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Modeling the relationship among occupational stress, psychological/physical symptoms and injuries in the construction industry

Omosefe Osarieme Abbe

Louisiana State University and Agricultural and Mechanical College

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MODELING THE RELATIONSHIP AMONG OCCUPATIONAL STRESS,
PSYCHOLOGICAL/PHYSICAL SYMPTOMS AND INJURIES IN THE CONSTRUCTION
INDUSTRY

A Thesis

submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in Partial Fulfillment of the
requirements for the degree of
Master of Science in Industrial Engineering

in

The Department of Construction Management and Industrial Engineering

by

Omosefe Osarieme Abbe
B.S., Berea College, 2005
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Abstract

The construction industry has one of the highest incidents of fatal and non-fatal accidents/injuries every year. As a high risk industry, there is a need to investigate factors that affect the occurrence of these accidents to be able to protect workers. Traditional approaches to workers' safety in the construction industry have focused on the physical and biomechanical aspects of work by improving tools, equipment and task completion methods. However, the impact of psychosocial factors, specifically stress as experienced by construction workers is an area of growing research. Research in the area of occupational stress in the Construction Industry is yielding results that suggest that overall work safety on the construction site, should take into account psychosocial aspects of work. Research is carried out to investigate the relationship existing among occupational stressors, psychological/physical symptoms and accident/injury/near-miss and work days lost outcomes as experienced by industrial construction manual workers engaged in a range of construction occupations. Workers' perceptions about stress levels on specific elements of work as well as responses about physical/psychosocial symptoms were obtained by administering a questionnaire adapted from previous research. Analysis of the data entailed investigation of relationships through correlation and regression analysis, existing between the levels job stressors as experienced by the workers and (a) Company Accident History (OSHA-300 form) reports (b) Employee self-reported injuries and (c) Lost work days in 12 months prior to the survey. Among the occupations surveyed, pipefitters were at the highest risk for getting injured and responded with the most negative levels of occupational stressors. Some of the occupational stressors significantly associated with self-reported and OSHA logged injuries were training, job certainty and safety climate of the company. The OSHA logged injuries were associated with the occurrence of headaches and feelings of tenseness on the job.

Introduction and Significance

According to the Occupational Safety and Health Administration (OSHA), in the year 2006 the Construction Industry ranked highest among all industries in the United States for fatal injuries with a total of 1,226 fatalities. The 2006 fatality rate for the construction industry per 100,000 workers was 10.8, the fourth highest after mining, agriculture and transportation industries. OSHA also reports that for 2005 and 2006, unspecialized construction laborers accounted for the largest percentage (27%) of all construction fatalities (Bureau of Labor Statistics, U.S. Department of Labor, 2006). Reports from the National Institute for Occupational Health and Safety also show that the Construction Industry consistently ranked highest from the period of 1976-2001 for number of non-fatal injuries (Workers' Health Chart Book, NIOSH Publication Number 2004-146, 2004). Traditionally, studies on health and safety in the Construction Industry propose interventions to construction workers' injuries from a physical standpoint, (e.g. making modifications to the biomechanical demands on the job through redesign of tools and equipment) (Hess et al., 2004, De Jong et al., 2003, Bernold et al., 2001); however, there is growing amount of research that is focused on investigating and establishing a link between psychological factors/occupational stress and workers' injuries in occupations like farming (Glasscock et al., 2006), oil and gas offshore work (Cooper & Sutherland, 1987), and specific to this proposal, construction workers' injuries (Goldenhar et al., 2003, Sobeih et al., 2006).

The aim of this thesis is to investigate the level of significance of the relationship existing among occupational stressors, psychological/physical symptoms and accident/injury/near-miss outcomes and lost work days as experienced by Industrial Construction manual workers engaged in a range of construction occupations. Responses about perceived levels of occupational physical and psychological stressors and psychological/physical symptoms were collected from workers by administering a questionnaire used in previous research (Goldenhar et al., 2003). Injuries and the resulting lost work days were obtained through recorded OSHA accident reports along with self-reported injuries. Correlation and Regression analyses were carried out to determine the relationships among the following sets of data acquired:

- (1) Occupational stressors and (a) the duration of routinely doing a particular construction task, (b) physical/psychological symptoms exhibited by workers, (c) all accident/near-miss/injury outcomes, and (d) lost work days
- (2) The duration of routinely doing a particular construction task and (a) physical/psychological symptoms, and (b) all accident/near-miss/injury outcomes

(3) Physical/psychological symptoms and (a) all accident/near-miss/injury outcomes, (b) lost work days

The significance of research investigating the link between occupational stress and work place injury among construction workers engaged in a range of occupations is that it will allow for the opportunity to identify elements specific to a particular type of construction occupation that initiate stress processes, which in turn can be mediated to ensure worker's safety.

Literature Review

Stress Models

Research into modeling stress and its effects on humans crosses several disciplines which is one of the significant challenges to creating a ‘meta-model’ for stress and its outcomes (Beehr & Franz, 1987). Stress modeling research has been approached mainly from Medicine, Clinical Counseling/Psychology, Engineering Psychology and Organizational Psychology with typical stressors, outcomes and moderators existing within different domains. Typically, stressors for all four major disciplines fall either in the physical or psychological domain while observed outcomes include physical & psychological strain as well as job performance (Beehr & Franz, 1987).

The diversity of research approaches to stress is also reflected in definitions for stress as found in literature. The definition of stress for the purpose of the proposed study is as follows “[A]n interaction of several variables involving a particular kind of relationship between a person and the environment which is appraised by the person as being taxing or exceeding coping resources and endangering well-being” (Schlebusch, 1998, 266). The distinguishing characteristics of this definition of stress are as follows:

- Stress is an ongoing process (interaction) and as such can be said to be dynamic
- There are distinct domains involved in the process:
 - The domain of the environment
 - The domain of the person
- Awareness and appraisal of stress by the individual(s) in the process (typically exhibited as **strain symptoms**).

Strain is defined as any “deviation from the normal state or responses” of an individual. Symptoms of stress/strain could be psychological, physiological or behavioral (French et al., 1982).

Occupational Stress Models

Koslowsky (1998) gives an indepth overview of specific models of the stress process in which he categorizes the models into **major** and **minor** models. The three major models will be briefly outlined in this paper and they are: (1) the micro/macro stressors model; (2) the person-environment fit model; and, (3) demand/strain model.

The micro/macro stressors model is based on a study by Kanner et al. (1981). The study analyzed and compared participants’ responses to “daily hassles & uplifts” (micro-stressors) and to

major life events (macro-stressors) and the impact of these stressors on the physical health of the participants. Findings from the study were as follows:

- Perpetual daily hassles (micro-stressors) offer a more direct and broader assessment of stress in life than major life events (macro-stressors).
- Major life events had a little effect on psychological symptoms independent of hassles.
- In contrast, results indicate that daily hassles affect psychological symptoms independently of major life events.

The extension of this model to the workplace would mean that attention should be paid to the seemingly minor hassles that inevitably are a part of the work environment when developing coping methods for occupational stress and strain symptoms.

French et al. (1982) proposed the first comprehensive person-environment fit model in which they suggested two types of person-environment fit and two types of accuracy or perceptions of the demands of the environment and personal abilities. The characteristics of the model are two types of perceived environments and job demands (objective and subjective), as well as two types of perceived abilities within the domain of the individual: objective and subjective abilities. Two kinds of misfits can occur that would initiate the stress transaction and lead to strain:

- An objective misfit: which is the inconsistency between objective demands of the environment and the objective abilities of the person
- A subjective misfit: a situation which is a result of the following:
 - Distortion and elevation of one's perceived abilities to match objective demands
 - Distortion and downgrading of perceived demands to match objective abilities
 - Some combination of the two above mentioned defense mechanisms

The stress interaction according to this model will produce the following situations (French, et al., 1982):

- The reduction in the **accessibility of self** when there is a distortion of the abilities of the person
- The reduction in the **contact with reality** when there is a distortion of the environment

The Demand-Control model has been defined as the “interaction between job demands- defined as the psychological stress involved in accomplishing the workload- and- decision latitude- the workers potential control over his or has task and his or her conduct during the work day” (Meijman, et al., 1995,114). This model proposes that interactions of different levels of decision latitude and job demands will result in different levels of strains as follows (Karasek, 1979):

- a. High Job Demand/High Decision Latitude: Optimum Level of Strain
- b. High Job Demand/Low Decision Latitude: Highest Level of Strain
- c. Low Job Demand/High Decision Latitude: Lowest Level of Strain
- d. Low Job Demand/Low Decision Latitude: Low Level of Strain

Table 1 provides a summary of the three preceding stress models and respective domains of stressors both physical and psychological, that the model attempts to explain.

Table 1: Summary of Major Stress Models and Stressor Domains

Model	Physical Stressors	Psychological Stressors
Micro/Macro Stressors	X	X
Person-Environment Fit	X	X
Demand/Strain model		X

Occupational Stress and Accident/Injury Relationships

Findings from research that have confirmed the link between occupation stress and injury outcomes can be found across disciplines. A few of the studies have been summarized for non-construction and construction industries.

Non-Construction Industries

Cooper & Sutherland, (1987) carried out a study into the sources of occupational and psychosocial sources of stress in offshore workers. In their study, they analyzed the responses to a stress questionnaire of a sample of offshore workers in the North Sea and recorded accident data for workers that led to injury. Also analyzed was the relationship of occupational stressors to other independent variables like personality measures and demographics. Dependent variables analyzed included job satisfaction and overall mental health. Results of the multiple step-wise regression analysis of data obtained showed that stressors originating from personal relationships (both at home and work) were of major concern with the participants in this survey and was a predictor of job dissatisfaction and reduced mental well being. Elements of mental health included levels of anxiety which were significantly high, and the authors cite the elevated levels of anxiety as being associated with increased vulnerability for accidents at work. The study also showed that workers with Type A coronary-prone behavior- which is characterized by a sense of time urgency, competitiveness, haste, aggressive behavior, impatience, agitation, extreme alertness, striving for achievement and explosiveness of speech- were at an increased risk of experiencing accidents leading to injury (Haynes, et al., 1978).

A Danish study carried out by Glasscock et al. (2006), investigated the effects of psychosocial factors and safety behavior on accidents leading to injuries among farmers. The sample size of 310 farmers completed questionnaires on three elements: (1) psychosocial factors associated with farm-work; (2) confounding factors (age, work hours, farm type and farm size); and, (3) safety behavior. Participants responded to questions on scales adapted for the separate categories of stressors. The categories of stressors considered in this study were as follows: Working conditions (Environmental Stressors), Personality/Safety Attitude and Perceived Stressors. Participants also responded to questions about psychological stress symptoms and individual safety behavior.

The motivation for this study was the lack of evidence that such a study had been carried out before among farmers, who, (as cited by the authors) by Danish statistics were engaged in an occupation with twice as many fatal accidents as that of the Danish Construction Industry. Another

significance of the study given by the authors was that research into occupational stress focused on other industries could not be generalized to farmers. The primary reasons for this assertion were the absence of specialized work for farmers (machine operation, livestock care) and the multiple job roles that exist for farmers (administrative & manual). Also noted as a departure from previous research was the high level of decision latitude on the job that exists for farmers that is not the norm in most other industries (Glasscock, et al., 2006).

Farmers were asked to complete a year of accident registration that was analyzed with responses from the questionnaire developed about stressors. Findings from this study showed “relationships exist between both stressor and stress symptom measures and occupational farm accidents that result in injury” (p. 187). Another significant find was that higher levels of stress symptoms when combined with poor safety habits were related to accident risk. The authors do not draw conclusions on stress and its symptoms as being as being direct causes of accidents. One area for possible exploration would be an examination into the relationship among stressors, strain symptoms and personal safety habits among farmers.

Construction Industry

Goldenhar et al. (2003) proposed a model showing the relationship between job stressors and injury/near-miss outcomes for construction workers. The three part model comprised of job stressors as the predictor variables, psychological/physical symptoms as mediators and injuries/near-misses as final outcomes or results. The model allowed the control variables (job stressors) to either directly influence injury/near miss outcomes or to indirectly affect them through the psychological/physical symptoms as intermediates. The main strength of the proposed model was that it took into account the possibility of all three components of concern in occupational stress modelling: (a) Job stressors (b) Psychological/Physical Symptoms (Strain) (c) Behavioral outcomes (Injuries/ Accidents/ Near-Miss incidents). The investigation was carried out by administering questions adapted from the NIOSH Job Stress questionnaire, the NIOSH Management Commitment to Safety Scale, Profile of Mood States (POMS) and the Northwestern National Life Insurance Company Survey to a sample of construction workers on perceived levels of three classifications of job stressors. The job stressors were categorized as: (a) Job-task demand; (b) Organizational Stressors; (c) Physical/Chemical Hazards; and, a fourth group of potential confounding variables was also included in the questionnaire. The study also looked into whether female and male construction workers had significantly different perceptions of dominant job stressors (Goldenhar et al., 2003).

The study confirmed findings from previous research showing the relationship between job stressors and injuries (Sobeih et al., 2006). A direct relationship was also observed between physical and psychological symptoms and injuries or near miss outcomes. The authors concluded from their findings that construction workers with elevated levels of psychological symptoms were at a higher risk for near-miss occurrences while higher levels of physical symptoms indicated a higher risk of experiencing injury. The study did not find support for modelling distinct gender differences in the perceived levels of occupational stressors, from the sample of construction workers participating in the study. Also, a number of the independent variables (job stressors) were shown to be directly related to both psychological and physical symptoms, the most significant ones being skill-underutilization (experienced significantly by female construction workers), job certainty, harassment and discrimination. Finally, the study showed that eleven of the twelve stressors considered and two control variables were directly related to injury or near miss outcomes, with most of the related stressors being in the domain of task/job related demands (Goldenhar et al., 2003).

Some limitations of this study included the use of self-reported injury and near miss data which had to be recalled from memory when it was inquired of the participant to indicate if they had such experience in the past 12 months. Also the sample population used in the study consisted solely of union workers in the Pacific Northwest, and there was no distinction in the types of construction industries represented or by the specific types of construction occupations the participants were engaged in.

A 2006 survey sponsored by The Chartered Institute of Building in the U.K. was conducted among construction industry professionals in the U.K. This survey was aimed at acquiring a better understanding of occupational stress at the professional level and to identify major occupational stressors for construction professionals as well as the methods they employed to cope with these stressors (Campbell, 2006).

The thrust for this study was the present limited research into occupational stress as it specifically affected the construction industry. Also stated as a reason for carrying out such a survey was the awareness by the International Labor Organization (2002) of occupational stress as a concern for construction manual workers but a lack of exploration by the organization into its effects on professionals within the industry (Campbell, 2006). The growing number of reported occupational stress related illnesses in the United Kingdom as reported by the Health and Safety Executive (2006) was also cited as a justification for carrying out research into occupational stress, its symptoms and coping methods. This survey deviates from several research investigations in that the sample

population for research was construction workers at the professional level and not manual construction workers. As such, several elements of distinct sets of occupational stressors like physical/environmental stressors e.g. office accommodations, do not apply to manual workers, however in the domain of Job/Task demands the elements that construction professionals perceive to be highly stressful are very similar for manual construction workers as shown in other studies (Gillen et al., 2002, Goldenhar et al., 2003).

The survey was carried out by administering a web-based questionnaire to 847 construction industry professionals (mostly managers) about general demographic and screening questions and questions of their perceptions of levels of specific occupational stressors that were categorized into the following domains: Physical, Organizational, Job Demand, Job Role and Other factors. A majority of the questions were forced choice and the use of scaled responses was not reported. An overwhelming majority of the participants in the survey were male (93%) and about 42% of all participants worked in large companies (greater than 500 employees) (Campbell, 2006).

In the domain of job/task demands, the elements of “Too much work”, “Pressure” and “Ambitious Deadlines” ranked the highest of all occupational stressors inquired into from the survey questionnaire. Other stressors perceived to be significant were “Conflicting Demands” and several organizational stressors like “Lack of feedback”, “Poor Communication”, “Inadequate Staffing” and “Poor Planning” (Campbell, 2006). Questions were asked on the survey into overall perception of stress levels in the construction industry and the frequency and duration of time taken off from work due to stress. Findings showed that even though 58% of the respondents indicated that the construction industry had become more stressful within the last 5 years and 42% had experienced stress symptoms, only 5.9% of respondents had actually taken time off at all due to stress, with a week reported by half of the respondents who had taken time off.

Even though the findings in this survey reported significant percentages of respondents who perceive high levels of occupational stress among construction professionals, no statistical analysis was carried out to exclude confounding factors that could initiate stress processes among the participants, and to test for the reliability of the data acquired. However, as earlier mentioned the survey did show some consistency with other research indicating some occupational stressors to be very dominant in the construction industry.

In response to the dearth of research specifically targeting female construction workers, Goldenhar et.al. (1998) carried out an investigation into the impact of specific job stressors on women in the construction industry. The participants were all laborers and the job stressors examined were

classified into areas of “Job/Task Demand”, “Organizational Factors” and “Physical Conditions”. The model used for this study was one that allowed for work stressors to produce acute psychological and physiological reactions in the workers which in turn would lead to illness and/or injury.

In addition to investigating the impact of job stressors on female construction workers, the authors hypothesized that support from co-workers and supervisors would act as moderators on the effects of stressors on the well being and job satisfaction of the female construction workers, which was also included in the model. In addition to the importance of targeting female construction workers, this study also is of great interest in that female construction workers differ from female workers in most other industries because their work setting is non-traditional. Therefore, in addition to the effects of classic job stressors that have been studied in women working in traditional jobs, this study investigated the possibility of very different perceptions of dominant job stressors and their levels of effect by female construction workers.

Results from the study indicated that skill-underutilization as well as having to over-compensate to prove oneself on the job were associated with psychological symptoms in the sample of participants surveyed. Also, while support from co-workers and supervisors did not moderate the association between control and gender based harassment and discrimination as hypothesized by the authors, it did have a significant effect of job satisfaction (Goldenhar et al., 1998).

Even though population samples and perceptions of what factors contribute to occupational stress vary in the studies, findings from the studies summarized have confirmed that there is a relationship between occupational stress and injury outcomes.

Research Hypothesis

Model

The relationship model used by Goldenhar et al. (2003) was used to guide this study. The independent variables in the model were the psychosocial elements of work, the specific occupations that groups of workers are engaged in as well as years of experience in respective occupations, and the type of construction industry (Industrial Construction).

