs. Of farmers who reported using HPDs, their mean use when exposed to high noise was 48.5% ($SD = 33.1$). Most participants indicated that they were interested in increasing their use of HPDs.

To obtain good representation of women and minority group members, both of these groups were oversampled. When weights were applied to counter the effects of oversampling women and persons from minority groups, the distribution of men was 91% and of non-Hispanic Whites was

Table 2. Sample Demographics (Unweighted) (n = 532)

Characteristic	Mean	*SD*	*N*	%
Age (years)	52.1	11.5		
Male gender			368	69
Race				
Caucasian/White			439	83
Asian			0	0
African American/Black			0	0
American Indian			58	11
Unknown race			34	6
Ethnicity				
Hispanic			6	1
Non-Hispanic			498	94
Unknown ethnicity			28	5
Years farming	28.8	13.1		
Farm role				
Operator			454	85
Full time paid employee			11	2
Part-time paid employee			12	2
Non-paid farm worker			47	9
Acres	2,263	5,836		

98%, closely matching the population distribution of farmers in these four states. Sample demographics are summarized in Table 2. As anticipated, correcting for the oversampling by weighting increased the standard errors for tests in the overall sample.

Logistic regression analysis was conducted to predict the use of HPDs from demographics and other predictor variables while accounting for the disproportionate sampling by gender and ethnicity. Predictor variables other than the demographics were Perceived Barriers to Use, Perceived Benefits of Use, Self-Efficacy, Access/Availability, Interpersonal Norms, Interpersonal Modeling, and Interpersonal Support. Results of the logistic regression analysis are summarized in Table 3.

The logistic regression model predicting whether a farmer had ever used HPDs, adjusting appropriately for the unequal selection probabilities, was significant, $F(10, 299) = 4.34$, $p < .001$. Of the 391 cases who answered 50% or more of the questions, 74% were correctly predicted. Three of the predictor variables were significant predictors of use. High perceived barriers to use were associated with less likelihood of using HPDs ($OR = .44$, $p = .003$). A high access/availability score was associated with a higher likelihood of use ($OR = 1.75$, $p = .010$). Women were less likely than men to use HPDs when exposed to high noise ($OR = .43$, $p = .019$).

We also compared results with slightly different methods of summarizing survey item results. Although the obtained probability values differed slightly, exactly the same effects were significant, and the directions of the significant relationships were the same in analyses using more participants ($n = 391$) by allowing a scale score based on as few as 50% of items answered, $F(10, 381) = 5.63$, $p < .001$. In addition, to test the effect of dichomizing the dependent variable, we also conducted an analysis comparing just the top and bottom thirds of the use distribution. Although the sample size was reduced from 309 to 233, the same three predictors of use were found.

DISCUSSION

It is noteworthy that nearly half of study participants reported non-use of hearing protection when they were exposed to hazardous noise. Further, those farmers who reported any use of hearing protection reported a level of use (27.5%) that would not provide them protection from hearing loss. Low rates of use were also found in previous studies using convenience (Carruth et al., 2007; Gates & Jones, 2007; Jenkins et al., 2007) and population-based (Schenker et al., 2002) samples of farmers. Low use of hearing protection among this noise-exposed population remains problematic.

The findings of this study were generally consistent with other studies of HPD use among farmers and other worker groups. Barriers have been found to be predictive of HPD use in previous studies of farmers (McCullagh et al., 2002; Wadud et al., 1998) and other worker groups (Lusk, Ronis, & Hogan, 1997; Melamed et al., 1996; Wadud et al., 1998). Availability and convenience of HPDs were also found to be significant predictors in previous studies of farmers (McCullagh et al., 2002; Wadud et al., 1998) and other worker groups (Lusk et al., 1994; Lusk, Ronis, & Hogan, 1997).

There were also differences between predictors identified in our study and those found in previous reports. A significant predictor from McCullagh et al. (2002) study of farmers, interpersonal

Table 3. Logistic Regression Results Predicting Any Use of HPDs ($n = 309$)[a]

Any use	Odds ratio	Linearized *SE* of odds ratio	*t*	*p*	[95% Conf.	interval]
Perceived barriers	0.44	.12	−3.01	.003	0.26	0.75
Perceived value of use	1.09	.16	0.55	.581	0.81	1.45
Self efficacy	1.25	.33	0.87	.387	0.75	2.09
Situational influences	1.75	.38	2.60	.010	1.15	2.67
Interpersonal influences						
Interpersonal norms	0.87	.41	−0.29	.775	0.35	2.21
Interpersonal modeling	1.26	.30	0.96	.338	0.78	2.01
Interpersonal support	1.47	.67	0.84	.401	0.60	3.61
Age	1.00	.01	−0.30	.765	0.97	1.02
Female gender	0.43	.15	−2.36	.019	0.21	0.87
Minority	0.66	.32	−0.85	.396	0.25	1.73

[a]Pseudo-r-squared (Nagelkerke R square) = .343; $p < .001$.

support (a subscale measure of interpersonal influences), was not statistically significant in this study. Compared to the McCullagh et al. (2002) study, the results of the study presented here may be more representative because they are based on a larger, randomly selected, and more recent sample.

