

Predictors of Hearing Protection Behavior Among Firefighters in the United States

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Abstract

Background Noise-induced hearing loss (NIHL) is a major occupational health problem that can be prevented through the use of hearing protection devices (HPDs).

Purpose The purpose of this study is to identify significant factors related to firefighters' use of HPDs.

Methods A total of 404 firefighters from 35 fire departments in multiple states in the United States participated in an Internet-based survey from March 2010 to May 2011.

Results Pearson correlations and multiple regression analysis suggested that several modifying and cognitive-perceptual factors were significantly related to HPD use, including noise exposure, interpersonal influences, organizational support, perceived barriers to HPD use, and perceived susceptibility to hearing loss. The multiple regression model explained 56% ($R^2=.56$, adjusted $R^2=.54$) of the variance in firefighters' use of HPDs ($F_{13, 372}=35.65$, $p<.001$).

Conclusions Future research should focus on incorporating these significant predictors into effective behavioral interventions designed to promote the use of HPDs in this population.

Keywords Hearing protection · Firefighter · Predictors · Noise-induced hearing loss

Introduction

Noise-induced hearing loss (NIHL) is a significant occupational health problem worldwide [1–3]. In the United States, it is estimated to affect over 30 million workers, that has resulted in significant monetary costs for workers' compensation [4, 5]. NIHL also interferes with workers' communication, substantially affecting their social integration, self-image, quality of life, and personal safety [5, 6].

NIHL is caused by prolonged exposure to loud noise that gradually and irreversibly damages sensory hair cells in the inner ear. This damage lacks overt symptoms, such as pain, bleeding, or deformity, and as a result, it often goes unnoticed by affected individuals until their communication is impaired [5, 7]. NIHL has no effective treatment, but it is completely preventable. The best way to prevent NIHL is to eliminate noise through engineering controls. Unfortunately, these controls are often impractical, costly, or scientifically impossible to fully achieve. Hearing protection devices (HPDs) have also proven effective in preventing NIHL [8–11]; however, despite their beneficial effects, research shows that workers do not consistently wear them [12–14].

Firefighting is one of the most hazardous jobs. According to the United States National Fire Protection Association (NFPA) [15], there are over 1 million American firefighters who are at risk of developing NIHL at work. Noise exposure for firefighters is typically high in intensity and short in duration, unlike the steady and constant exposure experienced by workers in manufacturing industries. Noise survey data have consistently demonstrated that firefighters are exposed to dangerously high noise levels, exceeding the

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short-term permissible noise exposure limits recommended by the United States Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH) [16–19]. In a recent focus group study by Hong et al. [20], firefighters identified fire truck sirens, air horn warning signals, and power tools as the loudest sources of noise exposure on the job. Other identified noisy tasks included (1) ventilation (i.e., cutting holes in roofs with power tools); (2) extraction (i.e., use of power tools and air chisels); (3) fire attack jobs (i.e., use of high-pressure fire hoses); (4) station tasks (i.e., filling air bottles and maintaining trucks, equipment, and the fire house); and (5) miscellaneous tasks such as starting/idling trucks and setting air brakes [20].

Research has shown that noise exposure among firefighters results in greater risk of hearing loss than that expected from aging alone. As such, occupational health experts have recommended the wide implementation of hearing conservation programs for firefighters, including the use of HPDs and engineering controls to reduce noise exposures [16–19, 21–23]. Current advanced technology for firefighters includes two-way communication systems or vehicle intercom systems. These systems are designed to facilitate clear speech and to simultaneously attenuate siren and vehicle engine noise, providing for hearing protection and clear communication both en route to and at the scene of a fire. However, despite NFPA recommendations, use of these HPDs is not required for every American firefighting service and focus group discussions with firefighters have suggested that they are not used consistently. Furthermore, firefighters consider that exposure to noise is a routine and acceptable part of their job and NIHL is unavoidable [20].

In order to develop effective interventions to promote HPD use among firefighters, occupational health professionals must first understand the factors contributing to hearing protection behavior in this population. A number of studies have investigated predictors of HPD use in farmers [24], factory workers [25–27], and construction workers [12, 28]; yet, to date, little is known about the factors associated with HPD use among firefighters. Thus, the purpose of the present study is to identify significant factors contributing to hearing protection behavior among firefighters in the United States.