Dependent variables in the model were all records of injuries (OSHA-300 form and employee reports) and work days lost due to injury in the period of 12 months prior to the survey.

Like the Goldenhar et al. (2003) model, the physical as well as psychological symptoms had an intermediate role in linking job stressors to the occurrence of injuries/near-misses and work days lost. However, the model was not restricted to “stressor-symptom-outcome” path as the model allowed for job stressors to directly impact injury/near-misses and lost days at work outcomes. An illustration of the model is given as follows:

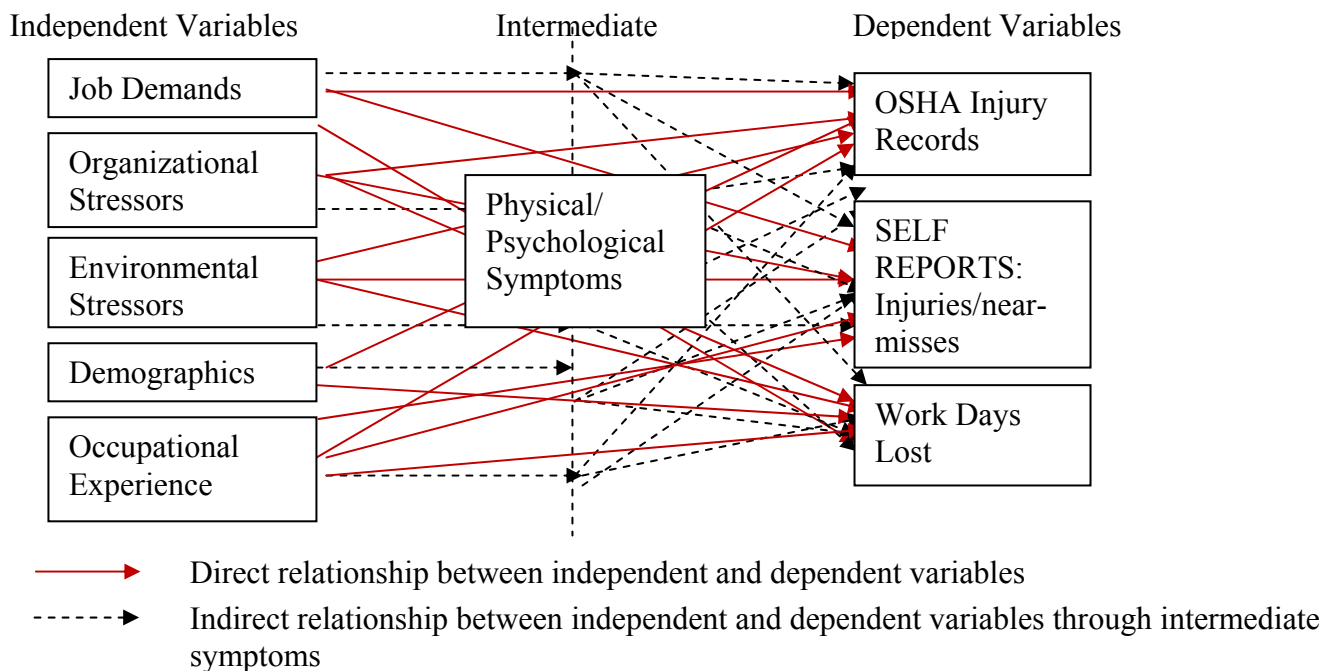


Figure 1: Partially mediated stressor-injury/near-misses days lost model (adapted from Goldenhar et al., (2003))

Hypotheses

Hypothesis 1: Correlation analysis of the occupational stress/stressor responses and the data on injuries will confirm the model proposed by Goldenhar et al. (2003), that occupational stressors can impact accident/injury/near-misses occurrences either directly or indirectly through intermediate psychological/physical symptoms.

Hypothesis 2: Differences will be observed in perceived levels of occupational stressors depending on the duration of routinely doing a particular construction occupation and the type of occupation.

In their study on modeling the relationships among occupational stressors, physical/psychological symptoms and injury/near-miss outcomes in construction workers in general, Goldenhar et al. (2003), showed that total months of working in construction was a significant estimate of physical and psychological symptoms the workers experienced. The argument for this hypothesis is that the existence of a relationship between the duration of working in construction and workers' symptoms can be an indicator of a relationship existing between the duration of working in construction and the perceived levels of stress from occupational stressors.

Also, different occupations will have varying physical demands (exposure and protection from noise, vibration, chemicals) and psychosocial elements (working in isolation, level of decision latitude, etc).

Hypothesis 3: Differences will be observed in physical and psychological symptoms reported by workers depending on the duration of routinely doing a particular construction occupation confirming findings by Goldenhar et al. (2003) that total months of working in construction was a significant estimate of physical and psychological symptoms the workers experienced.

Hypothesis 4: The duration of routinely doing a particular construction occupation and the type of occupation will have affect accident/injury/near-misses outcomes and lost work days either directly or indirectly through intermediate psychological/physical symptoms.

In their study, Goldenhar et al. (2003) showed the duration of working within the construction industry was a significant estimate of symptoms (physical and psychological) experienced by construction workers. Since physical and psychological symptoms were shown to have the propensity

to act as intermediates between other stressors (environmental and psychosocial), it can be asserted that symptoms experienced by workers can act as intermediates between the duration of routinely working in a construction occupation and accident/injury/near-miss outcomes and work days lost resulting from these incidents.

Experiment

Participants

Participants included construction workers engaged in a range of construction occupations routinely at least 6 months prior to administering the questionnaire. The total number of participants was 73 with only 68 usable responses. The following is the demographic break down of the participants whose responses were used: 2 Females, 62 Males, 4 Non-responses to gender; 21% African-American, 2% Asian or Pacific Islander, 62% Caucasian, 3% Hispanic and 13% preferring not to answer. The oldest participant was 72 years while the youngest was 20, with a mean age of 41(S.D. 14) years. The average number of years of construction experience was 17(S.D. 13) years, while the average number of years of current craft experience from participants that responded was 15 (S.D. 13) years. Only two workers were injured at the time the questionnaire was given.

The occupations of the participants included carpenters, foremen, millwrights, iron workers, scaffold builders, surveyors, planners, laborers, pipefitters, welders, insulators, boiler-makers, crane operators, maintenance and safety personnel. All participants worked at various sites of the same Industrial Construction company in Louisiana. A comparison of the distribution across occupations of the participants in the survey with the total work force of the company is detailed in Table 2.

Table 2: Occupation Distribution Comparison (Total Work Force with Study Participants)

	Entire Company		Participants	
Total Work Force	8420	100%	68	100%
Boilermaker	470	6%	8	12%
Carpenter	145	2%	6	9%
Combination Welders	165	2%	1	1%
Operators	247	3%	2	3%
Instrument Technician	50	1%	1	1%
Foreman	612	7%	5	7%
Helpers	853	10%	2	3%
Insulators	61	1%	2	3%
Ironworkers	142	2%	6	9%
Laborers	640	8%	4	6%
Millwright	442	5%	8	12%
Pipefitter	2455	29%	14	21%
Planners	67	1%	2	3%
Safety	200	2%	2	3%
Sandblasters	3	0%	1	1%
Welders	268	3%	4	6%

Measures

Survey Instrument

An adaptation of the questionnaire used by Goldenhar et al. (2003) was administered to the participants. The questionnaire addressed three categories of occupational stressors as well as demographic information and the duration of routinely doing a particular construction occupation. The categories of occupational stressors that were inquired into were: Job Demands, Organizational Stressors, and Environmental Stressors. Demographic information such as gender, age, and years of working in construction, was collected from participants. Workers were also asked to respond to questions that inquired about physical as well as psychological symptoms they had experienced, that previous research has shown to have direct relationships with elevated levels of stress.

The questionnaire was available in both English and Spanish; however none of the Spanish questionnaires were selected by any of the participants. Responses to questions about perceived levels of occupational stress were graded on a Likert scale from 0 (least severe, least acceptable, etc) to 6 (most severe, most acceptable, etc). Reliability of the questionnaire was high with a Cronbach's coefficient calculated as 0.86.

Elements in the "Job Demands" category included questions about job control, physical demands, work load, overcompensation and skill-underutilization, and responsibility for the safety of others. Organizational stressor elements included questions about the perceived safety climate of the workplace, training, job certainty, social support, harassment and discrimination. The Environmental category included questions about exposure to noise, vibration, chemicals, asphalt, asbestos and protection from these elements (Goldenhar et al., 2003). The elements under investigation and the questions adapted for this survey are given in Appendix II.

In addition to responding to the questionnaire about occupational stress levels, workers were asked to report on accidents and injury occurrences in past 12 months prior to the period that the stress questionnaire will be administered. The participants recorded self-reported responses to injury occurrences by circling the location of injuries on a body chart provided with the questionnaire. The instructions on the body chart asked participants to indicate multiple injuries to one body location by placing the number of injuries next to the circled location. OSHA accident history reports (OSHA-300 forms) were collected alongside self-reported accidents/injuries, as well as company records of total lost work days in the past 12 months preceding the start of the survey. Self-reported near-miss occurrences were not obtained from participants because of concerns of data validity. It was assumed that workers would more accurately remember injuries/accidents because of the physical nature of

these incidents as opposed to near-miss occurrences. Participants' consent was obtained for the study in compliance with requirements to meet Institutional Review Board approval at the Louisiana State University.

The need for security clearance for entrance to the company's work sites limited direct access to the employees that participated in the study. The questionnaires were given to a company representative, who was responsible for distributing them to employees who wished to participate in the study. The participants were given two weeks to complete the questionnaires, after which the completed questionnaires were returned to the company representative. The investigator then collected all completed questionnaires from the company representative after the two weeks allowed for completion.

Table 3: Questionnaire (Adapted from Goldenhar et al., (2003))

Job Task Demands
Job Control
1. How much control (do/did) you have over the types of tasks you (are /were) assigned to do during a workday?
2. How much control (do/did) you have over getting the contractor to provide you with proper personal protective equipment that you (need/needed)?
3. How much control (do/did) you have over how fast you worked?
4. In general how much control would you say you (have/had) over your work and work related factors?
Job Demands
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
1. How often on this job (do/did) you (have/had) to work harder than others to "prove" yourself?
Skill-underutilization
1. At work, how often (are/were) you given a chance that would help you to improve or perfect your skills?
Responsibility for the safety of others
1. At work, how much responsibility do you have for the safety of others on the jobsite?
Organizational Stressors
Safety Climate
1. At the jobsite, employees, supervisors, and managers (work/worked) together to ensure the safest possible working conditions

Table 3 Continued

2. At this jobsite, significant shortcuts (are/were) taken, which could put a worker's health and safety at risk
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
1. At this jobsite, sometimes I (am/was) was given a task to do and I (am/was) not sure how to do it
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
Job certainty
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
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 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
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?

Table 3 Continued

3. have you ever had unwanted physical contact, including that of a sexual nature, by co-workers?
4. have you ever had 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?
Exposures and protection from them
Hours of exposure
How many hours per day are you exposed to each of the following hazardous or unpleasant conditions:
1. Noise
2. Vibrations
3. Chemicals
4. Asphalt
5. Asbestos
6. Lead
Safety and compliance index
1. How often do you wear earplugs?
2. How often do you wear safety glasses
3. How often do you wear safety work shoes?
4. How often do you wear a facemask?
5. How often do you wear a hard hat?
Outcomes
Psychological Symptoms
1. In the past year, how often have you felt tense due to issues related to your job?
2. In the past year, how often have you felt angry due to issues related to your job?
3. In the past year, how often have you felt sad due to issues related to your job?
Physical Symptoms
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?

OSHA 300 Data

OSHA300 Data: This form was a log of work related injuries and illnesses that employers are required to keep for all such incidents. Details to be filled out include a Case Number, Date of Injury or Onset of Illness, Location of occurrence, Description of injury and/or illness, part of body affected and object/substance that caused the injury/illness. Other information recorded on the form included the number of work days lost due to the recorded injury/illness and the type of illness resulting from the accident.

Data Analyses

Method

A simple correlation of the participants' responses with dependent variables (self-reported/OSHA injuries and lost work days) did not yield significant relationships. A principal components analysis was then carried out on participants' responses to reduce the number of variables to be used for analysis. The self-reported and OSHA logged injuries were binary coded to represent the occurrence or non-occurrence of injury: 1 indicating an injury occurrence and 0 representing no injury occurred. Simple forward step-wise and Nominal logistic regressions were then used to determine the level of relationship among the retained factors from the principal components analysis and binary coding of the occurrence of injuries (self-reports/OSHA) as well as the actual lost work days to determine if there were significant relationships among:

- (1) Occupational stressors and (a) the duration of routinely doing a particular construction occupation, (b) physical/psychological symptoms exhibited by workers, (c) all accident/injury/near-miss outcomes, and (d) lost work days
- (2) The duration of routinely doing a particular construction occupation and (a) physical/psychological symptoms, and (b) all accident /injury/near-miss outcomes
- (3) Physical/psychological symptoms and (a) all accident/injury/near-miss outcomes, (b) lost work days

Results

Descriptive Statistics

First the mean scores and the corresponding standard deviations of each category investigated in the questionnaire were calculated, and are reported in Table 4. Reverse scoring was used on variables that recorded negative feedback on the questionnaire. A score of 0 indicated that there was no perception of the variable being measured while a score of 6 indicated a high perception of the variable.

Table 4: Descriptive Statistics of participants' responses; Sample size 68

Component	Total	Mean	S.D.	Qualitative Ranking
Job Control	20	5.4	1.3	Very Adequate
Job Demands		3	1.3	Sometimes tasking
Skill-Underutilization*		3.7	1.7	Rarely occurring
Responsibility for the safety of others*		1.3	1.3	High
Overcompensating at work*		4.2	2	Rarely occurring
Safety Climate		4.3	0.6	Safety is frequently a high priority
Training		4.4	0.8	Training is just adequate
Social Support		4.7	1	High level of social support
Harassment and Discrimination*		5.8	0.8	Almost never occurring
Hours of Exposure*		5.6	1	Less than 2 hours exposure to noise, vibrations, chemicals etc.
Safety Index		5.1	0.6	High level of safety compliance
Psychological Symptoms*		4.3	1.3	Rare occurrence of psychological symptoms
Physical Symptoms*		4.6	1.1	Rare occurrence of physical symptoms
Injuries		1.5	1.1	

**Indicates reverse scoring used on responses*

Descriptive Statistics by Components and Occupation

The participants' responses were further classified by the components of the questionnaire and the type of occupations. Again a score of 0 indicated no perceived levels of the component being measured while a score of 6 indicated the highest level of perception of the component. The participants' responses to the components on the questionnaire classified by occupations as follows:

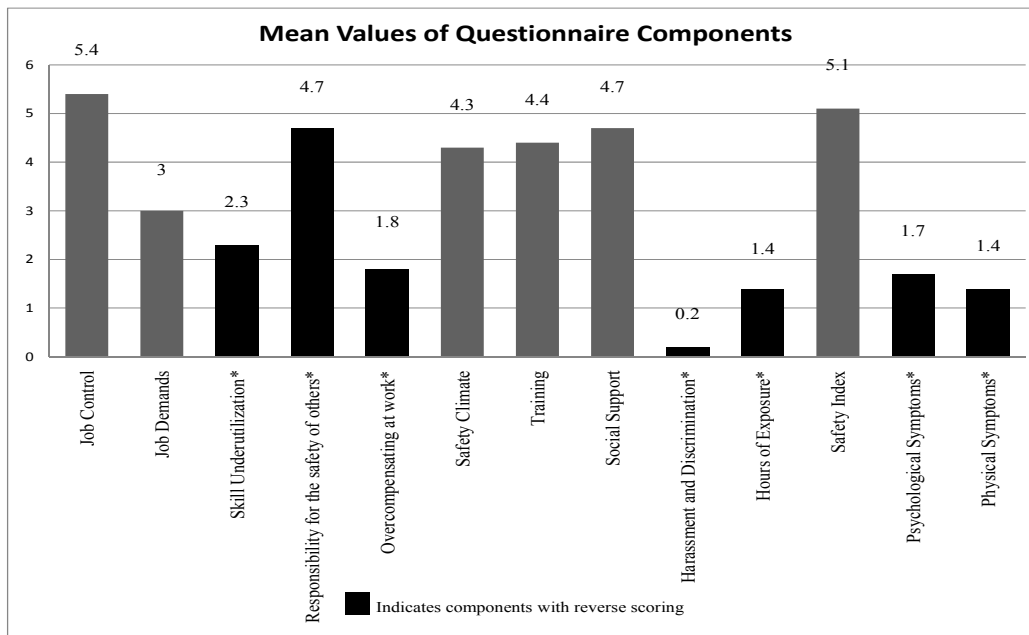


Figure 2: Participants' mean scores on questionnaire components

Job Demands

Job demands were measured on participants' perception of the pace of their work and the intensity of their work (how hard they worked). Carpenters experienced the most job demands of all the participants while runners experienced the least job demands. Safety personnel and Equipment Technicians also experienced very high levels of job demands after Carpenters. Other occupations that reported low levels of job demands were Foremen and Crane Operators.

Job Control

Mean scores on job control showed most of the occupations experienced very high levels of job control. Job control components included control over types of tasks performed, obtaining personal protective equipment, pace of work and general work related factors. The occupation reporting the least amount of job control was Insulators.

Responsibility for the Safety of Others

Taking responsibility for the safety of co-workers measured participants' attitudes to caring about other workers' safety. The perception of this component was generally high among the participants. The lowest scores were reported for Combination Welders and Helpers/Maintenance personnel. These

two occupations recorded that their perceptions of their responsibility for the safety of others was just adequate. All the other occupations reported high, very or extremely high perceptions about caring for the safety of others in the work place.

