Safety, Health, and Well-Being of Municipal Utility and Construction Workers

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Objective: To provide a baseline description of psychosocial workplace stressors and supports along with safety, injury, health, and well-being indicators in a sample of utility and construction workers for a National Institute for Occupational Safety and Health–funded Total Worker Health™ intervention study. **Methods:** Survey responses and health assessments were collected from a total of 349 employees in two municipal utility departments. **Results:** Participants demonstrated poor weight control and body mass index and provided reports of frequent poor health habits, injury, and pain. Although safety climate was good, less desirable levels of psychosocial workplace stressors and supports were observed. These stressors and supports were found to relate with many of the health, injury, and pain indicators. **Conclusions:** These results demonstrate the need for workplace interventions to promote and protect construction worker health and the importance of the psychosocial work environment.

The construction industry (North American Industry Classification System, NAICS, 23) is one of the largest occupational sectors in the United States, with 7.7 million wage and salary workers and 1.9 million self-employed or unpaid family workers; furthermore, this sector has a projected job growth of over 20% between 2010 and 2020.[1,2] The utilities sector (NAICS, 22) employs an additional 551,800 workers.[1] Because utility and construction work requires physical stamina and involves irregular hours and exposure to weather, dangerous tools, and equipment, workers are significantly more prone to injury than US workers on average.[3,4] For example, the rate of work-related injury and illness among local government utility and construction workers in 2012 was 5.4 and 9.7, respectively, per 100 full-time workers compared with the 3.3 per 100 across all industry sectors.[5] The leading cause of time-loss injuries for construction workers not involving contact with objects is overexertion—the straining of muscles beyond their capacity—and construction workers as a whole most frequently report back-related injuries.[6,7] In the UK, construction workers are also at increased risk of other work-related injuries and disease, including musculoskeletal disorders, injuries, respiratory disease, and skin cancer.[8] Other risks include exposure to harmful fumes, chemical burns, falls from high places, and injuries from tools and materials used.[9]

Despite the large numbers of utility and construction workers and their documented susceptibility to workplace injury, these occupational groups remain relatively understudied and that latter has been targeted as an occupational sector in need of research as part of the National Occupational Research Agenda. In particular, the National Occupational Research Agenda has identified a need for research with an intervention and prevention focus, not only on safety and injury but also on general health promotion.[10] In response to these concerns in 2011, the National Institute for Occupational Safety and Health (NIOSH) targeted funding toward research projects on workers in construction-related industries with goals to reduce pain and injury, improve general worker health, and prolong positive labor force participation through the Total Worker Health™ (TWH) program. In fact, a special issue of the *Journal of Occupational and Environmental Medicine* was recently dedicated to TWH. The TWH concept focuses on (1) the workplace as an important context for health and prevention interventions and (2) the importance of interventions that integrate both health promotion and health protection aspects.[11]

The purpose of this article is to describe baseline levels of physical and mental health, injury, and limitations in physical activities because of injury-related pain and discomfort in a sample of construction workers from two municipal utility departments before implementation of a randomized controlled trial of a safety and health workplace intervention. A description of this intervention as well as the results of the trial will be reported in a future article. Here, we describe the work environment and perceptions of psychosocial workplace factors, including workplace support, stressors, and safety climate, the latter of which are considered to be health and safety hazards. Although the importance of improving indicators of health, injury, and safety—as well as their risk factors—needs little explanation to the readers of this journal, our focus additionally is on psychosocial workplace stressors that are introduced as health and safety hazards that are preventable, consistent with the TWH perspective.[11] In the remainder of this article, we focus on how psychosocial workplace stressors relate to injury, safety, and health and how these perceptions of the work environment can impact workplace interventions.

PSYCHOSOCIAL STRESSORS, SAFETY, AND HEALTH

Workers face a number of stressors on the job that affect their performance at work, their relationships at home, their safety, and also their physical and mental health. Workplace stress plays an important role in illness and injury propensity.[12,13] Stress is a psychological and physiological reaction to a cognitive appraisal that a threat exists. Appraised threats can range from the mundane (eg, frustration of goal attainment) to severe (eg, imminent physical injury). Individual differences in the outcome of this appraisal process explain why some people may exhibit stress whereas others do not in objectively similar environments. A growing body of research supports the link between (perceived) environmental stressors and negative physiological outcomes. Although research outside the utility and construction industries suggests that work and family contexts can provide a variety of benefits to health and well-being, these contexts can also be a source of stress, particularly when obligations in one context interfere with obligations in the other.[14] Traditional psychosocial workplace stressors include high job demands and low job control,[15] as well as negative leader behaviors,[16] job insecurity[17,] and work-family conflict.[18] Family stressors that have been linked with strain (the result of stress) include family time commitments, parental demands, and elder-care demands.[19,20] The physiological and psychological responses to workplace stress are complex and include increases in cardiovascular risk, depression, and work–life conflict as well as decreases in exercise, job satisfaction, and organizational commitment.[21]

