

Safe Workload Ergonomic Exposure Project

A Dissertation

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BY

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This project is dedicated to Horace and Neville, long may they fly,

and

Danielle Berkow-Schwartz, for the joy she brings to our lives.

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Abstract

Background: In 2016, there were 2,384,600 people employed as janitors. Their work, involving a reportedly high physical workload, appeared to place them at risk for days away from work with a rate 2.7 times higher than all other occupations. A Minnesota union identified to researchers at the University of Minnesota a concern relevant to a possible relation between the daily workload and adverse occupational outcomes among a population of janitors.

Objective: To determine if there is a relation between exposures of ergonomic workload, mental workload, job satisfaction, stress, physical fitness, and the outcome of injuries in janitors, and to assess the relations between exposures of physical (ergonomic) and mental workload and the outcome of stress in a population of janitors.

Methods: Following an initial focus-group discussion among janitors, which identified common and hazardous tasks potentially leading to occupational injuries, a specially designed self-administered questionnaire was developed, pre-tested, and distributed to the janitors. Questions addressed various exposures, including workload, and comprehensive information regarding injury occurrence over two six-month sequential periods (May 2016-October, 2016; November 2016-April 2017). Quantitative ergonomic analyses were performed on a sub-group of janitors (n=30); these included data collection to identify Borg Perceived Exertion (Borg) and Rapid Entire Body Assessment (REBA) scores.

Descriptive, multivariable with bias adjustment analyses were conducted on the resulting data

Results: Eight tasks were found to be common for janitors. All average REBA scores for the tasks were identified in the high-risk category. The task of repeatedly emptying small trash cans (<25 pounds) was significantly related to injuries. Average Borg scores fell between the very light perceived exertion and somewhat difficult perceived exertion categories. Multivariable regression analyses indicated that age-sex-standardized ergonomic workload, measured by task frequencies and REBA or Borg scores, were positively related to injury occurrence. A decreased risk of injury was associated with both increased job satisfaction and increased physical fitness. A highly suggestive increased risk of injury was associated with increased mental workload. Multivariable regression identified a relation between ergonomic workload and stress. A risk of stress was identified for mental workload.

Conclusions: This research increases understanding of the relations between occupational exposures and the outcomes of injury and stress among janitors.

Keywords: Janitors, Ergonomics, Mental Workload, Stress, Injury Epidemiology

Chapter 1: Introduction

While there are over 2,384,000 janitors working in the United States, their burden of injury has rarely been studied in detailed resolution (1,2). Janitors have a risk for injury- and illness-related days away from work that is 2.7 times higher than for all American occupations combined (2). There is a known relation between workload and injury (3); but, it has not been sufficiently demonstrated in this population.

The Bureau of Labor Statistics (BLS) reported that the incidence rate for nonfatal occupational injuries and illnesses involving days away from work was 2.7 times higher for janitors than all other occupations (2), indicating that janitors are in a high-risk occupation. While there is limited information about this occupationally-classified population, janitors often are undocumented immigrants who are easily intimidated into not reporting about safety violations (4).

Janitors are exposed to respiratory and dermatologic disorders, psychosocial stressors, mental disorders, infectious diseases, and injuries, particularly musculoskeletal disorders (5). It has been reported that they have a physically demanding occupation, with a high physical workload (2).

The janitorial industry has employed many immigrants due to few barriers to entry (4); immigrants tend to work in riskier occupations and get injured more often (6). Because some of these immigrants may be undocumented, they may

fear reporting unsafe work conditions due to anxiety of being deported. It is also known that injuries at work are significantly associated with lower English proficiency which is prominent in the janitor population(7). Lower English proficiency, both written and spoken, also increases the difficulty of research among this population.

Lack of reporting of occupational injury outcomes is a potential issue with the research process. Workers may be unclear about when and where to report outcomes and, instead, rely on their own threshold of when to report, based on event circumstances (8). Underreporting may also be related to unwillingness to reveal incidence (9). Research has found “considerable evidence of fear of reprisal for reporting injuries” (10). Other potential barriers to reporting include having too much time pressure to take time to report, fears of the report never being read, and perceiving that injuries are part of the job.

While there is limited literature relevant to janitors’ workload and injuries, this has not yet been adequately investigated. The objective of the Safe Workload Ergonomic Exposure Project (SWEEP) Study was to examine how workload factors such as ergonomic workload, mental workload, stress, job satisfaction, and fitness relate to the adverse outcomes of stress and injury. This will serve as a basis for possible interventions to reduce future injuries. This study is a model for future projects to examine workload and injuries and improve the health of janitors.

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Chapter 2 Literature Review

In the following chapter, literature pertinent to the relevant research is reviewed and critiqued. This includes relevant background literature on both the independent and dependent variables, addressed through the published research, as well as operational definitions and a matrix table of pertinent literature sources.

Definitions:

Workload

Workload is a multi-faceted construct that has many components. There is also not a clear scientific definition of the construct of “workload” (1–3). The Service Employees International Union Local 26 (SEIU L26), currently uses the industry standard as a measure of workload for their contract negotiations -- defined as a group measure of average square feet cleaned per person per shift (4). The current study, elaborated upon in a subsequent chapter, examines both mental and ergonomic workloads.