Theoretical Framework

The theoretical framework used in the present study to identify predictors of HPD use among firefighters was originally derived from the Health Promotion Model [29], Social Cognitive Theory [30], and the Health Belief Model [31]. As shown in Fig. 1, predictors of HPD use are divided into two categories: modifying factors and cognitive–perceptual factors. Modifying factors include three categories: (1) demographic (i.e., age, gender, ethnicity, and years in

fire services)/experiential (i.e., occupational noise exposure)/biological (i.e., hearing ability) factors; (2) interpersonal influences (i.e., social models and interpersonal support for using HPDs); and (3) situational factors (i.e., choice of HPDs and organizational support for health). Cognitive–perceptual factors include three categories related to HPD use and two categories related to hearing loss. The former is comprised of (1) perceived self-efficacy (i.e., confidence in one’s ability to use HPDs correctly); (2) perceived benefits (i.e., expected positive results of HPD use); and (3) perceived barriers (i.e., potential negative aspects of HPD use). The categories related to hearing loss are (1) perceived susceptibility to hearing loss and (2) perceived severity of hearing loss. In this framework, the outcome health promotion behavior is use of HPDs. As presented in Fig. 1, all modifying and cognitive–perceptual factors have direct effects on use of HPDs. The modifying factors also have additional indirect effects on HPD use, exerting their influence through the cognitive–perceptual factors.

Method

Study Design and Participants

The present study involved the pretest data collected as a part of an ongoing hearing protection and cardiovascular disease prevention intervention study. Firefighters were recruited to participate in the study from occupational health clinics, fire departments, or a hearing test clinic in three states (California, Illinois, and Indiana) in the United States. A total of 722 firefighters from over 35 fire departments were recruited between March 2010 and May 2011. Among them, a total of 404 had actually participated in the study, resulting in response rate of 56% (404/722). All study protocols were approved by the Committee of Human Research of the University of California San Francisco and the Institutional Review Board of NorthShore University Health Systems in Glenview, Illinois, in the United States. Informed consent was obtained from all interested volunteers before completing the pretest survey, audiometric tests, and interventions. Audiometric tests were administered by certified staff in the occupational health clinic, audiologist’s office, or fire departments. Participants completed the survey and training online in the clinics or fire departments right after the audiometric tests or at their own convenience in their preferred location where internet access was available.

Measures

The online pretest survey was modified from prior research on predictors of hearing protection behavior in factory and

