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Safety climate, hearing climate and hearing protection device use among transportation road maintainers:

Hearing climate and HPD use

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Abstract

Background: It is important to understand workplace factors including safety climate that influence hearing protection device (HPD) use. We sought to characterize and investigate the association between HPD use, safety climate, and hearing climate, a new climate measure specific to hearing.

Methods: Using a participatory, *Total Worker Health®* approach, a survey was developed and distributed among transportation 'maintainers' who perform road maintenance and repair. A new hearing climate measure was designed by adapting a safety climate measure. HPD use was assessed by asking workers how often they wear HPD while in noise. The differences in safety climate and hearing climate were compared by frequency of HPD use using ANOVA. Log binomial regression models were used to identify if safety climate and hearing climate predict the prevalence of HPD use.

Results: Among 166 maintainers, 54% reported always or almost always wearing HPD (high frequency). As compared to low frequency, high frequency HPD users reported a statistically significant higher safety climate (mean (std) of 3.94(0.65) versus 3.64 (0.65), p=0.004) and hearing climate (mean (std) of 3.78 (0.75) versus 3.38 (0.57), p=0.003). Hearing climate (p=0.03), but not safety climate (p=0.40), was a statistically significant predictor of increased prevalence of HPD use.

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Conclusions: Hearing climate predicts frequency of HPD use and may be a useful measure when assessing and improving hearing conservation programs. Results from this study provide baseline, pre-intervention hearing climate and HPD use frequencies that are expected to increase subsequent to the implementation of a hearing health intervention.

Keywords

safety climate; hearing protection device use; transportation workers; hearing conservation; personal protective equipment; hearing climate

Introduction

Noise-induced hearing loss (NIHL) is one of the most common occupational illnesses in the United States, with nearly 22 million workers noise-exposed workers in the United States.[1] While hearing loss in itself is a disability, even workers with mild hearing loss experience reduced audibility (loudness) and dynamic range (range of softest to loudest sound capable of being heard) and often have difficulty understanding speech, especially in noisy environments.[2] Preventing or reducing worker exposure to noise is imperative to preventing NIHL.

Among U.S. worker, the highest prevalence of hazardous workplace noise exposures occurs in the mining (76%) and construction (44%) industries.[3] Clearly, the most effective way to prevent NIHL is to eliminate noise hazards. Following the hierarchy of controls, when elimination is not feasible, engineering controls, administrative controls and lastly, personal protective equipment (PPE) are prioritized. However, for many workers, including those at-risk in the mining and construction industries, the workplace is constantly changing and elimination or retrofitting of noisy equipment is not possible or feasible. Thus, these workers must often rely on PPE, specifically hearing protection devices (HPD), to protect hearing health.

Of the estimated 325,900 construction trade workers within the transportation sector, 76% may be exposed to hazardous noise levels.[3] Transportation maintenance workers or “maintainers” are construction trade workers within the transportation sector who maintain and repair roadways while performing seasonal tasks including snow plowing, tree removal, road paving, and mowing. High noise tasks include applying asphalt (90 dBA)[4], sewer maintenance (100–109 dBA)[4], street maintenance (84–105 dBA)[4], clearing brush while using a chain saw (105–108 dBA)[5] or wood chipper (102–105 dBA),[5] lawn maintenance with riding mower (88–96 dBA)[5] or weed trimmer (101–98 dBA).[5] Maintainers’ noise exposures are above the OSHA action level of 85 dBA, and are also variable, changing between and within days with each new task. Due to the work environment and lack of engineering controls, workers rely on HPD including foam earplugs or over-the-ear muffs to reduce noise exposure.

As part of a hearing conservation program, it is important to understand the workplace factors that influence employee’s HPD use. Safety climate refers to workers’ perceptions about the importance management gives to organizational policies, procedures, and practices regarding safety.[6] Safety climate has been positively linked to safety outcomes as well as

safety behaviors such as increased PPE use.[7–9,10,11]. Associations have been observed between higher general safety climate and increased PPE use,[10,12–18] although few have examined HPD use specifically.[13–16]

The current analysis is part of a broader study, HearWell, which uses a participatory, *Total Worker Health®* approach to design, implement and assess a hearing conservation program for transportation workers. As the first part of the HearWell program, we sought to understand the work organizational and psychosocial factors, specifically general safety climate, that influence hearing conservation. Subsequent efforts of the HearWell program include the design, implementation and evaluation of a hearing health intervention. The goals of the current study are multifold. First, we sought to characterize HPD use among transportation maintainers. Second, we sought to characterize general safety climate as well as a new measure, hearing climate, which specifically characterizes workers' perceptions about organizational policies, procedures and practices regarding hearing and noise. We hypothesized that hearing climate would be related to, but distinct from, the general safety climate measure. Given that safety is a broad issue, we hypothesized that within the overarching general safety climate of an organization there are in fact distinct, yet related, climates. Given that we are interested specifically in hearing and behaviors related to hearing, we hypothesized that a hearing climate variable would be a better predictor of HPD use as compared to general safety climate. Importantly, survey results including frequency of HPD use and hearing climate will serve as baseline measures that will be reassessed and compared at a second time point following the implementation of the intervention delivered as part of the larger HearWell study.

Materials and Methods

The study uses a community-based participatory research approach as outlined in the Center for the Promotion of Health in the New England Workplace (CPH-NEW) Healthy Workplace Participatory Program (HWPP).[19] Worker-based design teams in collaboration with a manager-led steering committee were formed to design and implement a hearing conservation program using a participatory *Total Worker Health®* approach. Design teams consisted of line-level employees including 5 to 6 maintainers and a crew leader at two regional maintenance garages. As part of the CPH-NEW HWPP, the design team used the intervention design and analysis scorecard (IDEAS) to identify root causes of hearing damage, as well as to design, implement and evaluate a hearing health intervention.[20] As a first step of the IDEAS process, design teams brainstormed barriers to hearing health and surveyed the workforce to assess congruence with design team perceptions. Design team members, identified that safety, including use of personal protective equipment (PPE), was important and a high priority. However, they indicated that when workers were told to wear their PPE, they rarely consider hearing protection devices (HPD) as part of PPE. One member of the design team explained: "If you went out in the workforce right now and just grabbed a guy in the hallway and said…tell me what is PPE? He'll say my hat, my vest, my gloves, and maybe glasses. No way would they say hearing protection." The design teams provided input on all aspects of the study including survey items and development of the new hearing climate scale. The University Institution Review Board reviewed and approved all study methods and all study participants provided written, informed consent.