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Psychosocial workplace stressors of particular focus in this article include safety climate, high job demands, low job control, conflicts between work and family roles, and poor organizational support, which have been shown to be related to health, safety, and well-being in prior research, but not examined together in one study with the combination of health and safety outcomes we present here. We believe that these stressors may be significantly related to a number of health, safety, and well-being outcomes in construction workers and that understanding these relationships will have implications for the future design of TWH interventions and programs. Thus, identifying ways of designing workplace interventions that target the reduction of a number of workplace psychosocial stressors is needed. Although others have discussed particular psychosocial workplace stressors as targets of interventions such as job stress interventions,[22] work–family stress reduction interventions,[21,23] and lack of supervisor support,[24] examination of these together in one study as a set of workplace hazards is unique. In summary, in this article we report not only the health, safety, and injury indicators in a sample of construction workers but also their relationships with psychosocial perceptions of the work environment.

METHODS

This project was conducted as part of the Oregon Healthy Workforce Center, one of four Total Worker Health™ Centers for Excellence funded by the NIOSH. The study focuses on construction and field workers in two municipal public works agencies in Oregon. Before reporting study details regarding participants, measures, and procedures, we begin with a brief description of the organizational contexts and the nature of the work.

Organizational Contexts and Nature of Work

Construction and maintenance work environments in the Pacific Northwest result in a variety of occupational hazards. Although tasks performed in the focal organizations vary across organizations and across work units within organizations, there are commonalities among the various work units. First, work is generally performed outdoors, which in the Pacific Northwest can generate problems from October through June as persistent rainfall and colder winter temperatures create an environment where falls, slips, and weather exposure-related injuries are likely. The operation of heavy equipment in these conditions also exacerbates injury risks. Second, typical work tasks (eg, pouring concrete, digging trenches, cleaning streets, and installing and maintaining public water and sewer structures) can be characterized as arduous requiring a certain level of stamina and physical fitness. For example, installing a water main may require a water mechanic to be submerged in a ditch for an entire workday, holding up upward of 50 lb of material for extended periods. Third, work is performed over long, 10-hour shifts starting at 6:30 AM. Therefore, employees are required to come to work alert and ready to take on physically demanding tasks, often before the sun rises.

Specific examples of work vary by organization and work unit. The typical maintenance worker is responsible for performing unskilled and limited semiskilled work and to routinely use power tools in the performance of their assigned tasks. Crew members generally work independently, although closely supervised by a crew leader. Utility workers perform a variety of tasks, including skilled concrete finishing work and allied trades, including surface preparation, building concrete forms, structural reinforcement, materials preparation, masonry, and plastering. Supervisors and public works utility workers are also responsible for driving trucks, operating equipment, cleaning sewers, renovating and repairing signs and equipment, setting forms for sidewalks, and maintaining contact with operations via a two-way radio. Although this is just a sample of the tasks involved in this line of work, it is evident that a typical day on the job requires employees to remain physically fit and to be mentally alert.

Organizations and Participants

Supervisors and employees in two public works departments from a city in the Pacific Northwest participated in this study. Work in Organization A focuses on construction and maintenance projects for the city's transportation and sewer systems; work in Organization B focuses on construction and maintenance projects for the city's water systems.

Participants were recruited from eight work divisions in Organization A and four work divisions in Organization B. In Organization A, 229 of 292 (78%) participated; in Organization B, 120 of 228 (53%) participated. Participants completed the assessments discussed below on paid company time and were provided with a $25-gift card for their participation. Table 1 provides descriptive statistics for several demographic variables. Most participants were white, married, with children living at home, and with at least a high school education (or equivalent); a sizable minority were also caring for an adult inside or outside their home (eg, parent). On average, participants were around 45 years old, worked around a 40-hour workweek, and had worked for their current organization for about 10 years. Participants in Organization B were significantly younger, more educated, less likely to be divorced, separated, or widowed, less likely to be caring for an aging adult, and had significantly shorter job tenures than participants in Organization A.

Measures and Equipment

Physical Health Assessments

General physical health was measured using the physical health composite of the Short-Form Health Survey (Version 2).[25] Blood pressure and heart rate were measured using an Omron HEM-907EL device with an arm cuff; three readings were taken with a 1-minute rest period between readings, and we report the average of these three readings. Height and weight were recorded without shoes and socks on a stadiometer; readings were entered into a Tanita body composition device, which calculates body mass index (BMI), body fat percentage, and bioelectrical impedance.