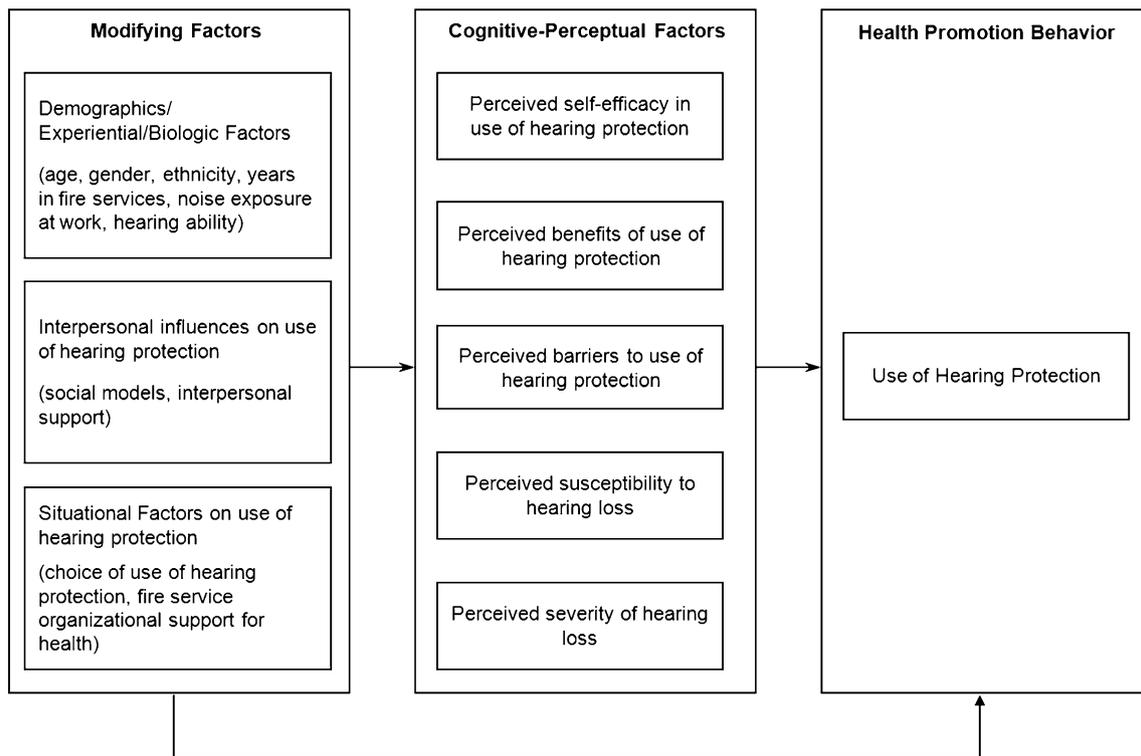


Fig. 1 Theoretical model

construction workers [25, 28, 32]. Validity and reliability of the instruments were examined and reported in detail in previous publications [12, 26, 28, 33]. The present study was the first to include measures of perceived susceptibility to hearing loss and perceived severity of hearing loss. As shown in Table 1, all measures demonstrated acceptable reliability coefficients (Cronbach's $\alpha = .70-.96$) for the current sample, with the exception of the perceived barriers to hearing protection scale (Cronbach's $\alpha = .69$). Considering that many of earlier studies demonstrated the perceived barrier to be a significant predictor of HPD use for various worker groups [12, 25–28, 33], this scale was included in the model, even though its reliability was a bit lower than the acceptable level. All variables are described in detail below and in Tables 1 and 2.

Dependent Variable: HPD Use

The dependent variable, frequency of HPD use when exposed to high noise levels, was measured by two questions regarding the self-reported percentage of time (0–100%) HPDs were used during the participant's most recent emergency situation/run and in the past 3 months. Due to strong correlations between these two questions ($r = .74, p < .001$), the average score of the two items was used as the dependent variable.

Independent Variables: Modifying Factors

Demographic/Experiential/Biological Factors Demographic data were collected using single item measures for age, gender, ethnicity, and years in fire services. Noise exposure at work was measured by a single question (i.e., "How often are you exposed to loud noise when working as a firefighter?") on a 5-point Likert scale (1 = rarely or never, 5 = daily). Hearing ability was assessed by two methods: self-reported perception of hearing and standard audiometric tests. Perceived hearing was measured by the question, "How good is your hearing?" on a 5-point Likert scale (1 = poor, 5 = excellent). Objective hearing ability was assessed by audiometric tests, which were performed using a microprocessor pure-tone audiometer in bilateral ears at frequencies of 0.5, 1, 2, 3, 4, 6, and 8 kHz. The audiometer was calibrated according to the American National Standards Institute (ANSI) S3.6-1996 standard [34]. Audiometric hearing tests were conducted in a double-walled booth that conformed to the ANSI criteria for ambient noise in audiometric rooms.

Interpersonal Influences on Use of Hearing Protection This scale measured firefighters' perceptions about others' (i.e., co-workers, captain or immediate supervisor, fire service mentor or role model) beliefs regarding HPD use using two subscales: social modeling and interpersonal support.

Table 1 Model components, instrument, description, descriptive statistics, and Cronbach's alpha coefficient ($N=404$)

Model components	Instrument	No. of Items	Mean	SD	Range	Cronbach's alpha
Interpersonal influences	Social models ^a + Interpersonal support ^a	6	2.46	1.08	1–5	.96
	Social models ^a	3	2.49	1.09	1–5	.94
	Interpersonal support ^a	3	2.42	1.20	1–5	.95
Situational factors	Choice of HPDs ^b	1	3.04	1.51	1–5	n/a
	Fire service organizational support for health ^b	2	3.65	0.96	1–5	.89
Self-efficacy	Self-efficacy in HPD use ^b	2	4.18	0.70	1–5	.74
Perceived benefits	Benefits of HPD use ^b	3	4.28	0.58	1–5	.80
Perceived barriers	Barriers to HPD use ^b	6	2.56	0.61	1–5	.69
Perceived susceptibility	Susceptibility of hearing loss ^c	2	3.58	0.77	1.5–5	.81
Perceived severity	Severity of hearing loss ^d	2	3.50	0.56	2–4	.71
Health behavior	Use of HPDs (%) ^e	2	33.71	33.65	0–100	.85