Study population

A cross-sectional study was performed among unionized, state workers within the Department of Transportation maintenance garages across a New England state. Maintenance garages are regionally distributed across the state and are assigned a series of state roadways to maintain and repair. Each garage employs approximately 15 workers, and the majority have the job title “maintainer”. However, a few crew leaders, one or two supervisors, and a dispatcher also work within each garage. Workers perform seasonal tasks including mowing and road repair in the spring, summer, and fall, and snow and brush removal in the winter. Workers report to the garage each morning and receive task and work location assignments. Depending on the task, workers may work alone or in a crew of 3 to 4 alternating workers. Since the task for each worker changes from day to day, the work structure also changes with workers alternating between lone and crew-based work.

Study measures

The design team and researchers created a survey to assess workplace perceptions about safety and hearing and noise as well as HPD use. Perceived general safety climate was assessed using a short 6-item scale[21] that assessed co-worker behavior norms, safety feedback, management commitment, and worker involvement on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). To address the gap in culture with respect to hearing protection, in collaboration with the design team, we created a new hearing climate measure by adapting the chosen general safety climate measure[21] by substituting the terms ‘general health and safety problems’ and ‘general safety problems’ with the terms ‘use of hearing protection’ and ‘hearing’. A general safety climate or hearing climate variable was computed by averaging the responses to the 6 individual questions, respectively.

The frequency of HPD use was captured using the survey item “*If you use noisy tools or are in noisy areas, do you use hearing protectors (e.g., earplugs or earmuffs)?*” rated from always (1) to rarely or never (6) on a 6–point frequency scale. A similar survey item was used to assess HPD use during high noise exposure among a variety of construction trade workers.[22] Demographic and work-related factors including job title and tenure were also collected.

Study population and recruitment

Researchers visited 12 garages out of 48, distributed across the state from December 2017 to January in 2018. The 12 garages were randomly selected from 24 centrally located garages within the state. All workers who regularly reported to the garage were eligible for the study. At the beginning of the workday, research staff described the study, answered questions, and obtained informed consent. Workers were given a computer tablet and asked to complete a 15-minute electronic Qualtrics survey. Rosters of all employed and present workers were collected at each garage to assess participation levels.

Analysis

Summary statistics including mean, standard deviations and percentages were calculated to describe participant characteristics. We assessed how and whether to aggregate the climate variables. The aggregation of a climate score assumes a homogenous perception of

occupational health and safety (or hearing) across the level which aggregation occurs. Climate scores can be aggregated at the organization level,[23] at the group level,[24,25] or may be reported at the individual level.[26] We chose the level of aggregation based on the approach outlined by Huang et al.[26] First, we examined the theoretical justification that the climate may differ between work groups. Given the work structure of the maintainers, where they work out of garages spread across the state, garage level, rather than organizational level aggregation seemed appropriate. While prior work among Australian construction road maintainers report distinct group-level safety climates, the Australian workers maintain stable small workgroup sub-units of 4 workers on average.[27] However, since maintainers work alone or in small crews at highway locations and furthermore the crew and location change from day-to-day, we hypothesized that similar to lone workers,[26] general safety climate among transportation workers would be based on individual perceptions of organizational and supervisor practices as it relates to safety as compared to shared perception among a group. Continuing with the criteria outlined by Huang et al.,[26] we examined whether there was statistical justification for homogeneity of climate within group. To test the lone worker assumption, we calculated within-group agreement indices, specifically intra-class correlation coefficients, ICC(1) and ICC(2) for both general safety climate and hearing climate, designating each garage as the group level factor. We used ICC(1) and ICC(2) cut-points of ICC(1) >0.10 and ICC(2) >0.70, as previously used in a study of construction contractor safety.[28]

We conducted an exploratory factor analysis (EFA) in SPSS version 24.0 as a first step to determine whether general safety climate items and hearing climate items loaded individually on two distinct factors (i.e., general safety climate factor and hearing climate factor). We utilized principal axis factoring (PAF) with an oblique rotation method. Exploratory factor analysis is a statistical technique where the goal is to identify the underlying relationship between measured variables (e.g., whether the measured variables are part of the same underlying construct). In order to confirm the results from the EFA that general safety climate and hearing climate are two related but distinct factors, we conducted confirmatory factor analyses (CFA). Confirmatory factor analysis is used to determine if the data fit a hypothesized measurement model, often determined through an EFA. An initial model was conducted whereby general safety climate items were specified to load onto a general safety climate factor and hearing climate items were specified to load onto a hearing climate factor, but the factors were not allowed to correlate. The Cronbach's alpha, a measure of internal consistency for a scale that ranges from 0 to 1, with higher scores indicating greater internal consistency, was computed for both climate variables.

We used one way analysis of variance (ANOVA) to identify statistically significant differences in general safety climate and hearing climate by participant characteristics. Given that noise exposures among this population is often above 85 dBA, HPD use was dichotomized into workers who always or almost always use HPD (high frequency HPD users) versus workers who reported wearing HPD usually/often/sometimes/rarely or never (low frequency HPD users). Differences in perceived overall general safety climate and hearing climate as well as the individual climate constructs were compared by HPD use category using ANOVA.

Correlations between general safety climate and hearing climate were assessed using Pearson correlation coefficients. Multivariable regression models of prevalence ratios were used to identify the independent contribution of general safety climate and hearing climate in predicting hearing protection device use after adjusting for statistically significant predictors, as identified in ANOVA. Prevalence ratios were calculated using SAS PROC GENMOD with log-binomial regression. ANOVA and regression analysis were performed in SAS 9.4 (SAS Institute, Cary, NC) and p-values less than 0.05 were used to identify statistical significance.

