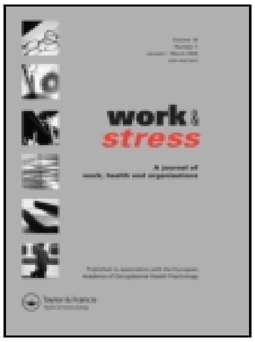

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Modelling relationships between job stressors and injury and near-miss outcomes for construction labourers

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Construction work is an inherently dangerous occupation and exposure to additional job stressors is likely to exacerbate the level of danger, increasing workers' risk for injury. Thus, it is important to identify and then reduce worker exposure to extraneous job stressors. This study examines the relationships between a variety of job stressors and injury or near-miss outcomes among construction workers. Self-reported questionnaire data collected from 408 construction labourers (male and female) via telephone interview were analysed using structural equation modelling. A theoretical model was tested whereby work stressors, classified into three groups, could be related, either directly or indirectly through the mediating effects of physical or psychological symptoms/strain, to self-reported injuries and near misses. Ten of the 12 work-related stressors were found to be directly related to either injury or near misses, including: job demands, job control, job certainty, training, safety climate, skill under-utilization, responsibility for the safety of others, safety compliance, exposure hours, and job tenure. Other stressors (i.e. harassment/discrimination, job certainty, social support, skill under-utilization, safety responsibility, safety compliance, tenure in construction) were indirectly related to injuries through physical symptoms or indirectly related to near misses through psychological strain. There was no support for the modelled gender differences. Implications for health and safety on construction sites are discussed.

1. Introduction

Occupational safety and health researchers have recognized the importance of examining the relationship between job-related stressors and injury outcomes for workers across a variety of occupations. For example, job stress has been identified as a risk factor for injury among farmers (Kidd *et al.*, 1996; Thu *et al.*, 1997) and forestry workers

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(Slappendel *et al*., 1993). The association between job stressors and musculoskeletal injuries has also been a source of discussion and research, with samples including office workers (Marcus & Gerr, 1996), healthcare workers (Ahlberg-Hultén *et al*., 1995; Bigos *et al*., 1991), US Army personnel (Feuerstein *et al*., 1997), arc welders (Johansson & Nonås, 1994), and offshore petroleum workers (Rundmo, 1992). Even professional dancers (Hamilton *et al*., 1989; Liederbach *et al*., 1994; Mainwaring *et al*., 1993) and gymnasts (Kolt & Kirkby, 1994) have been shown to be at increased risk for injuries related to job stressors.

The existence of job stressors on construction sites—the focus of the present study—has also been identified. The most obvious stressors on construction sites are physical (e.g. working with heavy equipment, noise, vibration) and chemical exposures (e.g. asbestos, lead, epoxy resins). Indeed, the direct relationship between these types of stressors and illness and injuries on construction sites has been well documented (Ringen *et al*., 1995). Other types of job and organizational stressors, including a high level of job demands, insufficient social support, harassment and discrimination, the overall work environment, and the composition of the crews have been shown to increase construction workers' risk for adverse physical and psychological and, potentially, injury outcomes (Helander, 1991; Holmstrom *et al*., 1992a,b; van der Molen *et al*., 1998). Additional studies have been conducted in construction settings with crane operators (Cooper & Kelly, 1984) and construction managers (Sutherland & Davidson, 1989). Finally, two other studies of job stressors in construction settings have used female samples (Goldenhar & Sweeney, 1996; Goldenhar *et al*., 1998) to better understand the types and levels of job stressors that may be related to adverse health and safety outcomes for women.

The present study addresses three limitations in the studies mentioned above. First, while a variety of stressors have been included in these studies, the number included in any given study has typically been small. Thus, it has not been possible to compare the impact of different stressors on outcomes, and the results in any given study may be compromised by model misspecification due to omitted variables. The present study examines the impact of 12 job stressors from three categories (job-task demands, organizational stressors, physical/chemical hazards and protection from them), while also including five control variables. Second, while some of the studies have examined physical and/or psychological symptoms as outcomes, and others have examined behavioural safety outcomes, no research has included both types of outcome. As a result, the potential mediating role of physical/ psychological symptoms in linking job stressors and behavioural safety outcomes has also not been examined. The present study investigates the mediating role of physical and psychological symptoms in a model with number of injuries and near-misses as behavioural outcomes; an understanding of this mediating role can advance our knowledge of the mechanisms through which job stressors influence safety outcomes, which can ultimately enhance the development of stress management and safety-related interventions. Finally, while it is an important development that researchers studying job stressors in construction settings have used female samples, it is also important to examine if, and how, linkages between job stressors and safety outcomes and the mediating role of physical/psychological symptoms are different for women versus men. If these relationships are different, safety interventions may target different types of job stressor, depending on the gender composition of the work site. Research on these gender differences requires a sample having men and women in the same jobs, and the present study uses such a design.

2. A multipredictor stress-injury model

The theoretical model used to guide this research is illustrated in Figure 1. It is a partially-mediated model in that it allows for the exogenous stressor and control variables (i.e. job-task demands, organizational factors, physical and chemical hazard exposures) to both directly and indirectly (through physical and psychological symptoms) influence the near miss and injury outcome variables. The partially-mediated specification was chosen to allow for the possibility that relationships between the exogenous variables and the two outcome variables would exist beyond those accounted for by the physical/psychological symptom-mediating variables. These relationships would justify and provide support for the inclusion of the paths associated with the direct effects in the partially mediated model.

The first exogenous variable category is Job-Task Demands. It includes the 'classic' job stress measures such as job control (i.e. one's perception of how much decision latitude s/he has in the job) and job demands (i.e. one's perception of the level of job difficulty—how hard the job is). A third indicator included in this category is overcompensation, which has been identified as an important concern of women working in non-traditional occupations (Johnson, 1991) and refers to the perception of having to work at least twice as hard as others (e.g. men doing the same job) just to gain co-worker respect. Finally, skill utilization and having responsibility for the safety of others are also included in this first category.