^a Ordinal scale: 1 = never, 5 = always

^b Ordinal scale: 1 = strongly disagree, 5 = strongly agree

^c Ordinal scale: 1 = absolutely not likely, 5 = absolutely likely

^d Ordinal scale: first item: 1 = not serious at all, 4 = very serious; second item: 1 = it would not bother me at all, 4 = it would bother me tremendously

^e Measured by percentage (0–100%) of the time

Social modeling measured how much participants perceived that others use HPDs when exposed to noise on the job.

Interpersonal support measured how much others are perceived as encouraging the participant to use HPDs. All

Table 2 Demographic and hearing-related characteristics of participants ($N=404$)

Characteristics	N (%)	
Gender	Male	373 (92.8)
	Female	29 (7.2)
Ethnicity	Asian/Pacific Islander	24 (6.0)
	African-American or Black	18 (4.5)
	Caucasian or White	323 (80.5)
	Hispanic or Latino/a	28 (7.0)
	Native American or American Indian	2 (0.5)
	Other	6 (1.5)
Noise exposure at work	Daily	194 (48.1)
	Weekly	147 (36.5)
	Monthly	43 (10.7)
	Yearly	7 (1.7)
	Rarely or never	12 (3.0)
Perceived hearing	Excellent	43 (10.6)
	Very good	131 (32.4)
	Good	168 (41.6)
	Fair	50 (12.4)
	Poor	12 (3.0)
	Mean (SD)	
Age (22–70 years)	45.0 (8.1)	
Years in the fire service (0–38 years)	17.4 (8.2)	
Measured hearing ^a (0–90 dB)	24.7 (15.5)	

^a Audiometric data: average of hearing threshold levels at 4 and 6 kHz in the worse ear

interpersonal influence items were measured on a 5-point Likert scale (1 = never, 5 = always). Social modeling and interpersonal support were highly correlated ($r=.79, p<.001$), thus two subscales were combined to represent interpersonal influence.

Situational Factors on Use of Hearing Protection This three-item scale included two subscales: choice of HPDs and fire service organizational support for health. Choice of HPDs was measured by level of agreement with a single statement: “At your fire department, you have a choice of different types of hearing protection.” Fire service organizational support for health was measured by two items: “Your fire service organization is generally concerned about your health and well-being,” and “Your fire service organization is committed to improving your health and well-being.” All situational factors were measured on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

Independent Variables: Cognitive–Perceptual Factors

Perceived Self-Efficacy in Use of Hearing Protection This scale was developed by the researchers to measure firefighters’ confidence in their ability to use HPDs correctly. An example of an item from this scale is: “You are confident you can use your hearing protection properly.” All perceived self-efficacy items were measured on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

Perceived Benefits of Use of Hearing Protection A three-item scale measured beliefs regarding the positive consequences of using HPDs. An example of an item from this scale is: “Regular use of hearing protection is beneficial to you because it helps protect your hearing.” All items were measured on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

Perceived Barriers to Use of Hearing Protection This six-item scale assessed perceived impediments to HPD use (i.e., inconvenience, discomfort, difficulty using HPDs, and interference with communication). An example of an item from this scale is: “It is difficult to hear other people talk when you are wearing hearing protection.” All items were measured on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

Perceived Susceptibility to Hearing Loss Perceived susceptibility, or the perceived chance of developing hearing loss, was measured using a two-item scale. An example of an item from this scale is: “If you don’t use hearing protection when you are exposed to loud noise, how likely do you

think it is that you will develop hearing loss within five years?” Both items were measured on a 5-point Likert scale (1 = absolutely not likely, 5 = absolutely likely).

Perceived Severity of Hearing Loss Perceived severity, or the perceived seriousness of hearing loss, was measured using a two-item scale. The first item, “If you developed hearing loss due to noise exposure, how serious of a problem would it be for you?,” was measured on a 4-point Likert scale (1 = not serious at all, 4 = very serious). The second item, “How much would it bother you to lose hearing due to noise exposure?,” was also measured on a 4-point Likert scale (1 = it would not bother me at all, 4 = it would bother me tremendously).