Results:

Participant Characteristics and Hearing Protection Device Use

A total of 166 individuals across 12 maintenance garages were consented and enrolled in the study. Across the garages, a total of 176 workers were present at the time of the survey, for a participation rate of 94%. The mean (sd) number of employees at each of the 12 garages was 13.8 (2.3) and ranged from 10 to 19. The majority of participants were male (97%), white (69%) and had a job title of maintainer (85%) as compared to supervisor or crew leader (15%) (Table 1). The participant's mean (sd) age was 44(11) years with a tenure of 12(10) years. The majority (63%) of respondents completed high school with 26% having some college and 8% a college degree. On a scale of 1–6 (always to rarely or never) participants reported a mean (sd) of 2.7 (1.5) HPD use while using noisy tools or in noisy areas. This corresponds to 54% of workers reporting they always or almost always wear HPD while using noisy tools or in a noisy area.

Perceived general safety climate and hearing climate

The ICC(1) for general safety climate and hearing climate were low at 0.007 and 0.045, respectively. This was also the case for ICC(2) which were 0.11 and 0.38 for general safety climate and hearing climate. Based on both the theoretical and statistical justification, aggregation of climate variables was not performed[29] and the individual construct or psychological climate is presented for each.

Results of the EFA where general safety climate and hearing safety climate items were postulated to load onto two distinct factors, indicated that general safety climate items loaded independently and significantly on a general safety climate factor, with all loadings exceeding .40; further results indicated that all hearing climate items loaded independently and significantly on a hearing climate factor, with all loadings exceeding .40. In addition, eigenvalues exceeded 1.0, indicating a two factor solution for general safety climate and hearing climate. The initial CFA model specified two factors, with general safety climate items loading onto one factor and hearing safety climate items loading onto another factor, and were not allowed to correlate. This initial CFA model fit the data poorly [$\chi^2(54) = 180.49$; $p < .001$; RMSEA = .12; CFI = .85; TLI = .82; SRMR = .22], indicating that general safety climate and hearing safety climate should be allowed to correlate. We utilized standard fit indices as indication of good fit (e.g., a non-significant χ^2, RMSEA <.08, CFI and TLI >.90, SRMR <.05). Next, we conducted a CFA model that allowed the general safety climate and hearing climate factors to correlate which yielded improved model fit

[$\chi^2(53) = 117.64$; $p < .001$; RMSEA = .09; CFI = .93; TLI = .91; SRMR = .05], supporting our assumption that general safety climate and hearing safety climate are related factors. Furthermore, a chi-square difference test favored the model with two correlated factors (general safety climate and hearing climate). The Cronbach's alpha for safety climate and hearing climate were $\alpha = 0.82$and $\alpha = 0.88$, respectively.

The mean (sd) perceived general safety climate and hearing climate scores were 3.79 (0.67) and 3.60 (0.70), respectively. The detailed distribution of responses for each safety climate and hearing climate items are available in Figures 1 and 2. Variations in general safety climate and hearing climate by race, education and tenure were not statistically significant. However, workers older than 46 years, as well as supervisors, reported a statistically significant higher general safety climate and hearing climate (Table 2).

The majority of workers agreed or strongly agreed with general safety climate items (Table 3). When workers were separated into high frequency HPD users who report always or almost always wearing HPD when using noisy tools or in noisy areas, as compared to low frequency HPD users, there were statistically significant difference in some, but not all general safety climate items (Table 3). The majority of workers across both HPD use frequency categories agreed or strongly agreed with the general safety climate items representing constructs of coworker behavior norms, safety feedback, as well as worker involvement. However, within the management commitment construct, more high frequency of HPD use workers (70–75%) agreed or strongly agreed with the survey items as compared to low frequency HPD users (51–61%) with 2 of the 3 items statistically significant ($p<0.05$). The mean (sd) general safety climate was higher among high frequency HPD users (3.94 (0.65)) as compared to low frequency HPD users (3.61 (0.65)) and this difference was statistically significant ($p=0.002$).

A smaller percentage of workers agreed with hearing climate items as compared to general safety climate items (Table 3). While the majority of workers agreed or strongly agreed with items representing co-worker behavior norms, worker involvement and some items of management commitment; half or fewer workers agreed or strongly agreed with items representing safety feedback, and two of the management commitment items. With the exception of the one hearing climate item within the co-worker behavior norms, more high frequency HPD users agreed with survey items as compared to low frequency HPD users, and the difference was statistically significant. The mean (sd) hearing climate was higher among high frequency HPD users (3.78 (0.75)) as compared to low frequency HPD users (3.38 (0.57)) and this difference was statistically significant ($p=0.0002$).

We examined the independent associations between general safety climate and hearing climate and HPD use in multivariable regression models of prevalence ratios after adjusting for statistically significant variables identified in the ANOVA analysis. There was a moderate correlation ($r = 0.57$) between the general safety climate and hearing climate variables. There was a statistically significant increased prevalence of frequent HPD users with increasing hearing climate (Table 4). The increased prevalence of frequent HPD users with increasing general safety climate was not significant ($p = 0.40$), nor was median age or supervisor status in the multivariable models.

Discussion

The presence of standards, policies and procedures alone do not assure that hearing conservation programs will achieve the intended results of improving HPD use or protecting worker hearing. Climate measures can provide an assessment of worker perceptions of workplace policies and how they affect practices. Importantly, we found that hearing climate, a researcher- and worker-designed measure specific to hearing and noise, predicted HPD use frequency independent of general safety climate, which aligns with prior research that specific climates may predict specific outcomes.[30] The hearing climate measure was a better predictor of HPD use, showing statistical significance in multivariable models a part from safety climate. This evidence supports the concept that general safety climate and hearing climate are related but conceptually distinct and suggests that general safety climate and hearing climate may differentially predict outcomes. It is likely that safety behaviors, including PPE use, are nuanced and may need to be considered individually when evaluating and improving specific safety programs.

