Hearing Protection

Work climate and hearing protection behaviors in construction workers

By Jan Brady and OiSaeng Hong

NOISE-INDUCED HEARING LOSS (NIHL) is a threat affecting 30 million workers in the U.S. (NIOSH, 1996). Occupational NIHL is preventable. Workers can protect against this condition by using engineering controls that potentially block or reduce noise emission from industrial machinery. While such controls can be highly effective, they are not always economically or reasonably feasible. This is particularly true for the construction industry where the work environment changes frequently and ambient conditions can change dramatically (Ringen et al., 1995). Another way to reduce NIHL is to strictly adhere to policies that require monitoring noise levels and wearing hearing protection devices (HPDs) in high noise areas. Unfortunately, although such policies often exist in work settings, NIHL remains a pervasive problem.

Hearing can also be protected with the consistent use of HPDs such as earplugs or earmuffs. However, studies indicate that not all workers use HPDs when exposed to hazardous noise levels at work (Hong, 2005; Hong et al., 2005; Lusk et al., 2003; Lusk et al., 1999; Melamed et al., 1994; Suter, 2002). Given that engineering controls are cost prohibitive for many organizations and that hearing protection policies are often ineffective, workers must be educated about the hazards associated with exposures to high noise and the importance of protecting their hearing by using HPDs when exposed to loud noise.

Studies related to health behaviors have primarily focused on personal perceptions, attitudes and values that influence performance. Influencing factors have included the concepts of self efficacy, barriers, benefits or outcome expectations, and outcome value (Hong et al., 2005; Pender et al., 1990; Strecher et al., 1994). Few studies have focused specifically on hearing protection behaviors; of those that have done so, the concept of work climate as an influencing factor is not clearly explicated (Lusk et al., 1997; Melamed et al., 1996). Contemporary research related to health promotion activities in work settings as identified by Ribisl and Reischl (1993) has tended to emphasize the importance of individual behaviors while ignoring the influence of the contextual dimension.

In the organizational literature, work climate factors have been demonstrated to significantly influence worker performance and behavior (Denison, 1993; Tracey, 2000). Previous studies have focused mainly on the individual worker and personal attitudes associated with HPD use. Therefore, it is also important to explore the contextual factors that influence workers to wear HPDs.

The concept of the work climate and its influence on worker performance and behavior has been extensively discussed in organizational literature (Denison, 1993; Reichers & Schneider, 1990; Tracey, 2000; Tagiuri, 1968). While the terms "climate" and "culture" have occasionally been used interchangeably, it is helpful to distinguish between these terms.

Culture generally refers to an organization's overall values, assumptions, traditions and beliefs—the underlying foundation for why and how the organization exists and operates. Climate, a more subjective concept, typically refers to shared perceptions about the work environment atmosphere; an atmosphere that workers perceive is created through the enacted policies, practices, procedures and rewards of the organization (Schneider, B., et al., 1994). As such, "climate is the manifestation of an organization's culture" (Reichers & Schneider, 1990) and represents what workers sense about their work environments. The concept of work climate refers to "a relatively enduring quality of the internal environment of an organization that 1) is experienced by its members; 2) influences behavior; and 3) can be described in terms of the values of a particular set of characteris-

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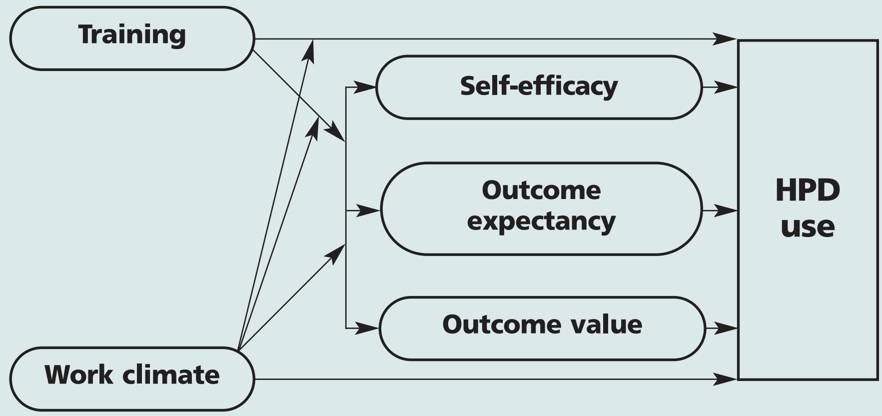
Figure 1

Conceptual Model with Predictors for Use of HPDs



tics (or attributes) of the organization" (Tagiuri, 1968).

Organizational behavior studies designed to examine the relationship between work climate factors and training effectiveness have provided evidence that climate plays an influential role in training outcomes. What has not been extensively studied with scientific rigor is how work climate factors influence the practice of health-related behaviors in work settings. Relative to safety and health promotion behaviors in organizational settings, several researchers have strongly urged that future studies address the influence of work climate factors (Hofmann & Stetzer, 1996; Pender et al., 1990; Ribisl & Reischl, 1993; Sloan & Gruman, 1988). Neal et al. (2000) suggest that workers' perceptions of safety climate are influenced by the general organizational climate and, in turn, safety climate influences knowledge and motivation for engaging in safety behaviors in workplace settings. Results from the work of Ferraro (2002) corroborated that organizational climate exerts influence on safety performance behaviors in the workplace.