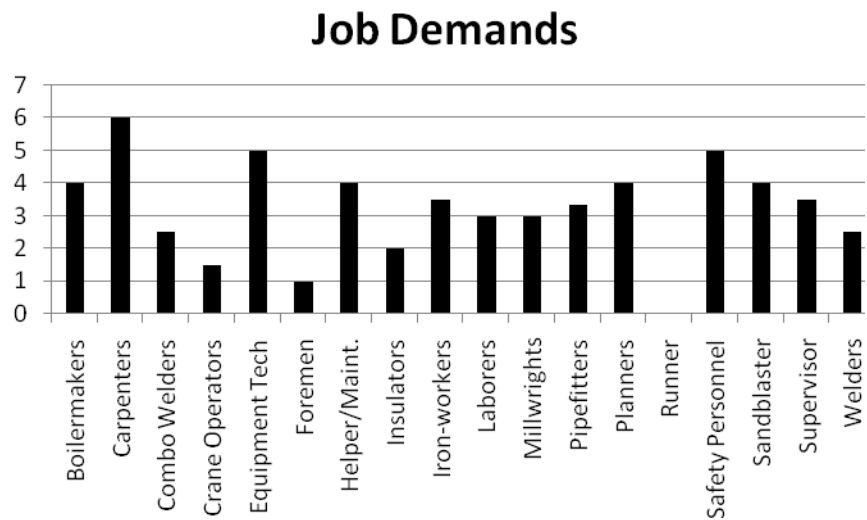


Figure 3: Mean scores of participants’ responses to perceived job demands, by occupations

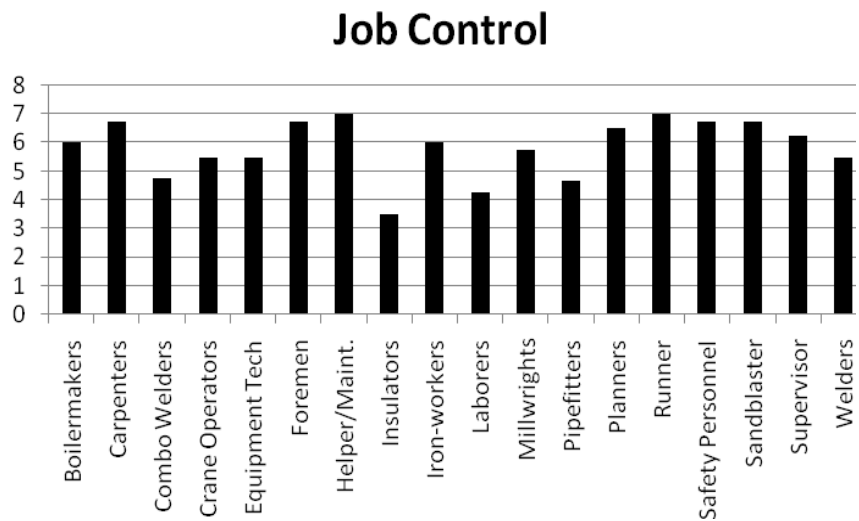


Figure 4: Mean scores of participants’ responses to perceived job control, by occupations

Overcompensating on the Job

Overcompensating on the job measured how often workers increased their efforts on the job in order to “prove” themselves capable of doing their work.

The following trend was observed for overcompensating on the job; there were three distinct groupings of the occupations:

Never overcompensating: Boilermakers, Foremen, Helpers/Maintenance, Insulators, Planners, Millwrights and Welders

Low-Moderately overcompensating: Combo-welders, Crane Operators, Laborers, Pipefitters, Safety Personnel and Supervisors

Highly Overcompensating: Carpenters, Equipment Technicians, Iron-workers and Sandblasters.

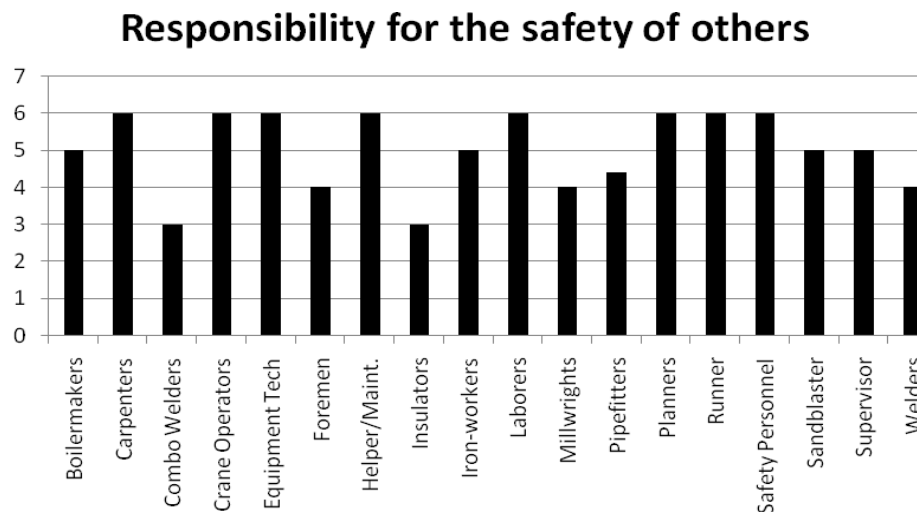


Figure 5: Scores of participants for safety responsibility in the work place, by occupations

Safety Climate

Measures of safety climate included participants’ perceptions on contributions of all employees to safety, assessment of the organizations priority towards project goals vs. workers’ protection and compliance to good safety, enforced by supervisors. Safety Climate responses were generally high and none of the occupations reported low levels of perceived safety climate.

Training

Training measurements assessed Preparedness to perform as assigned task, Training to use personal protective equipment and to safe working practices and the perception on general training for workers

in the company. Insulators and Crane operators reported the lowest levels of perceived training in the work place, while Carpenters responded to having very adequate levels of training.

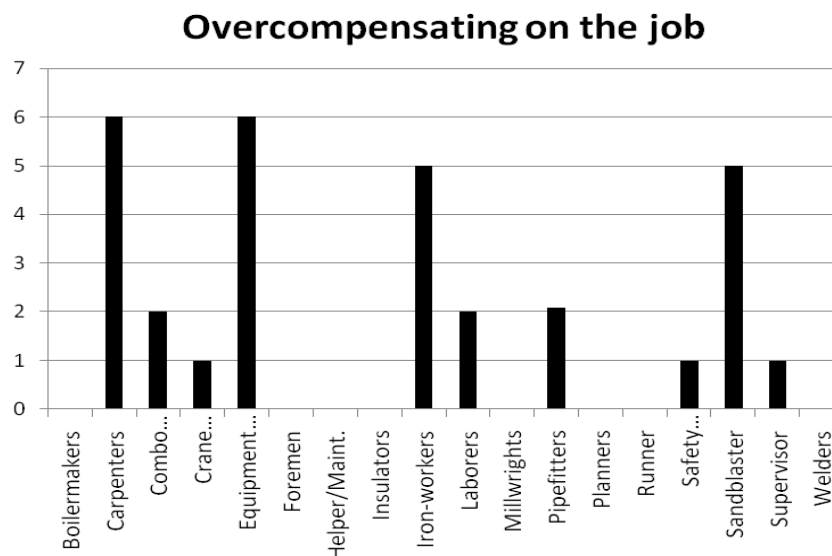


Figure 6: Mean scores of participants for overcompensating on the job, by occupations

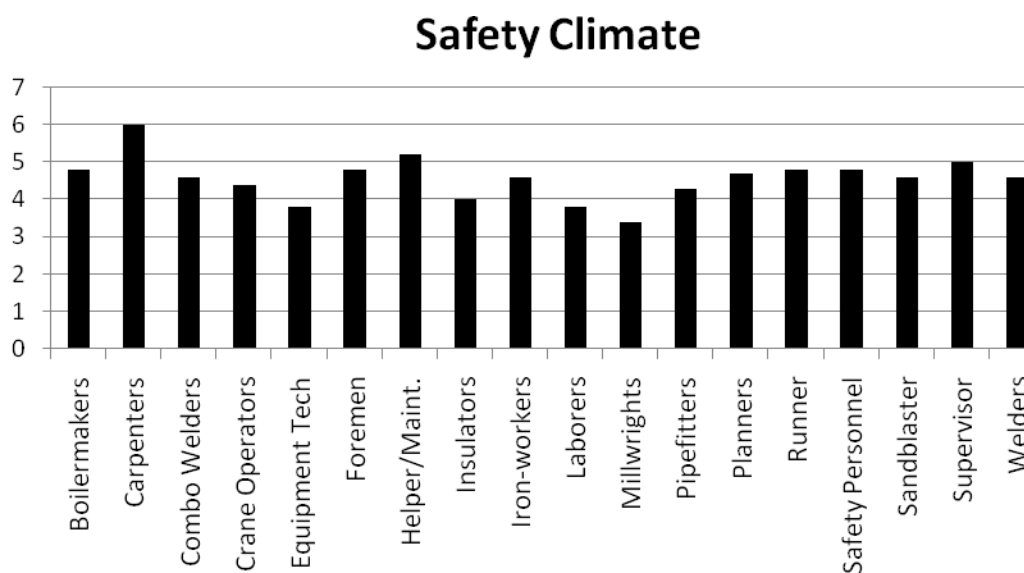


Figure 7: Mean scores of participants for perceived safety climate, by occupations

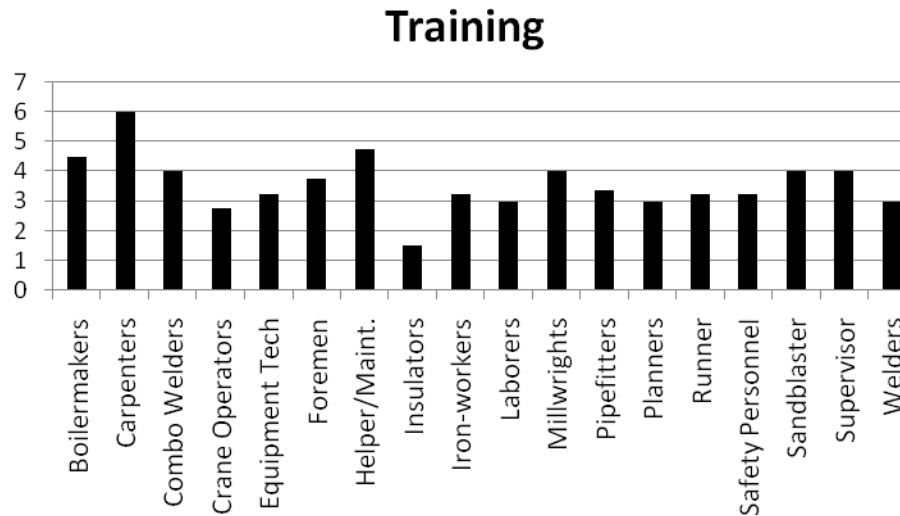


Figure 8: Mean scores of participants for perceived training levels, by occupations

Social Support

Components that were measured for social support included perceptions of the participants of supervisors and co-workers contributions to making work life easier, safer and support during on the job crises. All occupation groups reported high, very or extremely high levels of social support in the work place.

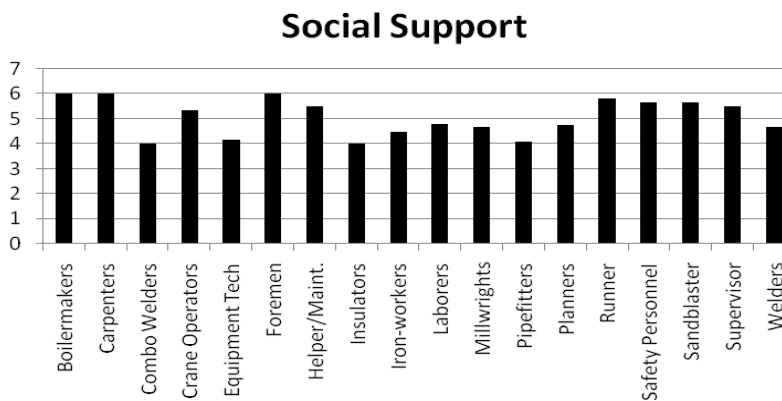


Figure 9: Mean scores of participants for perceived social support, by occupations

Harassment and Discrimination

The Harassment and Discrimination elements of the questionnaire measured the occurrence of sexual harassment from supervisors and co-workers, physical contact (including contact sexual in nature) by

supervisors and co-workers and discrimination based on gender by co-workers and supervisors. While some occurrence was reported, the general trend was that there was little to no occurrence of these kinds of harassment or discrimination reported by the participants.

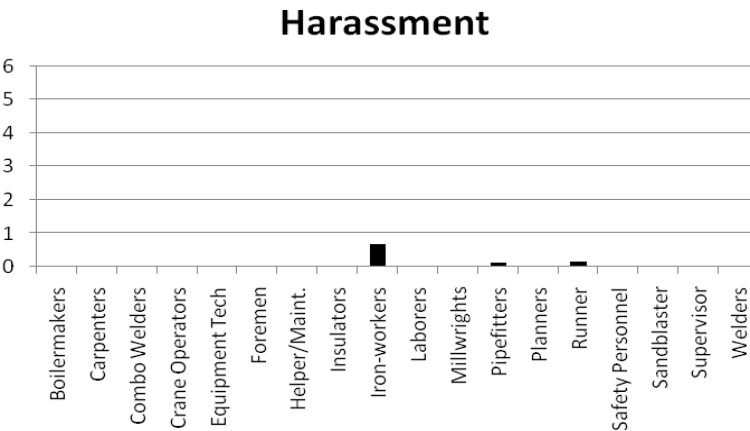


Figure 10: Mean scores of participants for harassment and discrimination occurrence by occupations

Job Certainty

Job certainty measured participants confidence of career advancement and continued self-support upon job termination. Job certainty measures also included, the confidence of the participants to find employment upon job termination. The confidence levels of job certainty and career advancement as well as ongoing self-support upon job termination was very high for all occupation groups.

Skill-underutilization

Skill-underutilization measured how often participants were given the chance to improve their craft skills. Welder reported that they had the least chance to improve their skills (higher perceived levels of Skill-underutilization). Carpenters, Laborers, Runners and Supervisors reported experiencing no Skill-underutilization. Other occupations reported low to moderate Skill-underutilization.

Self Reported Injuries v. OSHA Recorded Injuries

Out of the 68 participants’ responses used in this study, 20 injuries were reported to have happened 12 months prior to taking the survey. The total number of accidents, fatalities and injuries documented for OSHA was 74 (with one fatality). While the participants in this study only represented a sub-set of employees from the company, comparison of the self-reported injuries with those in OSHA logs revealed that pipefitters had the most injuries in both records of self-reported and OSHA

logged injuries. Boilermakers were the next group with the most injuries according to the OSHA logs followed by millwrights and helpers together ranked third highest. According to self-reported injuries, iron-workers ranked second for most injuries followed by boilermakers and equipment technician ranked together in third highest. From the OSHA data, pipefitters, boilermakers, millwrights were observed to have the highest occurrence of injuries and would be considered “high risk occupations” at this company.

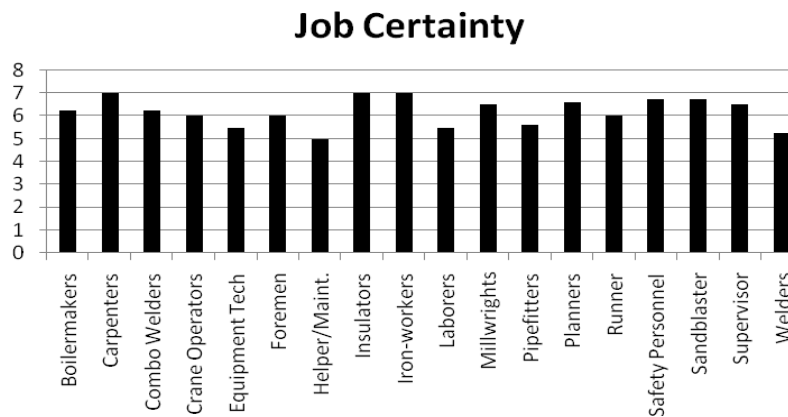


Figure 11: scores of participants for job certainty by occupations

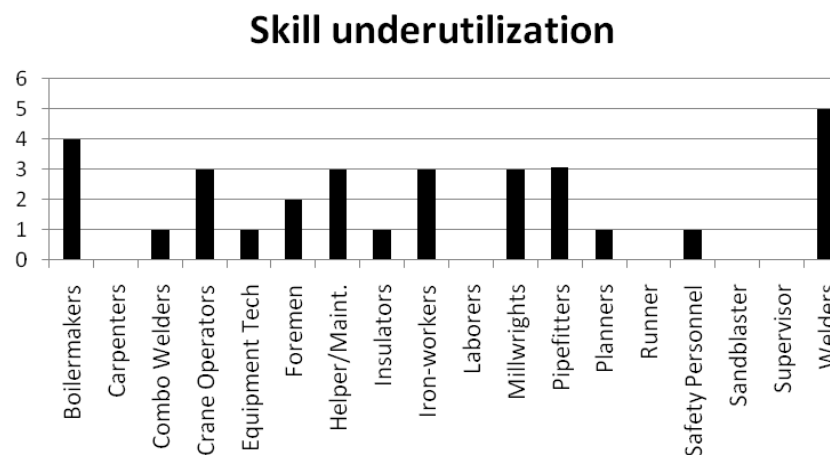


Figure 12: Means scores for skill-underutilization, by occupation

The injury incident rate for the company was shown to be higher than the injury incident rate for the Non-residential building sector of the Construction industry. The company’s incident rate was 8.1 injuries for every hundred workers, while the incident rate for the Non-residential Construction

industry for the same year was 5.2 injuries for every hundred workers (U.S. Department of Labor, 2007). The incident rate was calculated as the ratio of the number of injury cases and the total number of hours worked by all employees in a year multiplied by the approximate number of hours worked by 100 workers in one year (200,000 hours)- 40 hours a week x 50 weeks a year (U.S. Department of Labor, 2007).

It should be noted that because of confidentiality of the company's records and identity and the identity of the employees, comparison of injuries from the participants' self-reports to the OSHA logs had to be done based on the employees' occupations and the location of the body where the injury occurred. Three of the injuries reported by the participants in the survey could not be accounted for in the OSHA logs based on occupation type of the employee, the OSHA logs which give a detailed description of the occurrence of injury (body part, activity of the employee and location of work where the injury occurred), were also used to compare the two sets of injuries for injury under-reporting based on the body parts inflicted. A total of five injuries reported by the participants were not recorded in the OSHA logs after comparison. The comparison of the injuries by body part of injury, showed that in the no finger injuries got recorded in the self-reports, this was due to the fact that the questionnaire did not differentiate between finger and hand injuries. However, when combined, the OSHA records of hand and finger injuries far outnumber the hand injuries in the self-reports. One explanation for this could be that the employees who reported the finger injuries in the OSHA logs were not part of the participants in this study.