Work-Related Injury

“Work-related” includes any activities, including travel, associated with the job or events that occur in the work environment. Work-related injuries are defined as any wounds or damage to the body associated with the job that occur in the working environment; they result from acute traumatic events that involve:

restriction of normal activities for at least four hours; and/or the use of professional medical care; and/or loss of consciousness, loss of awareness, or amnesia for any length of time(5,6). Based on discussions with the community partner, SEIU L26, pain was also included in the injury outcome for this study.

Ergonomic Workload

Ergonomics can be defined as the “design or modification of the work environment to match human characteristics and capabilities”(7). As such, ergonomic workload is a person’s physical activity as they engage in their daily occupation activities. The current study measured both task frequency for janitorial tasks and calculated task ergonomic subscores, which include physical exertion and physical forces/loads/angles/repetitions involved in the workers’ activities.

Physical Fitness

Physical fitness is defined as the ability to conduct “...daily tasks with vigor and alertness without undue fatigue and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies" (8). This is consistent with the operational definition for the current study. In this study, fitness was measured by a modification of a validated self-reported physical fitness item included on the general survey for all janitors: “During your work time in the past 7 days, on how many days did you do moderate or vigorous physical activities like heavy lifting, vacuuming, cleaning, walking, or climbing up stairs? Think about only those

physical activities that you did for at least 10 minutes at a time” (9). This general self-reported fitness item is identified in both the National Health Interview Survey and the 2010 NIOSH Long Haul Truck Driver Survey, and refers to the Centers for Disease Control and Prevention (CDC) standards for physical fitness (10).

Mental Workload

“Workload is a term that represents the cost of accomplishing mission [task] requirements for the human operator” (14). One of the most cited measures of mental workload is the National Aeronautics and Space Administration Task Load Index (NASA TLX), which is a multidimensional rating scale that uses six dimensions of workload to “provide diagnostic information about the nature and relative contribution of each dimension in influencing overall operator workload” (15).

Stress

Stress, operationally defined as the extent to which people perceive that demands are greater than their ability to cope with those demands, was measured by a single-item question. This was created in the 1970s for occupational health professionals to monitor perceived well-being (16). The item is: “Stress means a situation in which a person feels tense, restless, nervous or anxious or is unable to sleep at night because his/her mind is troubled all the time. Do you feel this kind of stress these days?” It is measured on a five-item Likert scale. This scale was validated with the Nordic Questionnaire for

Psychological and Social Factors at Work, which includes the emotional exhaustion scale of the Maslach Burnout Inventory for construct (does the measure capture the trait?), and concurrent criterion validity (does the measure give the same answer as another, trusted, measure?) (16). Stress was also measured by the four-item version of the Perceived Stress Scale (PSS). This version, known as the PSS-4, contains four of the 14 items of the original PSS-14 and has a Cronbach's alpha (internal consistency) of 0.77 (17,18). Although there is also a PSS-10, the PSS-4 was chosen to lessen participant burden.

Job Satisfaction

Job Satisfaction, operationally defined as “the global content a worker experiences about their employment,” was measured by the Andrews and Withey Job Satisfaction Scale (19). This scale includes five items that measure general feelings about a job, co-workers, the nature of the work, resources (equipment, information, supervision), and work quality (surroundings, hours, work load). It was validated with the Job Descriptive Index and the Minnesota Satisfaction Questionnaire, as well as with job performance, organizational commitment, and intent to turnover (voluntarily leave the organization) (20)

Potential Risk Factors

The exposures and, thus, potential risk factors for injury to janitors include: ergonomic workload; mental workload; stress; job satisfaction; fitness; and heart rate variability.

Ergonomic Workload

In the Seattle area, ergonomic workload was studied relevant to perceived intensity, resulting in identification of a positive relation to injuries (21,22). School janitors have been studied by examining motions (pushing, pulling, grasping with the left hand, grasping with the right hand etc.), showing musculoskeletal injuries were associated with increasing time spent pushing and pulling (23). Similar to other service professions, the vast majority of reported janitors' injuries fall under the sprains, strains, and tears categories, with an incidence rate 2.7 times higher for musculoskeletal disorders than the United States (US) occupational average for private industry, state government, and local government (24). This appears as a good indication that physical workload needs to be examined in janitors to understand the risk for work-related injuries. Other research in different occupations has found relations between physical workload, ergonomics, and injury (25,26); but, no apparent research has been conducted with janitors in the depth proposed for the current study, involving a more comprehensive ergonomics approach.

High force and high repetition lead to increased risk of wrist injury, and the combined interaction (or force and repetition) is greater than either variable alone (27). Acceleration of the back in the sagittal plane or greater moments (torque) on the L4/L5 vertebrae, lead to increased risk of back injury (28). As such, the current study operationally defined ergonomic workload as a construct containing force, repetitions, and posture, including synergistic effects.

The Rapid Entire Body Assessment (REBA) is a practitioner's field tool (29,30) designed to assess postures. It is "sensitive to musculoskeletal risks in a variety of tasks, dividing the body into segments to be coded individually, with reference to movement planes, and provides a scoring system for muscle activity caused by static, dynamic, rapidly changing or unstable postures" (31). The REBA is commonly implemented in the world of ergonomics research as well as its use as a tool for ergonomists operating in industry (32–37). This scale was created by a group of ergonomists, physical and occupational therapists, and nurses who divided the body into segments and coded over 600 different postures commonly found in the health, manufacturing, and electricity industries (31). It has been validated against the New Zealand Manual Handling Hazard Control Record, the Rapid Upper Limb Assessment, the Manual Task Risk Assessment Tool, and the National Institute of Occupational Safety Health (NIOSH) lifting equation (29,38–40). The REBA is also being used in the promising domain of virtual reality for occupational safety (41). In general, "observation-based assessments [such as the REBA] appear to provide the levels of costs, capacity, versatility, generality, and exactness, best matched to the needs of occupational safety and health practitioners who have limited time and resources at their disposal and need a basis for establishing priorities for intervention" (42).