It is valuable to explore how work climate factors and hearing protection training influence workers' perceptions and behaviors associated with the use of HPDs in work settings; contextual factors in the work setting contribute to the creation of a work climate that represents workers' perceptions of the prevailing attitudes in an organization. This article discusses the relationship between work climate factors and construction workers' use of HPDs. This relationship must be understood in order to develop increased awareness and understanding about the influence of the work environment on construction workers' use of HPDs in their work settings.

Conceptual Framework

Research findings and the literature support the concept that social interactions occurring in the work setting are major contextual factors that play a critical role in determining workers' perceptions and behaviors (Reichers & Schneider, 1990; Ribisl & Reischl, 1993). Workers are continually influenced by work setting factors and their interactions among peers and supervisors, thus strongly suggesting the value of drawing on a social interaction theory as the conceptual framework for this study. This study was designed to explore how work setting characteristics (workers' perceptions of work climate factors) relate to construction workers' perceptions and behaviors about protecting their hearing.

Derived from concepts related to Bandura's social cognitive theory (SCT) and work climate factors reported in the literature, the conceptual model that guided the focus of this study was developed by the primary author of this article and is depicted in Figure 1. This model suggests that workers' post-training use of HPDs is influenced by hearing protection training; workers' perceptions of the climate of the work setting; perceived self-efficacy in using HPDs; perceived outcome expectancy; and perceived value for using HPDs. Workers' behaviors are influenced by contextual factors, especially the behaviors of others in the work environment. Thus, the modeled behaviors and the support of coworkers and supervisors can influence the behavior of individuals in organizational settings.

Research Design & Methodology

This ex post facto study used secondary analysis as the research design to explore additional concepts from the study of construction workers conducted by Lusk (1997) in a research project funded by NIOSH. Lusk measured workers' perceptions of factors that related to the use of HPDs in work settings; these factors included both a personal and organizational focus. The intent of the study described in this article was to extricate some of these factors and specifically examine the influence of organizational factors (work climate) on workers' use of HPDs, thus expanding knowledge gained from the original study.

Study Participants

This study used the data collected from 798 construction workers in a Midwestern state who participated in a hearing protection intervention study (Lusk, 1997). Participation was voluntary and informed consent of participants was obtained. Data collection and hearing protection training occurred when workers were assembled in classroom settings for regular training. The study sample consisted of three trade groups: carpenters, operating engineers (heavy-equipment operators) and plumbers/pipefitters. Of the original 798 participants, a total of 146 workers who reported no noise exposure were excluded from the secondary analyses performed for this study. Since the topic of interest was workers' use of HPDs when exposed to potentially harmful noise, it was reasonable to include only those workers who reported actual exposures to high noise levels in their work environments. Therefore, the final sample for secondary analysis in this study consisted of 652 workers.

Measures

Portions and reconstructions of the original instruments reported by Lusk, et al. (1997a) that were used in this study are described in the following section.

Abstract: *Work environments pose multiple threats to the safety and health of construction workers including the potential for occupational noise-induced hearing loss (NIHL), caused by frequent exposures to hazardous noise. While permanent in nature, NIHL can be prevented if hearing protection devices (HPDs) are used appropriately—that is, 100% of the time when exposed to high-noise environments.*

This study was designed to explore how construction workers' perceptions of work climate factors relate to their use of HPDs. Study results indicated that work climate factors were associated with construction workers' behaviors relative to their use of hearing protection in high noise environments. Work climates that were perceived by construction workers to be nonsupportive relative to the use of HPDs had a negative influence on hearing protection behaviors. As workers perceived their work settings to be more supportive for using HPDs, their self-efficacy, outcome expectancy and outcome value for using HPDs also increased.

Table 1

Pearson Product-Moment Correlations

	Work climate (1)	Self-efficacy (2)	Outcome expectancy (3)	Outcome value (4)
Work climate (1)	1.000			
Self-efficacy (2)	.388*	1.000		
Outcome expectancy (3)	.180*	.383*	1.000	
Outcome value (4)	.188*	.281*	.422*	1.000

Note. **p < .01, two-tailed.*

Independent Variables

Training

Hearing protection training was the intervention provided to workers in the original study (Lusk, 1997). Based on a Solomon 4-group design, construction workers in the original study were randomly assigned to 1 of 4 groups: 1) pre-test and post-test; 2) pre-test, training and post-test; 3) training and post-test; and 4) post-test only. Since no pretest effect on HPD use was reported in the original study, the original Solomon 4 groups were collapsed into 2 groups for this study, thus representing the groups of construction workers who had received hearing protection training (n = 336) and those who had not (n = 316). Construction workers who received the hearing protection training represented 51.5% of the overall sample (N = 652) in this study. For data analysis, training was coded as "yes" or "no" and used as a dummy variable.

A self-administered written questionnaire in booklet format was used for both pre-test and post-test data collection; it took 35 to 45 minutes to complete the questionnaire. For purposes of this study, secondary data analysis focused on the posttest data collected approximately 10 to 12 months after the hearing protection training occurred.

A total of four instructors/trainers (working as a team of two in each training session) provided all the hearing protection training by using a standardized script and instructional format to ensure consistency. Overall, each session lasted about 45 minutes and included a 20-minute video segment that was specifically developed for construction workers and based on previous research by Lusk, et al. (1997). In the video, a discussion about the importance of hearing protection was portrayed between an occupational health nurse and a construction worker. Also portrayed in the video were interactions among construction workers as they discussed the use of HPDs in their work settings. The training program included an opportunity for questions and answers, along with a guided-practice session during which participants could try various types of hearing protection. Brochures containing general information about hearing loss and HPD availability were also distributed as part of the training program (Lusk et al., 1999).