Data Analyses

Data were analyzed using SPSS 18. Demographic characteristics and study variables were analyzed using descriptive statistics. Means, standard deviations, and ranges were reported for continuous variables. Frequencies and percentages were reported for categorical variables. Many of the predictor variables (i.e., interpersonal influences, perceived benefits, perceived barriers, perceived susceptibility, and perceived severity) were assessed by multiple items that should intercorrelate. Internal consistency reliability for each scale was examined using Cronbach’s alpha coefficients. Scale reliability was considered acceptable if the alpha coefficient was greater than .70 [35]. The relationships between the predictor variables and HPD use were assessed using bivariate and multivariate analyses. Associations between the predictors and the dependent variable were assessed using Pearson correlation coefficients. Multiple regression was used to determine significant predictors of the HPD use when all other variables were statistically controlled for and to test the overall fit of the model. To avoid possible collinearity issues in the planned multiple regression analyses, correlations among independent variables were reviewed and decisions were made regarding exclusion for any variables that correlated at $r=.5$ or greater [36]. Since age and years in the fire service were highly correlated ($r=.74, p<.001$), age was excluded from the multiple regression model. Number of years in fire services was preferred because it was more meaningful for the purpose of this study and more strongly correlated to HPD use than age. Self-reported perceived hearing and measured hearing ability were highly correlated ($r=.51, p<.001$) and only perceived hearing ability was significantly associated with HPD use ($r=.12, p<.05$). Therefore, perceived hearing ability was chosen as the sole indicator of participants’ hearing status and was included in the model.

Results

Description of Study Participants

Characteristics of the study participants are summarized in Table 2. Participants were predominantly middle-aged (mean age=45 years), White (81%) males (93%) who had worked in fire services for an extended period of time (mean=17 years). About 48% of participants reported daily exposure to loud noise levels on the job. The majority (85%) of participants perceived their hearing as good or better. Mean use of HPDs was 34% of the time. Approximately 41% of the firefighters reported that they used HPDs less than 50% of the time that they were needed and 30% reported never using HPDs.

Correlations of Predictors with HPD Use

Pearson correlations of the dependent variable and the predictor variables are summarized in Table 3. Number of years in fire services, noise exposure at work, perceived hearing ability, interpersonal influences, choice of HPDs, fire service organizational support for health, perceived self-efficacy in use of HPDs, perceived benefits of using HPDs, perceived barriers to using HPDs, perceived susceptibility to hearing loss, and perceived severity of hearing loss were all significantly related to HPD use. Gender and ethnicity (white versus non-white) were not significantly related to HPD use. All correlations between independent variables were smaller than .5, thus, multicollinearity was not a concern.

Significant Predictors of HPD Use Among Firefighters

The results of the multiple regression analysis are presented in Table 4. The overall model explained 56% ($R^2=.56$, adjusted $R^2=.54$) of the variance in firefighters' HPD use ($F_{13, 372}=35.65$, $p<.001$). Three modifying factors, noise exposure at work ($\beta=4.82$, $p<.001$), interpersonal influences ($\beta=18.55$, $p<.001$), and organizational support ($\beta=-2.96$, $p=.028$) were significant predictors of HPD use. Two cognitive-perceptual factors, perceived barriers to use of HPDs ($\beta=-9.61$, $p<.001$) and perceived susceptibility to hearing loss ($\beta=6.27$, $p<.001$), were also significant predictors of HPD use.

Discussion

The present study showed that modifying factors (noise exposure, interpersonal influences, and organizational support) and cognitive-perceptual factors (barriers to HPD use and perceived susceptibility to hearing loss) were significant

predictors of HPD use among American firefighters. Although several studies have explored hearing protection behavior in farmers [24], factory workers [25–27, 33] and construction workers [12, 13, 28, 32], this study was the first to apply behavioral theories to understand firefighters' use of HPDs.

Results were similar to those from previous studies of other occupational groups. Noise exposure was a significant factor for firefighters to use HPDs, indicating firefighters who reported more frequent exposure to loud noise used HPDs more than those who with less frequent exposure to loud noise. This is consistent with earlier studies with factory workers, which reported workers who were exposed to higher level of noise used more HPDs compared to those who were exposed to lower level [25, 27].