The Borg scale enables calculation of a psychophysical basis for perceived exertion (11,43). It ranges from a value of six (very, very light) to 20 (very, very

hard), with data obtained from observer-asked subject self-report. Aside from its use in ergonomics (44–47), the Borg scale is used in medicine for various health outcomes, including respiratory disorders (48,49), perceptual psychology, and exercise science (50–52). The scale has been validated for load weight and physical work capacity (53).

Physical stresses affect people differently based on age and gender anthropometry (54,55). Buchholz (1996) determined that a randomly selected worker from a crew performing the same operation is appropriate to measure that operation. Results from field data collection, with a standardized checklist (such as the REBA and the Borg), have been validated by videotaping evaluation (56). David (2005) also found that observation-based assessments are appropriate for occupational safety and health research.

Mental Workload

In the human factors' literature, one of the most cited measures of mental workload is the NASA Task Load Index (TLX). This is a multidimensional rating scale that uses six dimensions of workload to “provide diagnostic information about the nature and relative contribution of each dimension in influencing overall operator workload” (15). TLX subscales are a likert-type scale with 21 selection points. The six dimensions assessed are mental demand, physical demand, temporal demand, performance, effort, and frustration. The ratings indicate how a person “appraises their interaction with the task environment” (57). This is

consistent with the operational definition for this study. A raw-TLX scale (unweighted) was used in the current study, as the weighted scale adds participant burden and is correlated to the unweighted scale +0.94 (58).

Fitness

Fitness is related to both workload and injury (59,60). Increased mental workload can increase task errors and injury rates (61,62). The SEIU L26 janitors' union currently uses the industry standard for a measure of workload -- a group measure of average square feet cleaned per person per shift; but, it is of interest to determine how the industry standard compares to measurements relevant to ergonomics and fitness.

Stress

It is not enough to merely focus on the physical causes of injuries; psychosocial factors are also expected to show a relation to injuries. These psychosocial factors are also related to workload; one psychosocial factor examined is stress. Stress, which at least 83% of American workers experience, can lead to symptoms of ill-health if prolonged (16,64). Stress can result from various environmental exposures and may vary by gender (65). Single-item test methods have been validated for use in measuring stress (16,66).

Job Satisfaction

Another psycho-social factor is job satisfaction. This is correlated with job performance, organizational commitment, and turnover intentions (20). Job

satisfaction is measured by the five item Andrew and Withey Job Satisfaction Questionnaire, which has high reliability and construct validity (19).

In this chapter, literature relevant to the current research was discussed. This includes the variables addressed through the research as well as necessary operational definitions and a matrix table of key sources. The following chapters address the overall methodology and specific aims.

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Table 2-1: Overview of studies to date: Summary of literature in Matrix form

Author(s); Title, Journal; Publication Date, Year	Purpose of Study	<u>Methods:</u> Study Design; Target Population; Sampling; Selection of Subjects	Population: Number of Subjects; Subject Characteristics; Participation (original targeted/final participants)	<u>Relevant Variable</u> s: <u>Dependent and Independent</u>	Data Sources, Contact Procedures, and Data Collection Period Used: Existing Data Bases; Data Collection Instruments; In-person interviews; Telephone interviews; Mailed interviews	Analyses, e.g., descriptive, analytic; Sensitivity and Other Analyses	Key Findings; Critique, Comments, Conclusions
Ansari, N. A., & Sheikh, M. J. (n.d.). Evaluation of work Posture by RULA and REBA: A	To assess if working conditions were safe in an industrial setting	Observational Study Design: 15 workers engaged in small scale industry in Maharashtra, India. The workers had	Rapid Entire Body Assessment (REBA) and Rapid Upper Limb Assessment	Ergonomic workload was the exposure, as measured by	Videos were taken; then resulting images were used for checklist analysis.	Only descriptive analysis of results were identified.	<u>Conclusions:</u> 40% of the workers were at high risk which indicated a needs to “investigate and change [working

<p>Case Study. <i>IOSR Journal of Mechanical and Civil Engineering Ver. III, 11(4), 2320–334.</i></p>		<p>average stature 168.34 cm + 2.69 S.D., average age 35.8 years + 3.02 S.D., average weight 63.6 kilograms + 6.66 S.D. and average experience 11.2 years.</p>	<p>nt (RULA) were used to assess ergonomic load.</p>	<p>REBA and RULA, outcome was the test scores</p>		<p>tasks/condition s] immediately;" 4 7% workers were found at medium risk levels.</p> <p><u>Critique:</u> Using images from videos is not the best way to use the REBA and RULA tools. The N of 15 is small. The study did not discuss work-appropriate alternative postures that are practical. The analysis is only descriptive. Finally, the</p>
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							paper does not have appropriate English quality.
Borg, G. A. (1982). Psychophysical bases of perceived exertion. <i>Med Sci Sports Exerc</i> , 14(5), 377–381.	To create a new perceptual exertion scale for human factors, medicine, and sports	A discussion of ratio-scaling methods, category methods, and how to combine them	N/A	N/A	N/A	Power Functions for describing psychophysical relations	<p><u>Conclusions:</u> The Borg scale is a foundational tool for psychophysical research; this paper discusses some of the internal rationales for the scale creation.</p> <p><u>Critique:</u> Perceived exertion is easy and fast to measure; however it is self-reported. While this</p>