Work-Climate Scale

The work-climate scale included 21 items that measured workers' perceptions of organizational or work setting factors facilitating or impeding their use of hearing protection. Examples of items in this scale were: "Nobody at work cares if I wear hearing protection," and "Pressure from coworkers can often get in the way of wearing hearing protection." The climate scale items were drawn from multiple scales used by Lusk, et al. (1997) and were originally measured on various (3-point, 4-point, 5-point and 6-point) Likert scales. Prior to secondary analysis, appropriate items were reverse scored and the values for each of the 21 items were transformed into standardized scores; thus, the mean was equal to zero and the standard deviation was equal to one. Following this conversion to standardized scores, the work-climate scale was computed as the mean of the standardized scores on the 21 items. Reliability (Cronbach's alpha) of the work-climate scale developed for this study was 0.89.

Construction workers reported an overall perception that their work climates were fairly moderate in terms of supportiveness for hearing protection behaviors. Scores ranged from 1.246 to 1.515 (M = 0.001, SD = 0.550). For additional analyses, the work-climate scale was recoded into a dichotomous variable using a median split. Low scores on the work-climate scale (1.246 through 0.020) were considered to represent perceptions of individuals (n = 326) from work settings with nonsupportive climates (low-climate level) for the use of HPDs. High scores on the work-climate scale (0.019 to 1.515) were considered representative of individuals (n = 326) who perceived that their work environments supported the use of HPDs (high-climate level).

Self-Efficacy Scale

The self-efficacy scale consisted of 12 items drawn from several scales originally developed by Lusk, et al. (1997a). Items on this scale represented construction workers' perceptions about their ability to use HPDs correctly and adequately. Examples of items in this scale were: "I can use hearing protection correctly," and "I do not always use my hearing protection the way it should be used." All self-efficacy items were measured on a 6-point Likert scale (1 = strongly disagree, 6 = strongly agree). Items that were negatively worded were reverse scored for data analysis and a self-efficacy score was computed using the mean of the 12 items. Scores on the self-efficacy scale ranged from 2.2 to 6.0 (M = 4.2, SD = 0.70). Reliability (Cronbach's alpha) of the self-efficacy scale used for this study was 0.76.

Outcome Expectancy Scale

Seven items represented workers' perceptions about the potential results or benefits related to using hearing protection. These items were drawn from the benefits and barriers scale of Lusk, et al. (1997a) and were measured on a 6-point Likert scale (1 = strongly disagree, 6 = strongly agree). Examples of items in

Table 2

Mean Scores of Self-Efficacy, Outcome Expectancy & Outcome Value by Work Climate Level

Variable	Work climate level	Mean	*t* value	*df*	*p* (two-tailed)
Self-efficacy	low	4.0	-9.48	646	< .001
	high	4.4			
Outcome expectancy	low	5.1	-4.80	650	< .001
	high	5.4			
Outcome value	low	84.0	-4.88	630	< .001
	high	88.6			
HPD use	low	38.4	-8.17	648	< .001
	high	59.8			

this scale were: "Wearing hearing protection protects me against hearing loss from noise exposure," and "Regular use of hearing protection is beneficial to me because it helps protect my hearing." Appropriate items were reverse scored prior to statistical analysis and the outcome expectancy score was computed from the mean of the seven items. HPD outcome expectancy scores ranged from 2.3 to 6.0 ($M = 5.3$, $SD = 0.72$). Reliability (Cronbach's alpha) of the outcome expectancy scale used for this study was 0.70.

Outcome Value Scale

Five items were used to measure workers' perceptions of the importance of the expected outcomes resulting from the use of HPDs. These items were the original items developed by Lusk, et al. (1997a), based on Pender's (1990) value of outcome exercise scale [as cited in Lusk et al. (1997)]. Examples of scale items included possible outcomes of using HPDs such as "protection of inner ear" or "keep out harmful noise." Items were measured on a visual analog scale (100 mm in length), ranging from slightly important (0%) to highly important (100%). Workers were asked to mark an "X" on the line of the visual analog scale to indicate the point that described their personal rating of the importance of the outcome associated with using hearing protection.

In scoring the five items on this scale, a 10 cm ruler was used to measure the point where the "X" was made; each millimeter on the line corresponded with 1% of value. For example, an "X" measured at 60 mm on the line was coded as 60%. The score for the outcome expectancy scale was then computed using the mean percent from these five items. Scores ranged from 6.6% to 100% ($M = 86.3\%$, $SD = 12.0\%$). Reliability (Cronbach's alpha) of the outcome value scale in this study was 0.87.

Dependent Variable

Use of HPDs

Five items measured the frequency of HPD use by construction workers. Items measured percentage of time workers reported using HPDs (e.g., earplugs or earmuffs) when exposed to high noise levels at their most recent and previous jobsites, and at three specific time periods (i.e., past week, past month, past 3 months). Since these five items were highly correlated ($r = 0.79$ to 0.96), an overall mean HPD use score was computed from the mean of these five items. This overall mean HPD use score represented the ratio level measure that was used as the dependent variable in the multivariate regression analysis. Self-reported HPD frequency use ranged from 0% to 100% ($M = 49.1\%$, $SD = 35.1\%$). When construction workers were exposed to hazardous noise in their work settings they reported using HPDs only about half of the time (49%). With regard to using self-reported measures as the primary dependent variable, researchers have investigated the results of such measures in other studies and found the self-reported measures to be valid and reliable (Hofmann & Stetzer, 1996; Lusk et al., 1995).