Injury and Pain/Discomfort

Injury-related assessments involved questions regarding the frequency of minor injuries (minor cuts, bruises, or sprains requiring first aid or no treatment) and major injuries (more serious sprains and cuts, muscle or joint pain, or fractures requiring recovery time or medical treatment) and their impact on work over the last 6 months. Furthermore, we asked participants how many times they filed a worker's compensation claim in the last 6 months, indicating a compensated respite from work to recover from a work-related injury. Pain and discomfort were assessed with respect to location (neck/shoulders, forearm/wrists, low back, and lower extremities) and severity such that it interfered with your normal work and home activities (zero = "not at all" through three = "moderately" to five = "extremely") in the last 3 months. Furthermore, we assessed the extent to which pain and discomfort made difficult the performance of several common activities (eg, heavy household chores, using any hand-held tool or equipment) in the last 7 days (zero = "no difficulty to four = "unable to perform").

Health-Related Behaviors and Sleep

Health-related assessments involved questions about exercise and physical activity (eg, how many days in the last week engaging in a target activity) as well as the amount of alcohol and tobacco

TABLE 1. Linear Mixed-Effects Model Tests of Differences in Participant Demographic Characteristics Across Organizations

Domain	Variable	Organization A ($G = 8$; $N = 211–228$) Mean or Percentage	Organization B ($G = 4$; $N = 113–120$) Mean or Percentage	*P* Value
Individual characteristics	Male	90%	89%	0.92
	Age, yrs	45.57	42.42	0.02*
	Race/ethnicity			
	White	79%	75%	0.53
	Black or African American	7%	6%	0.73
	Multiple	7%	11%	0.30
	Other	5%	6%	0.88
	Educational attainment			
	Did not finish high school	3%	1%	0.56
	Finished high school (or GED)	43%	25%	<0.01*
	College/technical school (1–3 yrs)	46%	51%	0.40
	College/technical school (≥4 yrs)	8%	23%	<0.01*
Family relationships	Marital status			
	Married or living as married	74%	83%	0.07
	Divorced, separated, or widowed	16%	7%	0.03*
	Never married	10%	10%	0.97
	Has children at home	56%	60%	0.51
	Caring for adult	35%	23%	0.02*
Work characteristics	Job tenure, yrs	11.64	9.17	<0.01*
	Hours worked per week	40.66	41.17	0.66
	Job level			
	Supervisor	9%	8%	0.85
	Crew leader	15%	23%	0.06
	Crew member	76%	69%	0.15

Models account for nesting of employees in workgroups with random effects. *P* value is significance of mean or percentage difference across organizations.
*$P < 0.05$.
G, number of workgroups; *N*, number of responding participants.

use. Sleep quality was assessed using the Pittsburg Sleep Quality Index.[26]

Workplace Safety Climate, Stressors, and Supports

Group-level safety climate was measured with a six-item scale ($\alpha = 0.83$).[27] Several commonly used measures of psychosocial workplace stressors were included: Work-to-Family and Family-to-Work Conflict scales[28] (five items each with $\alpha = 0.94$ and 0.90, respectively), Job Decision Latitude and Job Demands subscales of the Job Content Questionnaire[29] (nine items, $\alpha = 0.84$, and five items, $\alpha = 0.72$, respectively). Finally, workplace supports were measured using two scales: Perceived Organizational Support[30] (seven items, $\alpha = 0.84$) and Team Cohesion[31] (six items, $\alpha = 0.93$). All of these scale items have a common response format (ie, one = "strongly disagree" through three = "neither agree nor disagree" to five = "strongly agree") with the exception of the Perceived Organizational Support (ie, one = "strongly disagree" through four = "neither agree nor disagree" to seven = "strongly agree").

Procedures

Data collection was completed between August 2012 and December 2012 at the beginning of the workday (ie, around 7 AM). The assessment process had two parts. First, participants were administered a survey—containing the measures discussed above—individually in a paper format, taking typically between 35 and 50 minutes to complete. Second, on the same day after the survey, participants were involved in a 30-minute physical health assessment discussed above. Thus, the first blood pressure and heart rate readings were recorded after the participants had been sitting completing the survey for about 35 to 50 minutes. When the arm cuff is attached, an additional resting period of 3 minutes was provided. Participants then were directed to stand on a stadiometer to gather input for the BMI, body fat percentage, and bioelectrical impedance assessments.