							paper discusses some correlation with heart-rate, it only mentions ergometer (machines that measure muscular work) reliability, in passing.
Buchholz, B., Paquet, V., Punnett, L., Lee, D., & Moir, S. (1996). PATH: A work sampling-based approach to ergonomic job analysis	To utilize the PATH (Posture, Activity, Tools and Handling) method.	Pilot Observational Study Design: Six construction laborers during four road construction operations	Performed PATH analysis with work sampling for construction workers	Time interval, action, tool, hand usage, postures	Each observer selected a number of workers (preferably a crew) performing the same operation from which a single worker is observed per observer. The crew is followed for three or four hours during	Intra and Inter observer agreement for reliability, descriptive statistics of the postures	<p><u>Conclusions:</u> The PATH method can be used to identify specific construction operations and tasks that are ergonomically hazardous.</p> <p><u>Critique:</u> Using only six workers intuitively seems too</p>

<p>for construction and other non-repetitive work. <i>Applied Ergonomics</i>, 27(3), 177–187. https://doi.org/10.1016/0003-6870(95)00078-X</p>					<p>each sampling period (from beginning of shift to break or from break to end of shift). Observations are made at fixed intervals of usually 45 or 60 s. Forty-five seconds is the minimum interval used that maintains reliability. The specific worker for each observation is randomly determined from those selected for analysis at the start of the day. The task in which the specified</p>		<p>small a sample to generalize. The PATH design seems very laborious, with a 1:1 observer to subject ratio. The observers would also need to be trained to be unobtrusive, which the paper neglects to mention. This paper is valuable in that it discusses work-sampling techniques, which are rare in the ergonomic literature.</p>
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					worker is engaged is recorded.		
Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. <i>Journal of health and social behavior</i> , 385-396.	To present evidence for the reliability and validity of the 14-item Perceived Stress Scale (PSS)	Cross-sectional study design: College students were sampled; one group was freshmen living in dorms at University of Oregon, and the second group was in a psychology class. Students completed scales on life events, perceived anxiety, depressive symptomatology, physical	There were three samples: two of college students (n=332, n=114), and a more heterogeneous group enrolled in a smoking-cessation program (n=64) for a total n=510.	Data came from the five scales and student health services records.	Students completed the questionnaires during a 1.5 hour class session, health service data came from the 90 days before and 46 days after. The smokers were measured at the beginning and end of a six week period.	Descriptive data were captured from health records. Coefficient alpha reliability for the PSS was calculated (internal reliability). Correlations for concurrent and predictive validity were found for the four other scales.	<u>Conclusions:</u> The PSS has adequate internal and test-retest reliability and is correlated in the expected manner with a range of self-reported and behavioral criteria. <u>Critique:</u> This study used a young population, which is a limitation. The population was also more educated and had fewer

		symptomatology, and perceived stress.					minority members than the general population; 64% of the smokers were absent from the second data point.
Coyle, A. (2005). Comparison of the Rapid Entire Body Assessment and the New Zealand Manual Handling "Hazard Control Record", for assessment of manual	To describe a case study showing two separate tools to assess, plan and implement changes in manual handling practices in the supermarket	Observational Study Design: Case study with a major supermarket chain in New Zealand	Undisclosed	No outcome data were collected; this project only considered exposures.	Video footage was taken of staff undertaking the following tasks: unloading a pallet; packing lower shelves; catching boxes from overhead; manually handling a pallet; operating a manual pallet jack; and checkout operator placing items	These videos were measured with both tools.	<u>Conclusions:</u> REBA is more useful if specific ergonomic changes are being implemented to decrease risk of work-related injury. The New Zealand Code lacks specificity and objectivity and takes into account many other ergonomic factors. It

handling hazards in the supermarket industry. <i>Work</i> , 385–396.	industry.				into a trolley.		directs the user toward implementing controls. <u>Critique:</u> REBA IRR was not stated. The New Zealand Manual Handling Code is a fairly rare tool, so it would have been more helpful to use a more prominent assessment technique.
Dennis, R., Farhart, P., Clements, M., Ledwidge, H. (2004). The relationship	Examine the relation between bowling workload of first-class fast bowlers	All the fast and fast-medium bowlers from the men's New South Wales state squad (n= 12) of mean age	Exposures were from observation and sports scores, injury outcomes from	Bowling workload and match workload were exposures; injury	Bowling workload has been evaluated by examining the frequency, type of bowling and the time frame within which the	Risk ratio estimates and confidence intervals were compared with estimates	<u>Conclusions:</u> The risk of injury was much higher for those bowlers with a per session, weekly and monthly