Results

Demographic Characteristics of the Sample

A total of 652 workers who reported exposure to loud noise at work were included in the analysis. These workers represented 3 trade groups: carpenters ($n = 164$), operating engineers ($n = 288$) and plumbers/pipefitters ($n = 200$). Study participants ranged in age from 20 to 63 years with a mean age of 36 years. In terms of gender and race/ethnicity, study participants represented a fairly homogeneous group since they were predominantly male (96.3%) and Caucasian (90.2%). Length of time that workers had practiced their trade ranged from 1 to 45 years with a mean of 11.4 years. Most of the workers (91.1%) had at least a high-school education. On average, construction workers reported using HPDs only about half (49%) of the time when they were exposed to high noise levels in their work environments.

Relationships among Key Study Variables

Results of Pearson product-moment bivariate correlations among key study variables are summarized in Table 1. As shown in Table 1, all correlations were positive and statistically significant ($p < .01$). As workers perceived their work settings to be more supportive for using HPDs, their self-efficacy, outcome expectancy and outcome value for using HPDs also increased. Work climate showed a stronger relationship with self-efficacy ($r = 0.39$) than with outcome expectancy ($r = 0.18$) or with outcome value ($r = 0.19$). A moderately strong relationship ($r = 0.42$) was found between outcome expectancy and outcome value. A comparison of mean scores for self-efficacy, outcome expectancy and outcome value for using HPDs between the low- and high-climate groups is presented in Table 2. As expected, workers in high-climate settings (supportive for HPD use) reported significantly higher levels of self-efficacy, outcome expectancy and outcome value ($p < .001$).

Table 3

Bivariate Correlations of Work Climate Items with HPD Use

Work climate item	*r* with HPD use
Coworker pressure gets in way[a]	.13**
No time for HPDs[a]	.33**
HPD information unavailable[a]	.07 (*NS*)
Nobody cares if I wear HPDs[a]	.22**
Can ask for HPD help	.10*
HPDs available at worksite	.26**
Own HPDs assigned to me	.19**
Need request for HPDs[a]	.13**
Not enough HPDs available[a]	.18**
HPD supply is far away[a]	.18**
Free to use many HPDs	.21**
HPD work signs present	.16**
HPD choices available	.11**
Coworker thinks I should wear	.20**
Supervisor thinks I should wear	.20**
Coworker wears (models) HPDs	.41**
Supervisor wears (models) HPDs	.29**
Supervisor encourages me to use	.20**
Supervisor praises me for use	.13**
Coworker encourages me to use	.13**
Coworker praises me for use	.15**

Note. *[a]Reverse scored item. *$p < .05$, two-tailed. **$p < .01$, two-tailed.*

Relationship of Work Climate with Use of HPDs

Bivariate correlations of the 21 work climate items with use of HPDs are presented in Table 3. All items except one were significantly associated with construction workers' use of HPDs. Workers' reported use of HPDs was most strongly correlated with peer support (coworker use of HPDs) ($r = 0.41$) and having enough time to use HPDs ($r = 0.33$). Slightly lower in strength was the bivariate correlation between workers' reported use of HPDs and supervisor modeling of HPD use ($r = 0.29$).

Bivariate linear regression revealed a positive relationship ($r = 0.34$, $p < .001$) between work climate and HPD use. Work climate was a significant predictor for construction workers' use of hearing protection, accounting for 11.4% of the variance in HPD use ($F = 83.69$, $p < .001$). HPD use was also compared between workers in a supportive work climate (high-climate group) and workers in a nonsupportive work climate (low-climate group) using a median split of the work climate scale. The high-climate category included work climate scores ranging from 0.0186 through 1.515, and indicated work settings where the use of hearing protection was encouraged and supported. The low-climate category represented work climate scores ranging from 1.246 through 0.020, thus indicating work settings where HPD use was not strongly supported or encouraged.

Demographic characteristics of workers in the high- and low-work-climate groups indicated that workers in the high-climate group were significantly older than those in the low-climate group (mean age of 38 vs. 33 years) ($t = 5.38$, $p < .001$). Of the 3 trade groups, operating engineers tended to report more supportive work climates for HPD use. More than half (64.6%) of the operating engineers were in the high-work climate group. The 2 groups did not show significant differences in other demographic variables.

As shown in Table 2, there was a statistically significant difference in mean HPD use between construction workers in high-climate settings and workers in low-climate settings ($t = 8.17$, $p < 0.001$). In the high-climate group, workers reported using HPDs 59.8% of the time when exposed to high-noise environments, while workers in the low-climate group reported using hearing protection only 38.4% of the time when they were exposed to high noise levels.

Significant Factors Affecting HPD Use

Hierarchical multiple regression was used to enter the predictor (independent) variables in systematic steps as suggested by the conceptual model illustrated in Figure 1. Predictor variables (training, work climate, self-efficacy, outcome expectancy and outcome value) were entered in ordered steps or "blocks," thus allowing an examination of the R^2 changes at each step. As suggested by Astin (1993), demographic variables (age, trade group) were entered first, at Step 1, in the multiple regression analysis to control for their effects (eliminate their influence) on the dependent variable (HPD use). By entering variables related to demographic characteristics in Step 1 of the analysis, statistical control was exerted and variables entered at subsequent steps could then reveal their contributions to prediction beyond that provided by demographic characteristics. Since trade group was a categorical variable that represented the 3 groups of construction workers, 3 dichotomous dummy variables were created. The carpenters' category served as the reference group; therefore, it was not entered into the multiple regression (Astin, 1993).