RESULTS

Our results focus on aspects of the survey responses and health assessments. Analytical models accounted for nonindependence of the data (ie, the nesting of workgroups in organizations and employees in workgroups) using a generalized linear mixed-effects modeling approach.[32] Continuous variables were modeled with an identity link function; dichotomous categorical variables were modeled with a logit link function. In the earlier subsections (ie, Tables 1 to 5), we test for differences in survey responses and health assessments across organizations. In the final subsection (ie, Table 6), we provide model parameter relating select workplace stressor and supports and select health, injury, and pain and discomfort indicators controlling for organization.

Pain/Injury and Physical Health Indicators

Table 2 provides results for the self-reported injury and pain variables by organization. Participants in Organization B were significantly more likely to report working in spite of minor injuries than in Organization A; no other differences across organizations were

TABLE 2. Linear Mixed-Effects Model Tests of Differences in Self-Reported Injury, Pain, and Discomfort Variables Across Organizations

Domain	Variable	Organization A ($G = 8$; $N = 193$–226) Percentage	Organization B ($G = 4$; $N = 102$–120) Percentage	*P* Value
Injury	In the last 6 mos			
	Had minor injuries with no missed work	34%	46%	0.03*
	Missed ≥1 d work for work-related injury	12%	15%	0.38
	Filled one or more worker's compensation claim	10%	13%	0.46
Pain and discomfort	In the last 3 mo, pain/discomfort in ____ resulted in moderate to extreme interference with work/home activities			
	Low back	35%	42%	0.26
	Neck/shoulders	29%	39%	0.07
	Lower extremities	25%	26%	0.99
	Forearms/wrists	18%	18%	0.92
	In the last 7 d, pain/discomfort created at least some difficulty in			
	Kneeling/squatting	44%	48%	0.40
	Stooping/bending to floor	42%	46%	0.52
	Doing heavy household chores	38%	38%	0.87
	Recreational activities using arm, shoulder, and hand	38%	38%	0.93
	Standing for ≥1 hr	37%	36%	0.82
	Getting in/out of car	35%	34%	0.92
	Putting on shoes/socks	33%	33%	0.98
	Using hand-held tool	31%	37%	0.30
	Reaching an object on high shelf	27%	26%	0.88

Models account for nesting of employees in workgroups with random effects. *P* value is significance of percentage difference across organizations.
*$P < 0.05$.
G, number of workgroups; *N*, number of responding participants.

TABLE 3. Linear Mixed-Effects Model Tests of Differences in Health Assessment Variables Across Organizations.

Domain	Variable	Organization A ($G = 8$; $N = 214$–227) Mean or Percentage	Organization B ($G = 4$; $N = 106$–118) Mean or Percentage	*P* Value
General physical health	SF12 physical health composite	47.21	47.74	0.54
Body mass and composition	BMI	31.66	30.27	0.09
	Underweight BMI	1%	0%	0.91
	Normal BMI	13%	20%	0.10
	Overweight BMI	29%	34%	0.32
	Obese BMI	58%	46%	0.10
	Fat mass percentage	31.58	29.04	0.02*
Blood circulatory system	Heart rate (per minute)	72.19	70.94	0.40
	Systolic blood pressure	128.85	126.95	0.23
	Diastolic blood pressure	79.65	79.06	0.68
	Normal blood pressure	23%	25%	0.75
	Prehypertensive blood pressure	50%	53%	0.80
	Stage I hypertension	21%	19%	0.75
	Stage II hypertension	6%	4%	0.57
	On blood pressure medication	26%	17%	0.08

Models account for nesting of employees in workgroups with random effects. *P* value is significance of mean or percentage difference across organizations.
*$P < 0.05$.
BMI, body mass index; *G*, number of workgroups; *N*, number of responding participants.

TABLE 4. Linear Mixed-Effects Model Tests of Differences in Self-Reported Health-Related Behaviors and Sleep-Related Variables Across Organizations

Domain	Variable	Organization A ($G = 8$; $N = 199$–229) Mean or Percentage	Organization B ($G = 4$; $N = 104$–120) Mean or Percentage	*P* Value
Health-related behaviors	Consider self physically active at work	46%	61%	0.04*
	Do ≥3 d/wk			
	Hard physical activity	47%	59%	0.07
	Moderate physical activity	56%	66%	0.09
	Exercise to strengthen or tone	33%	39%	0.48
	Exercise and work up a sweat	60%	74%	0.01*
	Use tobacco product(s) in the last week	39%	32%	0.20
	Smoke cigarettes	23%	17%	0.18
	Use other tobacco product	22%	18%	0.54
	Use alcohol daily	17%	17%	0.90
	Drank five alcohol drinks or more in 1 d (last 6 mos)	31%	29%	0.69
Sleep	Typical sleep duration (in hrs)	7.17	6.94	0.07
	Insomnia scale score	2.65	2.76	0.38
	With insomnia symptoms ≥1 d/wk	26%	30%	0.50
	Indicate fairly or very bad sleep quality	28%	40%	0.04*
	At least once per week			
	Feels tired during wake time	70%	82%	0.02*
	Snores	50%	49%	0.84
	Does not feel rested upon waking	18%	27%	0.05*
	Uses sleep medication	14%	15%	0.82
	Has daytime dysfunction because of sleep	9%	12%	0.60