The second category, Organizational Stressors, includes measures of safety climate, the availability of skills and safety training, job certainty, support from co-workers and supervisors and harassment/discrimination. Recent theoretical and empirical studies indicate that safety climate is a multidimensional construct that is often used interchangeably with the term safety culture (Clarke, 2000; Guldenmund, 2000). Although similar, in that they both pertain to attitudes within a company or work-group, safety climate is

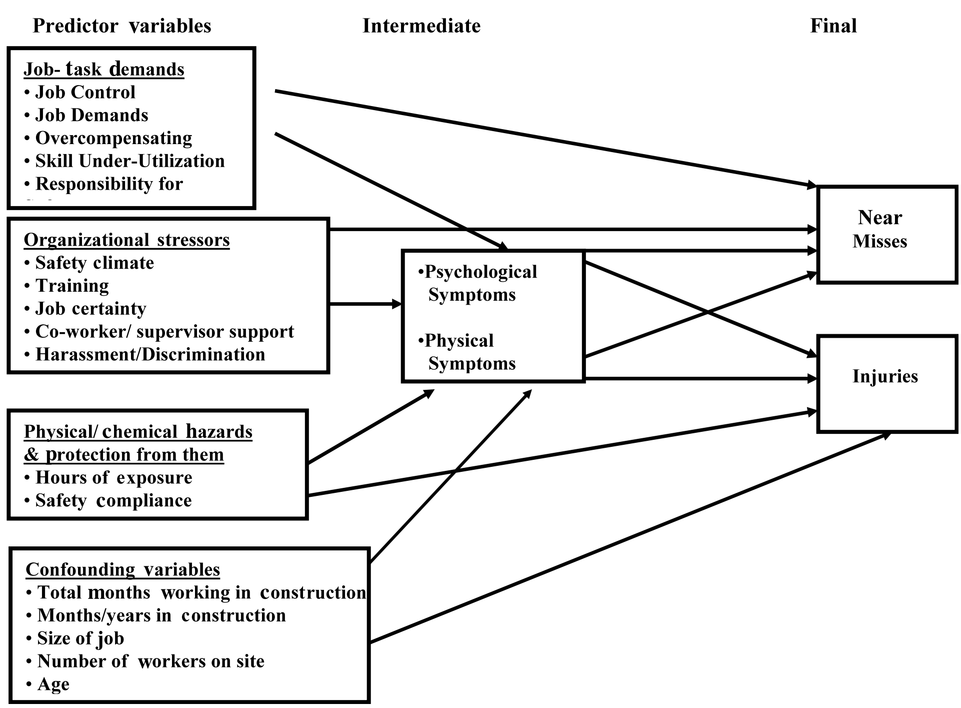

Figure 1. Partially mediated Stressor-Injury/Near miss theoretical model.

theoretically based and refers specifically to workers' and managements' attitudes towards safety, while it has been argued that safety culture is not theoretically grounded and pertains to the convictions underlying the workers' and managements' attitudes (Clarke, 2000; Cox & Flin, 1998). Although the multidimensional nature of safety climate is no longer being debated, the exact nature of the dimensions is still being studied; see Clarke (2000) for a review. While some definitional disagreement still remains, five dominant themes comprising the safety climate construct seem to consistently emerge: work task/work environment, personal involvement, management attitudes, safety management system, and management actions. Most importantly, in the area of construction it has been shown that managements' commitment to providing a safe and healthy work environment is the primary safety climate indicator for explaining safety climate behaviour among construction workers (Dedobbleer & Beland, 1991; Mattila *et al*., 1994). In addition, Cox *et al*. (1998), suggest that management actions have the greatest effect on workers' perceptions of safety commitment. Thus, we chose to include survey items measuring management commitment to safety as an indicator of jobsite safety climate and as a potential stressor for workers.

Other variables in the organizational stressors category include not having the proper skills and safety training, and not receiving co-worker and supervisor support. These variables have all been identified as potential stressors (Iverson & Erwin, 1997), particularly for workers in non-traditional occupations (LeBreton & Loevy, 1992; Tallichet, 1995). Having an increased responsibility for the safety of others as well as job (un)certainty are integral to working in construction and may act as additional job stressors (Murphy, 1991; Studensky & Barczyk, 1987). Finally, gender-based harassment/discrimination, has been identified as a source of stress related to adverse psychological and physical outcomes, particularly for women working in a variety of traditional and non-traditional occupations (Fitzgerald, 1993; Gutek & Koss, 1993; Hamilton *et al*., 1987; Kasinsky, 1992;Landrine *et al*., 1995; Schneider *et al*., 1997).

The third category of exogenous variables (Physical and Chemical Hazards and Protection from Them) contains a measure of exposure and how a worker protects herself from that exposure. As stated earlier, the direct relationship between physical stressors (e.g. working with heavy equipment, noise, and vibration) as well as chemical stressors (e.g. asbestos, lead, epoxy resins), and illness and injuries on construction sites has been well documented (Ringen *et al*., 1995).

In addition to the three categories of stressor variables, a number of control variables (e.g. size of job, number of workers on site, age of worker) were also included because research has shown them to be potentially related to injury or illness on construction sites (Ringen *et al*., 1999; Weeks & McVittie, 1995). These control variables are included in the present research to ensure that conclusions reached about the relationships between the three categories of job stressors and the mediating and outcome variables are not confounded.

Two mediating constructs (psychological and physical symptoms) are also integral to the Mediated Multipredictor Stress-Injury Model. Previous research has shown that a number of the stressors included in this study are related to adverse psychological and physical outcomes for construction workers (Goldenhar *et al*., 1998). Also, other research has suggested that physical or psychological symptoms may act as mediators between job stressors and injury outcomes for construction workers (Kerr, 1957; Leather, 1987; Weeks & McVittie, 1995). So, while adverse psychological and physical symptoms are clearly important for all workers, the construction industry may be particularly interested in knowing whether or not workers experiencing these types of symptoms are at greater risk for injuries and near misses.

Finally, as noted previously, an important feature of the present study is its focus on potential gender differences in the relationships among the stressor and outcome variables. Prior research does indicate that men and women may differ in their experience of job stressors, even if they are employed in the same jobs. Women, for example, are much more likely to encounter discrimination and sexual harassment on the job than are men, particularly in non-traditional jobs such as construction (Fitzgerald, 1993; Magley *et al*., 1999). Sexual harassment has been linked with a range of negative physical, psychological and job-related outcomes (Fitzgerald, 1993; Goldenhar *et al*., 1998). Another type of potential gender-based difference in the experience of stress is that social support may be more strongly linked with health and well-being for women than for men. For example, Vermeulen & Mustard (2000) found that high levels of social support eliminated psychological distress for women, but not for men. Additionally, Goldenhar *et al*. (1998) found that higher levels of social support from co-workers and supervisors were associated with greater job satisfaction for female construction workers, possibly because supervisors are key for facilitating job training, assignment of desirable tasks, and protection from harassment.

Other stressors that may operate differently for male and female construction workers include skill utilization and overcompensation. For example, women working in non-traditional jobs may not be given the same opportunities to learn and use necessary job skills to the same degree as men (Goldenhar & Sweeney, 1996), but may also feel the need to 'prove themselves' at work by overcompensating in their work (Goldenhar & Sweeney, 1996; Johnson, 1991). Thus, it might be expected that female construction workers would report lower levels of skill utilization and higher levels of overcompensation than male construction workers, and that these may be more strongly linked with job satisfaction and health in the female construction workers.

In summary, the strengths of the study presented here are (1) that we evaluate a conceptual model of injury outcomes that includes a broad set of work-related stressors, (2) that we compare a partial and fully mediated model to examine the importance of physical and psychological symptoms as intervening variables linking stressors and the injury outcomes, and (3) that potential gender differences are being examined, using a sample of women and men performing equivalent jobs.