Self Reported Injuries and Stress Responses

A principal components analysis was carried out on Pearson's correlations of the response variables using SAS® JMP 5.0.1©. The extracted components were then rotated using the varimax (orthogonal) rotation of which nine factors were retained. The factors were retained on the following criterion: Eigenvalues greater than 1.5, this criterion was used because it was the largest break among the Eigenvalues and resulted in the retention of components that accounted for approximately 71% of the total variance.

The response variables and their corresponding factor loadings were obtained (See Appendix I, Table II) and the loading factor for variable to load onto a component was set to the absolute value of 0.60 or greater. A value of $|0.60|$ was set in order to create well defined constructs for each component. Table 5 provides information on the variables that loaded onto each component and the labels subsequently assigned to the components.

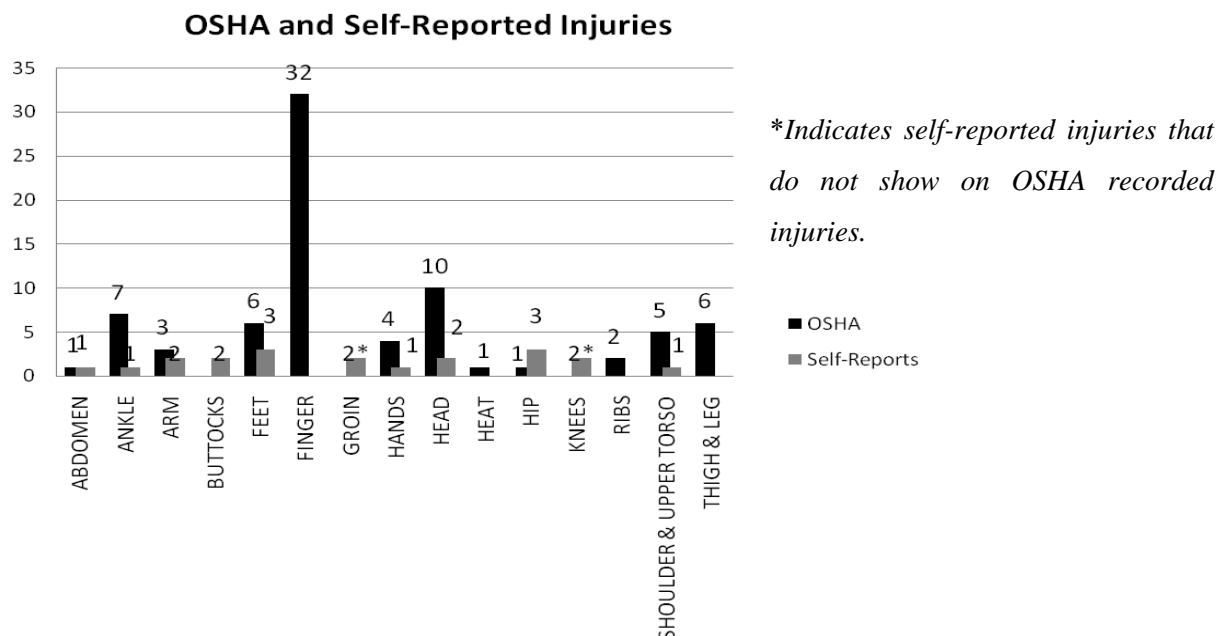


Figure 13: OSHA and Self-reported injuries classified by location of injury

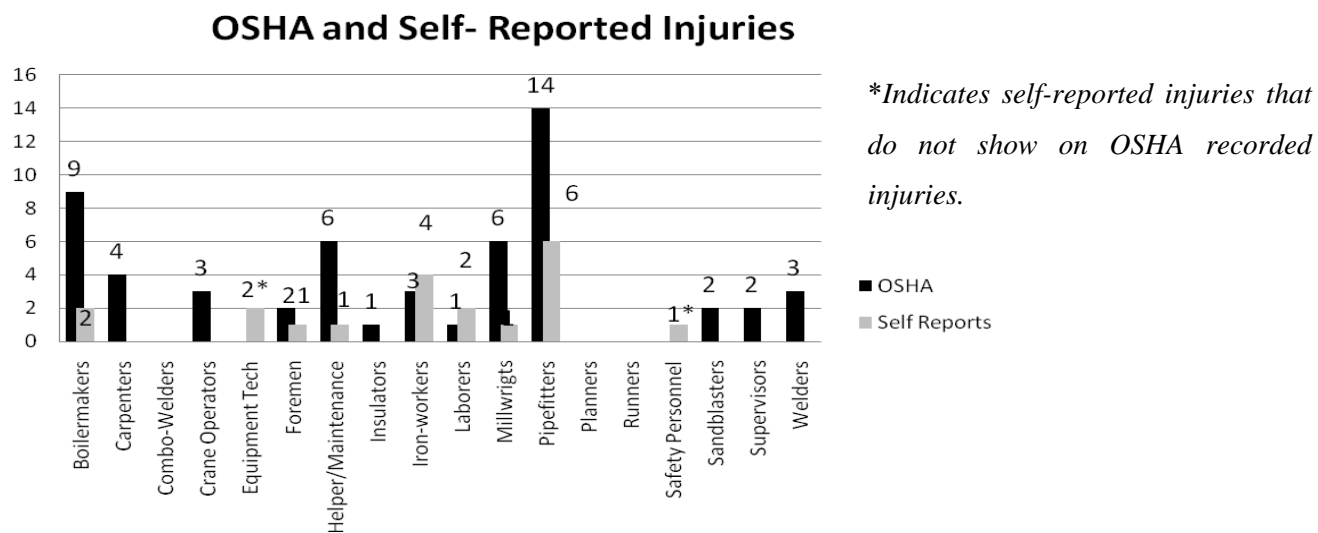


Figure 14: OSHA and Self-reported injuries based on occupation type

Table 5: Summary of principal components obtained and labels assigned after factor rotation for self-reported injuries.

Component	Variables	Label
1-1	Job Control, Skill-Underutilization; Responsibility for safety; Safety Climate (Q 1, 3,4); Social Support (Q 1,2,3)	Task Demands and Management
1-2	Harassment and Discrimination	Harassment and Discrimination
1-3	Hours of Exposure to physical elements (Q 4,5,6)	Exposure to chemical elements
1-4	Social Support (Q 4, 5)	Social Support from peers
1-5	Safety Index (Q 2, 5)	Safety Compliance
1-6	Job Certainty (Q 2, 3)	Job Certainty
1-7	Training (Q 2, 3)	Training
1-9	Job Demands (Q 1, 2); Skill overcompensation	Task Pace

Next, the self-reported injuries were binary coded (0 for non injury; 1 for occurrence of injury) and Simple forward step-wise regression was performed using the standard scored obtained from the factor loaded components (1-1 through 1-7 and 1- 9; there was no factor loading for component 1-8) as the variables and the coded injury data to test for any significant relationships. Nominal logistic regression was also carried out with the components and the coded injury data to confirm the presence of significant relationships (See Appendix II, Table V).

Injuries and Lost Work Days Recorded for OSHA

The analysis of OSHA recorded injuries required collapsing the data into occupations and using the average values of the responses by occupation type because the specific injuries in the OSHA logs could not be associated with exact employees due to anonymity of both the questionnaire responses and the OSHA records of the injuries. A principal components analysis was also carried out on Pearson's correlations of the mean values of the response variables classified by the participants' occupations using SAS® JMP 5.0.1©. The injuries and lost work days were also classified by respective occupations. The extracted components were then rotated using the varimax (orthogonal) rotation of which nine factors were retained. The factors were retained on the following criterion:

Eigenvalues greater than 2.0 where the largest break in Eigenvalues occurred. These components accounted for approximately 84% of the total variance.

The response variables and their corresponding factor loadings were obtained (See Appendix I, Table IV) and the loading factor for variable to load onto a component was set to the absolute value of 0.60 or greater. Table 6 provides information on the variables that loaded onto each component and the labels subsequently assigned to the components.

Table 6: Summary of principal components obtained and labels assigned after factor rotation for self-reported injuries and OSHA recorded injuries classified by occupation.

Component	Variables	Label
2-1	Overall decision latitude; Responsibility for the safety of others; Management's attitude towards safety Social Support from supervisors; Confidence in training level	Management social support and attitude toward safety and training
2-2	Control over work-pace; job preparedness; harassment and discrimination; Individual Safety compliance	Harassment; Personal Safety compliance and preparedness
2-3	Hours of exposure to chemical elements; Psychological and physical outcomes	Exposure and Illness outcomes
2-4	Overcompensating on the job; Initial training and overall social support	Overcompensating on the job; overall social support
2-5	Organizational attitude to safety; Gender Discrimination by supervisors; Feeling tense on the job	Multiple variables not measuring a single construct
2-6	Social Support from co-workers	Social Support from peers
2-7	Training; Hours of exposure to noise and vibration; Insomnia	Multiple variables not measuring a single construct
2-8	Compliance to PPE (safety glasses); Job certainty upon termination	Multiple variables not measuring a single construct
2-9	Compliance to PPE (facemask); Experiencing Headaches	Multiple variables not measuring a single construct

The self-reported injuries and OSHA recorded injuries were binary coded (0 for non injury; 1 for occurrence of injury) and simple forward step-wise regression was performed using the obtained standard scores from the components (1 through 9) as the independent variables and the coded injury data (OSHA and self-reported) as the dependent variables to test for any significant relationships.

Actual lost work days from the OSHA documentation were used in a simple forward step-wise regression as the dependent variable and the rotated factors retained as the independent variables.

Hypothesis 1

Correlation analysis of the occupational stress/stressor responses and the data on injuries will confirm the model proposed by Goldenhar et al. (2003), that occupational stressors can impact accident/injury/near-misses occurrences either directly or indirectly through intermediate psychological/physical symptoms.

While correlation analysis did not yield significant associations, results of the simple stepwise regression after the principal components analysis of all the participants' responses showed that the self-reported injuries among the participants was strongly related to Job Certainty upon termination (Factor 1-6) and Training on safety and the use of personal protective equipment (Factor 1-7). Nominal Logistic regression was also carried out which confirmed the findings of the step-wise regression (See Appendix I, Table V). The results of the step-wise regression are given in Table 7.

Table 7: Step-wise regression results for response variables and self-reported injures.

Parameter	L-R Chi-square	p- value	R-Square
Factor1-6 (Job Certainty)	4.939416	0.0263	0.1076
Factor1-7 (Training)	5.844877	0.0156	0.2349

Pearson's correlation of the participants' responses also shows strong relationships between the following psychological and physical symptoms and several response variables as shown in Table 8. The correlations of the variables should be interpreted as follows:

- Higher scores on a reverse-scored variable indicate lower perceived levels of the variable
- Lower scores on a reverse-scored variable indicate higher perceived levels of the variable
- Positive and negative correlations between two reverse-scored variables should be read as normal correlations
- Positive correlation between a reverse-scored variable and a normal-scored variable indicate that higher scores, i.e. **lower** perceived levels of the reverse-scored variable result in higher scores (**higher** perceived levels) of the normal-scored variable and vice versa.

Table 8: Significant ($p \leq 0.05$) correlations of psychological and physical outcomes to response variables

	*Tenseness	*Anger	*Sadness	*Insomnia	*Stomach Disorders	*Headaches	*Low back pain
Overall Experience			-0.28				
Control over PPE		0.38					
Control over work pace						0.26	
Work Pace*		0.41					
Work Intensity*		0.26					
Skill- underutilization*		0.33					
Overcompensating*	0.42	0.54	0.29	0.40		0.37	
Employee Safety Contribution		0.38					0.34
Risking Shortcuts	-0.51	-0.56	-0.44	-0.58	-0.49	-0.53	-0.51
Safety Priority		0.23			0.29		0.37
Preparedness*		-0.41		-0.48		-0.50	-0.36
Safety Training						0.26	0.21
General Training							-0.10
Social Support from supervisors		0.39		0.28			0.28
Safety Support from supervisors		0.39		0.16			0.48
Work Support from supervisors		0.26		0.23			0.19
Social Support from co-workers				0.12			
Safety Support from co-workers				0.11	0.26		0.44
Work Support from co-workers	0.37	0.43	0.36	0.18	0.31		0.43
Sexual Harassment from co-workers*	0.53	0.46	0.45	0.43	0.41	0.42	0.52
Sexual Harassment from supervisors*	0.44	0.36	0.43	0.28	0.30	0.37	0.50
Physical/Sexual contact from co-workers*	0.40	0.34	0.43	0.29	0.38	0.41	0.41
Physical/Sexual contact from supervisors*	0.43	0.38	0.43	0.40	0.50	0.50	0.43
Gender discrimination from co-workers*	0.46	0.38	0.45	0.36	0.45	0.46	0.44
Gender discrimination from supervisors*	0.48	0.40	0.72		0.51	0.36	0.49
Confidence of self-support upon job termination	-0.24						
Hours of exposure to noise*		0.26					
Hours of exposure to vibrations*					0.36	0.31	
Hours of exposure to chemicals*		0.49	0.30		0.46	0.43	0.33
Hours of exposure to asphalt*					0.35		
Hours of exposure to asbestos*			0.28		0.38		
Hours of exposure to lead*					0.32		
Safety compliance to face protection*						-0.18	
Feeling Tense on the job*		0.60	0.55	0.49	0.55	0.49	0.52
Feeling Angry on the job*			0.55	0.48	0.49	0.53	0.55
Feeling Sad on the job*				0.27		0.42	0.60
Insomnia*						0.47	0.53
Stomach Disorders*						0.55	0.47
Headaches*							0.49

* Reverse-scored variables: higher scores indicating lower perceptions of variable and vice versa

- Negative correlation between a reverse-scored variable and a normal-scored variable indicate that higher scores, i.e. **lower** perceived levels of the reverse-scored variable result in lower scores (**lower** perceived levels) of the normal-scored variable and vice versa

Simple forward step-wise regression of the mean values of the participants' responses classified by occupations showed that the occurrence of self-reported injuries was related to Overall decision latitude, Responsibility for the safety of others, Management's attitude towards safety, Social Support from supervisors, Confidence in training level (Factor 2-1); Job certainty upon termination, Personal safety compliance to eye protection (Factor 2-8); Experiencing headaches as a physical symptom and Personal safety compliance to face protection (Factor 2-9). Step-wise regression of the OSHA logged injuries classified by workers' occupations showed the occurrence of injuries to be related to Organizational attitude to safety, Gender Discrimination by supervisors, Feeling tense on the job (Factor 2-5); Personal safety compliance (facemask protection) and the occurrence of headaches as a physical symptom (Factor 2-9).

Table 9: Step-wise regression fit of self-reported injuries and response variables

Parameter	p-value	R-Square
Factor 2-9(Compliance to PPE (facemask); Experiencing Headaches)	0.0201	0.2300
Factor 2-8 (Compliance to PPE (safety glasses); Job certainty upon termination)	0.0239	0.4470
Factor 2-1 (Management social support and attitude toward safety and training)	0.0011	1.0000

Table 10:Step-wise regression fit of OSHA logged injuries and response variables

Parameter	p-value	R-Square
Factor 2-9 (Compliance to PPE (facemask); Experiencing Headaches)	0.0108	0.3156
Factor 2-5 (Organizational attitude to safety; Gender Discrimination by supervisors; Feeling tense on the job)	0.0002	1.0000

Hypothesis 2

Differences will be observed in perceived levels of occupational stressors depending on the duration of routinely doing a particular construction occupation and the type of occupation.

Differences were observed in the scores of participants to all variables that measures perceptions of occupational stress. Differences were observed among the different occupation types as well as by number of years of experience by the workers. The most significant findings are discussed while Table 13 provides a summary of findings for all occupations.

Boilermakers

Boilermakers with work experience of ten years and greater but less than twenty consistently scored highest within the group on perceptions about Training, Safety Climate of the company and Job Control, high scores on these variables indicated positive responses. These workers also perceived the highest levels of social support from workers and supervisors and had highest levels of job certainty among the group. Interestingly, this group of workers also reported the lowest levels of perceived Job Demands and Overcompensating on the job. Boilermakers with work experience of ten years and greater but less than twenty had high scores on Skill-underutilization and Responsibility for the safety of others, high scores on these variables indicated low levels of perceived stress. Boilermakers with about 5 years experience scored lowest on perceptions about training, safety climate of the company and job control. These workers also scored lowest on perceptions about Harassment, Social Support and Job Certainty and reported the highest levels of job demands.

Carpenters

Job control, Responsibility for the safety of others, perception of Safety climate of the company, Social Support and Job certainty increased as the number of years of experience increased for carpenters. Skill-underutilization as well as Harassment was shown to also increase with experience for this group. Generally job demands and Overcompensating on the job were shown to decrease with years of experience.

Crane Operators

The number of years of experience of crane operators did not affect the responses to perceived levels of Training, Overcompensating on the job, Job Control and Personal safety compliance. However as the number of years of experience increased, crane operators' perceptions of safety climate of the company decreased. Skill-underutilization, Job Demands and Responsibility for safety of others increased as years of experience increased for crane operators.

Foremen

Perceptions about Harassment did not change among foremen with their number of years of experience. Job demands, Job Control, Safety Climate, and Personal safety compliance decreased as number of years of experience increased, while Skill-underutilization, Social Support and Training on the job increased. Foremen with work experience of about 15 years and less perceived more social support than foremen with experience greater than 15 years. Job certainty declined for foremen with less than 25 years experience and increased for those with greater than 25 years of experience. Overcompensating on the job was generally high for the group but showed to decrease for foremen

with experience of 15 years and less and increased for those with more than 15 years of experience. Overall experience was strongly correlated to the number of hours of exposure to chemical among foremen; as years of experience increased, foremen scored lower of their responses to chemical exposure which meant they were increasingly exposed to chemicals.

Table 11: Significant correlation of years of experience to chemical exposure for foremen

Variable	by Variable	Correlation	Count	p-value
Number of hours exposure of chemicals*	Overall Experience	-0.9705	4	0.0295

**Reverse-scoring used on variable*

Insulators

Perceptions about Job control, Personal safety compliance, Training, Job Demands and Skill-underutilization increased as years of experience increased for insulator workers, while Job Certainty and Social Support decreased with the number of years of experience increased.