Models account for nesting of employees in workgroups with random effects. *P* value is significance of mean or percentage difference across organizations.
*$P < 0.05$.
G, number of workgroups; *N*, number of responding participants.

significant. Overall, about 13% of participants reported missing at least 1 day in the last 6 months because of a work-related injury, with similar rates for filing at least one worker's compensation claim in the same period. Furthermore, a sizable minority report working in spite of minor injuries. A sizable minority of participants report moderate to extreme pain that interferes with work and home activities; more in the neck and shoulders, less in the wrists and forearms. Many report at least some discomfort in performing several everyday tasks because of pain and discomfort.

Table 3 provides results for the physical health indicators by organization. Participants in Organization B had significantly lower fat mass percentages than in Organization A; no other differences across organizations were significant. Overall, physical health composite scores from the SF12 are population normed to have a mean of 50; in this sample, however, mean scores on this composite measure were significantly lower than this norm ($\hat{u} = 47.42$; 95% confidence interval = 46.56 to 48.24), indicating poorer levels of reported physical health than the general population. Mean BMI scores for these participants were very high with a very large percentage (54%) falling into the Obese BMI category. Although the nature of their work can be physically demanding—leading potentially to more lean muscle mass that can inflate BMI numbers—the average fat mass percentage score at around 30% suggests that these high BMI scores are not entirely attributable to a preponderance of the lean muscle mass. The mean heart rate and diastolic blood pressure readings are close to the accepted guidelines, but systolic blood pressure is above the accepted guideline; indeed, only about 25% of participants in this sample would be categorized as having normal blood pressure. Notably, only a small minority report currently taking blood pressure medication.

Health-Related Behaviors and Sleep

Table 4 provides results for the self-reported health-related behaviors and sleep-related variables by organization. Participants in Organization B were significantly more likely to report being physically active at work, exercising to work up a sweat than in Organization A. Nevertheless, participants were also more likely to report higher levels of very bad sleep quality, feeling tired during wake time, and not feeling rested upon waking than in Organization A. No other differences across organizations were significant.

Overall, about half characterize themselves as physically active at work and most report moderate or hard physical activity or exercise 3 days or more a week; about a third actually exercise to strengthen or tone. About a third of participants report using tobacco products. Although a moderate minority report using alcohol daily, more than a quarter report some binge drinking behavior in the last 6 months.

Participants reported sleeping on average around 7 hours per night. A sizable minority, however, indicate that sleep quality is fair or very bad; indeed similar percentages report insomnia-like symptoms at least 1 day per week on average. These patterns manifest in a small minority of participants reporting daytime dysfunction because of sleep and not feeling rested upon awakening; a larger majority report feeling tired during wake time.

Safety Climate, Workplace Stressors, and Supports

Table 5 provides results for the self-reported perceptions of workplace safety, stressors, and supports by organization. Because many of the psychosocial scales do not have a widely understood

TABLE 5. Linear Mixed-Effects Model Tests of Differences in Workplace Safety, Stressors, and Supports Across Organizations

Domain	Variable	Organization A ($G = 8$; $N = 219–229$) Mean (% Above Scale Midpoint)	Organization B ($G = 4$; $N = 118–120$) Mean (% Above Scale Midpoint)	*P* Value
Safety climate	Group level safety climate	3.12 (52)	3.27 (61)	0.21
Workplace stressors	Work-to-family conflict	2.45 (22)	2.72 (31)	0.07
	Family-to-work conflict	1.96 (3)	2.03 (5)	0.37
	Job decision latitude	3.29 (65)	3.49 (77)	0.06
	Job demands	2.95 (40)	3.06 (44)	0.20
Workplace supports	Perceived organizational support	3.99 (44)	3.98 (51)	0.95
	Team cohesion	3.62 (74)	3.62 (75)	0.98

Models account for nesting of employees in workgroups with random effects. *P* value is significance of mean difference across organizations. Scale scores are the mean of scale item responses. Perceived organizational support scale items range from one "strongly disagree" to seven "strongly agree" with a midpoint of four "neither agree nor disagree"; all other scale items range from one "strongly disagree" to five "strongly agree" with a midpoint of three "neither agree nor disagree." Higher scores indicate greater agreement that the participant experiences the named construct.