<p>p between fast bowling workload and injury in first-class cricketers: a pilot study. <i>Journal of Science and Medicine in Sport</i>, 7(2), 232–236. https://doi.org/10.1016/S1440-2440(04)80014-8</p>	<p>and injury with the aim of identifying a "safe" fast bowling workload threshold.</p>	<p>25.2 years (range 21-34 years) participated in this study, which was conducted during the 1999-2000 Australian summer cricket season. A fast or fast-medium bowler was defined as a bowler for whom the wicketkeeper [cricket goalie] would normally stand back from the stumps.</p>	<p>Cricket Australia's Injury Surveillance System</p>	<p>was the outcome (a condition that affected availability for team selection, limited performance during a major match or required surgery).</p>	<p>bowling was completed. This was achieved by recording the number of bowling sessions and deliveries (match or training) bowled in a given period of time (i.e., workload per session (day), per week, per month and per season). Match workloads were recorded from scorecards for all matches in which the participants bowled during the season. Video</p>	<p>from generalized estimating equations with a log link and a binomial distribution.</p>	<p>bowling workload above the group mean, especially when a high workload was consistent and sustained.</p> <p><u>Critique:</u> Greater understanding of cricket would lead to more enjoyment and comprehension in reading this article. However, the relation between recreational workload and injury is clearly identified. The workload measures of task type, task</p>
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					surveillance was conducted at each of the state squad training sessions. Bowlers were asked to keep a record of the number of deliveries they bowled at any club or interstate training sessions.		frequency, and time frame are also relevant.
Elo, A. L., Leppänen, A., & Jahkola, A. (2003). Validity of a single-item measure of stress symptoms. <i>Scandinavian Journal</i>	To investigate the content, criterion, and construct validity of a single-item measure of stress	Four sets of independent cross-sectional data were used, from four Nordic countries, for a total N=4958	Four sets of questionnaire and interview data in which the stress-symptoms item was included.	Stress, health, mental resources, sleep, vitality, optimism, work characteristics, emotional	Four data bases were used: Finland Post, comprised symptoms of ill health and mental resources (N=1014). The second, from four Nordic	Distributions, correlations, and factor analysis	<u>Conclusions:</u> The single stress-symptoms item converged with items on psychological symptoms and sleep disturbances and with validated

<p><i>of Work, Environment & Health, 29.6, 444–451.</i></p>	<p>symptoms.</p>			<p>exhaustion</p>	<p>countries (Denmark, Finland, Sweden, Norway), included well-known validated scales on exhaustion, mental health, sleep, vitality, and optimism; therefore, the convergence between the measures could be studied (N=1015). The third, from a Finland metal factory, included three indicators of health and four work characteristics</p>		<p>measures of well-being.</p> <p><u>Critique:</u> As one of four data sources were from multiple countries, some people may have been in more than one sample, which raises issues. Less information is available on the validity of the single-item in areas of life other than work. The single-item stress scale was not validated outside of the</p>
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					(N=773). The fourth, representing the Finnish working population; described group differences in stress symptoms (N=2,156) and allowed comparison with a study on emotional exhaustion in the working population		Nordic lands.
Gentzler, M., & Stader, S. (2010). Posture stress on firefighters and emergency	To use ergonomic evaluations to analyze the threat of back injuries	Observational Study Design: Firefighters and emergency medical technicians (EMTs) in an urban U.S. fire	19 male firefighters, one female; ages were 18-55	Ergonomic tools used for the exposure evaluation included	During a scheduled training exercise in fall 2006, task observations were collected from all 20 participants.	N/A	<u>Conclusions:</u> High to very high risks were found for lifting the hose above the shoulder to drain it of excess water and for rolling

<p>medical technicians (EMTs) associated with repetitive reaching, bending, lifting, and pulling tasks. <i>Work</i>, 37(3), 227–239. https://doi.org/10.3233/WOR-2010-1075</p>	<p>for three firefighter/EMT tasks.</p>	<p>department</p>		<p>the NIOSH lifting equation, REBA, RULA, and anthropometric measurements of equipment and people.</p>	<p>Two older male supervisors (not participants) were interviewed about potential task hazards.</p>	<p>hoses on the ground. Extreme risk was found for lifting the hose from chest height to above the shoulders during hose drainage. High risk was found for EMT tasks that require reaching for overhead equipment or seated tasks that require horizontal bending and twisting.</p> <p><u>Critique:</u> REBA IRRs were not stated.</p> <p>Size (n) of population is</p>
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							small.
Jakobsen, M. D., Sundstrup, E., Persson, R., Andersen, C. H., & Andersen, L. L. (2014). Is Borg's perceived exertion scale a useful indicator of muscular and cardiovascular load in blue-collar workers with lifting tasks? A cross-sectional workplace study.	To investigate associations between perceived exertion and objectively assessed muscular and cardiovascular load during a full working day among workers involved in manual lifting tasks.	Repeated measures cross-sectional study design. Identification of participants was made in cooperation with the Confederation of Danish Employers, the Confederation of Danish Industry, the Danish Chamber of Commerce and the Danish Construction	N=200: 159 men and 41 women from 14 workplaces with manual lifting tasks participated. The participant's gender and age distribution reflected the gender and age distribution at all the workplaces	The dependent variables for this analysis were 2 CR-10 ratings completed by the subjects. The independent variables were physical capacity (maximal voluntary isometric	The participants were asked to rate their average perceived exertion of the past two hours, at midday and after 7.5 hours of work on a Borg CR10 scale. Maximal voluntary isometric contraction was found through knee extensor, shoulder elevation and back extensors; cardiovascular fitness was measured through VO2 Max from a	Using linear regression significant but weak associations were found between perceived exertion and high neck muscle activity. Using logistic regression perceived exertion ≥ 4 (high exertion) was related to high activity of the trapezius	<u>Conclusions:</u> During a full working day among blue-collar workers with lifting tasks, high neck muscle activity increased the odds for experiencing high perceived physical exertion. Perceived exertion of at least 4 on the BORG CR10 scale appeared to be a good indicator that high muscular loading occurs. <u>Critique:</u> Much of the literature on perceived physical