A summary of the hierarchical multiple regression results is presented in Table 4. As illustrated in Table 4, the overall model with all the independent variables entered at Step 6 significantly predicted the use of hearing protection by construction workers. As a group, the predictor variables accounted for 21.2% (adj. $R^2 = 20.1\%$) of the variance in HPD use by construction workers. After controlling for demographic characteristics and training effects, work climate factors made a significant contribution to the explanatory power of the model. When work climate entered the regression equation at Step 3, a significant change in the R^2 occurred, increasing the explanatory power of the model by 6.1%.

The results suggested that workers who reported being in supportive settings tended to use hearing protection more than workers in nonsupportive settings. However, in addition to work climate, three other significant contributors to the model were trade category, self-efficacy and outcome value. Of the 4 significant predictors, type of construction worker (operating engineers) and work climate factors were the strongest predictors for HPD use, indicated by standardized betas of .25 and .20, respectively.

An unexpected and perplexing result, depicted in the regression results displayed in Table 4, was the nonsignificant and negative standardized beta (.02) for outcome expectancy in Step 6. The negative sign would suggest that construction workers used HPDs more when they perceived a low expectancy for the results associated with using hearing protection. Since the bivariate correlation between outcome expectancy and HPD use was positive ($r = 0.13$, $p < .01$), the negative beta for outcome expectancy revealed in Step 6 of the hierarchical regression might be indicative of multicollinearity between outcome expectancy and outcome value. The bivariate correlation between these 2 variables was 0.42 ($p < .001$), indicating a moderate correlation. Furthermore, the beta for outcome expectancy changed signs when outcome value entered the regression equation at Step 6, a sign often signaling the possibility of multicollinearity (Hamilton). When multicollinearity exists, the coefficient estimates tend to be unstable and less precise.

Table 4

Results of Hierarchical Regression with Model Predictors of HPD Use

Variable	B	SE B	ß	*t*	Sig.	R^2 change (p-value)
Step 1						
Age	0.154	0.174	.046	0.885	.377	
Operating engineers	24.797	4.347	.3353	5.704	.000	
Plumbers/pipefitters	6.453	3.561	.086	1.812	.070	
Step 2						
Age	0.129	0.174	.039	0.742	.458	.005 (.056)
Operating engineers	25.314	4.347	.360	5.824	.000	
Plumbers/pipefitters	6.498	3.554	.086	1.828	.068	
HPD training	4.985	2.605	.71	1.914	.056	
Step 3						
Age	0.059	0.168	.018	0.352	.725	.061 (.000)
Operating engineers	17.988	4.328	.256	4.156	.000	
Plumbers/pipefitters	1.138	3.517	.015	0.323	.746	
HPD training	5.422	2.515	.078	2.156	.031	
Work climate	16.936	2.456	.266	6.894	.000	
Step 4						
Age	0.101	0.167	.030	0.606	.545	.016 (.000)
Operating engineers	17.400	4.293	.247	4.053	.000	
Plumbers/pipefitters	0.659	3.489	.009	0.189	.850	
HPD training	4.230	2.516	.061	1.681	.093	
Work climate	13.462	2.626	.212	5.127	.000	
Self-efficacy	7.005	1.984	.138	3.531	.000	
Step 5						
Age	0.097	0.167	.029	0.584	.560	.001 (.522)
Operating engineers	4.261	2.517	.061	1.693	.091	
Plumbers/pipefitters	13.379	2.630	.210	5.087	.000	
HPD training	6.529	2.119	.128	3.081	.002	
Work climate	13.462	2.626	.212	5.127	.000	
Self-efficacy	6.529	2.119	.128	3.081	.002	
Outcome expectancy	1.209	1.889	.025	0.640	.522	
Step 6						
Age	0.055	0.166	.016	0.328	.743	.012 (.002)
Operating engineers	17.332	4.269	.247	4.060	.000	
Plumbers/pipefitters	0.033	3.474	.000	0.009	.993	
HPD training	4.332	2.500	.062	1.733	.084	
Work climate	12.814	2.619	.201	4.894	.000	
Self-efficacy	5.936	2.113	.117	2.809	.005	
Outcome expectancy	-0.972	2.002	-.020	-0.485	.628	
Outcome value	0.369	0.118	.124	3.116	.002	

Note. *Overall model (step 6):* $R^2 = .21$, $F(8, 631) = 21.24$. $p < .001$.

Discussion

In the area of health education, limited attention has focused on the environmental aspects associated with the settings where individuals are expected to enact healthy behaviors. Most studies on health promotion and health behavior issues have focused on a combination of personal and situational factors related to enacting healthy behaviors. The purpose of this study, however, was to examine the context of the work setting as a distinct factor that influences construction workers' use of HPDs.

Results indicate that work climate factors are associated with construction workers' behaviors relative to their use of hearing protection in high-noise environments. A significant difference was found in the use of hearing protection between construction workers in supportive and nonsupportive climates. In supportive climates, however, the average reported use of HPDs by construction workers is approximately 60%, which is still inadequately low. Therefore, even more inadequate and certainly disconcerting is the mean HPD use of 38% reported by construction workers in low climate settings.