Interpersonal influences (social modeling and interpersonal support on HPD use) were by far the strongest predictor of firefighters' HPD use in this study ($\beta=18.55$, $p<.001$). This is consistent with Ronis et al.'s [28] findings regarding the influence of social modeling on construction workers' use of hearing protection and Hong et al.'s [25] findings that social norms (i.e., workers' beliefs about how much others think they should use HPDs) are among the strongest predictors of HPD use in white factory workers. Among firefighters in particular, the strong interpersonal influence on HPD use may be reflective of a unique work culture (similar to the military) that highly values observational learning and encouragement from others. For example, in a study of factors contributing to eye protection use among soldiers, Wong and Seet [37] describe the substantial influence of peers on behavior. Soldiers live and work in tightly knit communities of fellow soldiers. In these communities they form close support systems, often surpassing that of the family. As a result, others' actions may strongly influence an individual soldier's behavior. As a potential intervention strategy, Wong and Seet [37] suggest requiring high-ranking military officials to act as role models for eye protection use. Similarly, firefighters work closely in teams, where they also form strong support systems. Given the high-risk nature of firefighting, trust, loyalty, and teamwork are essential among members of a department. If, as this model suggests, interpersonal influences strongly promote HPD use among firefighters, then behavioral interventions to increase use of HPDs by firefighters should focus on encouraging fire department leaders and firefighter union representatives to model and to support the use of HPDs on the job.

The model was an excellent fit to the data, accounting for over one-half of the variance in firefighters' hearing protection behaviors ($R^2=.56$, adjusted $R^2=.54$). This fit was higher than most previous studies of hearing protection behavior in non-firefighting workers [12, 24, 25, 27, 28, 33], which supports the rationale for using a comprehensive

Table 3 Correlations of HPD use with predictor variables (N=404)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Use of HPDs	1													
2 Gender (male) ^a	-.08	1												
3 Years in fire services	-.15**	.07	1											
4 Ethnicity (white) ^b	-.06	.13**	.02	1										
5 Noise exposure at work ^c	.19***	-.09	-.03	-.08	1									
6 Perceived hearing ability ^d	.12*	.00	-.24***	-.01	-.09	1								
7 Interpersonal influences ^e	.67***	-.08	-.11*	-.04	.06	.13**	1							
8 Choice of HPDs	.29***	-.06	-.04	.08	.04	.06	.46***	1						
9 Organizational support	.11*	.02	-.04	.01	-.05	.12*	.27***	.37***	1					
10 Self-efficacy in HPD use	.29***	.03	-.01	-.03	-.02	.09	.28***	.24***	.20***	1				
11 Benefits of HPD use	.28***	-.07	-.01	-.06	.01	-.04	.21***	.13*	.13**	.35***	1			
12 Barriers to HPD use	-.36***	.07	.07	-.06	-.03	-.11*	-.21***	-.14**	-.07	-.25***	-.39***	1		
13 Susceptibility to hearing loss	.33***	-.12*	-.03	-.02	.09	-.15**	.22***	.20***	.08	.19***	.42***	-.29***	1	
14 Severity of hearing loss	.15**	-.10	.00	-.18***	.07	.02	.11*	.04	.03	.15**	.33***	-.22***	.32***	1

* $p < .05$, ** $p < .01$, *** $p < .001$

^a Gender: 1 male, 0 female

^b Ethnicity: 1 white, 0 non-white

^c Ordinal scale: 1 = rarely or never, 5 = daily

^d Ordinal scale: 1 = poor, 5 = excellent

^e Interpersonal influences = Social models + Interpersonal support

Table 4 Summary of multiple regression for the model of HPD use predictors in firefighters

	β	SE	Standardized coefficients	<i>t</i>	Significance
Gender (male) ^a	2.71	4.58	.02	.59	.554
Years in fire services	−.27	.15	−.06	−1.79	.075
Ethnicity (white) ^b	−3.74	3.03	−.04	−1.24	.217
Noise exposure	4.82	1.26	.13	3.83	<.001
Perceived hearing ability	1.06	1.35	.03	.79	.431
Interpersonal influences	18.55	1.27	.60	14.59	<.001
Choice of HPDs	−.63	.91	−.03	−.68	.494
Organizational support	−2.96	1.34	−.08	−2.21	.028
Self-efficacy in HPD use	2.87	1.86	.06	1.54	.124
Benefits of HPD use	1.58	2.44	.03	.65	.517
Barriers to HPD use	−9.61	2.16	−.17	−4.46	<.001
Susceptibility to hearing loss	6.27	1.76	.15	3.56	<.001
Severity of hearing loss	−1.86	2.31	−.03	−.80	.422