Within this population of noise-exposed road maintainers, when asked how often they use HPD when using noisy tools or in noisy areas only 27% reported always and 28% almost always. Among the remainder, 3% reported rarely or never using HPD. Low HPD use is not unique to road maintainers. In a national study, in the highly noise exposed industries of mining, utilities and construction, non-HPD use was high at 13%, 20% and 31% respectively.[3] It is difficult to compare HPD use frequency across different occupations and work sectors as the level of noise and therefore the frequency of required HPD use is may differ. HPD use among the current population is higher as compared to residential Latino roofers, where 28% of respondents reported wearing HPD most or all of the time.[13] It is likely that the actual usage of HPD while in noise is lower than self-reported usage. In a study of Latino roofers, self-reported use of HPD most or all of the time varied by baseline questionnaire (28%) as compared to daily diary (12%).[13] Similar results have been observed in other construction trades, where workers reporting ‘always’ using HPD in high noise on a survey were observed to wear HPD only one-third of the time.[22]

This study used a short general safety climate measure to gauge workers’ perceptions about the organizational policies, procedures, and practices regarding safety are similar to prior research. While it is difficult to compare the general safety climate values across populations due to differences in scales as well as hazards present, the trends we observed with perceived higher general safety climate among supervisors and older workers are consistent with prior studies. Safety climate perceptions are rated higher among supervisors and managers over line-level employees,[31] while older workers exhibit more on-the-job safety practices compared with their younger counterparts.[32,33]

Consistent with research, higher general safety climate is associated with increased PPE use.[10,12–18,34] Results of general safety climate and HPD use specifically have been mixed. Arcury et al. found a positive correlation between general safety climate and self-reported eye protection, gloves and hard hat but hearing protection use was only positive at a baseline survey, but not with daily diary reports among residential roofers.[13] Dutra et al. found among construction workers, co-worker safety climate, but not contractor safety climate was

associated with hearing protection use, yet both contractor and co-worker safety climate were associated with use of other PPE including respiratory and fall protection.[14] The link between specific safety behaviors and specific climate measures has been previously supported.[30]

Within the general safety climate and hearing climate variables, we reviewed differences in the individual constructs including co-worker behavior norms, safety feedback, management commitment and worker involvement by HPD use frequency. For general safety climate, statistically significant differences within the management commitment construct were observed among low versus high frequency HPD users. Management commitment to safety has been shown to have a significant role in the safety climate of an organization, and may in fact account for over half of the variance in safety climate.[23,35,36] Along with management commitment to safety, it is often regarded that worker's involvement in safety practices[37,38] and communication/safety feedback[39] leads to perceptions of a more positive safety climate among employees. For hearing climate, the management commitment construct as well as safety feedback and worker involvement constructs differed between high and low frequency HPD users.

Interestingly, in the current population there was little support for the co-worker behavior norms as an important construct in differentiating high frequency HPD users, despite studies suggesting it is an important construct in predicting safety behaviors in construction workers.[40] This may be due to the fact that transportation maintainers often work alone or small groups, reducing the influence of coworkers. Alternately, it may also be a limitation of the survey item that was used to assess the co-worker behavior norm construct.

Understanding the workplace factors that influence the success of hearing conservation programs is critical to preventing noise-induced hearing loss. While reducing exposure through engineering controls or other methods is preferred to PPE use, understanding factors that support HPD use in environments of high noise exposure is important. Importantly, we chose to focus on one feature of the work environment, climate, as it relates to safety and hearing. Examining the individual constructs within the hearing climate measure may provide important factors to consider when assessing a hearing conservation. However, personal factors such as comfort and knowledge may play a role and should also be considered.

A workplace climate supportive of hearing health is only one component of a workplace program designed to protect and promote hearing health. Likewise, this survey is one component of a multistep process using a participatory, Total Worker Health® framework to design a comprehensive hearing conservation program. Importantly, the hearing climate results have informed the customization of hearing conservation training and noise hazard identification. Specifically, low agreement within the management commitment construct of hearing climate, suggested the need to train managers and crew leaders on how to best support hearing health. Within HearWell project, training and education components for both supervisor and maintainers has been developed and are being tested. Furthermore, the statistical analysis of within-group indices (ICC(1) and ICC(2)) suggested that the climate variables should not be aggregated at the work group and in fact, the maintainers are more

similar to lone workers, similar to truck drivers.[26] With respect to climate, lone workers are characterized by working alone or out of earshot of coworkers. With this in mind, the HearWell intervention has been tailored to equip lone workers with the knowledge, skills, and self-efficacy to promote individual hearing protection use. We expect an increase in both frequency of HPD use as well as hearing climate following the HearWell intervention.

The study results should be evaluated in light of its limitations. The study relies on self-reported HPD use which has been validated against researcher observation among a variety of populations including manufacturing workers;[41,42] construction trade workers;[22,43] and roofers[13]; although not within the current population. Prior research suggests that workers tend to over-report HPD use on surveys.[22,41–43] Furthermore, the reporting validity of HPD use varies based on characteristics of the workers' noise environment, specifically workers in variable noise environments, as is the case for the current population, tend to have lower, although still significant, agreement between self-report and observation.[43] Working in a variable noise environment, the maintainers must assess the noise level and time they will spend in the noise and then choose to wear HPD in contrast to constant noise environments such as a factory where HPD use is required based on high noise locations. Therefore, in addition to assessing the frequency of HPD use, our survey items also required workers to assess when HPD use is required based on use of noisy tools or in noisy areas. To increase the accuracy of self-reported HPD use, surveys were anonymous and performed by study staff rather than Department of Transportation personnel and the data was dichotomized as previous research indicates highest agreement of self-report and researcher observations among never and always HPD users.[22] The relatively high level of perceived general safety climate and hearing climate may indicate that these workers are not representative of transportation workers or construction workers performing similar tasks. Likewise, the lone nature of transportation maintainers may limit the generalizability of study results to workers who consistently work in work groups where co-worker support may play a larger role in predicting safety climate as well as safety behaviors including PPE use. While the hearing climate variable was an important predictor of HPD use, it is yet to be tested in other populations. Furthermore, the cross-sectional nature of the study limits our ability to ascribe causality and in fact, people reporting higher hearing climate may report higher HPD use.

The study provides a new hearing climate measure that successfully differentiates between high and low frequency HPD users. Furthermore, it provides input on the hearing climate of an organization that allows for the assessment of workers' perceptions about the organizational policies, procedures, and practices that support hearing health. General safety climate may be a general a measure of safety practice, but that there are various facets of safety (such as hearing climate) that can provide more detailed information about specific types of safety practice, when that level of detail is needed to assess risk and change behavior. Hearing climate, distinct from general safety climate, also outlines areas where a hearing conservation program can be improved, ultimately leading to the preservation and promotion of worker hearing.