3. Methods

3.1. *Sample*

Efforts were undertaken to sample union construction labourers in the Pacific Northwest. We worked closely with the locals' Business Agents (BAs) to obtain as large and representative a sample as possible because of the nature of the industry and the need to access individuals through union membership lists (which are not released to outsiders). We were not able to directly contact randomly selected individuals from the membership list. Letters (from the union) explaining the study, and a postage-paid postcard, acknowledging willingness to participate in the study and requesting a telephone number, were sent out in advance to all members for whom addresses were available (approximately 2500). From that mailing, 688 postcards were received with valid contact information. This is a 28% return response rate—we do not know how many postcards were not returned because the individual was no longer a member, had moved, or was not interested in participating. Although low, this type of response rate is not atypical for a passive mail-based strategy (Rossi *et al*., 1983), nor is it atypical of union efforts to contact members for other reasons (personal communication with K. Conlan).

Of the 688 postcard responses returned, 591 individuals were found to be eligible to participate (i.e. having worked as a labourer in construction for at least 3 consecutive months at some time during the past year). A random number was generated and was used to randomly select postcards returned by the union members. Of the 591 eligible respondents, trained interviewers conducted the 30-min telephone interview with 408 labourers (195 males and 213 females). This represents 69% of possible interviewees.

3.2. *Questionnaire development*

The questionnaire comprised a number of previously validated scales plus the construction and gender-specific issues identified above (e.g. skill under-utilization, having to over-compensate at work, harassment and discrimination). The questionnaire was pre-tested with 20 male and 20 female construction workers and recommended changes were incorporated into the final survey. To keep respondents using a consistent worksite as their frame of reference for answering questions, the interviewer provided the following introduction: 'As we go through this questionnaire, we would like you to think about a specific jobsite and answer the questions with that jobsite in mind. That is, if you are currently working on a jobsite, please answer the questions with your current jobsite in mind. If you are not currently working on a jobsite, please think about the last job you finished and keep that one in mind when you answer the questions. OK, do you have a jobsite in mind?' The respondent was periodically reminded of this throughout the interview.

Table 1 contains the items and scales used to measure all of the model variables, as well as their means, standard deviations, and ranges. Six of the constructs (job control, safety climate, harassment/discrimination, training, job certainty, social support) comprised four or more items. To investigate discriminant validity, the 29 items representing these six variables were included in an exploratory factor analysis using a principal components estimation approach. Using the criterion of an eigenvalue > 1.00, a 6-factor solution provided the best fit and all items factored as expected. To provide further evidence in support of the 6-factor model, two alternative models were also examined (5- and 7-factor models), and these were found not to have a simple structure. A description of the scales and all items used in this analysis are provided below, while Cronbach αs are presented in Table 2.

3.2.1. *Stressors: exogenous variables:*

3.2.1.1 *Job-task demands:* The National Institute for Occupational Safety and Health (NIOSH) Job Stress Questionnaire (Hurrell & McLaney, 1988) was the primary source for questions measuring job control and job demands. As noted above, the four job control items factored well and were used to create the job control scale. Two additional items representing job demands (frequency of working hard and fast) were used, as was an item tapping the degree to which respondents felt that they had to constantly 'prove' themselves (overcompensation), which has been identified as an important source of stress by women construction workers (Goldenhar & Sweeney, 1996). Two other items in the job-task demand category ('having responsibility for the safety of others' and 'skill under-utilization') were also included since they tapped types of demands not reflected in the job control variable. Although the job demands, overcompensation, skill under-utilization, and responsibility for safety variables were measured with only one or two items, these variables were included in the model to expand the range and nature of job stressors to be examined. Scale reliability is demonstrated in the current study by Cronbach α coefficients

Table 1. Stressors, intermediate and final outcome measures.

Job-task demands

Job control (5-point scale: Very little to A great deal) **Mean = 14.53 (SD = 4.0; range = 0−20)**

1. How much control (do/did) you have over the types of tasks you (are/were) assigned to do during a work-day?
2. How much control (do/did) you have over getting the contractor to provide you with the proper personal protective equipment that you (need/needed)?
3. How much control (do/did) you have over how fast or slow you (work/worked)?
4. In general, how much control would you say you (have/had) over your work and work-related factors?

Job demands (5-point scale: Never to Always) **Mean = 7.29 (SD = 1.8; range = 2−10)**

1. How often (do/did) you have to work very fast on the job?
2. How often (do/did) you have to work very hard on the job?

Overcompensating at work (5-point scale: Never to Always) **Mean = 2.70 (SD = 1.5; range = 1−5)**

1. How often on this job (do/did) you feel that you (have/had) to work harder than others in order to 'prove' yourself?

Skill under-utilization (5-point scale: Never to Always—Recoded) **Mean = 2.57 (SD = 1.2; range = 1−5)**

1. At work, how often (are/were) you given a chance to do the things that would help you to improve or perfect your skills?

Responsibility for safety of others (4-point scale: Very Little to a lot) **Mean = 3.55 (SD = .85; range = 1−4)**

1. At work, how much responsibility do you have for the safety of others on the jobsite?

Organizational stressors

Safety climate (4-point scale: strongly disagree to strongly agree) **Mean = 16.37 (SD = 2.9; range = 5−20)**

1. At this jobsite, employees, supervisors, and managers (work/worked) together to ensure the safest possible working conditions.
2. At this jobsite, significant shortcuts (are/were) taken, which could put a worker's health and safety at risk (Recoded).
3. The protection of workers (is/was) a high priority with supervisors at this jobsite.
4. At this jobsite unsafe work practices (are/were) corrected by supervisors.
5. When you were a new employee at this jobsite, you learned that you were expected to follow good safety practices.

Training (4-point scale: Strongly disagree to strongly agree) **Mean = 16.37 (SD = 2.9; range = 5−20)**

1. At this jobsite, sometimes I (am/was) given a task to do and I (am/was) not sure how to do it (Recoded).
2. I believe that I have been properly trained to use all types of personal protective equipment.
3. Overall, I believe that I have had the training I need to work safely.
4. Overall, I wish that I had been better trained before ever working on a construction site (Recoded).

Job certainty (4-point scale: Very uncertain to certain) **Mean = 11.02 (SD = 3.2; range = 4−16)**

1. How certain are you that job promotion and job advancement will exist for you in the construction industry during the next few years?
2. If you lost your job, how certain are you that you could support yourself?
3. If you lost your job, how certain are you that you could find a job to replace your income?
4. How certain are you about your job future?

Social support (5-point scale: Never to Always) **Mean = 24.14 (SD = 5.0; range = 7−30)**

1. How often does your immediate supervisor make an extra effort to make your work life easier for you?
2. How often does your immediate supervisor make an extra effort to make your work life safer for you?
3. How often can your immediate supervisor be relied upon to help you when a difficult situation arises at work?
4. How often do your co-workers make an extra effort to make your work life easier for you?
5. How often do your co-workers make an extra effort to make your work life safer for you?
6. How often can your co-workers be relied upon to help you when a difficult situation arises at work?