Work climates that were perceived by construction workers to be nonsupportive relative to the use of HPDs had a negative influence on hearing protection behaviors. Since the average age of workers in the low-climate group was 33 years, it is unfortunate to realize how vulnerable this group is for acquiring occupational NIHL so early in life. With the permanent nature of such a hearing loss, the future quality of life for these construction workers is jeopardized. As occupational NIHL is entirely preventable, it is crucial to emphasize that workers must wear HPDs 100% of the time whenever they are exposed to high noise levels in order to prevent hearing loss (Berger, 2000; Dear, 1998).

A critical component of supportive work climates is having adequate time and appropriate equipment available for using HPDs.

A critical component of supportive work climates is having adequate time and appropriate equipment available for using hearing protection. But even more important in work settings, as revealed in this study and previously reported by others (Hong et al., 2005; Lusk et al., 1997), is the visibility of role models to encourage workers to wear their HPDs. In a sense, the work setting provides an opportunity for ongoing "real time" testimonials where the beliefs and behaviors of coworkers dynamically affirm the value of HPD use. In this study, when coworkers demonstrated desired hearing protection behaviors, construction workers were more likely to enact similar behaviors, as evidenced by the moderately strong correlation between peer modeling and workers' reported use of HPDs. Interestingly, supervisor modeling had a slightly lower correlation with workers' HPD use. In the sample of construction workers in this study, the influence of coworkers was stronger than that of supervisors, thus emphasizing the critical importance of peers in modeling desired behaviors.

Findings from this study both support and somewhat contradict earlier studies reported in the literature. In a study of painters and their use of respirators, White, et al. (1988) found that social factors, such as perceived attitudes of others in the work setting, played a major role in promoting health protective behaviors. Similarly, the research of Zohar (1980) and the work of Leinster, et al. (1994) substantiated the importance of management commitment for producing adequate hearing protection behaviors in the workplace.

Slightly different from the perceptions reported by construction workers in this study, Richey (1992) determined that modeling of desired safety behaviors by supervisors and management was more influential than behavior modeling by coworkers. In contrast to these findings that emphasized the importance of a supportive work setting, Melamed, et al. (1996) reported that social and management pressure explained little additional variance in HPD use among factory workers in Israel. However, Melamed, et al. admitted that their findings might have been the result of a ceiling effect related to the already conscientious use of HPDs in factory sites where management had agreed to participate in the study. In more recent studies, DeJoy, et al. (2004) reported that organizational climate plays an important role in contributing to good safety performance.

Clearly, findings from this study align with previous studies that highlighted the importance of supportive work climates to encourage the enactment of safety behaviors. What differs among the studies is the source of the more influential modeling support: coworkers or supervisors. For the construction workers in this study, the influence of coworkers was found to be somewhat stronger than that of supervisors. Perhaps this greater influence from work peers is related to the nature of the construction industry itself where OSHA requirements relative to hearing protection are not as stringent, and where workers tend to be more transient—often changing sites as a team and encountering variable supervisors.

The results of this study also demonstrated that work climate factors were positively associated with construction workers' perceptions of their self-efficacy for using HPDs, their expectancy of the outcomes (benefits) for using HPDs and their valuing of the outcomes related to the use of HPDs. All three relationships were statistically significant with the correlation between work climate factors and self-efficacy being the strongest among the three. The relationship between self-efficacy and work climate factors is especially important to consider, in light of the research findings reported by Schwarzer (1992) indicating that self-efficacy exerts a powerful influence on behavior.

Since the self-efficacy scale measured workers' perceptions about their ability to use HPDs correctly and effectively, it is understandable that supportive work climates contributed to higher levels of self-efficacy perceptions. As study participants were encouraged to use HPDs in their work settings and as they observed modeled behaviors, it is not surprising that their confidence to use HPDs correctly was enhanced. Furthermore, by observing consistent hearing protection behaviors of peers and supervisors, construction workers were more likely to anticipate the beneficial outcomes and values associated with using HPDs.

Not surprisingly, when construction workers highly valued the outcomes associated with wearing hearing protection, (e.g., prevention of hearing loss, protection from harmful noise) their use of HPDs increased. However, somewhat surprising and certainly perplexing was the nonsignificant negative beta (.02) of outcome expectancy in the final step of the hierarchical regression analysis. This finding would suggest that high expectations of the outcomes (benefits) from wearing HPDs contributed to a low use of HPDs—a finding somewhat contrary to logical expectation.

A more likely reason for this finding is the possibility of multicollinearity between outcome expectancy and outcome value, since they appear to measure similar concepts. Although the bivariate correlation of 0.42 ($p < .001$) between these two variables is not necessarily high to produce multicollinearity, a linear combination of the two variables with an undetectable third predictor variable could produce a multicollinearity problem (Hamilton, 1992). Perhaps more refined instruments are needed to improve the measurement precision of these variables in future research studies.

Recalling that HPD modeling by peers and supervisors significantly predicted construction workers' HPD use, training sessions could be designed to include on-site peer groups along with supervisors and managers. It would be advantageous to consider training programs that incorporate teams or groups of workers whose daily work activities involve close interaction. Supervisors also should be included in such training sessions, thus providing visible commitment and credible support for hearing protection efforts. In essence, not only must supervisors and organizational management "speak" a commitment for training efforts, but they must visibly "practice" it too. When messages about the importance of using HPDs are consistently conveyed throughout the organizational setting and among various levels, there is greater potential for increased transfer of knowledge, skills, and attitudes from training programs to work environments (Ford & Fisher, 1993).