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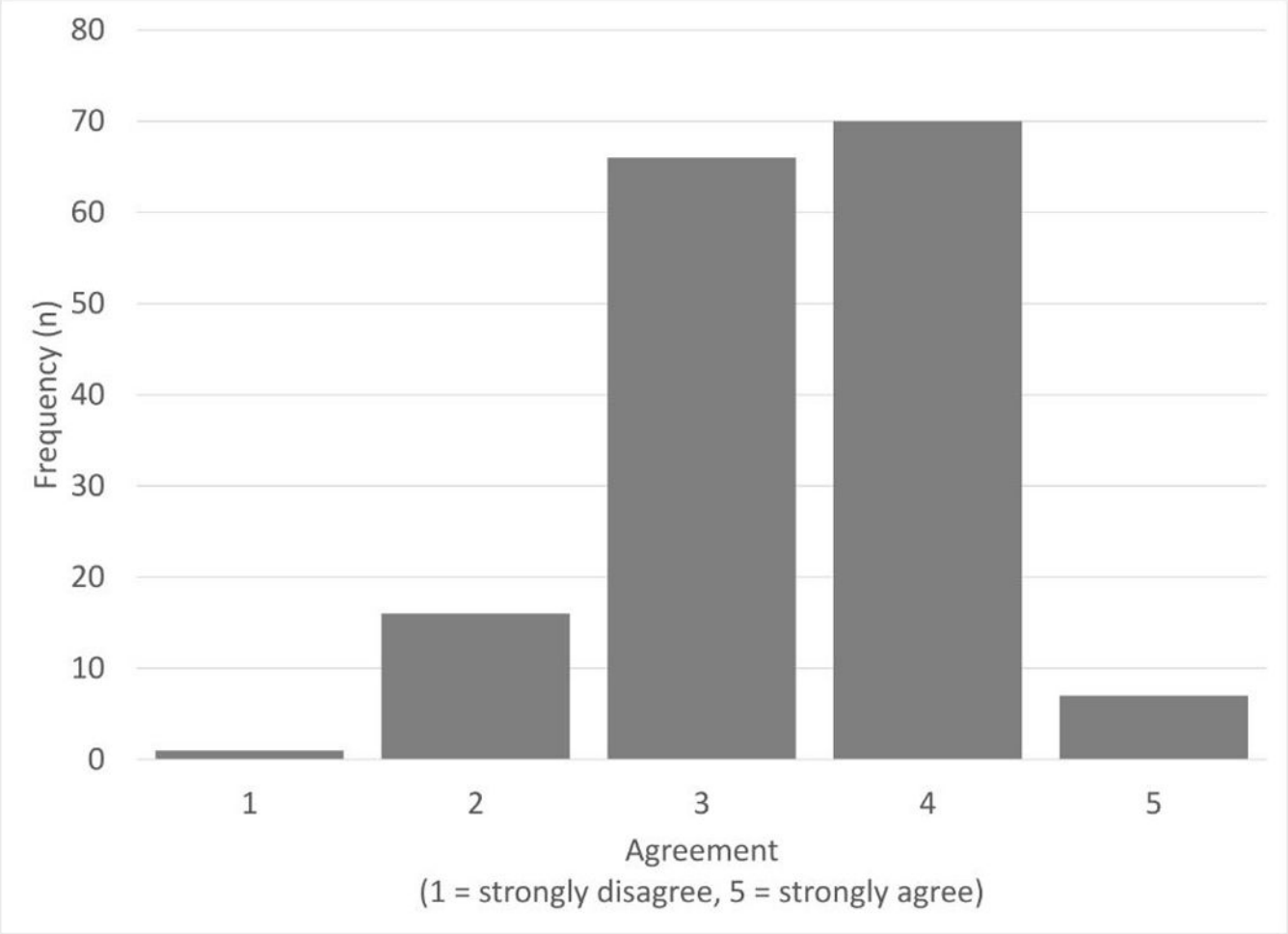

Figure 1.
Frequency distribution for safety climate reported among maintainers.