Harassment and discrimination (2-point scale: No, Yes) **Mean = 1.38 (SD = 2.0; range = 0−9)**

In the past year, on the jobsite:

1. have you ever had unwanted suggestions about, or references to, sexual activity directed at you by co-workers?
2. have you ever had unwanted suggestions about, or references to, sexual activity directed at you by supervisors?
3. have you ever experienced unwanted physical contact, including that of a sexual nature, by co-workers?
4. have you ever experienced unwanted physical contact, including that of a sexual nature, by supervisors?
5. have you ever felt that you were mistreated due to the fact that you were a female/male by co-workers?
6. have you ever felt that you were mistreated due to the fact that you were a female/male by supervisors?

(*Table continues on p. 225*)

Table 1 *(Continued)*

Exposures and protection from them

Hours of exposure (Summed scale) **Mean = 14.74 (SD = 8.4; range = 0–44)**

1. How many hours per day are you exposed to each of the following hazardous or unpleasant conditions: noise, chemicals, asphalt, asbestos, and lead?

Safety Compliance Index (5-point scale: Never to Always) **Mean = 12.12 (SD = 2.7; range = 3–15)**

1. How often do you wear earplugs?
2. How often do you wear safety glasses?
3. How often do you wear safety shoes?

Outcomes

Psychological symptoms (5-point scale: Never to Always) **Mean = 6.79 (SD = 1.93; range = 3–13)**

1. In the past year, how often have you felt tense?
2 In the past year, how often have you felt angry?
3 In the past year, how often have you felt sad?

Physical symptoms: (5-point scale: Never to Always) **Mean = 8.7 (SD = 2.75; range = 4–20)**

1. In the past year, how often have you experienced insomnia or had trouble sleeping?
2. In the past year, how often have you felt symptoms of nausea or stomach disorders?
3. In the past year, how often have you experienced headaches?
4. In the past year, how often have you experienced low-back pain?

Near miss **0–1 near miss = 56%**
2–5 near miss = 29%
6 or more near miss = 14%

Injuries (Yes responses for injury were summed and then trichotomized: head + neck + eyes + shoulder + arms + wrist + hand + upper back + lower back + legs + ankles + feet + other)
0 injury = 62%
1 injury = 16%
2 or more injury = 22%

(Table 2) (Cronbach, 1951), and the α statistics were similar to those found in previous research (Hurrell & McLaney, 1988).

3.2.1.2. *Organizational Stressors:* Four items from the NIOSH Management Commitment to Safety Scale (DeJoy *et al*., 1995) were adapted for use to measure the safety climate in the present study. Leather (1987), argued that in addition to providing the materials and equipment necessary for working safely, construction management needs to provide 'that which is psychologically necessary to convince lower organizational members that safety really counts as a primary organizational goal'. Although the coefficient α was fairly low (.63) for the training measure (i.e. employee's perception of the amount of training they received), it was retained in the model because other studies have shown it to be an important source of stress (Goldenhar & Sweeney, 1996). The NIOSH Job Stress Questionnaire was the source for questions measuring job certainty and social support. Job certainty is a constant stressor given the fact that construction workers are always working themselves out of a job and thereby find themselves having to look for new work on an on-going basis. There is a plethora of evidence showing that social support from co-workers and supervisors affects a worker's level of job stress. The sexual harassment/discrimination items were based on questions from the Northwestern National Life Insurance Company survey (NNLIC) on workplace violence (Northwestern National Life Insurance Company, 1993).

3.2.1.3. *Physical and chemical hazards and protection from them:* The exposure variable is a summation of total hours per day for all reported exposures. Thus, the total number of hours could equal more than an 8-h workday. The index of safety compliance index is comprised of multiple safety behaviours including respondents' use of earplugs, safety glasses and safety shoes.

3.2.1.4. *Control variables:* These variables, although not of primary interest, may be related to construction-related injuries and therefore were controlled for in the analyses.

Table 2. Zero order correlations and coefficient αs. (p values in parentheses).

Variable name	α	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Job control	.70																					
2. Job demands	.68	− .02																				
		(.73)																				
3. Over-compensation		− 25	.23																			
		(.01)	(.01)																			
4. Skill utilization		− 32	− .11	.16																		
		(.01)	(.03)	(.01)																		
5. Responsibility for others' safety		.17	.02	− .16	− .25																	
		(.01)	(.74)	(.01)	(.01)																	
6. Safety climate	.83	.46	.01	− .22	− .35	.21																
		(.01)	(.77)	(.01)	(.01)	(.01)																
7. Training	.63	.34	.07	− .14	− .23	.14	.53															
		(.01)	(.18)	(.01)	(.01)	(.01)	(.01)															
8. Job certainty	.75	.39	.12	− .21	− .26	.11	.23	.23														
		(.01)	(.01)	(.01)	(.01)	(.03)	(.01)	(.01)														
9. Social support	.87	.49	− .05	− .29	− .36	.24	.56	.37	.26													
		(.01)	(.34)	(.01)	(.01)	(.01)	(.01)	(.01)	(.01)													
10. Harassment & discrimination	.78	− .25	− .01	.22	.16	− .07	.17	− .30	− .34	− .34												
		(.01)	(.78)	(.01)	(.01)	(.15)	(.01)	(.01)	(.01)	(.01)												
11. Hours of Exposure		− .17	.14	.16	.11	.07	− .13	− .12	− .10	− .17	.17											
		(.01)	(.01)	(.01)	(.03)	(.19)	(.01)	(.01)	(.06)	(.01)	(.01)											
12. Safety Compliance Index		.17	.07	.02	− .11	− .04	.16	.16	.15	.18	− .14	− .10										
		(.01)	(.15)	(.74)	(.03)	(.44)	(.01)	(.01)	(.01)	(.01)	(.01)	(.04)										
13. Total months in construction		.14	.07	− .10	− .10	.13	.08	.17	.09	.09	.06	.03	.03									
		(.01)	(.17)	(.05)	(.90)	(.01)	(.11)	(.01)	(.06)	(.07)	(.22)	(.49)	(.55)									
14. Months/years in construction		.17	.19	− .04	− .15	.05	.14	.12	.27	.06	.01	− .06	.03	.13								
		(.01)	(.01)	(.47)	(.01)	(.34)	(.01)	(.02)	(.01)	(.20)	(.97)	(.20)	(.58)	(.01)								
15. Size of job		− .01	.14	.12	− .05	− .09	− .01	− .04	.07	.01	.01	.03	.17	− .05	.09							
		(.95)	(.01)	(.01)	(.31)	(.08)	(.91)	(.39)	(.19)	(.95)	(.99)	(.57)	(.01)	(.32)	(.06)							
16. Number of workers on job		− .03	.10	.08	.04	− .07	− .07	− .08	.04	− .01	.04	.01	.15	.03	.12	.45						
		(.52)	(.04)	(.12)	(.38)	(.57)	(.16)	(.12)	(.48)	(.80)	(.44)	(.97)	(.01)	(.49)	(.02)	(.01)						
17. Age		.01	− .06	− .10	.01	.09	− .07	− .01	− .02	− .07	.07	.18	− .13	.43	.03	− .05	− .14					
		(.27)	(.23)	(.05)	(.90)	(.06)	(.15)	(.83)	(.71)	(.16)	(.15)	(.01)	(.01)	(.01)	(.54)	(.35)	(.01)					