G, number of workgroups; *N*, number of responding participants.

TABLE 6. Linear Mixed-Effects Model Slopes Relating Self-Reported Work Perceptions With Health, Injury, and Pain/Discomfort Variables.

	Health						Injury/Pain		
Work Perceptions	**PHC**	**BMI**	**FMP**	**HR**	**SBP**	**DBP**	**MWI**	**PD3**	**PD7**
Stress or stressors									
Work-to-family conflict	− 1.62*	0.72*	0.95	0.79	1.21	1.43*	0.53*	0.36*	0.48*
Family-to-work conflict	− 0.93	0.75	0.60	0.57	1.35	1.79*	0.66*	0.33*	0.37*
Job decision latitude	1.36*	− 1.40*	− 1.60*	− 2.16*	− 0.39	− 1.18	− 0.53*	− 0.30	− 0.19
Job demands	− 0.49	0.35	0.78	1.43	0.91	2.12*	0.50*	0.38*	0.55*
Workplace supports									
Perceived organizational support	0.56†	− 0.52	− 1.05*	− 1.25*	− 0.39	− 0.83	− 0.38*	− 0.31*	− 0.30*
Team cohesion	0.50	− 0.52	− 1.10	− 0.95	0.58	− 0.17	− 0.61*	− 0.52*	− 0.33*

Models account for nesting of participants in workgroups with random effects and control for organization with fixed effects. Work perceptions variables: higher scores indicate greater agreement that the participant experiences the named construct. Parameters for the injury/pain variables are in the log-odds scale.

*$P < 0.05$.

†$P < 0.08$.

BMI, body mass index; DBP, diastolic blood pressure; FMP, fat mass percentage; HR, heart rate; MWI, missed work at least once in last 6 months because of injury; PD3, pain/discomfort in neck/shoulders, forearms/wrists, low back, or lower extremities resulted in moderate to extreme interference with work/home activities in the last 3 months; PD7, pain/discomfort created at least some difficulty to kneeling/squatting, stooping/bending to floor, doing heavy household chores, recreational activities using arm, shoulder, or hand, standing for an hour or more, getting in/out of car, putting on shoes/socks, using hand-held tool, or reaching an object on high shelf in the last 7 days; PHC, SF12 physical health composite; SBP, systolic blood pressure.

metric and criterion for interpretation (eg, in contrast with a BMI score), we supplement mean survey responses with the percentage of participants with mean responses above the item response midpoint to reflect those participants above the point of indifference (ie, greater agreement) with respect to that psychosocial variable. No significant differences across organizations on these variables were observed.

Overall, a small majority of participants rated their workgroup safety climate favorably. A majority of participants view favorably their degree of decision latitude in their job. A sizable minority, however, indicate strenuous psychological job demands. Few indicate notable interference with work obligations from family obligations; about a quarter, however, indicate notable inference with family obligations from work obligations. Only about half of participants view their organization as generally supportive; in contrast, most viewed their workgroup as a cohesive unit.

Relationships Between Psychosocial Workplace Stressors and Health, Injury, and Pain/Discomfort Variables

Table 6 provides parameter estimates for the prediction of several health, injury, and pain/discomfort variables from work stressor or support perceptions in Table 5 controlling for organization. To simplify the presentation, the pain and discomfort variables were combined into two summary variables indicating (1) any moderate to extreme interference with work or home activities in the last 3 months because of pain and discomfort across the four body locations listed in Table 2 (ie, PD3 in Table 6) and (2) at least some difficulty in completing any of the nine tasks reported in Table 2 because of pain and discomfort in the last 7 days (ie, PD7 in Table 6).

Work-to-family conflict was negatively related to the physical health composite and positively related to BMI, diastolic blood pressure, missing work because of injury, and experiencing pain or

discomfort affecting home and work activities, as would be expected. Family-to-work conflict related similarly to these variables, although not significantly so for the physical health composite and BMI. Job decision latitude was positively related to the physical health composite and negatively related with BMI, fat mass percentage, heart rate, and missing work because of injury, again, all in the expected direction. Job demands were positively related to diastolic blood pressure, missing work because of injury, and experiencing pain or discomfort affecting home and work activities, as expected. Perceived organizational support was positively related to the physical health composite and negatively related to fat mass percentage, heart rate, missing work because of injury, and experiencing pain or discomfort affecting home and work activities, as expected. Team cohesion was negatively related to missing work because of injury and experiencing pain or discomfort affecting home and work activities, as expected.