<p><i>European Journal of Applied Physiology</i>, 114(2), 425–434. https://doi.org/10.1007/s00421-013-2782-9</p>				<p>contraction, cardiovascular fitness, muscular and cardiovascular workload)</p>	<p>maximal cycle ergometer test, and muscular and cardiovascular workload were found through electrocardiography and electromyography recordings from the heart, leg, lower back, and shoulder.</p>	<p>muscle.</p>	<p>exertion identifies study conduct in a controlled laboratory. This study was conducted in actual workplaces, which is a strength. The subjects faced recall bias for the BORG test, as it is difficult to remember the last two hours with any accuracy.</p>
<p>Janowitz, I. L., Gillen, M., Ryan, G., Rempel, D., Trupin, L., Swig, L., and Blanc, P. D. (2006). Measuring</p>	<p>To discuss appropriate and validated assessments for assessing the physical demands</p>	<p>Observational Study Design: Using Rapid Entire Body Assessment (REBA) in a work sampling mode, expanding it with selected items from the</p>	<p>The sampling strategy is designed to recruit employees from widely different economic groups</p>	<p>Cases are defined by occurrence of a new presentation of an on-the-job</p>	<p>Observational data, collected with a work-sampling method facilitated by a personal digital assistant.</p>	<p>IRR kappa for REBA, as well as ANOVA for occupational categories.</p>	<p><u>Conclusions:</u> The inter-rater reliability kappa was 0.54 for UB and 0.66 for LB. The scoring algorithm demonstrated significant variation by</p>

<p>the physical demands of work in hospital settings: Design and implementation of an ergonomics assessment. Applied Ergonomics, 37(5), 641–658. https://doi.org/10.1016/J.APERGO.2005.08.004</p>	<p>of hospital jobs.</p>	<p>UC Computer Use Checklist, and developed a scoring algorithm for ergonomics risk factors for the upper (UB) and lower body (LB).</p>	<p>performing a heterogeneous range of jobs with varying psychological and physical attributes. Participants were recruited from a study base of 6000 hospital workers at two institutional sites (excluding physicians)</p>	<p>musculo skeletal injury (either acute or cumulative trauma), assessed by occupational health providers at each site's hospital-based employee health clinic.</p>			<p>occupation in anticipated directions (administrators ranked lowest; support staff ranked highest on both scores)</p> <p><u>Critique:</u> This is a rare paper to emphasize IRR for REBA. This publication also addresses several things, which may have been better split between a paper on the sampling techniques, and another paper on the REBA and UC Computer Use Checklist.</p>
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<p>Jones, T., & Kumar, S. (2010). Comparison of Ergonomic Risk Assessment Output in Four Sawmill Jobs. International Journal of Occupational Safety and Ergonomics, 16(1), 105–111. https://doi.org/10.1080/10803548.2010.11076834</p>	<p>To examine the agreement between five ergonomic risk assessment methods, calculated on the basis of quantitative exposure measures and to examine the ability of the methods to correctly classify</p>	<p>Observational ergonomic study design: Assessment comparison study.</p>	<p>Workers 18–65 years of age performing four sawmill occupations observed to be associated with upper extremity MSIs were recruited from four sawmill facilities in Alberta, Canada.</p>	<p>The five ergonomic risk assessment methods evaluated in this study are RULA, REBA, the quantitative American conference of governmental industrial hygienist's threshold limit</p>	<p>Observational data for ergonomic assessments, surface EMG for maximum and job-simulated exertions. Five minutes of job performance of board-edger operators, lumber graders, and trim-saw operators and 15 minutes of the job performance of the saw filers was recorded. Only the upper extremity used to perform the primary job task was assessed.</p>	<p>Univariate analysis with the Wilcoxin Signed Ranks test (significance level of .01) was used to determine whether the differences observed between risk level distributions were significant. Percentage agreement between methods was</p>	<p><u>Conclusions:</u> REBA and Borg are compared, with a 72% agreement. The assessments are dichotomized to risk/no risk. REBA and RULA had 3 categories. <u>Critique:</u> REBA IRR is not stated. This is an important ergonomics paper due to the breadth of scope, comparing RULA, REBA, ACGIH TLV<SI< and OCRA). The work-sampling</p>
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	four at-risk jobs.			value for mono-task hand work (ACGIH TLV), the strain index (SI), and the concise exposure index (OCRA)	Postures required to perform the jobs were defined by randomly selecting 10 repetitions of the primary task.	assessed.	strategy of random selection of task postures may be suspect, as they result from a short (5-minute) observation.
Koehoorn, M., Ostry, A., Hossain, S., & Village, J. (2011). Injury risk associated with physical	To examine ergonomic factors (physical demands, exposures, school environment characteristics)	Prospective cohort study over four years.	All custodial workers employed for at least one month during the study follow-up period (2003–	Outcome variables included: date of incident; type of incident (medical aid only for those	Custodial workers were identified using four occupational titles: building engineer; assistant building engineer; head custodian; and custodian. The	Poisson regression models; Two injury outcomes were modelled: all injuries and musculoskeletal injuries.	Conclusions: Pushing/pulling tasks led to more injuries. <u>Critique:</u> This study discusses both an ergonomic and