Brief "tool box" or "tailgate" sessions (Schneider, S., et al., 1995) that are common in the construction industry might effectively reinforce annual HPD training. Having HPD equipment available during these sessions would encourage construction workers to practice with the devices and try them on for size, thus improving their sense of self-efficacy. Comprehensive HPD training is valuable, but desired behaviors must be encouraged and reinforced in the work environment if adequate use of HPDs and reduction of occupational NIHL are to be achieved.

Limitations of the Study

It is helpful to note some of the limitations of this study. Midwestern U.S. construction workers comprised the sample for this study; therefore, findings cannot be generalized beyond this specific population if one applies strict research principles. Regional differences due to varying sociocultural and economic factors could influence construction workers' use of HPDs. Nevertheless, NIHL is a common threat for construction workers in general and findings from this study provide baseline information that would be relevant for multiple workers in the construction industry.

In data analysis for this study, no individuals in upper management levels of the construction industry were included. Future studies involving upper levels of management would certainly increase the opportunity to develop a more comprehensive understanding and an insightful analysis of the work climate factors associated with NIHL among construction workers. It would be beneficial to collect data from all levels of construction personnel in order to identify the multiple variables involved.

Although the hearing protection training for construction workers in this study was standardized and provided by a total of four similarly trained instructors working in teams of two, it is possible that teaching styles and skills of the individual trainers had varying influence on post-training use of HPDs.

In this study, self-reported measures were used to assess construction workers' perceptions of climate factors in their work environment and the percentage of time that they wore HPDs when exposed to hazardous noise levels in their work settings. Workers may have been inclined to provide socially desirable responses and may have reported a higher frequency of HPD use, thus reducing the accuracy of study findings. However, Hofmann and Stetzer (1996) found meaningful support for the validity of self-reported measures in their research involving workers' reporting of unsafe behaviors in a chemical processing plant.

To achieve success in reducing the threat of NIHL among construction workers, collaborative efforts among multiple researchers are needed.

Secondary analysis of existing data was the technique applied in this research study. Despite the presence of several disadvantages associated with performing secondary data analysis, distinct advantages exist. Provided that safeguards for confidentiality and protection of human subjects are maintained, secondary data analysis increases potential benefits for study participants by reducing additional burden that subsequent surveys and measurements might generate. At best, using a pre-existing data set provides an efficient and economical approach for conducting additional studies in the current environment of limited resources (both time and money).

However, one of the primary drawbacks of secondary data analysis is the limitation imposed by pre-existing variables and scales that have been designed and developed from another theoretical perspective. Scales and measurements may lack validity and might not match the desired precision for secondary analysis. Nevertheless, using secondary data analysis provides expanded opportunities for researchers to refine questions of interest and add to existing knowledge.

From a practical perspective, working with pre-existing data sets affords access to large sample sizes, which are often not readily available and difficult to obtain. Performing secondary analysis on data from large sample sizes thus maximizes research efforts by increasing statistical power to detect significant differences. Lastly, such analysis encourages researchers to be creative by looking at existing data from another point of view or within a different theoretical framework; consequently, secondary data analysis can prompt increased data sharing and facilitate collaborative research efforts. To achieve success in reducing the threat of NIHL among construction workers, collaborative efforts among multiple researchers are needed. ■

References

Astin, A.W. (1993). *Assessment for excellence: The philosophy and practice of assessment and evaluation in higher education.* Phoenix, AZ: Oryx Press.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice-Hall.

Berger, E.H. (2000, October). Hearing protection: Dual protection. *Occupational Health & Safety, 69*(10), 98-102.

Dear, T.A. (1998). Updating damage risk criteria to include performance under workplace noise regulations." *Journal of Occupational Hearing Loss, 1*(1), 61-66.

DeJoy, D.M., Gershon, R.R.M. & Schaffer, B.S. (2004, July).

Preventing NIHL in Construction Workers

More than 500,000 construction workers are exposed to hazardous noise. Compared with manufacturing, the U.S. construction industry is less stringently regulated with regard to hearing conservation programs. In a study of 652 Midwestern construction workers, findings revealed:

- Construction workers reported using hearing protective devices (HPDs) less than half (49%) of the time when working in high-noise environments.
- Work climate factors such as supervisor and coworker support, encouragement and social modeling of HPD use consistently tended to influence construction workers' hearing protection behaviors.
- In high climate settings (supportive environments) construction workers reported a significantly greater HPD use than those in low climate settings (60% vs. 38%).
- Construction workers in supportive work climates also reported higher levels of self-efficacy, outcome expectancy, and outcome value for using HPDs.

Work climate factors are critical components to consider when planning interventions to reduce the threat of NIHL for construction workers. Even when construction workers receive hearing protection training, they are still more likely to use HPDs when they perceive coworker and supervisor support to do so. The influence of social modeling in the work setting plays a significant role in promoting hearing protection behaviors among construction workers.

Safety climate: Assessing management and organizational influences on safety. *Professional Safety, 49*(7), 50-57.

Denison, D.R. (1993). What is the difference between organizational culture and organizational climate? A native's point of view on a decade of paradigm wars. (Working paper #729). Ann Arbor, MI: University of Michigan, School of Business Administration.

Ferraro, L. (2002). *Measuring safety climate: The implications for safety performance.* Unpublished doctoral dissertation, University of Melbourne.

Ford, J.K. & Fisher, S. (1993). The transfer of safety training in work organizations: A systems perspective to continuous learning. *Occupational Medicine: State of the Art Reviews, 9*(2), 241-259.

Hamilton, L.C. (1992). *Regression with graphics: A second course in applied statistics.* Belmont, CA: Duxbury Press.