$R^2=.56$, and adjusted $R^2=0.54$, $F_{13,372}=35.65$ ($p<.001$)

^aGender: 1 male, 0 female

^bEthnicity: 1 white, 0 non-white

framework based on the Health Promotion Model, Social Cognitive Theory, and the Health Belief Model. One explanation for this improvement in fit may be the inclusion of two new cognitive–perceptual variables into the model, namely, perceived susceptibility to hearing loss and perceived severity of hearing loss. These two variables, along with perceived benefits and barriers, comprise the Health Belief Model, which has been found to be useful in understanding preventative health behaviors [38]. In the present study, only perceived barriers to HPD use and perceived susceptibility to hearing loss (among these four variables) were found to be significant predictors of firefighters' hearing protection behavior. Perceived barriers to HPD use has been consistently significant predictor of the use of HPDs across a variety of occupational groups such as workers in farming, construction, and manufacturing [12, 24–28, 32, 33]. It is important to incorporate guidance on overcoming the barriers (such as trying different types of HPDs to find one that is comfortable) into the hearing protection intervention programs. For firefighters, in particular, there are a variety of HPDs from conventional types of HPDs (earplugs and earmuffs) to the two-way communication system or vehicle intercom system designed to provide them with clear communication and hearing protection both en route to and at the fire scene [20]. Therefore, the benefits of using these advanced hearing protection systems should be communicated well to firefighters who may have concerns about possible difficulty with communication with the use of HPDs.

This is the first study that included and found the significance of perceived susceptibility to hearing loss as a predictor of the use of HPDs among firefighters. If reducing the chance of hearing loss is a key motivation for using HPDs, workers must perceive they are susceptible to hearing loss in order to be motivated. In addition if that perception is variable enough across workers it should be predictive of

use. This was specified by the Health Belief Model and a clarification that the measure of susceptibility should be conditional on non-use of the protective behavior was made and empirically supported by Ronis [38]. The current study appropriately used a conditional measure. A possible implication for intervention is that one of the pieces of information to present is that firefighters are susceptible to hearing loss. Perhaps this only needs to be emphasized to firefighters who report low susceptibility, since many of them are already aware of their chance of developing hearing loss.

Interestingly, the relationship between organizational support and HPD use in the regression analysis was negative, indicating that the participants who reported more support from their fire services were less likely to use HPDs than those who reported less. This significant effect was opposite in sign to the significant positive correlation of organizational support with HPD use. Examination of a series of multiple regression analyses revealed that the sign of the coefficient of organizational support switched from positive to negative when interpersonal influences was added to the model. This suggests that interpersonal influences (by far the strongest predictor of HPD use) which is correlated with organizational support took over the effect of organizational support in predicting HPD use. This was apparently due to collinearity between them that was not strong enough to be detected by examining the correlations. The positive correlation of organizational support and HPD use appears to more accurately represent the relationship. Increasing organizational support for use of HPDs seems useful despite the regression result for it.

Although the prevalence of HPD use is not directly related to the focus of this study, it is concerning that this sample of firefighters reported only using HPDs one-third of the time that they are needed. According to focus group discussions conducted by Hong et al. [20], limited HPD use

among firefighters may be due to a lack of understanding about the damage caused by noise, a risk-taking culture unique to firefighting, and/or the belief that HPDs interfere with the ability to communicate and to perform duties effectively. To reduce the morbidity associated with NIHL in this population, future research should focus on developing and testing interventions to educate firefighters about the irreversible damaging effects of noise exposure on their hearing ability. Firefighters should also be taught about the variety of HPDs available that do not interfere with communication on the job. As the results of this study suggest, interventions incorporating social modeling and interpersonal support by fire department leaders and union representatives may also be particularly useful in promoting hearing protection behavior in this population.

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