<p>demands and school environment characteristics among a cohort of custodial workers. Ergonomics, 54(8), 767–775. https://doi.org/10.1080/00140139.2011.592603</p>	<p>associated with injury risk among custodial school workers.</p>		<p>2006) in one school district located in a large urban region, located in the Canadian province of British Columbia, were eligible for inclusion.</p>	<p>with time lost from work); description of the injury; part of body injured; occupation code; and whether the incident resulted in a worker's compensation claim.</p> <p>Exposures included : type of school (elementary: grades primary</p>	<p>employment records also provided information. Reports of occupational health and safety incidents filed by custodial workers were available in a central database maintained by the School Board.</p>		<p>epidemiological analysis, and blends them well by not just doing a quantitative assessment of physical exposures which are typically done in ergonomic studies. A limitation includes the known underreporting of occupational health and safety incidents, which is noted in the paper.</p>
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				to 7; or secondary: grades 8 to 12); presence and number of detached classrooms adjacent to main school; presence of school elevator; presence of gravel, grass or paved compound surrounding the school; the			
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				number of monthly rental hours (external use of school after school hours).			
Motamedzade, M., Ashuri, M. R., Golmohammadi, R., & Mahjub, H. (2011). <i>Journal of research in health sciences JRHS. Journal of Research in Health Sciences</i> (Vol. 11).	To compare ergonomic risk assessment outputs from the Quick Exposure Check (QEC) and REBA in terms of agreement in distribution	Observational Study Design: cross-sectional study	There were 40 jobs with 123 tasks at a single plant.	QEC and REBA	All jobs were observed by a trained occupational health practitioner. Job information was collected to ensure the completion of ergonomic risk assessment tools.	Spearman correlation coefficient, Wilcoxon signed-rank test and Kruskal-Wallis tests were used for comparing the risk assessment outputs of applied methods.	<u>Conclusion:</u> Correlation between final scores (r=0.731) and the action levels (r=0.893) of two applied methods. Comparison between the action levels and final scores of two methods showed that there were no

<p>Univ. of Medical Sciences. Retrieved from http://jrhs.umsha.ac.ir/index.php/JRHS/article/view/211</p>	<p>n of postural loading scores, based on analysis of working postures.</p>					<p>significant differences among working departments.</p> <p><u>Critique:</u> They used banded REBAs. No IRRs, due to only one rater. Having one rater is both a strength and a weakness, as the biases of the rater are constant, but said biases would not be balanced out by other ergonomic assessors. The project would have been much stronger by conducting a comparison analysis with</p>
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							the plant's actual injury data.
Seixas, N.S. (2013). Janitors Workload and Health and Safety Study. University of Washington, Seattle, WA.	To address exposures and health status over three years of work among union and non-union janitors and security officers.	Cross-sectional retrospective design: Union janitors were selected by the union. Non-union janitors were often recruited by snowball sampling.	276 union janitors, 78 non-union janitors, 76 security officers.	Independent factors: musculoskeletal stressors; chemical use; psychosocial risks; Outcomes included : injuries; pain; upper-extremity disability ; stress; pulmonary and	Janitors were recruited by their union or an immigrants' rights organization. Questionnaires were administered by interviewers. Somali participants were interviewed by native Somali speakers.	Work intensity was stratified into tertiles. Prevalence ratios were used to assess negative outcomes.	<u>Conclusions:</u> Work intensity was higher for non-union janitors, and increased over the three years for union janitors. Increased workload may lead to increased injury, pain, and work stress rates. <u>Critique:</u> Intensity was a self-reported measure, which is a weakness. There may also be recall bias.

				dermatological symptoms.			
Sieber, W. K., Robinson, C. F., Birdsey, J., Chen, G. X., Hitchcock, E. M., Lincoln, J. E., ... Sweeney, M. H. (2014). Obesity and other risk factors: The National Survey of U.S. Long-Haul Truck Driver	To create a targeted national survey for illness and injury in long-haul truck drivers.	Cross-sectional study design: 1,670 long-haul truck drivers (LHTD) at 32 truck stops across the lower 48 United States. Locations were selected by geographic weighting. 5,514 individuals were approached; 3,759 met eligibility and 1,670 drivers completed at least one part	Interviewees collected data during 2010 from 1,670 long-haul truck drivers at 32 truck stops across the 48 contiguous United States that were used to compute prevalence estimates for self-	Study variables included: work environment; work history and driving practices; health conditions and other risk factors; health insurance coverage; sleep and	Limited-access highway segments were stratified by geographic region and truck traffic volume. Truck stops were selected and truck drivers entering truck stops during a three-day interview period were recruited by the interview team. Drivers were recruited during different 8-hour shifts between 7 a.m. and 10 p.m. In-person	Prevalence of self-reported health conditions and risk factors among LHTD and those reported in the 2010 National Health Interview Survey (NHIS) adult working population were compared. Statistical tests were	<u>Conclusions:</u> Obesity and smoking are 2x more prevalent in drivers than the general working population. Injury is barely considered in this article. <u>Critique:</u> The study in general seems quite well done. The geographical sampling in particular is very interesting. As this is a cross-sectional