(*Table continues on p. 227*)

Table 2 (*Continued*)

Variable name	α	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
18. Psychological symptoms	.68	−.23	.03	.20	.19	.04	−.17	−.08	−.29	−.25	.32	.13	−.14	.09	−.03	−.02	.01	.05				
		(.01)	(.55)	(.01)	(.01)	(.37)	(.01)	(.09)	(.01)	(.01)	(.01)	(.01)	(.01)	(.07)	(.55)	(.63)	(.83)	(.35)				
19. Physical symptoms		−.26	.04	.14	.13	.01	−.09	−.08	−.33	−.14	.30	.19	−.14	.08	−.05	−.01	.01	.08	.50			
		(.01)	(.37)	(.01)	(.01)	(.96)	(.08)	(.10)	(.01)	(.01)	(.01)	(.01)	(.01)	(.10)	(.33)	(.77)	(.81)	(.10)	(.01)			
20. Near miss		−.15	.12	.08	−.06	.10	−.06	−.14	−.03	−.12	.13	.14	−.18	−.02	.01	−.04	−.04	−.04	.22	.22		
		(.01)	(.01)	(.10)	(.20)	(.05)	(.21)	(.01)	(.51)	(.01)	(.01)	(.01)	(.01)	(.74)	(.90)	(.46)	(.47)	(.46)	(.01)	(.01)		
21. Injuries		−.10	.06	.10	−.04	−.09	−.15	−.14	−.11	−.08	.16	.13	−.05	.01	.11	.05	−.01	.05	.15	.23	.13	
		(.04)	(.25)	(.05)	(.38)	(.06)	(.01)	(.01)	(.03)	(.10)	(.01)	(.01)	(.35)	(.97)	(.03)	(.33)	(.94)	(.33)	(.01)	(.01)	(.01)	

For example, in Ontario, Canada, it was shown that lost-time injury frequency increases as firm size decreases (McVittie *et al*., 1997). Also, both having experience working in construction and being older have been shown to be potentially related to injury outcomes (Ringen *et al*., 1999; Weeks & McVittie, 1995). On larger jobs, there is a greater chance that more women will be hired over the life of the job. This has been mentioned by women construction workers as positively influencing their psychological well-being.

3.2.2. *Outcomes: endogenous variables.*
3.2.2.1. *Psychological health outcomes:* The three items with the highest average factor loadings (respectively) on the Profile of Mood States (POMS) Tension-Anxiety, Depression-Dejection, and Anger-Hostility scales were used to measure psychological symptoms (McNair *et al*., 1981). Similar POMS items have been used in prior NIOSH job stress studies and have been found to produce adequate reliabilities when combined into factors (Hurrell, 1985). For example, a recent study of 230 data entry operators who were asked about feelings of tension, anger and sadness over the past month yielded a Cronbach's α for these items of .73 (unpublished NIOSH data). This corresponds closely to the Cronbach's α of .68 achieved for these items in the present study.

3.2.2.2. *Physical health outcomes:* Additional questions derived from the Northwestern National Life Insurance Co. survey (Northwestern National Life Insurance Company, 1993) pertained to respondents' experience with nausea, headaches, insomnia and low-back pain. We were interested in the total amount of health problems experienced by respondents, so a scale was created by summing reports of the frequency with which the problems noted above were reported by respondents. Since these outcomes reflect diverse types of problems and the variable created represents a count of these problems, coefficient α is not appropriate.

3.2.2.3. *Injuries:* Quality self-reported injury data may be difficult to capture. Therefore, rather than asking a general open-ended question about whether or not the respondent had been injured sometime during the past year, the interviewer systematically mentioned each major body part to the respondent and asked if it had been injured during the past year (see Table 1 for the complete list). The injury variable used in these analyses is a summation of the responses to these questions. Once summed, the variable was trichotomized into: no injuries, one injury, or two or more injuries experienced during the last year. There is precedence for this approach in a recent paper modelling the direct relationships between predictor variables and injury outcomes (Iverson & Erwin, 1997). As with the physical symptoms variable, coefficient α is not appropriate for this count variable. The skewness value for the injuries variable was .850, which is within acceptable limits (Hair *et al*., 1998).

3.2.2.4. *Near misses:* Respondents were also asked to recall the total number of near misses (i.e. an incident that could have resulted in an injury but did not) that they had experienced during the past year. The interviewers then coded the answers into four categories: (1) 0 or 1, (2) 2–5, (3) 6–10 or (4) more than 10 near misses. The final two categories were collapsed and the variable was trichotomized into: 0 or 1 near misses, 2–5 near misses, or 6 or more near misses. The skewness for this variable was .261, which is within acceptable limits (Hair *et al*., 1998).

4. Analytical strategy

LISREL 8.51 (Jöreskog & Sörbom, 1993) with maximum likelihood estimation was used to evaluate a latent variable structural equation model based on the theoretical model detailed in Figure 1. Three important sets of paths estimated include: (1) the paths from the 17 exogenous variables to physical and psychological symptoms, (2) the paths from physical and psychological symptoms to the two outcome variables (near misses and injuries), and (3) the paths from the 17 exogenous variables to near misses and injuries. The model evaluated also included correlations among the exogenous variables, and correlations were allowed between the error terms for the equations of the two symptom variables and for the equations of the injury and near-miss variables. For the eight multi-item scales for which coefficient α was appropriate (see first column in Table 2), random measurement error was accounted for by fixing to a value of 1.0 a factor loading linking each scale to a corresponding latent variable, and the amount of measurement error associated with each scale was fixed at the value of one minus the reliability multiplied by the variance of the measure (Kenny, 1979). For other variables, a factor loading linking the variable with a factor was set at 1.0 and the error variance was assumed to be zero.

Finally, it was noted previously that the sample included 195 males and 213 females. To investigate potential gender differences, we used multi-sample analysis and the first model examined (Model A) specified that the paths representing all of the three sets of key relationships mentioned above had equal values in the male and female samples. However, all other parameters (e.g. correlations among the exogenous variables, measurement error variances, residuals for the structural equations) were allowed to be different in the two gender groups. The specification of the model in this way was chosen to avoid unnecessary assumptions of gender equality for unimportant parts of the model and to allow for subsequent model comparisons to test the assumptions noted above that the key relationships had equal parameter estimates across the two groups.