Hofmann, D.A. & Stetzer, A. (1996). A cross-level investigation of factors influencing unsafe behaviors and accidents. *Personnel Psychology, 49*(2), 307-339.

Hong, O. (2005). Hearing loss among operating engineers in American construction industry. *International Archives of Occupational and Environmental Health, 78*(7), 565-574.

Hong, O., Chen, S.P. & Conrad, K.M. (1998). Noise-induced hearing loss among male airport workers in Korea. *AAOHN Journal, 46*(2), 67-75.

Hong, O., Lusk, S.L. & Ronis, D.L. (2005). Ethnic differences in predictors for hearing protection behavior in black and white workers. *Research & Theory for Nursing Practice: An International Journal, 19*(1), 63-76.

Leinster, P., Baum, J., Tong, D. & Whitehead, C. (1994). Management and motivational factors in the control of noise-induced hearing loss. *The Annals of Occupational Hygiene, 38*(5), 649-662.

Lusk, S.L. (1997a). *Preventing noise-induced hearing loss in construction workers: A Final Report to NIOSH* (grant No. R01 OH03136) Washington DC: DHHS, NIOSH.

Lusk, S.L., et al. (1995). Predictors of workers' use of hearing protection: Implications for training programs. *Human Factors, 37*(3), 635-640.

Lusk, S.L., Ronis, D.L. & Hogan, M.M. (1997). Test of the health promotion model as a causal model of construction workers' use of hearing protection. *Research in Nursing & Health, 20*(3), 183-194.

Lusk, S.L. Hong, O.S., Ronis, D.L., et al. (1999). Effectiveness of an intervention to increase construction workers' use of hearing protection. *Human Factors, 41*(3), 487-494.

Lusk, S.L., Ronis, D.L., Kazanis, A.S., et al. (2003). Effectiveness of a tailored intervention to increase factory workers' use of hearing protection. *Nursing Research, 52*(5), 289-295.

Melamed, S., Rabinowitz, S., Green, M.S., et al. (1994). Noise exposure, noise annoyance: Use of hearing protection devices and distress among blue-collar workers. *Scandinavian Journal of Work, Environment & Health. 20*(4), 294-300.

Melamed, S., Rabinowitz, S., Feiner, M., et al. (1996). Usefulness of the protection motivation theory in explaining hearing protection device use among male industrial workers. *Health Psychology, 15*(3), 209-215.

NIOSH. (1996). *Preventing occupational hearing loss: A practical guide* (CDC Publication No. 96-110). Washington, DC: Author.

Neal, A., Griffin, M.A. & Hart, P.M. (2000). The impact of organizational climate on safety climate and individual behavior. *Safety Science, 34,* 99-109.

Pender, N., Walker, S.N., Sechrish, K.R.,et al. (1990). Predicting health-promoting lifestyles in the workplace. *Nursing Research, 39*(6), 326-332.

Reichers, A.E. & Schneider, B. (1990). Climate and culture: An evolution of constructs. In B. Schneider (Ed.), *Organizational Climate and Culture.* San Francisco, CA: Jossey-Bass.

Ribisl, K.M. & Reischl, T.M. (1993). Measuring the climate for health at organizations: Development of the worksite health climate scales. *Journal of Occupational Medicine, 35*(8), 812-824.

Richey, R. (1992). *Designing instruction for the adult learner: Systemic training theory and practice.* London: Kogan Page.

Ringen, K., Englund, A. & Welch, L., et al. (1995). Why construction is different. *Occupational Medicine: State of the Art Reviews, 10*(2), 255-259.

Schneider, B., Gunnarson, S.K. & Niles-Jolly, K. (1994) Creating the climate and culture of success. *Organizational Dynamics, 23*(1), 17-29.

Schneider, S., Johanning, E., Belard, J.L., et al. (1995). Noise, vibration and heat and cold. *Occupational Medicine: State of the Art Reviews, 10*(2), 363-383.

Schwarzer, R. (Ed.). (1992). Self-efficacy in the adoption and maintenance of health behaviors: Theoretical approaches and a new model. In R. Schwarzer (Ed.), *Self-efficacy: Thought Control of Action.* Washington, DC: Hemisphere.

Sloan, R.P. & Gruman, J.C. (1988). Participation in workplace health promotion programs: The contribution of health and organizational factors. *Health Education Quarterly, 15*(3), 269-288.

Strecher, V.J., Kreuter, M., Den Boer, D.J., et al. (1994). The effects of computer-tailored smoking cessation messages in family practice settings. *Journal of Family Practice, 39*(3), 262-270.

Suter, A.H. (2002). Construction noise: Exposure, effects and the potential for remediation; A review and analysis. *American Industrial Hygiene Association Journal, 63*(6), 768-789.

Tagiuri, R. (1968). The concept of organizational climate. In R. Tagiuri & G.H. Litwin (Eds.), *Organizational climate: Explorations of a concept* (pp. 11-32). Boston: Harvard University, Graduate School of Business Administration.

Tracey, J.B. (2000). *The effects of organizational climate and culture on the transfer of training.* Unpublished doctoral dissertation, State University of New York-Albany.

White, M.C., Baker, E.L., Larson, M.B., et al. (1988). The role of personal beliefs and social influences as determinants of respirator use among construction painters. *Scandinavian Journal of Work, Environment & Health, 14*(4), 239-245.

Zohar, D. (1980). Safety climate in industrial organizations: Theoretical and applied implications. *Journal of Applied Psychology, 65*(1), 96-102.

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