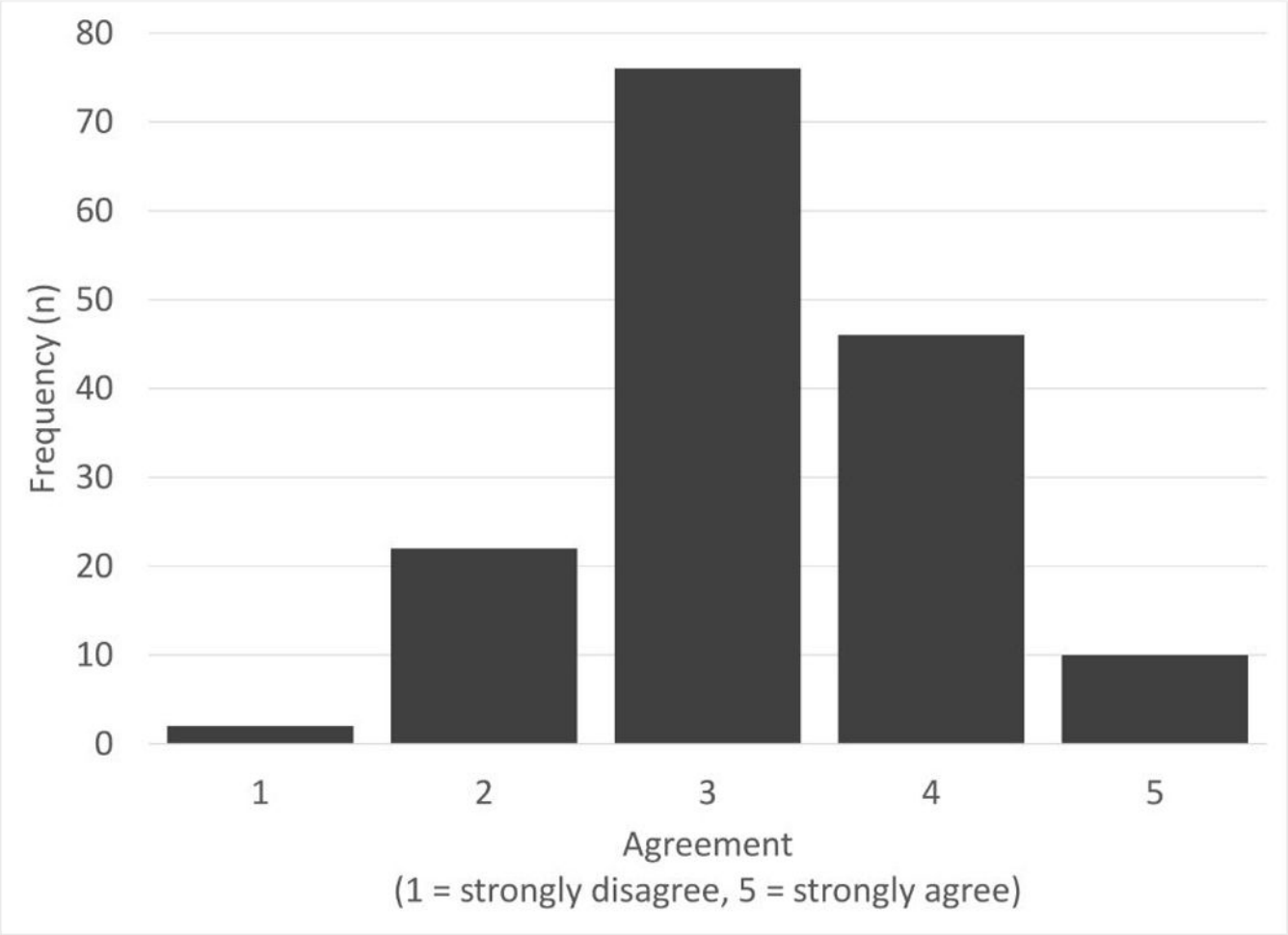

Figure 2.
Frequency distribution for hearing climate reported among maintainers.

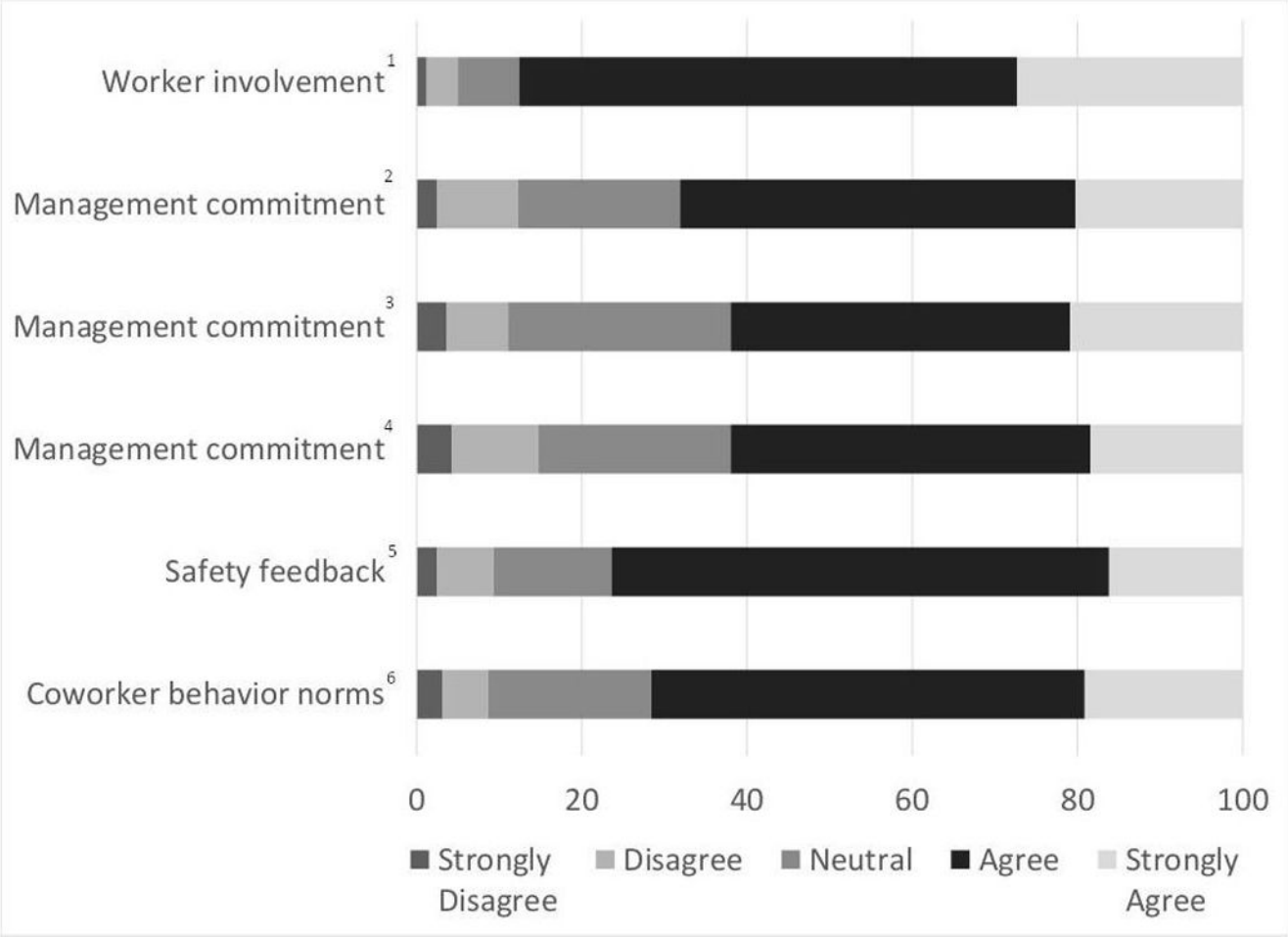

Figure 3.

Frequency distribution for safety climate items reported among maintainers. 1: I feel free to report safety problems where I work. 2: The health and safety of workers is a high priority with management where I work. 3: There are no major shortcuts taken when workers health and safety are stake. 4: Workers and management work together to ensure the safest possible work conditions. 5: Employees are told when they do not follow good safety practices. 6: New employees learn quickly that they are expected to follow good health and safety practices.