Dissimilar to previous studies of other worker groups, benefits of use (Lusk, Ronis, & Hogan, 1997), and self-efficacy of use (Lusk, Ronis, & Hogan, 1997; Melamed et al., 1996; Rabinowitz et al., 1996) were not statistically significant predictors of use (i.e., these factors did not separate users from non-users) in the study reported here. This finding suggests that even in the presence of high scores on the benefits of use and self-efficacy of use instruments, the presence of high barriers and/or low access and availability may limit the use of hearing protection among farmers. These findings provide suggestions for future revisions in the model. For example, evidence supports retaining barriers, access/availability, and gender in the model and possibly deleting age, perceived benefits of use, and self-efficacy.

Although originally created for explaining and predicting health *promoting* behaviors such as exercise and diet, in this study the Pender health promotion model served as the foundation for developing a model of health *protection*. The model performed well in this study, predicting a large (74%) variance in HPD use. This large predictive value affirms the validity of both the derived (farmers HPD use) and original (health promotion) models, and suggests the potential usefulness of the health promotion model in applications to other health protecting behaviors. Nonetheless, future refinements to the predictors of farmers HPD use model may be possible. These include model trimming as noted above, as well as results of future testing for mediation among study predictors.

Female farmers had lower rates of HPD use than their male counterparts. This result was consistent with studies of non-farmers by Tak et al. (2009), but inconsistent with findings from Lusk, Ronis, and Baer (1997) where use was similar between men and women. Reasons for gender-based use differences are unclear, but may possibly relate to different worker groups. Future study is needed to explain gender differences in use of HPDs.

The low rate of HPD use reported here and in previous studies affirms the need to develop interventions to increase HPD use among farmers. In addition, the predictors of hearing protector use identified 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. Based on results from the study reported here, interventions addressing farmers' barriers to HPD use and access/availability influencing HPD use are particularly relevant.

Use of the USDA National Agricultural Statistics Service facilitated population-based sampling of this unique and widely dispersed population. In addition, the rate of completed surveys (83%) for eligible resident farmers was highly satisfactory.

Limitations of the study included exclusion of hired farmworkers and low participation of persons from minority groups. However, the use of HPDs by hired farmworkers is likely determined by their employers, who are the farm owners included in this study. Researchers are challenged to develop techniques that include Hispanic and other minority farmers in future studies.

A further study limitation was the performance of the subscales measuring interpersonal influences. The Farmers' Interpersonal Modeling and Interpersonal Norms Influencing HPD Use instruments had α coefficients of .49 and .63, respectively. As is often the case with scales composed of a small number of items, calculation of Cronbach's α resulted in lower than desirable values (Devellis, 2003). These shorter instruments represented a balance between a satisfactory α and increasing respondent burden. We might infer that the lower α of the Farmers' Interpersonal Modeling of HPD Use instrument may have reduced the likelihood of identifying interpersonal modeling as a predictor of HPD use. However, application of the Spearman–Brown prophecy formula indicated that if the Modeling scale consisted of six items of the same quality as those included in it, the α would be .74 (Hartman & Pelzel, 2005). This finding suggested that the low number of items in this scale likely contributed to its low α coefficient. There is a need for revision of these instruments with the goal of increasing low reliability of these measures.

In reviewing responses to the survey questions, we conclude that response scale wording allowed respondents to inappropriately select *does not apply* options. We recoded these responses as missing, thereby increasing the amount of missing data. However, recoding did not result in any difference between results based on answers to 75% versus 50% of the scale items, leading us to conclude that the high rate of *does not apply* responses did not alter the results. Improvement in the design of response options will avoid this problem in the future.

The time to complete the surveys was not measured. These data may be useful in the design of future studies and represent an important variable to be included in future similar studies.

Nurses in a variety of acute and ambulatory care settings interact with farmers and are strategically positioned to offer preventive care for hearing health. Nurses, particularly those working in rural settings, have opportunities to apply knowledge concerning the hearing hazards of farmers, their patterns of use of hearing protection, and the factors that limit and support their use of personal protective equipment to preserve their hearing. Information from this study highlighted farmers as a high risk group for NIHL, guided clinicians in the hearing health assessment of their farmer-clients, and provided direction to develop interventions designed to promote farmers' HPD use.

Summary and Conclusions

A population-based, cross-sectional study of farmers' use of hearing protection was conducted using computer-assisted telephone survey techniques. With 83% of eligible participants responding, HPD use was found to be very low (27.5%) overall; only slightly more than half (56.8%) of the participants had ever used HPDs. Two hypothesized predictors of HPD use among farmers—barriers and access/availability—demonstrated statistically significant relationships in the expected direction. The hypothesized higher use of HPDs among women farmers was not supported in the sample studied. Overall the model correctly predicted a large proportion of cases, however, not all the components of the model were significant, suggesting potential for future model trimming.

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