In addition to Model A, we also examined four other models. First, we evaluated a more restrictive fully-mediated model (Model B) and compared it to our initial partially-mediated model. In the fully-mediated model we specified that the exogenous variables were *not* directly related to the two outcome variables (near misses and injuries), thus testing to see if the physical and psychological symptom variables were solely responsible for linking the exogenous and outcome variables. Thus, the fully mediated model restricted to zero the 34 paths from the 17 exogenous variables to the near misses and injuries outcome variables, and the direct comparison of the partially- and fully-mediated models provides an overall test of the significance of the direct effects. Next, since our data included male and female samples of adequate size, we also evaluated three other multi-sample models that allowed for the three sets of key relationships to be different across the two gender groups. The comparison of these models with the original model allows for a test of the potential moderating effects of gender on the specified relationships of theoretical interest. Model C allowed the four paths from physical and psychological symptoms to the near miss and injury variables to be different in the two groups, Model D allowed the 38 paths from the 17 exogenous variables to the near miss and injury variables to be different, and Model E allowed the 38 paths from the 17 exogenous variables to the physical and psychological symptom variables to be different.

5. Results

5.1. *Demographics, means and bivariate relationships*

The results in Table 1 show that, on average, the sample's tenure in the industry was 8.8 years and ranged from 3 months to 35 years. In 1993, the national median for job tenure of blue-collar construction workers (with the same construction employer) was 5 years (Center to Protect Workers' Rights, 1998). On average, the tradespeople in this sample worked in construction for 9.5 months out of the year (range 2–12 months). This is typical given the seasonal and intermittent nature of the industry (Center to Protect Workers' Rights, 1998). The average age of workers in this sample was 38 years, which is comparable to the national average age of a union construction worker of 39 years (Center to Protect Workers' Rights, 1998). Thus, it appears that this sample is fairly representative of the industry as a whole.

The means also show that, on average, respondents reported that their work was demanding, that they perceived a positive safety climate on their jobsite, felt responsible for the safety of others, and believed that they complied with safety practices. Overall, they believed themselves to have had adequate skills training, feel a sense of control on the job, and have social support from co-workers and supervisors. On the negative side, they reported sometimes having to overcompensate on the job and that they were not able to utilize their skills to the fullest. The respondents also had some concern related to job certainty, but they did not report experiencing a great deal of harassment and discrimination. The respondents in the sample expressed experiencing a range of physical and psychological symptoms. In terms of the final outcomes, 56% stated they had had 0–1 near misses in the last year, 29% reported having 2–5 near misses and 14% reported 6 or more near misses. A total of 62% reported 0 injuries, 16% reported 1 injury and 22% reported experiencing 2 or more injuries in the past year. The obtained skewness and kurtosis values for the near miss and injury variables indicated that neither outcome deviated substantially from normality.

Owing to the large sample size, many of the zero order correlations shown in the correlation matrix (Table 2), were statistically significant, however only a few reflected moderately strong relationships. Not surprisingly, age and job tenure ($r = .43$; $p < .001$), as well as size of job and number of workers ($r = .45$; $p < .001$) were significantly related. Physical and psychological symptoms were also related ($r = .50$; $p < .001$). Safety climate was positively related to job control ($r = .46$; $p < .01$), social support ($r = .56$; $p < .001$), and to training ($r = .53$; $p < .001$). Support and control ($r = .49$; $p < .001$) were also positively related.

5.2. *SEM results*

The results for Model A, including the significant completely standardized parameter estimates (common metric), are presented in Table 3. The χ^2 value for Model A was 83.4 (df = 72), and other indicators of model fit yielded favourable values (CFI = .99; RMSEA = .025, p-value for Test of Close Fit = .99). A total of 24 paths were found to be different from zero at either the .05 or .10 significance level. (Given that it is the first time these specific relationships have been examined in such a large model, we felt most comfortable with a more liberal significance criterion (i.e. $p \leq 10$) knowing that there was the potential greater risk of making a type I error.) The significant paths and the R^2 values for the four dependent variables are presented next. Note that the parameter estimates in Table 3 are reported as either gammas (γs) or betas (βs). Gammas are regression-like parameter estimates that describe the relationship between exogenous and endogenous variables, whereas betas are the regression-like parameter estimates that describe the relationship between two endogenous variables.

5.2.1. *Psychological symptoms:* Six of the direct paths between the exogenous variables and psychological symptoms were supported in the analysis (Table 3). Two of the significant predictors came from the job-task demands category, including skill under-utilization ($\gamma = .13$) and responsibility for safety ($\gamma = .13$). Three of these significant predictors were

Table 3. Significant path estimates.

Independent and intermediate outcome variables	Dependent variables: Psychological symptom	Physical symptom	Near misses	Injuries
Job-task demands				
Job control			− .19⋆	
Job demands		.11⋆	.13⋆	
Overcompensation				
Skill utilization	.13⋆⋆		− .12⋆⋆	
Responsibility for others	.13⋆⋆			− .10⋆⋆
Organizational stressors				
Safety climate			.20⋆	
Training			− .31⋆⋆	
Job certainty	− .27⋆⋆	− .29⋆⋆	.19⋆⋆	
Social support	− .20⋆⋆			
Harassment & discrimination	.22⋆⋆	.17⋆⋆		
Exposures and Protection				
Hours of exposure				.14⋆⋆
Safety Compliance Index		− .08⋆	− .11⋆⋆	
Controls				
Total months working in construction	.15⋆⋆	.15⋆		.12⋆⋆
Months/years in construction				.15⋆⋆
Size of job				
Number of works on site				
Age				
Intermediate outcomes				
Psychological symptoms			†.17⋆	
Physical symptoms				†.17⋆⋆

⋆$p < .10$; ⋆⋆$p < .05$;
† Only these two values are betas. The remaining values in the table are gammas.

from the organizational stressor category, including job certainty ($\gamma = -.27$), support ($\gamma = -.20$), and harassment and discrimination ($\gamma = .22$). The other significant predictor of psychological symptoms was total months working in construction ($\gamma = .15$), a control variable. The amount of explained variance for psychological symptoms was $R^2 = .37$.

5.2.2. *Physical symptoms:* For physical symptoms, five predictors were significant, and these came from all four of the categories of exogenous variables. From the job-task demand category, job demands was significantly related to physical symptoms, while from the organizational stressor category job certainty ($\gamma = -.29$) and harassment and discrimination ($\gamma = .17$) were significant predictors. From the exposure category, safety compliance was significant ($\gamma = -.08$), and total months working in construction ($\gamma = .15$) was a significant control variable. The amount of variance explained with respect to physical symptoms was $R^2 = .22$.

5.2.3. *Near misses:* A total of eight hypothesized paths leading directly to the near miss variable were also supported. These significant predictors included the mediator psychological symptoms ($\beta = .17$). From the job-task demands category, job control ($\gamma = -.19$), job demands ($\gamma = .13$) and skill under-utilization ($\gamma = -.12$) were significant. From the organizational stressor category, safety climate ($\gamma = .20$), training ($\gamma = -.31$), and job certainty ($\gamma = .19$), were significant predictors. From the exposure category, safety compliance ($\gamma = -.11$) was significant. The amount of explained variance was $R^2 = .21$ for the near-misses variable.