Iron-workers

Iron-workers experienced increasing levels of Social Support, Job Certainty, and Job Control with increasing years of experience. Perceived levels of Job Demands decreased significantly with increasing experience. Among Iron-workers with work experience of 20 years and less, perceived levels of Training and company Safety Climate decreased while increasing with workers with experience greater than 20 years. Personal safety compliance levels decreased as the number of years of experience increased. Overall experience was strongly correlated with Job demands, Skill-underutilization. Craft experience was strongly correlated to Skill-underutilization. As craft and overall experience increased, scores for Skill-underutilization of Iron-workers increased, indicating perceived lower levels of the variable. The same kind of correlation was observed for Job Demands and overall experience.

Table 12: Significant correlations with overall experience for Iron-workers

Variable	by Variable	Correlation	Count	p-value
Skill-underutilization*	Overall Experience	0.8453	6	0.0341
Skill-underutilization*	Craft Experience	0.8600	6	0.0280
Job Demands*	Overall Experience	0.8265	6	0.0426

**Reverse-scoring used on variable*

Laborers

Personal safety compliance and job control increased among Laborers while perceived levels of the company's safety climate and training decreased with increasing years of experience. Job Demand

levels generally decreased with the number of years of experience as well as Skill-underutilization, Overcompensating on the job, Responsibility for the safety of others, Harassment, perceived Safety Climate and Training.

Millwrights

Among Millwrights, Personal safety compliance and Job Certainty increased, while the perception on overall Social Support, company Safety Climate and Training decreased with years of experience. Job demands increased for workers less than 20 years experience and decreased for millwrights with more than 20 years experience; the reverse trend was observed for Skill-underutilization.

Pipefitters

Job control, perceived levels of Harassment, Safety Climate and Training, Skill-underutilization, Responsibility for the safety others and Personal safety compliance decreased, while Job certainty and Overcompensating on the job increased as the number of years of experience increased. Of notable interest among this group is that according to OSHA records and self-reported injuries, Pipefitters had the highest recorded cases of injuries. One possible explanation for this might be that Pipefitters may make up a great percentage of the employees at this company, however decline in levels of Job control, Responsibility for the safety of others, Personal Safety compliance combined with having to overcompensate on the job seems to suggest that this group of workers experience less than optimal levels of factors that contribute to occupational stress. Results from logistic and simple step-wise regression of the injury data with participants' responses already establish that Training had a significant effect on the occurrence of injuries, it can be inferred from this group that the decline in Training significantly lead to injury outcomes.

Hypothesis 3

Differences will be observed in physical and psychological symptoms reported by workers depending on the duration of routinely doing a particular construction occupation confirming findings by Goldenhar et al. (2003) that total months of working in construction was a significant estimate of physical and psychological symptoms the workers experienced.

Differences were also observed in the trends for physical and psychological symptoms the participants experienced as the number of years of experience increased for the various occupations as summarized in Table 13. For all the participants in general, the occurrence of feeling sad on the job was the only psychological symptom that was significantly related to their overall experience.

Table 13: General Trends for participants' perceptions of occupational stressors with increasing years of experience, grouped by occupations

Occupation	Job Control	Job Demands	Skill-mater.	Resp. for safety	Overcompensating	Safety Climate	Training	Social Support	Harassment	Job Certainty	Safety Compliance	Physical Outcomes	Psychological Outcomes	Hours of Exposure
Boilermakers	↗	↗	↘	↘	↗	↗	↗	↗	↘	↗	↘	↘	↘	↘
Carpenters	↗	↘	↗	↗	↘	↗	↗	↗	↗	↗	↘	↗	↗	↗
Combo Welders	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crane Operators	No effect	↗	↗	↗	No effect	↘	No effect	No effect	No effect	No effect	No effect	↗	↗	-
Equipment Tech	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Foremen	↘	↘	↗	↗	↗	↘	↗	↗	No effect	↗	↘	↘	↘	↘
Helper/Maint.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Insulators	↗	↗	↗	No effect	No effect	↗	↗	↘	No effect	↘	↗	↗	↘	No effect
Iron-workers	↗	*↘	*↘	↗	↘	↗	↗	↗	↘	↗	↘	↘	↘	*↘
Laborers	↗	↘	↘	↘	↘	↘	↘	↗	↘	↗	↗	↘	↗	*↗
Millwrights	↘	↘	↘	-	↘	↘	↘	↘	No effect	↗	↗	-	↗	-
Planners	No effect	↗	No effect	No effect	No effect	↗	No effect	↗	No effect	↗	No effect	↘	↗	↘
Pipefitters	↘	↗	↗	↘	↗	-	↘	-	↘	↗	-	↗	↗	↗
Runner	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Safety	No effect	↘	-	No effect	No effect	↘	↘	↘	No effect	No effect	↘	↘	↘	↘
Sandblaster	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Supervisor	↗	↘	↗	↘	↘	↘	↘	*↘	↘	↗	↘	↗	↗	↘
Welders	No effect	↗	↘	No effect	↗	↗	↗	↗	No effect	↗	↘	↘	↘	-

*Significant correlations with years of experience

- No trend observed

↘ Decreasing trend with years of experience

↗ Increasing trend with years of experience

Negative correlation of years of experience with sadness meant that with increasing experience, workers' scores on sadness decreased (indicating elevated levels of sadness). The occurrence of low back pain was significantly related to insomnia and feeling sad on the job, increasing as both insomnia and feelings of sadness increased while the experiencing headaches was also increased significantly as experiences of insomnia increased.

Table 14: Significant correlations for psychological and physical symptoms

Variable	By Variable	Correlation	Count	p-value
PSO3 (Feeling Sad on the job)	Overall experience	-0.2766	68	0.0224
PHO1 (Insomnia)	PSO3 (Feeling Sad on the job)	0.2516	68	0.0385
PHO4 (Low back pain)	PSO3 (Feeling Sad on the job)	0.4701	68	0.0001
PHO4 (Low back pain)	PHO1 (Insomnia)	0.4546	68	0.0001

Hypothesis 4

The duration of routinely doing a particular construction occupation and the type of occupation will have affect accident/injury/near-misses outcomes and lost work days either directly or indirectly through intermediate psychological/physical symptoms.

Pearson's correlation of the participants' responses as well as a simple step-wise regression with the number of days lost due to injury (from OSHA logs) did not show any significant relationships between the overall experience and occupation type and the occurrence of injury (OSHA/Self-Reports) or number of days lost due to injury.

However, the correlation analysis showed that the number of days lost due to injury was related to three components of harassment as follows: sexual harassment from co-workers and supervisors, and gender discrimination by co-workers. The number of days lost was strongly correlated with one element of personal safety compliance (wearing head protection), safety priority, preparedness on the job, workers' ability to control the pace of their work. Reverse scoring was used for sexual harassment variables, safety compliance and safety priority; higher scores indicated diminishing perceived levels of these variables. The resulting negative correlations indicate as days lost due to injury increased, participants' scores on these variables decreased which would mean elevated perceived levels of the variables. Also on the variable Preparedness, higher scores indicated that increasing unpreparedness on

the job (See Table 2; Training Q1), the positive correlation results indicate that days lost due to injury would increase as workers became increasingly unprepared on the job.

Table 15: Significant correlations for days lost due to injury

Variable	by Variable	Correlation	Count	p-value
Days Lost	Sexual Harassment by co-workers	-0.5949	18	0.0092
Days Lost	Sexual Harassment by supervisors	-0.6673	18	0.0025
Days Lost	Gender discrimination by supervisors	-0.5540	18	0.0170
Days Lost	Compliance to head protection	-0.5788	18	0.0118
Days Lost	Control of work pace	-0.5269	18	0.0247
Days Lost	Safety Priority	-0.5105	18	0.0304
Days Lost	Preparedness	0.5433	18	0.0198

Simple forward step-wise regression results showed the number of days lost due to injury was related to how much control workers had over the pace of their work, preparedness on the job, sexual harassment from co-workers & supervisors, gender discrimination from co-workers, and personal safety compliance to head protection (Factors 2-2). The simple step-wise regression results support 6 of the 8 findings from the correlation analysis for lost work days due to injury.

Table 16: Results from simple-step wise regression for days lost to injury.

Parameter	p-value	R-Square
Factor2- 2 (Control over work-pace; job preparedness; harassment and discrimination; Individual Safety compliance)	0.0138	0.3411

Discussion

In their study into modelling the relationship among occupational stressors, psychological/physical symptoms and injuries, Goldenhar et al. (2003) observed that construction workers with elevated levels of psychological symptoms were at a higher risk for near-miss occurrences while higher levels of physical symptoms indicated a higher risk of experiencing injury. Also, a number of the participants' response variables (job stressors) were shown to be directly related to both psychological and physical symptoms, the most significant ones being skill-underutilization (experienced significantly by female construction workers), job certainty, harassment and discrimination. Finally, the study showed that eleven of the twelve stressors considered and two

control variables were directly related to injury or near miss outcomes, with most of the related stressors being in the domain of task/job related demands (Goldenhar et al., 2003).

The study carried out here confirmed that a number of the occupational stressors in the study by Goldenhar et al. (2003) affected injury outcomes directly. Those occupational stressors were Job Control, Responsibility for the Safety of others, Safety Climate, Training, Job Certainty and Personal Safety Compliance. The other occupational stressors (Job Demands, Skill-underutilization, Overcompensating on the job, Social Support, Exposure to physical/chemical elements and Harrasment/Discrimination) were not significantly associated with injury outcomes. None of the demographic information was also shown to be significantly associated with injury outcomes. Also findings from the present study showed only one physical symptom (headaches) and one psychological symptom (feeling sad on the job) to be significantly associated with injury outcomes.

The analysis carried out by Goldenhar et al. (2003) employed a structural equation method (SEM) to create direct paths from the participants' response variable to injury/near-miss outcomes and paths from the response variables to injury/near-miss outcomes with psychological and physical symptoms as mediators. SEM is a viable statistical approach for significantly large sample sizes, however, the sample size under investigation in this study is much smaller (68) than the recommended sample size and as such SEM was not used. Although Regression methods and correlation analysis are not capable of yielding intermediated path relationships between variables, the analysis of the data did show that the psychological symptom of tenseness and physical symptom of headaches were related to injury and a number of the response variables measuring occupational stress. Even though the mediating role of psychological/physical symptoms cannot be inferred from the present analysis, the results show that occupational stressors experienced by this group could affect injury outcomes through the psychological outcome of feeling tense or the experience of headaches. The results of the analysis in this study indicate the effect pattern given in Figure 15, which is the resulting occupational stress-injury model. The model can be summarized as follows:

- Unhealthy levels of occupational stressors affect injury outcomes
- Unhealthy levels of occupational stressors also affect the occurrence of physical and psychological symptoms
- Training and Safety affect injury as well as the resulting lost work days
- Exposures to physical and chemical elements significantly affect the occurrence of physical and psychological symptoms.
- Psychological and physical symptoms **can** significantly affect injury outcomes

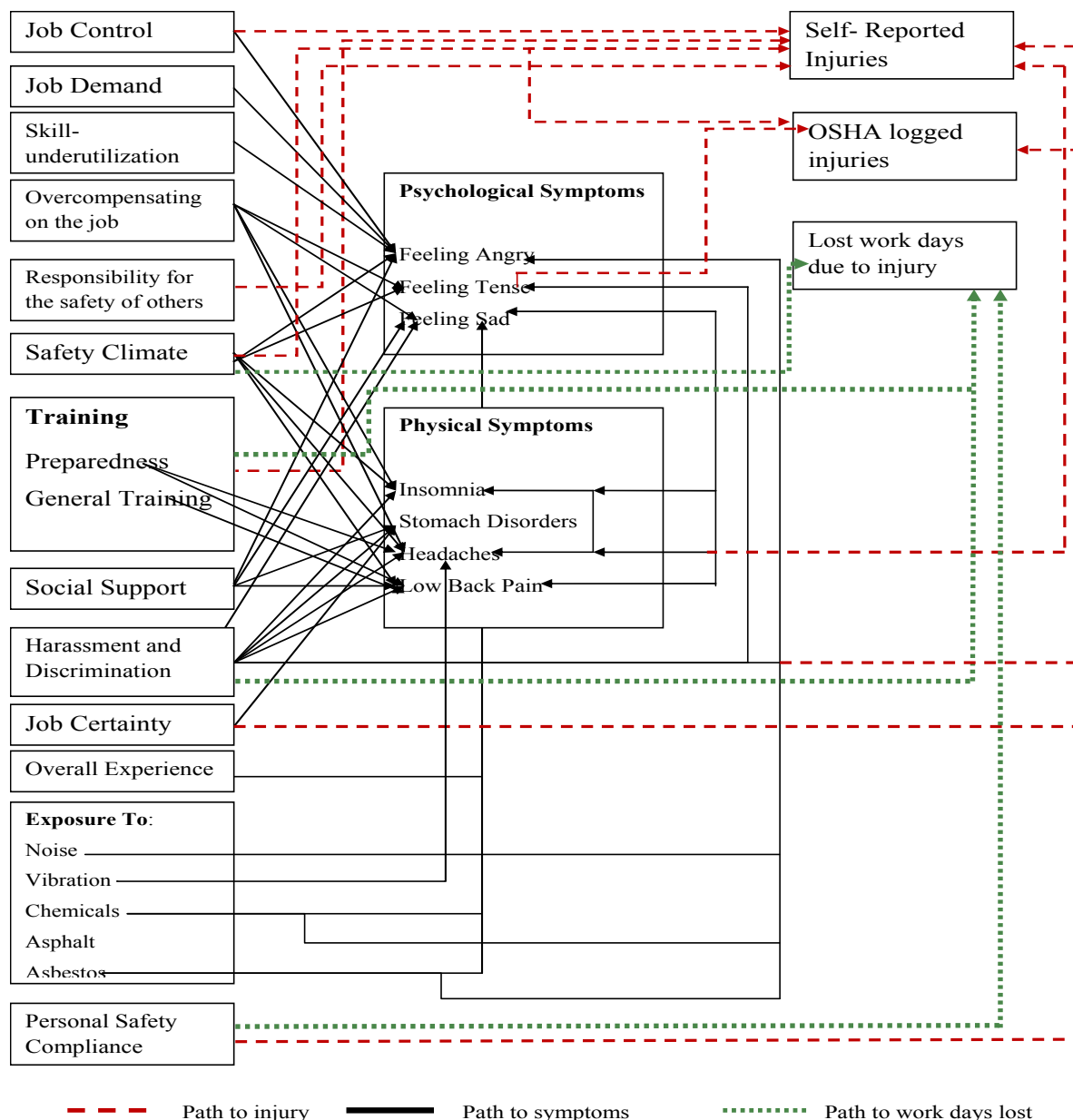


Figure 15: Observed effects pattern of occupational stressors, physical/psychological symptoms and injuries

In addition to investigating the effects of occupational stressors, psychological and physical symptoms on injury outcomes, the present study investigated the effects of stressors and psychological and physical symptoms on the resulting lost work days due to injury and findings indicated that Training, Safety Climate, Harassment/Discrimination and Personal Safety Compliance significantly affected work days lost due to injury; this was not investigated in the study by Goldenhar et al. (2003). The effects on occupation type and the duration of workers experience with an occupation type on the

perceptions of occupational stressors and psychological as well as physical symptoms were also investigated in this study. The results obtained indicated that workers engaged in diverse tasks had different perceptions of what elements of their work contribute to occupational stress. Also, the number of years of being engaged in a particular occupation did affect the levels of perceived occupational stressors. The only psychological symptom significantly associated with the duration of working in a specific occupation was the feeling of sadness on the job; no physical symptoms were shown to be significantly associated with duration of occupational experience.

Limitations and Additional Research Discussions

One limitation of the present study was the inability to analyze occupational stress responses and OSHA injuries for individual workers. Confidentiality of company records and identity as well as the identity of the employees involved in the study made it impossible to perform the analysis based on individual OSHA injury data. It is predicted that performing analysis with individual OSHA injury and lost work days records would have resulted in stronger significant occupational stress and injury associations. Another limitation of the study is the disproportionate number of participants for the respective occupations. Since the participation was voluntary and collected by random employees, having a consistent and fairly distribution of the occupations within the company was not achieved. Also, the study at the present cannot report trends as it was not longitudinal, and results here are only a snapshot in time of workers' perceptions of stress which could have be influence by confounding factors like specific time in production cycle (peak/low), personal stressors and other micro stressors experienced at the time (weather, traffic, etc.) Some other limitations include geographic specificity of the participants, the use of only one company and disproportionate gender distribution.

Longitudinal studies on occupational stress and injury outcomes should be carried out to investigate trends like what time of the year in a company's production cycle are workers more likely to get injures. Also, a future study should involve a larger sample size and include cross-section of workers from multiples companies to increase external validity of the experiment.

Lessons Learned

Data Collection

Some of the participants' responses were not used either because the participants did not complete the questionnaire or did not fill out the consent form provided. This could have been avoided if the investigator of this study was present to clarify questions or remind participants to complete the consent forms with the questionnaires.

Questionnaire

The section on harassment and discrimination in the questionnaire did not contain questions on racial/ethnic discrimination as well as questions about bullying and other forms of intimidation in the workplace. Questions covering bullying and racial discrimination should be included in future questionnaires. Also, harassment and discrimination was shown to be significant to lost work days resulting from injury even though responses indicated very little occurrence of harassment and discrimination, this relationship can be investigated further.

Implementation

The results from this study indicate the following significant observations that will be useful in implementing measures for continued worker protection:

- Self-reported injuries are significantly associated with training, the safety climate of the company, workers' responsibility for the safety of others, job certainty, the amount of job control, and the personal safety compliance of workers to personal protective equipment. Self-reported injuries are also significantly related to experiencing headaches, which in turn was significantly associated with control over work pace, overcompensating on the job, risking short-cuts, level of preparedness on the job, training, harassment, hours of exposure to vibrations and chemicals and compliance to personal safety on the job.
- The injuries recorded for OSHA are significantly related to the safety climate of the company and gender discrimination by supervisors. These injuries were also significantly related to feelings of tenseness on the job and the occurrence of headaches, which were also related to overall experience, control over work pace, overcompensating on the job, risking short-cuts, level of preparedness on the job, training, harassment, hours of exposure to vibrations, chemicals and asbestos and compliance to personal safety on the job.

Management should take actions to diminish the above mentioned factors that contribute to occupational stress negatively and increase the levels of factors that reduce the levels of occupational stress perceived by employees. Another important measure for management to take is to take steps to reverse negative trends observed with overall experience for the various occupation groups as shown by the results. From these results, Pipefitters run the highest risk of injuries based on trends for the response variables observed with overall experience and injury outcomes.