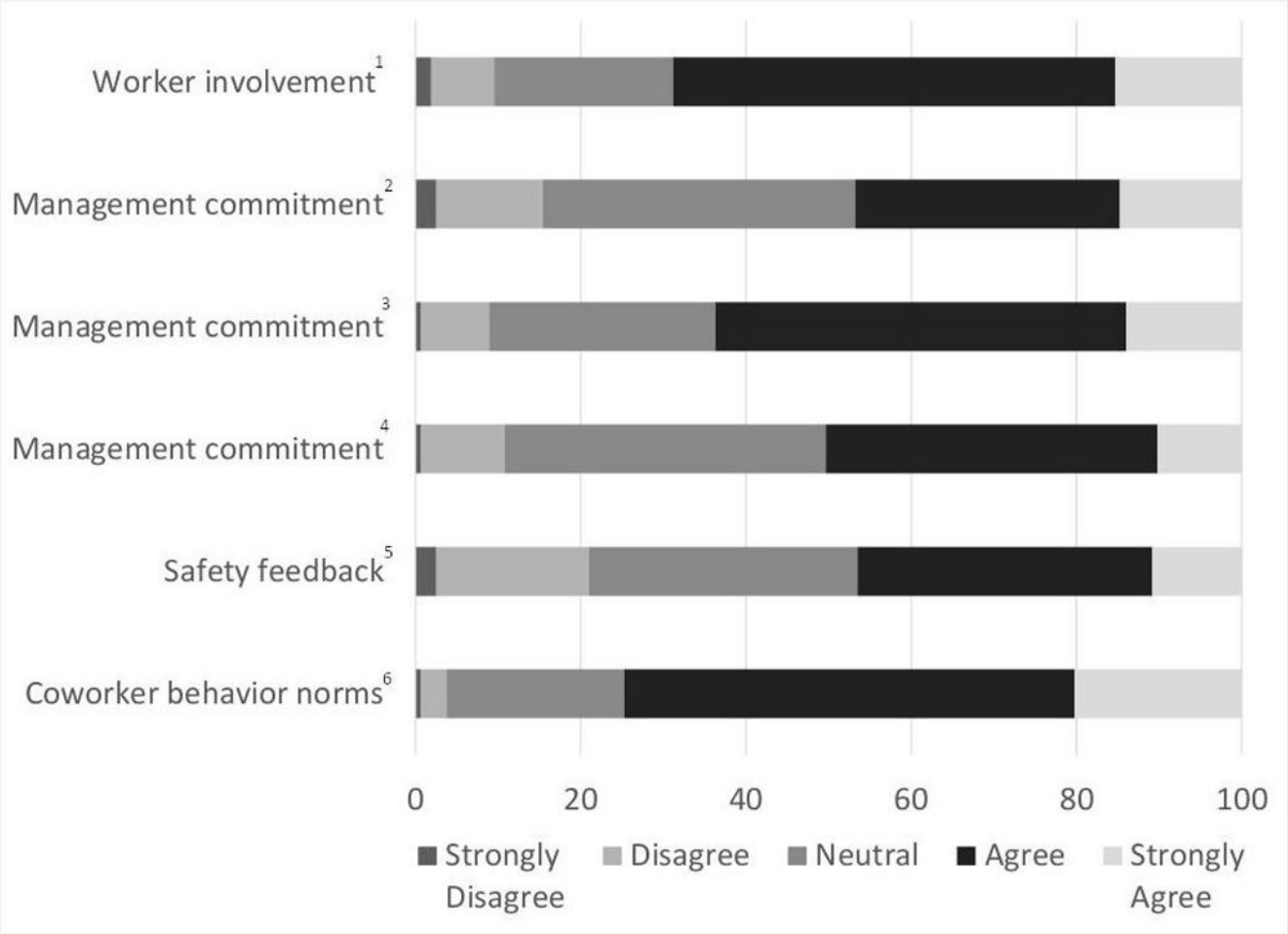

Figure 4.

Frequency distribution for hearing climate items reported among maintainers. 1: I feel free to report noise hazards where I work. 2: The hearing of workers is a high priority with management where I work. 3: There are no major shortcuts taken when workers hearing is at stake. 4: Workers and management work together to protect hearing. 5: Employees are told when they do not wear hearing protection. 6: New employees learn quickly that they are expected to use hearing protection.