DISCUSSION

The injury rates in this sample (see Table 2) are consistent with, but slightly higher than, the population-based rates for the construction and utility industry sectors noted previously. In addition, the prevalence of pain and discomfort because of injuries is still higher, suggesting greater risk in the longer-term employability of these workers, not to mention general functionality in nonwork domains. Perhaps the most striking results are the poor physical health indicators in this sample regarding body mass, body fat percentage, and blood pressure. The average BMI in this sample (see Table 3) is noticeably higher than the US national average for adult males of 26.6; the percentage of this sample classified as obese exceeds US adult male population estimates of 32.2%.[33,34] Furthermore, the systolic and diastolic blood pressure averages in this sample are higher than US adult estimates of 122 and 71 mm Hg, respectively.[35] Despite an active work environment and many who exercise, most participants are at a high level of risk for cardiovascular disease. Results of the health behavior and sleep quality indicators are consistent with this higher risk level. With respect to occupational safety, only half of participants indicate a positive safety climate.

These risks for injury and ill-health are also supported by the findings on workers' psychosocial perceptions. About half view their job as demanding, and only about half view their organizations as supportive; more participants indicate positive team cohesion. A smaller percentage indicate that their work obligations interfere with their family obligations and even fewer indicate that their family obligations interference with their work obligations. The bivariate relationships among work perceptions and health, injury, and pain/discomfort variables (see Table 6) were all in the expected directions, supporting the importance of workplace stressors and supports in relation to health and injury outcomes. To our knowledge, this is the first time some of these psychosocial workplace perceptions, such as perceived organizational support, have been related to such objective health outcomes, and all relationships found are in the expected directions.

Therefore, these results suggest the need for a workplace intervention to promote and protect worker physical and psychosocial health, a core tenet of the TWH initiative. A workplace intervention approach that combines reducing psychosocial workplace hazards by increasing psychosocial workplace supports and decreasing psychosocial workplace stressors, in combination with an approach of promoting health through education and incentives around healthy eating and exercise aimed at reducing BMI and hypertension, is suggested here as the most effective way of addressing poor health and injuries as noted in this sample.

Naturally, a limitation of this study is the cross-sectional nature of the data, and therefore no strong causal claims can be made for the observed associations. Indeed, rather than workplace stressors and supports influencing health, it may be the case that health influences workplace stressors and supports. Future research using designs more appropriate for making causal claims (eg, longitudinal designs or controlled randomized trials) is needed to adjudicate these competing interpretations.

REFERENCES

1. Henderson R. Industry employment and output projections to 2020. *Mon Labor Rev.* 2012;135:65–83.
2. Byun K. The U.S. housing bubble and bust: impacts on employment. *Mon Labor Rev.* 2010;133:3–17.
3. The Center for Construction Research and Training. The construction chart book: the U.S. construction industry and its workers. Available at http://www.cpwr.com/sites/default/files/publications/5th%20Edition%20Chart%20Book%20Final.pdf. Published 2013. Accessed January 17, 2014.
4. Bureau of Labor Statistics, US Department of Labor. *Occupational Outlook Handbook, 2014-15 Edition*. Construction Equipment Operators. Available at http://www.bls.gov/ooh/construction-and-extraction/construction-equipment-operators.htm#tab-3. Accessed January 17, 2014.
5. Bureau of Labor Statistics, US Department of Labor. Employer-reported workplace injuries and illnesses in 2012. In: *News Release (USDL 13-2119)*. Available at http://www.bls.gov/news.release/pdf/osh.pdf. Published November 7, 2013. Accessed March 6, 2014.
6. Bureau of Labor Statistics, US Department of Labor. Nonfatal occupational injuries and illnesses requiring days away from work, 2011. In: *News Release (USDL 13-2257)*. Available at: http://www.bls.gov/news.release/pdf/osh2.pdf. Published November 26, 2013. Accessed January 17, 2014.
7. Schneider S. Musculoskeletal injuries in construction: a review of the literature. *Appl Occup Environ Hyg.* 2001;16:1056–1064.
8. Stocks S, Turner S, McNamee R, Carder M, Hussey L, Agius R. Occupation and work-related ill-health in UK construction workers. *Occup Med (Lond)*. 2011;61:407–415.
9. Bureau of Labor Statistics, US Department of Labor. Occupational Outlook Handbook, 2014-15 Edition. Construction Laborers and Helpers. Available at http://www.bls.gov/ooh/construction-and-extraction/construction-laborers-and-helpers.htm. Accessed January 17, 2014.
10. Center for Disease Control and Prevention. *National Occupational Research Agenda (NORA): National Construction Agenda: For Occupational Safety and Health Research and Practice in the US Construction Sector*. Available at http://www.cdc.gov/niosh/nora/comment/agendas/construction/. Published October 2008. Accessed January 17, 2014.
11. Schill AL, Chosewood LC. The NIOSH Total Worker Health™ program: an overview. *J Occup Environ Med.* 2013;55:S8–S11.
12. Cooper CL, Liukkonen P, Cartwright S. *Stress Prevention in the Workplace: Assessing the Costs and Benefits to Organisations*. Dublin: European Foundation for the Improvement of Living and Working Conditions; 1996.
13. Clarke S, Cooper DCL. *Managing the Risk of Workplace Stress: Health and Safety Hazards*. London: Routledge; 2004.
14. Hammer L, Zimmerman K. Quality of work life. In: Zedeck S, ed. *American Psychological Association Handbook of Industrial Organizational Psychology, Vol. 3*. Washington, DC: American Psychological Association; 2011:399–431.
15. Karasek R. Job demands, job decision latitude, and mental strain: implications for job redesign. *Adm Sci Q*. 1979:24:285–308.
16. Barling J, Loughlin C, Kelloway EK. Development and test of a model linking safety-specific transformational leadership and occupational safety. *J Appl Psychol*. 2002;87:488–496.
17. Probst TM, Brubaker TL. The effects of job insecurity on employee safety outcomes: cross-sectional and longitudinal explorations. *J Occup Health Psychol.* 2001;6:139–159.
18. Cullen JC, Hammer LB. Developing and testing a theoretical model linking work-family conflict to employee safety. *J Occup Health Psychol*. 2007;12:266–278.
19. Luk DM, Shaffer MA. Work and family domain stressors and support: within- and cross-domain influences on work–family conflict. *J Occup Organ Psychol*. 2005;78:489–508.
20. Neal MB, Hammer LB. *Working Couples Caring for Children and Aging Parents: Effects on Work and Well-Being*. Mahwah, NJ: Lawrence Erlbaum Associates; 2007.
21. Hammer LB, Sauter S. Total Worker Health and work–life stress. *J Occup Environ Med*. 2013;55:S25–S29.