Conclusion

The result of this study showed associations between the occurrence of injuries among Industrial construction workers and job control, training, job certainty, safety climate of the organization, responsibility for the safety of others, harassment and discrimination and personal compliance to safety. Injury outcomes were also related to the experience of headaches and tenseness on the job. Lost work days due to injury were shown to be significantly related with training, safety climate, harassment and personal safety compliance. It can be inferred from these associations that training, safety climate of the organization, harassment and personal compliance to safety would be factors in the work place that would result in loss of man-hours because they could result in injuries leading to lost work days.

All the response variables measuring occupational stress were associated with one or more psychological or physical symptom. Even though the mediating role of psychological/physical symptoms cannot be inferred from the present analysis, the results show that occupational stressors experienced by this group could affect injury outcomes through the psychological outcome of feeling tense or the experience of headaches. Different trends were observed for occupational stressor variables and psychological/physical outcomes for the various occupations as years of experience varied. However, only one psychological symptom (feelings of sadness) was significantly related to overall experience for all the participants and none of the outcomes (psychological/physical) was related to the number of years of experience.

The benefits of conducting research into occupational stressors and their effects on Industrial Construction manual workers include:

- The ability to identify dominant factors of the work setting that initiate the stress process and design work and the work place to mediate those elements on industrial construction worksites.
- Approaching the development of healthier and safer work environments focusing not just on physical job aspects of construction work but on psychosocial aspects as well.
- Ultimately being able to contribute to research that is creating an awareness of the importance of psychosocial occupational health and safety

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Appendix I: Principal components analysis and Factor rotation tables

Table I: Principal components for participants' responses

Eigenvalue	11.27	7.78	4.35	3.27	2.75	2.46	2.07	1.67	1.53
Percent	21.68	14.96	8.37	6.29	5.29	4.73	3.98	3.21	2.94
Cum Percent	21.68	36.64	45.01	51.31	56.59	61.33	65.30	68.52	71.46
	Eigenvectors								
JC1	0.13	-0.18	-0.06	-0.14	-0.10	0.00	0.03	0.18	-0.25
JC2	0.17	-0.17	-0.01	0.10	-0.05	0.12	0.13	-0.04	-0.05
JC3	0.16	-0.15	-0.13	0.03	-0.03	-0.20	-0.23	0.00	-0.15
JC4	0.17	-0.18	-0.05	-0.01	0.05	0.04	-0.12	0.06	-0.13
JD1	0.13	0.04	-0.06	0.19	-0.25	0.21	0.12	-0.07	0.30
JD2	0.09	0.10	-0.05	0.06	-0.29	0.29	0.07	-0.02	0.21
SU	0.14	-0.14	0.17	0.18	-0.08	-0.06	0.00	0.04	-0.27
RO	-0.11	0.20	0.14	-0.02	0.07	-0.05	-0.13	0.05	0.01
OvC	0.15	0.10	-0.02	-0.07	-0.12	0.19	0.16	0.19	0.28
SC1	0.19	-0.13	0.08	-0.02	-0.02	0.14	-0.09	0.16	0.02
SC2	-0.23	-0.08	-0.03	-0.15	-0.12	0.06	-0.08	0.05	-0.03
SC3	0.18	-0.13	0.01	0.11	0.19	0.10	-0.19	-0.08	0.09
SC4	0.13	-0.16	0.07	0.09	0.13	0.13	-0.09	-0.16	0.09
SC5	0.10	-0.12	-0.09	0.00	0.32	0.12	-0.03	-0.13	0.13
Tr1	-0.14	-0.09	0.21	-0.13	0.09	0.02	-0.10	0.01	0.15
Tr2	0.13	-0.08	0.08	-0.13	-0.03	-0.36	0.22	-0.20	0.18
Tr3	0.10	-0.07	-0.01	-0.17	0.08	-0.36	0.27	-0.15	0.19
Tr4	-0.03	-0.08	0.17	-0.13	-0.12	0.27	-0.07	-0.28	-0.11
SS1	0.20	-0.14	0.13	-0.05	-0.03	0.16	-0.02	0.09	0.00
SS2	0.20	-0.17	-0.01	0.07	0.05	-0.02	-0.09	-0.01	-0.07
SS3	0.17	-0.22	-0.15	0.10	-0.06	0.06	0.07	0.09	0.00
SS4	0.13	-0.11	0.04	-0.33	0.13	0.10	-0.05	0.10	0.13
SS5	0.12	-0.03	0.11	-0.38	0.20	-0.03	-0.08	0.06	0.07
SS6	0.20	-0.10	0.13	-0.19	0.05	0.03	-0.06	0.04	0.15
HD1	0.13	0.20	-0.13	-0.13	0.08	0.06	-0.05	0.23	-0.07
HD2	0.14	0.18	-0.20	-0.10	0.12	0.06	-0.16	0.20	0.10
HD3	0.13	0.19	-0.24	0.10	0.12	-0.01	-0.12	-0.01	0.03
HD4	0.10	0.26	-0.19	0.08	0.03	0.04	0.08	-0.01	-0.01
HD5	0.13	0.23	-0.24	0.08	0.09	0.03	-0.06	0.01	0.00
HD6	0.15	0.18	0.03	0.10	0.09	0.10	-0.16	-0.28	0.09
JCt1	0.15	-0.14	0.12	-0.02	0.00	-0.07	0.09	-0.01	-0.05
JCt2	0.05	-0.12	-0.13	0.15	-0.07	-0.24	-0.29	0.10	0.10

Table I Continued

JCt3	0.07	-0.11	-0.17	0.18	-0.12	-0.28	-0.15	0.06	0.13
JCt4	0.10	-0.18	-0.12	0.20	-0.03	-0.07	0.15	-0.02	0.28
HoE1	0.02	0.12	0.19	-0.06	-0.16	-0.09	0.11	0.31	0.05
HoE2	0.06	0.15	0.20	-0.06	-0.02	-0.17	0.00	0.13	0.32
HoE3	0.15	0.07	0.16	0.13	-0.02	-0.22	0.12	0.00	-0.04
HoE4	0.04	0.08	0.24	0.21	0.00	0.02	-0.10	0.08	-0.12
HoE5	0.07	0.07	0.37	0.23	-0.01	0.00	-0.14	0.08	0.09
HoE6	0.05	0.07	0.36	0.24	0.02	-0.01	-0.13	0.11	0.06
SX1	-0.01	-0.10	0.04	0.09	0.24	0.22	0.41	0.01	-0.11
SX2	-0.09	-0.02	0.02	0.19	0.38	0.02	0.10	0.28	0.00
SX3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SX4	-0.08	0.07	0.07	0.14	0.20	-0.08	0.03	-0.32	-0.02
SX5	-0.08	-0.03	0.00	0.16	0.41	0.01	0.22	0.21	0.05
PSO1	0.18	0.18	0.07	-0.11	0.04	0.03	-0.05	-0.02	-0.17
PSO2	0.22	0.10	0.05	-0.02	-0.11	0.03	0.15	-0.03	-0.13
PSO3	0.15	0.19	0.08	-0.10	0.05	0.01	-0.07	-0.25	0.01
PHO1	0.17	0.10	-0.02	-0.01	-0.06	-0.02	0.28	-0.01	-0.23
PHO2	0.19	0.17	0.11	0.04	0.05	-0.04	0.05	-0.10	-0.13
PHO3	0.17	0.15	0.00	0.00	-0.04	-0.17	0.06	0.11	-0.15
PHO4	0.21	0.11	-0.03	-0.12	0.08	-0.06	-0.03	-0.14	-0.07

Table II: Rotated Factor Pattern for Principal components in Table I and loaded variables

	Task Demands and Management	Harassment and Discrimination	Exposure to Elements	Social Support from peers	Safety Compliance	Job Certainty	Training		Over compensating on the job
JC1	0.61	0.00	-0.19	-0.11	-0.18	0.01	0.09	0.46	-0.12
JC2	0.78	0.03	0.00	0.11	-0.01	0.07	0.13	0.03	0.22
JC3	0.61	0.18	-0.11	0.01	-0.21	-0.47	0.08	0.07	-0.25
JC4	0.77	0.08	-0.07	-0.15	-0.04	-0.14	-0.02	0.08	-0.11
JD1	0.25	0.24	0.09	0.20	-0.14	-0.05	0.01	-0.09	0.78
JD2	0.02	0.26	0.05	0.08	-0.27	0.11	-0.16	0.04	0.72
SU	0.66	-0.04	0.44	0.23	-0.09	0.00	0.12	0.13	-0.14
RO	-0.63	0.08	0.33	-0.12	0.02	0.07	-0.16	-0.08	-0.17
OvC	0.09	0.38	0.07	-0.27	-0.02	0.12	0.08	0.21	0.63
SC1	0.72	0.08	0.20	-0.31	-0.07	-0.01	-0.04	0.14	0.16
SC2	-0.40	-0.65	-0.32	0.00	-0.12	0.04	-0.26	0.16	-0.13
SC3	0.72	0.16	0.12	-0.22	0.11	-0.18	-0.09	-0.33	0.02
SC4	0.65	-0.06	0.10	-0.13	0.06	-0.01	-0.02	-0.35	0.06
SC5	0.51	0.11	-0.26	-0.26	0.33	-0.03	-0.01	-0.38	-0.02
Tr1	-0.20	-0.63	0.13	-0.34	0.07	0.12	-0.05	-0.13	-0.17
Tr2	0.25	0.03	0.03	-0.15	-0.16	-0.09	0.85	-0.09	-0.01
Tr3	0.15	0.06	-0.17	-0.20	0.04	-0.08	0.85	-0.07	-0.07
Tr4	0.17	-0.35	0.02	-0.08	-0.41	0.45	-0.19	-0.21	0.01
SS1	0.74	0.03	0.21	-0.32	-0.12	0.14	0.04	0.11	0.16
SS2	0.80	0.12	0.06	-0.07	-0.03	-0.18	0.10	-0.04	-0.07
SS3	0.84	0.03	-0.21	0.08	0.06	-0.21	0.09	0.18	0.22
SS4	0.42	0.04	-0.14	-0.72	-0.05	0.13	0.12	0.08	0.00
SS5	0.21	0.14	-0.03	-0.80	-0.07	0.16	0.22	0.02	-0.23
SS6	0.57	0.11	0.15	-0.58	-0.14	0.05	0.23	0.00	0.08
HD1	-0.08	0.78	-0.05	-0.30	0.02	0.02	-0.12	0.25	0.05
HD2	-0.04	0.77	-0.12	-0.37	0.06	-0.21	-0.19	0.09	0.14
HD3	-0.04	0.84	-0.11	0.03	0.08	-0.28	-0.14	-0.15	0.10
HD4	-0.23	0.83	-0.05	0.15	0.06	-0.01	-0.05	-0.03	0.24
HD5	-0.09	0.88	-0.11	0.05	0.07	-0.18	-0.14	-0.08	0.15
HD6	0.04	0.62	0.27	-0.06	-0.14	0.02	-0.10	-0.51	0.16
JCt1	0.58	-0.01	0.18	-0.11	-0.06	0.06	0.34	0.05	-0.04
JCt2	0.28	-0.07	0.00	0.07	-0.07	-0.73	-0.02	0.03	-0.08

Table II Continued

JCt3	0.30	0.01	-0.08	0.21	-0.05	-0.74	0.16	0.06	0.04
JCt4	0.51	-0.11	-0.15	0.17	0.21	-0.36	0.29	-0.08	0.36
HoE1	-0.26	0.08	0.47	-0.15	-0.08	0.09	0.20	0.43	0.15
HoE2	-0.30	0.17	0.50	-0.36	-0.03	-0.09	0.32	0.02	0.19
HoE3	0.16	0.34	0.52	0.10	-0.01	-0.02	0.42	0.02	0.00
HoE4	0.04	0.09	0.69	0.13	0.02	0.07	-0.14	-0.03	-0.05
HoE5	0.06	0.01	0.94	-0.04	0.01	0.01	-0.04	-0.16	0.09
HoE6	0.04	-0.01	0.93	-0.02	0.07	0.00	-0.05	-0.12	0.05
SX1	0.29	-0.15	-0.09	0.17	0.58	0.52	0.06	-0.02	0.05
SX2	-0.10	-0.12	0.11	0.04	0.82	-0.01	-0.17	0.00	-0.18
SX3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SX4	-0.25	0.00	0.11	0.25	0.19	0.10	0.07	-0.51	-0.22
SX5	-0.07	-0.09	0.00	0.03	0.87	0.07	-0.01	-0.05	-0.13
PSO1	0.09	0.70	0.27	-0.23	-0.22	0.24	0.05	0.01	-0.06
PSO2	0.31	0.61	0.24	0.00	-0.23	0.24	0.25	0.13	0.20
PSO3	-0.05	0.61	0.23	-0.24	-0.29	0.20	0.13	-0.31	0.02
PHO1	0.22	0.60	0.07	0.17	-0.07	0.29	0.31	0.21	0.09
PHO2	0.14	0.66	0.41	-0.02	-0.10	0.20	0.21	-0.11	0.00
PHO3	0.07	0.67	0.26	0.00	-0.11	-0.04	0.27	0.23	-0.03
PHO4	0.24	0.69	0.04	-0.24	-0.20	0.06	0.23	-0.13	-0.06

Table III: Principal Component for participants' responses classified by occupations

Eigenvalue	10.32	6.65	6.44	5.24	4.25	3.59	3.09	2.10	2.01
Percent	19.85	12.79	12.38	10.07	8.17	6.89	5.95	4.04	3.87
Cum Percent	19.85	32.64	45.02	55.10	63.27	70.17	76.11	80.15	84.02
	Eigenvectors								
JC1	0.21	0.16	0.00	0.02	0.25	0.04	0.06	-0.10	0.03
JC2	0.19	-0.01	-0.03	-0.08	-0.13	0.14	-0.10	0.26	-0.24
JC3	0.18	-0.12	0.24	0.03	-0.01	0.17	-0.06	0.02	-0.03
JC4	0.20	0.03	-0.02	-0.27	0.01	0.00	0.13	-0.02	0.19
JD1	0.17	0.05	-0.14	0.22	-0.05	0.01	-0.22	-0.15	0.05
JD2	0.02	-0.08	-0.27	0.16	0.12	0.14	0.01	-0.15	0.01
SU	0.18	-0.18	0.02	0.04	-0.13	0.00	-0.25	0.01	0.18
RO	-0.17	-0.15	-0.08	0.20	-0.12	-0.07	0.12	0.08	-0.01
OvC	0.13	0.12	-0.09	0.33	0.01	0.02	0.03	0.14	0.05
SC1	0.26	0.10	-0.10	-0.12	-0.06	-0.10	0.02	0.05	0.07
SC2	-0.20	-0.12	0.11	0.16	0.09	0.16	0.09	0.00	-0.02
SC3	0.21	-0.08	0.05	0.09	-0.26	-0.10	-0.09	0.15	-0.08
SC4	0.22	0.00	-0.01	-0.14	-0.04	0.17	0.13	0.19	0.15
SC5	0.11	0.17	-0.14	0.20	0.18	-0.09	0.11	0.09	0.02
Tr1	-0.23	0.07	-0.08	-0.01	-0.16	0.12	0.18	0.13	-0.13
Tr2	0.20	0.00	0.00	-0.22	-0.10	-0.15	0.17	0.15	0.08
Tr3	0.13	0.05	-0.06	-0.28	0.01	-0.20	0.19	0.05	0.03
Tr4	0.08	0.09	-0.10	0.13	-0.07	0.00	0.40	-0.02	0.10
SS1	0.19	0.08	-0.20	0.06	0.09	-0.03	-0.12	0.08	0.09
SS2	0.23	0.14	-0.09	-0.16	0.03	-0.03	0.03	-0.11	-0.04
SS3	0.16	0.11	-0.12	-0.11	0.27	0.04	0.02	-0.08	-0.15
SS4	0.17	0.12	0.03	0.24	0.14	0.08	0.13	0.11	-0.09
SS5	0.18	0.03	0.09	-0.08	-0.16	0.26	0.08	-0.18	-0.23
SS6	0.22	0.07	0.02	0.13	-0.17	0.07	-0.05	-0.11	-0.17
HD1	0.13	-0.21	0.19	0.02	0.13	0.08	0.10	-0.05	-0.06
HD2	0.15	-0.19	0.20	0.05	0.16	-0.12	0.00	-0.19	0.00
HD3	0.02	-0.13	0.22	0.03	0.13	-0.34	0.06	-0.10	-0.08
HD4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HD5	0.11	-0.19	0.17	0.06	0.13	-0.16	0.05	-0.29	0.05
HD6	0.12	-0.04	0.03	0.12	-0.34	-0.15	-0.01	-0.05	0.11
JCt1	0.21	-0.01	-0.07	0.12	0.00	-0.14	-0.15	0.05	-0.12
JCt2	-0.02	-0.26	0.07	-0.11	0.11	0.17	-0.01	0.14	-0.02
JCt3	0.03	-0.07	0.24	-0.09	0.18	-0.18	-0.08	0.14	0.25

Table III Continued

JCt4	0.03	-0.07	-0.12	0.12	0.15	-0.21	-0.25	0.16	-0.07
HoE1	-0.02	0.21	-0.06	-0.10	0.14	-0.12	-0.30	-0.07	-0.13
HoE2	-0.12	0.08	-0.01	-0.31	0.09	-0.11	-0.02	0.01	-0.02
HoE3	-0.02	0.21	0.24	-0.04	0.01	0.24	-0.07	-0.14	0.03
HoE4	-0.05	0.06	-0.03	0.21	0.27	-0.06	0.15	0.28	0.16
HoE5	-0.02	0.24	0.14	-0.02	0.05	0.17	-0.24	-0.16	-0.07
HoE6	-0.05	0.03	0.08	-0.05	0.07	0.13	-0.25	0.23	0.39
SX1	0.12	-0.11	0.07	0.16	0.16	0.13	0.10	0.03	0.08
SX2	0.10	-0.11	0.08	-0.07	0.07	0.29	0.00	0.35	-0.17
SX3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SX4	0.03	-0.10	-0.14	-0.08	0.01	0.21	-0.06	-0.18	0.43
SX5	0.14	-0.20	0.18	-0.01	0.13	0.07	-0.01	0.11	-0.13
PSO1	-0.03	0.07	0.19	0.11	-0.23	-0.09	-0.24	0.14	0.10
PSO2	0.00	0.27	0.23	0.11	0.10	-0.03	-0.08	0.01	-0.02
PSO3	-0.03	0.29	0.15	0.04	0.09	0.17	0.01	0.06	0.18
PHO1	0.06	0.02	0.15	0.17	-0.16	0.05	0.20	-0.22	0.21
PHO2	-0.03	0.29	0.20	0.00	-0.13	-0.01	0.08	-0.02	0.04
PHO3	-0.06	0.17	0.24	0.04	0.08	-0.19	0.11	0.09	-0.20
PHO4	0.06	0.14	0.27	0.03	-0.16	-0.14	0.09	0.16	0.08