5.2.4. *Injuries:* Finally, five of the hypothesized paths leading directly to the injury variable, as shown in Figure 1, were supported in the analysis. The significant predictors included the mediator physical symptoms ($\beta = .17$). Other significant predictors included responsibility for safety ($\gamma = -.10$), an organizational stressor, and hours of exposure ($\gamma = .14$) from the exposure category. Two confounding predictors were also significant: total months working in construction ($\gamma = .12$), and months worked per year ($\gamma = .15$). The amount of explained variance was $R^2 = .12$.

5.2.5. *Full mediation and gender moderation model comparisons:* As noted earlier, the model examined to this point assumed that the relationships between the 17 exogenous variables and the four dependent variables (68 paths), and the relationships among the four dependent variables (4 paths), were equal across the two gender groups. This assumption was directly tested in a supplementary analysis that compared this model to Model B that allowed for the 72 paths to have different values in the two groups. The null hypothesis tested with this model comparison is that the 72 key paths have equal values in the two groups. This alternative model was completely saturated (χ^2 and degrees of freedom equal zero), and the χ^2 difference test comparing the first alternative model to the theoretical model resulted in a non-significant difference (χ^2 difference = 83.4, df = 72). Thus, we failed to reject the restriction that the 72 paths have equal estimates in the two groups. Based on this finding, we concluded that there were no gender differences in the set of relationships identified when testing the model and Model A was retained for further examination.

The second alternative model examined, Model B, was a fully-mediated model that constrained the 34 direct paths linking the 17 exogenous variables to the injuries and near miss variables. The comparison of this model with the initially specified partially-mediated model allows for a direct test of the null hypothesis that the 34 paths equal zero (the full mediation hypothesis). This second alternative model had a χ^2 value of 166.13 (degrees of freedom of 106), and the comparison with the original model yielded a χ^2 difference of $166.13 - 83.4 = 82.73$, which exceeded the critical value for a difference in degrees of freedom of 34. Thus, the restriction of these direct effects to zero was rejected and the original partially mediated model (Model A) was retained.

As noted previously, Model C was examined to test the equality across gender of the four paths linking the physical/psychological symptoms and near miss and injury variables, and the χ^2 for this model was 74.79 (df = 68). The χ^2 difference for the comparison of Model A with Model C was 8.58, which is less than the critical value for four degrees of freedom; thus, we failed to reject the hypothesis that these four paths are equal in the two gender groups. Model D allowed the 17 paths from the exogenous variables to the near miss and injury variables to be different, and it yielded a χ^2 value of 45.92 (df = 38), which was not significantly different (χ^2 difference equals 37.45) from the χ^2 for Model A. A similar non-significant χ^2 difference was obtained with Model E, which allowed the 17 paths from the exogenous variables to the physical/psychological symptoms variables to be different. The χ^2 for Model E was 39.74 (df = 38) and the χ^2 difference relative to Model A was 43.63. In summary, Model A was shown to be preferable to the other four models examined and there was no support for gender differences in any of the theoretical models tested.

6. Discussion

6.1. *Relationships between intermediate and final outcomes*

The findings show that physical and psychological symptoms were directly related either to reported injuries or to near miss outcomes. It appears that in this sample of construction labourers, those reporting a higher degree of physical symptoms were at greater risk for experiencing an injury and those reporting a higher degree of psychological symptoms were at greater risk for experiencing a near-miss incident. Both of these direct relationships may be explained, in part, by the Adjustment Stress Theory (Kerr, 1957). Hinze (1997) applied Kerr's theory to the construction industry in an attempt to describe conditions that might affect incident occurrences on the job-site. In this theory, aspects of the worker's internal environment (e.g. worry, anxiety, depression) can create a mental diversion that preoccupies the worker's mind, thereby increasing the probability of experiencing an injury or near miss. Fatigue and bodily pain are also included in Kerr's theory as ways in which a worker's ability to remain safe on the jobsite might be compromised. The relationship between anxiety leading to inattention and thus resulting in a greater risk for injuries was also identified in Newfoundland fishermen (Murray *et al*., 1997). Given the current labour shortage and resulting long hours of work required of many tradespeople, both mental and physical fatigue may be of particular concern. Ideally, workers would be cognizant of when their psychological and physiological internal conditions had reached a level at which they would be at greater risk for these adverse outcomes.

6.2. *Relationships between predictor variables and intermediate outcomes*

In terms of the Job-Task Demand category, the significant positive relationship between skill under-utilization and psychological symptoms has been discussed previously (Johnson, 1991; Marshall, 1990; Murphy, 1991; Quinn & Woskie, 1988; Studensky & Barczyk, 1987). The additional information provided here is that skill under-utilization may also be associated with near-miss outcomes through psychological symptoms. Although workers may have a wide array of skills and abilities, it is not unusual to be 'tracked' into doing only one or two particular tasks (e.g. women construction workers only being trained—and therefore allowed—to flag traffic during roadwork constructtion). The skill under-utilization relationship with psychological outcomes may be due to the frustration caused by not gaining the skill set necessary to move up in the trade's hierarchy. Management commitment to training and job rotation may help to reduce these adverse psychological outcomes and thus near misses. Understanding these relationships should be of interest to the construction industry given that a near miss today may be a serious incident tomorrow. (Again, the significant negative relationship to near misses was unexpected, particularly given the bivariate findings.)

A number of the constructs categorized as organizational stressors in the model were also directly related to the intermediate outcomes, including: job-certainty, harassment and discrimination, and social support. Historically, job certainty (also called job insecurity) has been an important stressor for construction workers, and it was related to both physical and psychological symptoms in the present research. At the worker level, job certainty is a constant stressor given the fact that construction workers are always working themselves out of a job. Once the whole job, or a worker's small part of a larger job, is finished they must find work on a new jobsite often with a new employer. For union workers, job placement is facilitated (although not guaranteed) through the union hall. There is no similar structure for non-union workers. For female construction workers, job certainty also includes worrying about whether they will be hired at all, as well as about being the first to be laid off, even before the job is finished (Goldenhar & Sweeney, 1996). These findings suggest that not having a steady job and having to constantly worry about future employment appears to be directly related to physical and psychological symptoms and are therefore indirectly related to near miss and injury outcomes.

The Organizational Stressor 'Harassment and discrimination' was also related to both physical and psychological symptoms and therefore indirectly related to both outcomes. The existence of this relationship has been discussed by other authors (Crull, 1979; Fitzgerald, 1993; Gutek & Koss, 1993). The findings reported here, however, are different in a compelling way. That is, most research on the adverse consequences of workplace harassment and discrimination has been conducted, not surprisingly, on those workers who are either more affected by it, or are more vocal about its occurrence—women. Thus, given that approximately one-half of these data were collected from men, the positive associations between harassment and discrimination and the outcome variables indicates that they too face these types of stressors at the jobsite. This points to the fact that a hostile workplace can be stressful for all workers and that experiencing harassment and discrimination may ultimately result in more near misses or injuries. This is both deleterious to the workers as well as to the construction industry as a whole.