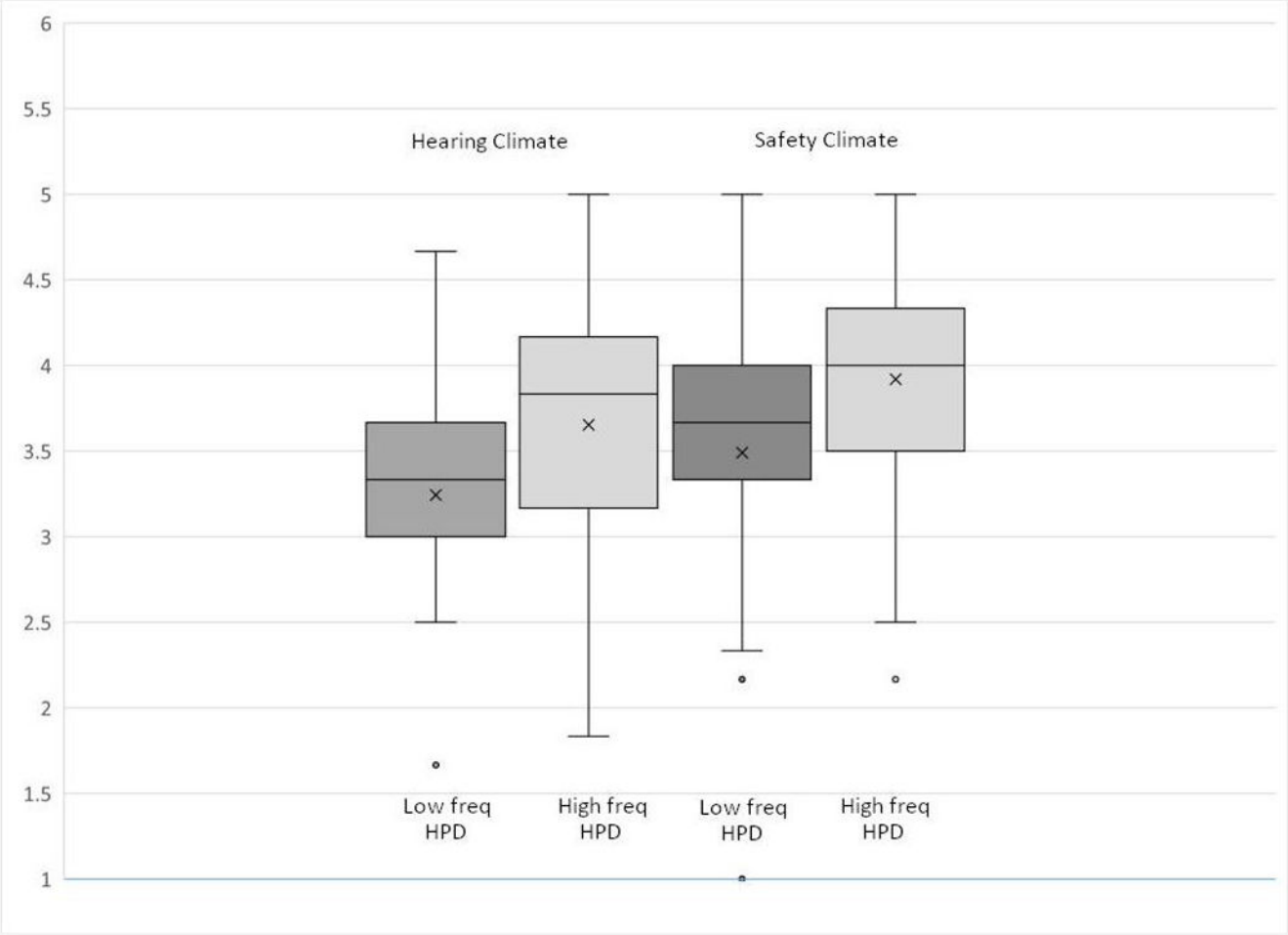

Figure 5.

Distribution of hearing climate and safety climate by hearing protection device (HDP) use frequency. The difference in hearing climate and safety climate by HPD use frequency is statistically significant, p=0.0002 and p=0.002, respectively.

Table 1:

Participant characteristics of surveys worker across 12 transportation maintenance garages

		n (%) or mean (SD)
Male		156 (97)
Race		
	White	113 (69)
	Black	19 (12)
	Other and mixed races	26 (16)
Age (yrs)		44 (10)
Job Title		
	Maintainer	135 (85)
	Supervisor or crew leader	24 (15)
Tenure (yrs)		12 (10)
Education		
	Less than high school	6 (4)
	High school graduate/GED/Trade	99 (63)
	Some college	41 (26)
	College degree	12 (8)
Frequency of hearing protection device use		2.7 (1.5)
	Always (1)	43 (27)
	Almost always (2)	45 (28)
	Usually (3)	31 (19)
	Often (4)	12 (7)
	Sometimes (5)	26 (16)
	Rarely or never (6)	5 (3)

Table 2:

Safety climate and hearing climate measures by participant characteristics.

		Safety climate			Hearing climate		
	n	**Mean**	**(SD)**	**p-value**	**Mean**	**(SD)**	**p-value**
Race							
White	119	3.78	(0.59)	0.36	3.58	(0.65)	0.44
People of color, mixed race	39	3.90	(0.83)		3.68	(0.85)	
Age							
<46 years	80	3.70	(0.66)	0.03	3.49	(0.70)	0.04
>46 years	79	3.93	(0.65)		3.72	(0.69)	
Job Title							
Maintainer	132	3.73	(0.67)	0.0005	3.52	(0.68)	0.0001
Supervisor or crew leader	23	4.24	(0.42)		4.12	(0.58)	
Education							
High school or less	87	3.89	(0.62)	0.24	3.64	(0.66)	0.38
At least some college	52	3.75	(0.71)		3.53	(0.76)	
Tenure							
<8 years	73	3.79	(0.64)	0.76	3.50	(0.65)	0.08
>8 years	75	3.82	(0.70)		3.72	(0.77)	

Table 3.

Safety climate and hearing climate measure items by hearing protection device use.

	Total sample		Low frequency HPD users		High frequency HPD users		
Agree or strongly agree with the general safety climate item	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	**p-value**
General safety climate[19]							
[a]New employees learn quickly that they are expected to follow good health and safety practices	116	(72)	49	(67)	67	(76)	0.20
[b]Employees are told when they do not follow good safety practices.	123	(77)	55	(76)	68	(77)	0.90
[c]Workers and management work together to ensure the safest possible work conditions.	101	(62)	38	(51)	63	(72)	0.01
[c]There are no major shortcuts taken when workers health and safety are stake.	101	(62)	39	(53)	62	(70)	0.02
[c]The health and safety of workers is a high priority with management where I work.	111	(68)	45	(61)	66	(75)	0.05
[d]I feel free to report safety problems where I work.	141	(88)	60	(83)	81	(92)	0.09
	Mean	(SD)	Mean	(SD)	Mean	(SD)	
Overall general safety climate	3.79	(0.68)	3.64	(0.65)	3.94	(0.65)	0.004
Hearing climate							
[a]New employees learn quickly that they are expected to use hearing protection.	118	(75)	49	(68)	69	(80)	0.08
[b]Employees are told when they do not wear hearing protection.	73	(47)	21	(29)	52	(61)	<0.0001
[c]Workers and management work together to protect hearing.	79	(50)	25	(35)	54	(64)	0.0003
[c]There are no major shortcuts taken when workers hearing is at stake.	100	(64)	37	(51)	63	(74)	0.003
[c]The hearing of workers is a high priority with management where I work.	73	(47)	26	(37)	47	(55)	0.02
[d]I feel free to report noise hazards where I work.	108	(69)	42	(58)	66	(78)	0.01
	Mean	(SD)	Mean	(SD)	Mean	(SD)	
Overall hearing climate	3.60	(0.70)	3.38	(0.57)	3.78	(0.75)	0.0003

Survey item constructs represent:

[a]co-worker behavior norms

[b]safety feedback

[c] management commitment

[d] worker involvement.

Table 4:

Adjusted prevalence ratios (PR) and 95% confidence intervals (CI) of hearing protection device use

	PR	95% CI	p-value
Hearing climate	1.32	(1.03, 1.69)	0.03
General safety climate	1.12	(0.87, 1.43)	0.40
Age greater than 40 years	1.07	(0.82, 1.40)	0.63
Supervisor	0.91	(0.62, 1.32)	0.60