Table IV: Rotated Factor Pattern for Principal Components in Table III with loaded variables

	Mgmt social support and attitude towards safety and training	Compliance to safety/ training; Harassment & control of work pace	Exposure and Outcomes	Overcompensating on the job; overall social support		Social Support from peers	Training and Physical outcomes		
JC1	0.52	0.27	0.34	-0.57	0.36	-0.03	0.00	-0.06	0.03
JC2	0.43	-0.13	-0.05	-0.12	-0.28	-0.42	-0.22	-0.58	0.00
JC3	0.06	0.62	0.25	-0.04	-0.28	-0.29	0.06	-0.56	0.10
JC4	0.90	0.14	0.03	0.10	0.03	0.03	0.18	-0.12	0.20
JD1	0.07	0.08	-0.01	-0.64	-0.16	-0.43	-0.30	0.22	0.37
JD2	-0.19	-0.13	-0.44	-0.48	0.39	-0.13	0.00	0.04	0.45
SU	0.16	0.43	-0.16	-0.05	-0.52	-0.25	-0.27	-0.16	0.49
RO	-0.64	-0.18	-0.52	0.00	-0.21	0.13	0.20	0.16	-0.08
OvC	-0.04	-0.08	0.06	-0.94	-0.24	-0.09	0.02	0.04	0.02
SC1	0.89	0.01	-0.03	-0.30	-0.18	-0.19	-0.09	0.02	0.08
SC2	-0.81	0.08	0.02	0.10	0.15	0.22	0.28	-0.19	-0.05
SC3	0.26	0.23	-0.18	-0.21	-0.72	-0.42	-0.14	-0.15	-0.06
SC4	0.68	0.03	0.04	-0.16	-0.20	-0.04	0.23	-0.49	0.25
SC5	0.20	-0.10	0.00	-0.86	0.16	0.15	-0.04	0.16	-0.13
Tr1	-0.38	-0.75	-0.09	0.25	0.03	0.06	0.33	0.02	-0.22
Tr2	0.87	0.11	-0.17	0.08	-0.29	0.02	0.13	-0.11	-0.11
Tr3	0.86	0.01	-0.18	0.15	0.07	0.12	0.09	0.07	-0.19
Tr4	0.24	-0.16	-0.16	-0.51	-0.06	-0.03	0.63	0.16	-0.08
SS1	0.45	-0.08	-0.10	-0.62	0.01	-0.05	-0.34	0.03	0.28
SS2	0.85	0.02	0.09	-0.22	0.16	-0.29	-0.07	0.03	0.05
SS3	0.56	0.04	0.05	-0.35	0.59	-0.11	-0.18	-0.14	0.01
SS4	0.11	0.16	0.22	-0.85	0.02	-0.10	0.13	-0.23	-0.19
SS5	0.34	0.10	0.26	0.02	-0.03	-0.74	0.30	-0.38	0.05
SS6	0.24	0.12	0.16	-0.43	-0.29	-0.70	0.00	-0.06	0.02
HD1	0.02	0.75	-0.07	-0.01	0.04	-0.09	0.20	-0.49	-0.01
HD2	0.07	0.98	-0.06	-0.05	0.00	-0.06	-0.01	-0.11	-0.05
HD3	-0.05	0.80	-0.11	0.15	-0.03	0.17	-0.06	0.16	-0.48

Table IV Continued

HD4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HD5	0.01	0.95	-0.13	0.00	0.05	-0.06	0.09	0.09	-0.01
HD6	0.12	0.15	-0.14	-0.09	-0.74	-0.36	0.12	0.29	0.04
JCt1	0.30	0.25	-0.18	-0.50	-0.23	-0.30	-0.41	-0.01	-0.02
JCt2	-0.16	0.29	-0.25	0.36	0.10	0.17	0.00	-0.62	0.18
JCt3	0.15	0.61	0.23	0.22	-0.15	0.56	-0.18	-0.09	-0.09
JCt4	-0.08	0.13	-0.34	-0.32	-0.02	0.15	-0.67	0.06	-0.02
HoE1	0.21	-0.21	0.36	0.00	0.34	-0.01	-0.65	0.29	-0.11
HoE2	0.28	-0.24	0.10	0.58	0.35	0.32	-0.17	0.13	-0.19
HoE3	-0.07	0.02	0.93	0.13	0.09	-0.13	0.15	-0.11	0.01
HoE5	-0.08	-0.11	0.85	0.03	0.20	-0.22	-0.23	0.03	0.01
HoE6	-0.09	-0.06	0.43	0.12	-0.20	0.51	-0.26	-0.18	0.42
SX1	-0.07	0.47	-0.03	-0.44	0.02	0.04	0.21	-0.37	0.16
SX2	0.08	0.05	0.01	-0.01	-0.03	-0.02	-0.02	-0.94	0.02
SX3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SX4	0.12	-0.01	-0.09	0.07	0.11	0.09	0.14	0.01	0.87
SX5	0.04	0.63	-0.06	0.00	-0.05	-0.05	-0.04	-0.62	-0.07
PSO1	-0.25	0.04	0.41	0.09	-0.70	-0.03	-0.23	0.15	-0.10
PSO2	-0.08	0.10	0.83	-0.26	-0.03	0.09	-0.09	0.13	-0.37
PSO3	-0.01	-0.20	0.87	-0.22	0.06	0.24	0.16	-0.02	-0.04
PHO1	-0.10	0.31	0.24	-0.19	-0.34	-0.19	0.61	0.20	0.08
PHO2	0.09	-0.18	0.76	0.04	-0.23	-0.02	0.26	0.23	-0.37
PHO3	-0.10	0.14	0.45	0.00	-0.02	0.18	0.03	0.11	-0.79
PHO4	0.18	0.17	0.48	0.01	-0.60	0.07	0.21	0.06	-0.45

Appendix II: Questionnaire and Reliability Measures

Consent Form for Thesis Research Study by Omosefe Abbe

1. Study Title: Modeling the relationships among occupational stressors, psychological/physical symptoms and injuries in the construction industry
2. Performance Site: At respective construction companies' site
3. Investigators: The following investigators are available for questions about this study, M-F, 8:00 a.m. - 4:30 p.m.

Omosefe Abbe: 859-358-4713
4. Purpose of the Study: The purpose of this research project is to determine whether there is an association among perceived stress on the construction site, physical and psychological symptoms, injuries and work days lost in Industrial Construction work settings
5. Subject Inclusion: Construction workers who have performed construction activities regularly in the past 6 months from the date of the survey
6. Number of subjects: Maximum of 100
7. Study Procedures: The study will consist of participants responding to a questionnaire about specific job stressors and injuries/ near miss experiences in the past year. The study will also entail using injury/accident/lost work days data collected from OSHA 300forms
8. Benefits: The results of the study will be provided to individuals concerned with environmental health and safety at the respective construction companies.
9. Risks: There are no risks beyond those that might be associated with filling out an anonymous questionnaire.
10. Right to Refuse: Subjects may choose not to participate or to withdraw from the study at any time without penalty or loss of any benefit to which they might otherwise be entitled.
11. Privacy: Results of the study may be published, but no names or identifying information will be included in the publication. Subject identity will remain confidential unless disclosure is required by law. Data obtained from OSHA 300/301 forms will be referred to by case number only and not use any employee identification information.
12. Signatures: _____

The study has been discussed with me and all my questions have been answered. I may direct

additional questions regarding study specifics to the investigators. If I have questions about participants' rights or other concerns, I can contact Robert C. Mathews, Institutional Review Board, (225) 578-8692. I agree to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.

Signature of Subject _____ Date _____

Questionnaire for Thesis Research Study by Omosefe Abbe

PLEASE NOTE COMPLETION OF THIS QUESTIONNAIRE IS VOLUNTARY AND ALL ANSWERS ARE COMPLETELY CONFIDENTIAL AND ANONYMOUS.

Demographic Questions

Occupation/ Craft: _____

Gender (Please check one): ☐ Female ☐ Male

Age: _____

Ethnic Background (Please check one):

- ☐ African American or Black (Non-Hispanic)
- ☐ American Indian or Alaskan Native
- ☐ Asian or Pacific Islander
- ☐ Caucasian (Non-Hispanic)
- ☐ Hispanic
- ☐ Prefer not to answer

Number of years of construction experience: _____

Number of years of construction experience, in present craft/occupation: _____

How long have you worked in your current job on a daily basis? _____ ☐ Months ☐ Years

Are you currently injured? (Please check one) ☐ Yes ☐ No

Job Task Demands

Job Control

1. How much control (do/did) you have over the types of tasks you (are /were) assigned to do during a workday?

- | | |
|---|---|
| <input type="checkbox"/> Totally Inadequate | <input type="checkbox"/> Barely Adequate |
| <input type="checkbox"/> Very Inadequate | <input type="checkbox"/> Very Adequate |
| <input type="checkbox"/> Barely Inadequate | <input type="checkbox"/> Totally Adequate |
| <input type="checkbox"/> Borderline | |

2. How much control (do/did) you have over getting the contractor to provide you with proper personal protective

- | | |
|---|---|
| <input type="checkbox"/> Totally Inadequate | <input type="checkbox"/> Barely Adequate |
| <input type="checkbox"/> Very Inadequate | <input type="checkbox"/> Very Adequate |
| <input type="checkbox"/> Barely Inadequate | <input type="checkbox"/> Totally Adequate |
| <input type="checkbox"/> Borderline | |

3. How much control (do/did) you have over how fast you worked?

- | | |
|---|---|
| <input type="checkbox"/> Totally Inadequate | <input type="checkbox"/> Barely Adequate |
| <input type="checkbox"/> Very Inadequate | <input type="checkbox"/> Very Adequate |
| <input type="checkbox"/> Barely Inadequate | <input type="checkbox"/> Totally Adequate |
| <input type="checkbox"/> Borderline | |

4. In general how much control would you say you (have/had) over your work and work related factors?

- | | |
|---|---|
| <input type="checkbox"/> Totally Inadequate | <input type="checkbox"/> Barely Adequate |
| <input type="checkbox"/> Very Inadequate | <input type="checkbox"/> Very Adequate |
| <input type="checkbox"/> Barely Inadequate | <input type="checkbox"/> Totally Adequate |
| <input type="checkbox"/> Borderline | |

Job Demands

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

- | | |
|------------------------------------|-------------------------------------|
| <input type="checkbox"/> Never | <input type="checkbox"/> Frequently |
| <input type="checkbox"/> Rarely | <input type="checkbox"/> Often |
| <input type="checkbox"/> Seldom | <input type="checkbox"/> Always |
| <input type="checkbox"/> Sometimes | |

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

- | | |
|------------------------------------|-------------------------------------|
| <input type="checkbox"/> Never | <input type="checkbox"/> Frequently |
| <input type="checkbox"/> Rarely | <input type="checkbox"/> Often |
| <input type="checkbox"/> Seldom | <input type="checkbox"/> Always |
| <input type="checkbox"/> Sometimes | |

Skill under-utilization

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

- | | |
|------------------------------------|-------------------------------------|
| <input type="checkbox"/> Never | <input type="checkbox"/> Frequently |
| <input type="checkbox"/> Rarely | <input type="checkbox"/> Often |
| <input type="checkbox"/> Seldom | <input type="checkbox"/> Always |
| <input type="checkbox"/> Sometimes | |

Responsibility for the safety of others

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

- | | |
|--------------------------------------|---|
| <input type="checkbox"/> None | <input type="checkbox"/> High |
| <input type="checkbox"/> Very Little | <input type="checkbox"/> Very High |
| <input type="checkbox"/> Little | <input type="checkbox"/> Extremely High |
| <input type="checkbox"/> Adequate | |

Overcompensating at work

1. How often on this job (do/did) you (have/had) to work harder than others to "prove" yourself?

- | | |
|------------------------------------|-------------------------------------|
| <input type="checkbox"/> Never | <input type="checkbox"/> Frequently |
| <input type="checkbox"/> Rarely | <input type="checkbox"/> Often |
| <input type="checkbox"/> Seldom | <input type="checkbox"/> Always |
| <input type="checkbox"/> Sometimes | |

Organizational Stressors

Safety Climate

1. At the jobsite, employees, supervisors, and managers (work/worked) together to ensure the safest possible working conditions

☐ Never
☐ Rarely
☐ Seldom
☐ Sometimes

☐ Frequently
☐ Often
☐ Always

2. At this jobsite, significant shortcuts (are/were) taken, which could put a worker's health and safety at risk

☐ Never
☐ Rarely
☐ Seldom
☐ Sometimes

☐ Frequently
☐ Often
☐ Always

3. The protection of workers (is/was) a high priority with supervisors at this jobsite

☐ Never
☐ Rarely
☐ Seldom
☐ Sometimes

☐ Frequently
☐ Often
☐ Always

4. At this jobsite unsafe work practices (are/were) corrected by supervisors

☐ Never
☐ Rarely
☐ Seldom
☐ Sometimes

☐ Frequently
☐ Often
☐ Always

5. When you were a new employee at this jobsite, you learned that you were expected to follow good safety practices

☐ Never
☐ Rarely
☐ Seldom
☐ Sometimes

☐ Frequently
☐ Often
☐ Always

Training

1. At this jobsite, sometimes I (am/was) was given a task to do and I (am/was) not sure how to do it

☐ Never
☐ Rarely
☐ Seldom
☐ Sometimes

☐ Frequently
☐ Often
☐ Always

2. I believe that I have been properly trained to use all types of personal protective equipment

☐ Decidedly Disagree
☐ Substantially Disagree
☐ Slightly Disagree
☐ Neutral

☐ Slightly Agree
☐ Substantially Agree
☐ Decidedly Agree

3. Overall, I believe that I have had the training I need to work safely

☐ Decidedly Disagree
☐ Substantially Disagree
☐ Slightly Disagree
☐ Neutral

☐ Slightly Agree
☐ Substantially Agree
☐ Decidedly Agree

4. Overall, I wish that I had been better trained before ever working on a construction site

☐ Decidedly Disagree
☐ Substantially Disagree
☐ Slightly Disagree
☐ Neutral

☐ Slightly Agree
☐ Substantially Agree
☐ Decidedly Agree

Job certainty

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?

<input type="checkbox"/> Quite Uncertain	<input type="checkbox"/> Slightly Certain
<input type="checkbox"/> Moderately Uncertain	<input type="checkbox"/> Moderately Certain
<input type="checkbox"/> Slightly Uncertain	<input type="checkbox"/> Quite Certain
<input type="checkbox"/> Neutral	
<input type="checkbox"/> Quite Uncertain	<input type="checkbox"/> Slightly Certain
<input type="checkbox"/> Moderately Uncertain	<input type="checkbox"/> Moderately Certain
<input type="checkbox"/> Slightly Uncertain	<input type="checkbox"/> Quite Certain
<input type="checkbox"/> Neutral	
<input type="checkbox"/> Quite Uncertain	<input type="checkbox"/> Slightly Certain
<input type="checkbox"/> Moderately Uncertain	<input type="checkbox"/> Moderately Certain
<input type="checkbox"/> Slightly Uncertain	<input type="checkbox"/> Quite Certain
<input type="checkbox"/> Neutral	
<input type="checkbox"/> Quite Uncertain	<input type="checkbox"/> Slightly Certain
<input type="checkbox"/> Moderately Uncertain	<input type="checkbox"/> Moderately Certain
<input type="checkbox"/> Slightly Uncertain	<input type="checkbox"/> Quite Certain
<input type="checkbox"/> Neutral	

Social Support

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 you work life *safer* for you?
3. How often can your immediate supervisor be relied upon to help 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?

<input type="checkbox"/> Never	<input type="checkbox"/> Frequently
<input type="checkbox"/> Rarely	<input type="checkbox"/> Often
<input type="checkbox"/> Seldom	<input type="checkbox"/> Always
<input type="checkbox"/> Sometimes	
<input type="checkbox"/> Never	<input type="checkbox"/> Frequently
<input type="checkbox"/> Rarely	<input type="checkbox"/> Often
<input type="checkbox"/> Seldom	<input type="checkbox"/> Always
<input type="checkbox"/> Sometimes	
<input type="checkbox"/> Never	<input type="checkbox"/> Frequently
<input type="checkbox"/> Rarely	<input type="checkbox"/> Often
<input type="checkbox"/> Seldom	<input type="checkbox"/> Always
<input type="checkbox"/> Sometimes	
<input type="checkbox"/> Never	<input type="checkbox"/> Frequently
<input type="checkbox"/> Rarely	<input type="checkbox"/> Often
<input type="checkbox"/> Seldom	<input type="checkbox"/> Always
<input type="checkbox"/> Sometimes	
<input type="checkbox"/> Never	<input type="checkbox"/> Frequently
<input type="checkbox"/> Rarely	<input type="checkbox"/> Often
<input type="checkbox"/> Seldom	<input type="checkbox"/> Always
<input type="checkbox"/> Sometimes	

Harassment and discrimination

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?

- ☐ Never
- ☐ Rarely
- ☐ Seldom
- ☐ Sometimes

- ☐ Frequently
- ☐ Often
- ☐ Always

2. have you ever had unwanted suggestions about, or references to, sexual activity directed at you by supervisors?

- ☐ Never
- ☐ Rarely
- ☐ Seldom
- ☐ Sometimes

- ☐ Frequently
- ☐ Often
- ☐ Always

3. have you ever had unwanted physical contact, including that of a sexual nature, by co-workers?

- ☐ Never
- ☐ Rarely
- ☐ Seldom
- ☐ Sometimes

- ☐ Frequently
- ☐ Often
- ☐ Always

4. have you ever had unwanted physical contact, including that of a sexual nature, by supervisors?

- ☐ Never
- ☐ Rarely
- ☐ Seldom
- ☐ Sometimes

- ☐ Frequently
- ☐ Often
- ☐ Always

5. have you ever felt that you were mistreated due to the fact that you were a female/male by co-workers?