22. Lamontagne AD, Keegel T, Louie AM, Ostry A, Landsbergis PA. A systematic review of the job-stress intervention evaluation literature, 1990–2005. *Int J Occup Environ Health*. 2007;13:268–280.
23. Hammer L, Kossek E, Anger W, Bodner T, Zimmerman K. Clarifying work-family intervention processes: the roles of work-family conflict and family-supportive supervisor behaviors. *J Appl Psychol*. 2011;96:134–150.
24. Hammer LB, Kossek EE, Bodner T, Crain T. Measurement development and validation of the Family Supportive Supervisor Behavior Short-Form (FSSB-SF). *J Occup Health Psychol*. 2013;18:285–296.
25. Ware J Jr, Kosinski M, Keller SD. A 12-item short-form health survey: construction of scales and preliminary tests of reliability and validity. *Med. Care* 1996;34:220–233.
26. Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res*. 1989;28:193–213.
27. Zohar D, Luria G. A multilevel model of safety climate: cross-level relationships between organization and group-level climates. *J Appl Psychol.* 2005;90:616–628.
28. Netemeyer RG, Boles JS, McMurrian R. Development and validation of work–family conflict and family–work conflict scales. *J Appl Psychol.* 1996;81:400–410.
29. Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B. The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. *J Occup Health Psychol.* 1998;3:322–355.
30. Eisenberger R, Huntington R, Hutchison S, Sowa D. Perceived organizational support. *J Appl Psychol.* 1986;71:500–507.
31. Chin WW, Salisbury WD, Pearson AW, Stollak MJ. Perceived cohesion in small groups adapting and testing the Perceived Cohesion Scale in a small-group setting. *Small Group Res*. 1999;30:751–766.
32. Raudenbush S, Bryk A. *Hierarchical Linear Models: Applications and Data Analysis Methods*. 2nd ed. Newbury Park, CA: Sage; 2002.
33. Center for Disease Control and Prevention. National Health and Nutrition Examination Survey: healthy weight, overweight, and obesity among U.S. Adults. Available at http://www.cdc.gov/nchs/data/nhanes/databriefs/adultweight.pdf. Published July 2003. Accessed March 7, 2014.
34. Flegal K, Carroll M, Ogden C, Curtin L. Prevalence and trends in obesity among US adults 1999-2008. *JAMA*. 2010;303:235–241.
35. Wright J, Hughes J, Ostchega Y, Yoon S, Nwankwo T. Mean systolic and diastolic blood pressure in adults aged 18 and over in the United States, 2001–2008. *Nat Health Stat Rep*. 2011;35. Available at http://www.cdc.gov/nchs/data/nhsr/shsr035.pdf. Accessed March, 7 2014.