Finally, one of the Organizational Stressors was related only to psychological symptoms. The finding linking co-worker and supervisor social support and fewer psychological symptoms was anticipated and has been identified in earlier research. Kissman (1990) showed that women in blue-collar jobs who had co-worker support were more satisfied with their jobs. Supervisor support was shown to be very important for women working in non-traditional occupations, particularly during their first year of work (McIlwee, 1982) and for minimizing any negative outcomes of job stressors overall (Ford, 1985). Iverson and Erwin (1997) also found that supervisory and co-worker support predicted occupational injury. Construction workers typically work in small groups or crews to get jobs done. If the nature of the crew is unsupportive of any worker, male or female, the psychological toll may lead to increased distractions, more near misses, and potential increased injuries.

6.3. *Relationships between predictor variables and final outcomes*

Eleven of the twelve stressors (the majority coming from the job-task demand and organizational categories) and two of the control variables were directly related to either injuries or near misses.

In terms of the Job-Task Demands, both Job demands and Job control were directly related to near misses. As early as the 1950s, Kerr (1950) identified worker control and worker participation in decision-making as being associated with fewer industrial injuries. Although both job demands and job control have been identified as two of the more potent job stressors across many workplaces (Karasek, 1989), their relationship to injuries (and near misses) has been the topic of less research. There has been some limited work and discussion of this relationship existing in the construction industry. It has been argued that injuries may occur because workers feel rushed by management to get the job done and are therefore less cautious (Dedobbleer *et al*., 1990; Smallwood & Ehrlich, 1999). Salminen *et al*. (1993) showed that the need to save time, tight schedules, and a lack of caution influenced the occurrence of incidents. Although it did not happen, we anticipated finding a significant negative relationship between job control and physical symptoms since this relationship has been discussed in previous research (Weeks & McVittie, 1995). If found, it would have provided even stronger evidence that if workers are given more control over their workpace and scheduling, they might be more cautious and therefore experience fewer near misses and fewer injuries.

Also from the Job-Task Demands category, having responsibility for the safety of others was directly related to injuries as well as indirectly related to near misses through psychological symptoms. Although it is not clear why one relationship would be direct and the other indirect, it is true that management as well as workers need to be constantly mindful of their responsibility for the safety of themselves and others on the construction site. It is possible that this constant safety vigilance could trigger adverse psychological outcomes leading to near misses and even injuries.

In terms of Organizational Stressors, what may be of particular interest to the construction industry is that respondents reporting more training also reported fewer near misses. The dangerous nature of the construction worksite makes having an untrained and unprotected workforce unacceptable in terms of health and safety. These findings, and the fact that construction ranks last in the percentage of employers providing formal job-skills training for their workforce (Center to Protect Workers' Rights, 1998), indicates an area in great need of improvement.

Two other Organizational Stressors, Job certainty and Safety climate, were also directly related to near misses, albeit in the opposite direction to what was expected. In the bivariate analysis however, the relationships between job certainty, safety climate and injuries and near misses were in the expected direction and non-significant, raising the possibility that a suppressor effect may be occurring. As discussed by Cohen and Cohen (1983), suppression can be created by specific patterns of correlations among predictor variables that suppress or hide their real relationship with a criterion. Suppression can occur in many theoretical contexts, and when it occurs the emphasis in interpretation is given to the path coefficients (rather than the zero order correlations).

From the Exposures and Protection category of stressors, participants reported that the greater their level of safety compliance, the fewer number of near misses they experienced. Safety compliance was also indirectly related to injuries through physical symptoms. It is possible that non-compliers, as measured in this study (i.e. not wearing safety glasses, safety shoes, earplugs) might also not practice other safe behaviours such as lifting correctly (causing backpain) or taking precautions to reduce their exposure to hazards (causing headaches or nausea). Also from this category, hours of exposure was related to injuries.

Two control variables that were positively related to injuries were total months working in construction and the number of months per year working in construction. These two, along with the previously discussed hours of exposure, all pertain to the amount of time a worker spends on the jobsite. This makes intuitive sense in that the more time spent on a jobsite, the greater the chances are of injury. Although we did not specifically look at the effect of 'working overtime', on injury or near miss outcomes, this finding suggests that working long hours, particularly over extended periods of time, may increase the risk of being injured. Indeed this relationship has been recently corroborated by both qualitative (Goldenhar *et al*., 2003) and quantitative (Dong, 2002) research studies on the effects of working overtime in construction.

The direct and indirect relationship (through physical symptoms) between total months working in construction (i.e. job tenure) and injuries as well as near misses (indirectly through psychological symptoms), may be explained by the fact that perhaps the longer one works in construction the greater the risk of experiencing psychological and physical symptoms, which in turn might increase the likelihood of injury and near miss occurrence.

6.4. *Limitations*

There are limitations associated with this study (see also Goldenhar *et al*., 1998). These include the use of cross-sectional (which means that conclusions cannot be drawn regarding the direction of effects) self-reported data, which were collected only from Labourers in the Pacific Northwest (i.e. the findings are perhaps not generalizable to other sectors). It would be ideal, albeit difficult, to gather prospective (subjective and objective) data from a large national sample of male and female construction workers. If this were possible and data were collected from trades other than labourers, there may have been gender differences in the hypothesized relationships. Nevertheless, these results do point to some important relationships for further study and for intervention by those in the construction industry and in the occupational safety and health community. It is also possible that including single-item measures might have been problematic in the analysis. However, of the three single-item perception questions (i.e. responsibility for safety, overcompensating, and skill under-utilization) only overcompensating was found to have no relationship to any of the endogenous variables. Thus, we would have been committing a mis-specification error had we left them out of the model. Finally, it may be the case that there was recall bias of injury reporting in using the 12-month reference period. Landen and Hendrick (1995) suggest that a shorter reference period is desirable for obtaining more accurate estimates. In an effort to reduce such bias, rather than asking a broad general question about injuries we attempted to trigger the respondent's memory by asking him or her about injury to each body part.

In conclusion, although the overall R^2 values for the four dependent variables were relatively low, many of the hypothesized relationships between the predictors and the outcome variables were supported. In addition to intervening to reduce physical and psychological symptoms of workers (which may be related to near misses as well as injuries), it appears that there are also a number of precursor targets for possible intervention. At the individual or worker level, complying with safety behaviours (i.e. using safety glasses and hearing protection) should reduce physical symptoms, leading to a reduction in injuries. Putting to use a worker's skill more effectively and making it clear that the crew (vs. the worker alone) is responsible for the safety of crewmembers should reduce psychological symptoms, thereby reducing the number of near misses. More importantly, organizational policies with respect to harassment and discrimination and the amount of worker autonomy or control may also be a target for intervention, for reducing the numbers of near misses and injuries among construction workers. Thus, there is no single approach to making the construction worksite a safer and healthier place to work for both male and female construction workers. This paper presents several possible avenues for doing that.

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