- ☐ Never
- ☐ Rarely
- ☐ Seldom
- ☐ Sometimes

- ☐ Frequently
- ☐ Often
- ☐ Always

6. have you ever felt that you were mistreated due to the fact that you were a female/male by supervisors?

- ☐ Never
- ☐ Rarely
- ☐ Seldom
- ☐ Sometimes

- ☐ Frequently
- ☐ Often
- ☐ Always

Exposures and protection from them

Hours of exposure

How many hours per day are you exposed to each of the following hazardous or unpleasant conditions:

- | | | |
|---------------|--|---|
| 1. Noise: | <input type="checkbox"/> Less than 2 hours | <input type="checkbox"/> Approx. 8 hours |
| | <input type="checkbox"/> Approx. 2 hours | <input type="checkbox"/> Approx. 10 hours |
| | <input type="checkbox"/> Approx. 4 hours | <input type="checkbox"/> Approx. 12 hours |
| | <input type="checkbox"/> Approx. 6 hours | |
| 2. Vibrations | <input type="checkbox"/> Less than 2 hours | <input type="checkbox"/> Approx. 8 hours |
| | <input type="checkbox"/> Approx. 2 hours | <input type="checkbox"/> Approx. 10 hours |
| | <input type="checkbox"/> Approx. 4 hours | <input type="checkbox"/> Approx. 12 hours |
| | <input type="checkbox"/> Approx. 6 hours | |
| 3. Chemicals | <input type="checkbox"/> Less than 2 hours | <input type="checkbox"/> Approx. 8 hours |
| | <input type="checkbox"/> Approx. 2 hours | <input type="checkbox"/> Approx. 10 hours |
| | <input type="checkbox"/> Approx. 4 hours | <input type="checkbox"/> Approx. 12 hours |
| | <input type="checkbox"/> Approx. 6 hours | |
| 4. Asphalt | <input type="checkbox"/> Less than 2 hours | <input type="checkbox"/> Approx. 8 hours |
| | <input type="checkbox"/> Approx. 2 hours | <input type="checkbox"/> Approx. 10 hours |
| | <input type="checkbox"/> Approx. 4 hours | <input type="checkbox"/> Approx. 12 hours |
| | <input type="checkbox"/> Approx. 6 hours | |
| 5. Asbestos | <input type="checkbox"/> Less than 2 hours | <input type="checkbox"/> Approx. 8 hours |
| | <input type="checkbox"/> Approx. 2 hours | <input type="checkbox"/> Approx. 10 hours |
| | <input type="checkbox"/> Approx. 4 hours | <input type="checkbox"/> Approx. 12 hours |
| | <input type="checkbox"/> Approx. 6 hours | |
| 6. Lead | <input type="checkbox"/> Less than 2 hours | <input type="checkbox"/> Approx. 8 hours |
| | <input type="checkbox"/> Approx. 2 hours | <input type="checkbox"/> Approx. 10 hours |
| | <input type="checkbox"/> Approx. 4 hours | <input type="checkbox"/> Approx. 12 hours |
| | <input type="checkbox"/> Approx. 6 hours | |

Safety and compliance index

- | | | |
|---|------------------------------------|-------------------------------------|
| 1. How often do you wear earplugs? | <input type="checkbox"/> Never | <input type="checkbox"/> Frequently |
| | <input type="checkbox"/> Rarely | <input type="checkbox"/> Often |
| | <input type="checkbox"/> Seldom | <input type="checkbox"/> Always |
| | <input type="checkbox"/> Sometimes | |
| 2. How often do you wear safety glasses | <input type="checkbox"/> Never | <input type="checkbox"/> Frequently |
| | <input type="checkbox"/> Rarely | <input type="checkbox"/> Often |
| | <input type="checkbox"/> Seldom | <input type="checkbox"/> Always |
| | <input type="checkbox"/> Sometimes | |
| 3. How often do you wear safety work shoes? | <input type="checkbox"/> Never | <input type="checkbox"/> Frequently |
| | <input type="checkbox"/> Rarely | <input type="checkbox"/> Often |
| | <input type="checkbox"/> Seldom | <input type="checkbox"/> Always |
| | <input type="checkbox"/> Sometimes | |
| 4. How often do you wear a facemask? | <input type="checkbox"/> Never | <input type="checkbox"/> Frequently |
| | <input type="checkbox"/> Rarely | <input type="checkbox"/> Often |
| | <input type="checkbox"/> Seldom | <input type="checkbox"/> Always |
| | <input type="checkbox"/> Sometimes | |
| 5. How often do you wear a hard hat? | <input type="checkbox"/> Never | <input type="checkbox"/> Frequently |
| | <input type="checkbox"/> Rarely | <input type="checkbox"/> Often |
| | <input type="checkbox"/> Seldom | <input type="checkbox"/> Always |
| | <input type="checkbox"/> Sometimes | |

Outcomes

Psychological Symptoms

1. In the past year, how often have you felt tense in the work place due to issues relating to your job?

- ☐ Never
☐ Rarely
☐ Seldom
☐ Sometimes

- ☐ Frequently
☐ Often
☐ Always

2. In the past year, how often have you felt angry in the work place due to issues relating to your job?

- ☐ Never
☐ Rarely
☐ Seldom
☐ Sometimes

- ☐ Frequently
☐ Often
☐ Always

3. In the past year, how often have felt sad in the work place due to issues relating to your job?

- ☐ Never
☐ Rarely
☐ Seldom
☐ Sometimes

- ☐ Frequently
☐ Often
☐ Always

Physical Symptoms

1. In the past year, how often have you experienced insomnia or had trouble sleeping?

- ☐ Never
☐ Rarely
☐ Seldom
☐ Sometimes

- ☐ Frequently
☐ Often
☐ Always

2. In the past year, how often have you felt symptoms of nausea or stomach disorders?

- ☐ Never
☐ Rarely
☐ Seldom
☐ Sometimes

- ☐ Frequently
☐ Often
☐ Always

3. In the past year, how often have you experienced headaches?

- ☐ Never
☐ Rarely
☐ Seldom
☐ Sometimes

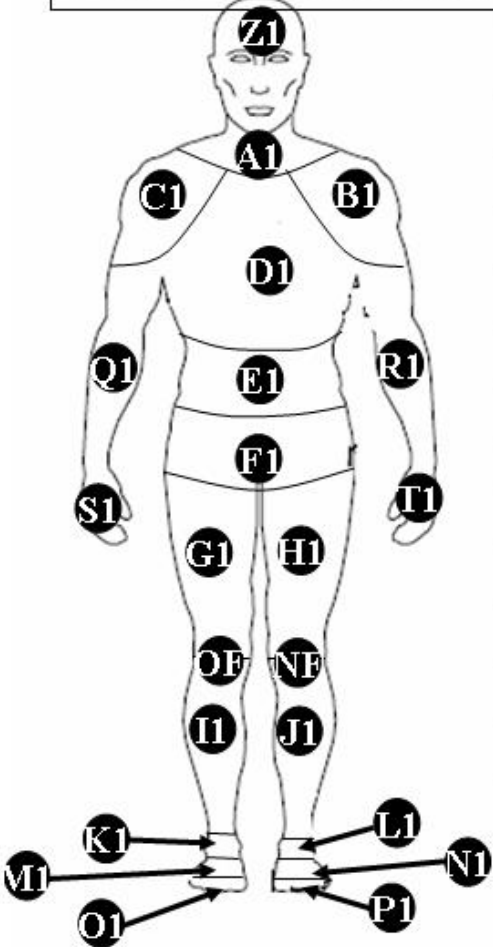
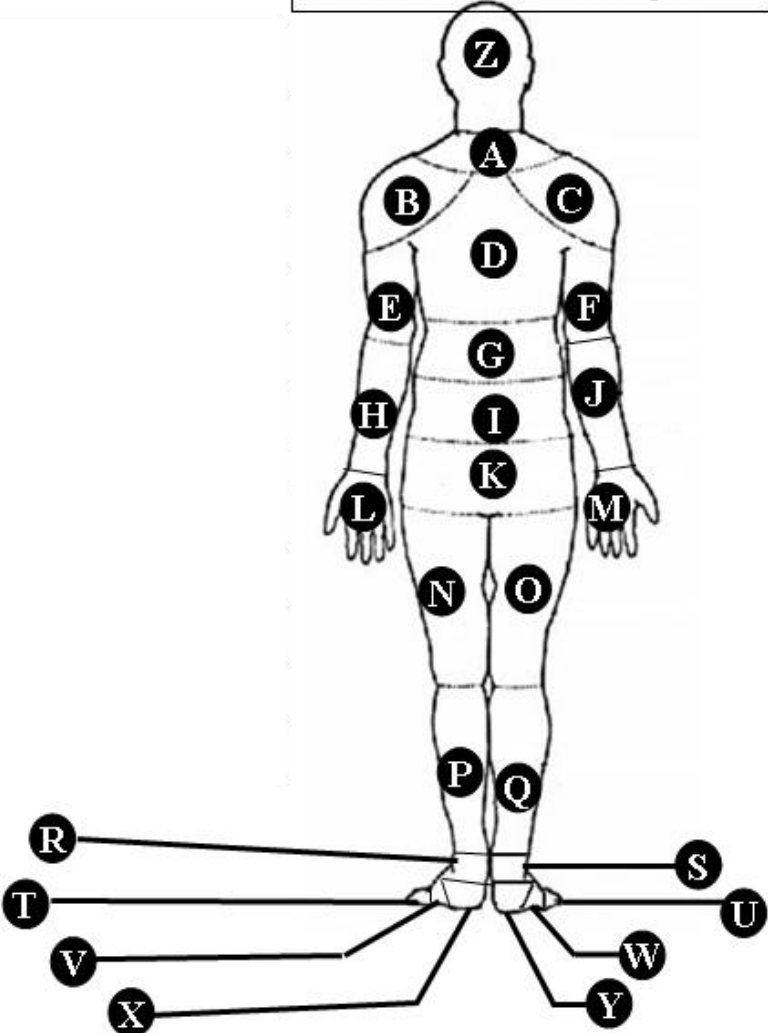
- ☐ Frequently
☐ Often
☐ Always

4. In the past year, how often have you experienced low-back pain?

- ☐ Never
☐ Rarely
☐ Seldom
☐ Sometimes

- ☐ Frequently
☐ Often
☐ Always

Please circle the region(s) of the body where you have been injured in the past year (12 months). Indicate multiple injuries by the number of times injured in that region (E.g. 1, 2, 3.....)

Front of Participant	Back of Participant
	

Cronbach's Alpha

Alpha Plot Alpha
Entire set 0.8607

Excluded Alpha Plot Alpha
Col

JC1	0.8586	
JC2	0.8535	
JC3	0.8567	
JC4	0.8548	
JD1	0.8570	
JD2	0.8599	
SU	0.8548	
RO	0.8675	
OvC	0.8553	
SC1	0.8536	
SC2	0.8771	
SC3	0.8557	
SC4	0.8563	
SC5	0.8597	
Tr1	0.8687	
Tr2	0.8567	
Tr3	0.8591	
Tr4	0.8668	
SS1	0.8516	
SS2	0.8536	
SS3	0.8560	
SS4	0.8564	
SS5	0.8575	
SS6	0.8526	
HD1	0.8571	
HD2	0.8570	
HD3	0.8580	

HD4	0.8594	
HD5	0.8582	
HD6	0.8552	
JCt1	0.8555	
JCt2	0.8626	
JCt3	0.8606	
JCt4	0.8600	
HoE1	0.8616	
HoE2	0.8599	
HoE3	0.8533	
HoE4	0.8612	
HoE5	0.8578	
HoE6	0.8585	
SX1	0.8617	
SX2	0.8623	
SX3	0.8610	
SX4	0.8683	
SX5	0.8642	
PSO1	0.8535	
PSO2	0.8502	
PSO3	0.8550	
PHO1	0.8542	
PHO2	0.8525	
PHO3	0.8548	
PHO4	0.8521	

Appendix III: Regression Analysis Results

Table V: Nominal Logistic Fit for Injury Occurrence with participants' responses

Iteration History

Iter.	Log Likelihood	Step	Delta-Criterion	Obj-Criterion
1	-32.57791749	Initial	1234042553	.
2	-19.56569587	Newton	1.3358686	0.66471311
3	-17.90011089	Newton	0.43964572	0.09299691
4	-17.57635115	Newton	0.08071763	0.01840972
5	-17.56154154	Newton	0.00440491	0.00084282
6	-17.5614952	Newton	0.00001466	0.00000264

Whole Model Test

Model	-Log Likelihood	DF	Chi-square	Prob>ChiSq
Difference	5.392147	2	10.78429	0.0046
Full	17.561495			
Reduced	22.953642			
R-Square (U)		0.2349		
Observations (or Sum Weights)		47		

Converged by Gradient

Lack of Fit

Source	DF	-Log Likelihood	Chi-square
Lack Of Fit	44	17.561495	35.12299
Saturated	46	0.000000	Prob>ChiSq
Fitted	2	17.561495	0.8280

Parameter Estimates

Term	Estimate	Std Error	Chi-square	Prob>ChiSq	Odds Ratio
Intercept	2.03533223	0.5561115	13.40	0.0003	.
Factor 1-6	-0.9750045	0.4624067	4.45	0.0350	0.0050488
Factor 1-7	-1.562414	0.7975744	3.84	0.0501	0.00003111

For log odds of 0/1

Effect Wald Tests

Source	Nparm	DF	Wald Chi-square	Prob>ChiSq
Factor 1-6	1	1	4.44595386	0.0350
Factor 1-7	1	1	3.8375124	0.0501

Effect Likelihood Ratio Tests

Source	Nparm	DF	L-R Chi-square	Prob>ChiSq
Factor1- 6	1	1	5.11154379	0.0238
Factor 1-7	1	1	5.8448773	0.0156

Table VI: Stepwise Fit for Days Lost due to injury and participants' responses

Stepwise Regression Control

Probability to Enter 0.250
Probability to Leave 0.100

Direction: Forward

Current Estimates

SSE DFE MSE R-Square R-Square Adj. Cp AIC
196735.55 14 14052.54 0.4313 0.3501 -2.257426 165.0588

Lock	Entered	Parameter	Estimate	nod	SS	"F Ratio"	"Prob>F"
X	X	Intercept	85.3529412	1	0	0.000	1.0000
		Factor 2-1	0	1	1430.802	0.095	0.7625
	X	Factor 2-2	-85.874684	1	117991.4	8.396	0.0117
		Factor 2-3	0	1	6689.815	0.458	0.5106
		Factor 2-4	0	1	1210.623	0.080	0.7811
		Factor 2-5	0	1	3551.259	0.239	0.6331
		Factor 2-6	0	1	15349.89	1.100	0.3133
		Factor 2-7	0	1	7129.577	0.489	0.4968
	X	Factor 2-8	44.1722107	1	31218.95	2.222	0.1583
		Factor 2-9	0	1	3851.458	0.260	0.6189

Step History

Step	Parameter	Action	"Sig Prob"	Seq SS	R-Square	Cp	p
1	Factor2-2	Entered	0.0138	117991.4	0.3411	-2.87	2
2	Factor2-8	Entered	0.1583	31218.95	0.4313	-2.257	3

Table VII: Stepwise fit for binary coded OSHA injuries grouped by occupation

Stepwise Regression Control

Probability to Enter 0.250
 Probability to Leave 0.100

Direction: Forward

Current Estimates

-Log Likelihood R-Square
 3.4742e-8 1.0000

Lock	Entered	Parameter	Estimate	nDF	Wald/Score ChiSq	"Sig Prob"
X	X	Intercept	-104.78762	1	0	1.0000
		Factor 2-1	0	0	0	.
		Factor 2-2	0	0	0	.
		Factor 2-3	0	0	0	.
		Factor 2-4	0	0	0	.
	X	Factor 2-5	-176.42614	1	0.000011	0.9973
		Factor 2-6	0	0	0	.
		Factor 2-7	0	0	0	.
		Factor 2-8	0	0	0	.
	X	Factor 2-9	343.457771	1	0.000011	0.9973

Step History

Step	Parameter	Action	L-R Chi-square	"Sig Prob"	R-Square	p
1	Factor 2-9	Entered	6.501461	0.0108	0.3156	2
2	Factor 2-5	Entered	14.09565	0.0002	1.0000	3

Table VIII: Stepwise fit for binary coded self-reported injuries grouped by occupation**Stepwise Regression Control**

Probability to Enter 0.250

Probability to Leave 0.100

Direction: Forward

Current Estimates

-Log Likelihood R-Square

2.8835e-8 1.0000

Lock	Entered	Parameter	Estimate	nDF	Wald/Score ChiSq	"Sig Prob"
X	X	Intercept	8.00407028	1	0	1.0000
	X	Factor 2-1	-132.01248	1	0.000009	0.9976
		Factor 2-2	0	1	6.18e-11	1.0000
		Factor 2-3	0	1	6.17e-11	1.0000
	X	Factor 2-4	-33.344121	1	8.037e-7	0.9993
		Factor 2-5	0	1	6.18e-11	1.0000
		Factor 2-6	0	1	6.17e-11	1.0000
		Factor 2-7	0	1	6.2e-11	1.0000
	X	Factor 2-8	-123.02823	1	0.000006	0.9981
	X	Factor 2-9	4.54072202	1	6.386e-8	0.9998

Step History

Step	Parameter	Action	L-R Chi-square	"Sig Prob"	RSquare	p
1	Factor 2-8	Entered	5.405945	0.0201	0.2300	2
2	Factor 2-9	Entered	5.102665	0.0239	0.4470	3
3	Factor 2-4	Entered	2.310779	0.1285	0.5453	4
4	Factor 2-1	Entered	10.68876	0.0011	1.0000	5

Vita

Omosefe Osarieme Abbe was born to Olusegun and Itohan Abbe in Benin city, Nigeria, on November 7, 1983. Omosefe lived in Reading, England; Port-Harcourt in her childhood years. She attended Queen's College, Lagos, where she completed secondary school studies in 1999. She attended Berea College, in Berea, Kentucky, U.S.A., where she earned a Bachelor of Science in Industrial Technology Management in 2005. After finishing undergraduate studies, she enrolled in the graduate program in industrial engineering at the Louisiana State University and Agricultural and Mechanical College, Baton Rouge, Louisiana, U.S.A.

Omosefe is an avid lover of art and musical expression and is classically trained in music. She loves to sing jazz and as a hobby, takes on graphic design projects; she also plays the piano.