<p>Health and Injury. <i>American Journal of Industrial Medicine</i>, 57(6), 615–626. https://doi.org/10.1002/ajim.22293</p>		<p>of the survey.</p>	<p>reported health conditions and potential risk factors.</p>	<p>demographics. Height and weight were measured.</p>	<p>interviews were administered.</p>	<p>performed to compare self-reported health conditions and potential risk factors from the LHTDS with those from the NHIS. Variance estimates used in analysis to compare the LHTDS and NHIS results were calculated using the Taylor series method.</p>	<p>project, causality is difficult to detect. If the survey was administered at different times throughout the year, perhaps a seasonal effect would have been found. There may have also been a volunteer bias for those truckers willing to be interviewed.</p>
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<p>Yurko, Y. Y., Scerbo, M. W., Prabhu, A. S., Acker, C. E., & Stefanidis, D. (2010). Higher Mental Workload is Associated With Poorer Laparoscopic Performance as Measured by the NASA-TLX Tool. <i>Simulation in Healthcare : The</i></p>	<p>To assess the relation between workload and performance during simulator training and in the OR on a complex laparoscopic task, across three studies, and to determine the value of the NASA-TLX tool as a</p>	<p>Simulator study on three separate institutional review board- and Institutional Animal Care and Use Committee- approved trials previously completed by the authors.</p> <p>Novice medical students who had no surgical, clinical, or simulator experience were the participants. They were trained on laparoscopic</p>	<p>N=28</p> <p>Participants of these trials were all novices (second-year medical students or senior premedical students) without any prior clinical, surgical, or simulator experience.</p>	<p>Performance, NASA-TLX scores, and inadvertent injuries during simulated surgery on inanimate models and live (intubated) pigs.</p>	<p>Analyzed the NASA-TLX workload and performance data from previously collected data.</p> <p>Performance and workload (TLX) scores were recorded at baseline, after proficiency achievement, and during the test. Inadvertent injuries incurred during the test were also collected.</p>	<p>Participant performance and NASA-TLX workload scores from each of these studies at baseline, at training completion, and during the porcine tissue test were analyzed and compared, using repeated measures analysis of variance.</p> <p>To assess the relations between performance</p>	<p><u>Conclusions:</u> NASA-TLX scores correlated significantly with performance scores. Participants with higher workload scores caused more inadvertent injuries.</p> <p><u>Critique:</u> Mental workload is an important way to predict injury, and the NASA TLX is a fast easy to use prediction method. The novelty of the medical setting and the live</p>
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<p><i>Journal of the Society for Simulation in Healthcare</i>, 5(5), 267–271. https://doi.org/10.1097/SIH.0b013e3181e3f329</p>	<p>supplemental and potentially predictive performance metric.</p>	<p>suturing and knot tying and then completed the tasks on a live pig.</p>				<p>e and NASA scores, correlations were calculated.</p>	<p>porcine test may have heightened the mental workload of the subjects; but, that effect would have been constant across the entire subject group.</p>
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Chapter 3 : Research Design and Methods

Specific Aims

Specific Aim #1: Conduct an ergonomic workload assessment of routine tasks conducted by Janitors of SEIU Local 26 (L26) and examine their association with work-related injuries.

1a: Develop a qualitative method for an ergonomic workload assessment of janitors. Conduct a focus group discussion to find common and hazardous tasks potentially leading to occupational injuries.

1b: Conduct an on-the-job ergonomic workload assessment

1c: Test the relation between ergonomic workload (Exposures) and occupational injury (Outcome).

Hypothesis 1.1: Ergonomic workload increases the risk of occupational injury.

Specific Aim #2: Examine the potential associations between mental workload, job satisfaction, stress, physical fitness, and occupational injury occurrences.

2a: Examine the relations between the workload factors of mental workload, psychosocial factors, and physical fitness (Exposures) and occupational injury (Outcome).

Hypothesis 2.1: Mental workload increases the risk of occupational injury.

Hypothesis 2.2: Job Satisfaction decreases the risk of occupational injury.

Hypothesis 2.3: Stress increases the risk of occupational injury.

Hypothesis 2.4: Physical fitness decreases the risk of occupational injury.

Specific Aim #3: Determine the relations between ergonomic and mental workloads and stress.

Hypothesis 3.1: High ergonomic workload increases the risk of stress.

Hypothesis 3.2: High mental workload increases the risk of stress.

Target Population

A closed prospective cohort study design was proposed. The target population was the ~4,000 janitors who are members of SEIU L26, comprised of approximately 20% Somali, 60% Hispanic, and 20% other members. This study was restricted to the ~1200 janitors who worked full time. Access to this population was enabled through the invitation by the SEIU L26, which also assisted with translation.

Janitors are a difficult population to research for several reasons, including turnover, immigrant status, and known lack of reporting of injuries. Turnover, defined as an individual's decision to stay or leave a job, is based on the investments that organizations commit to their employees (1). Compared to other occupational groups, janitors generally have high turnover rates (2). Organizations provide fewer resources for janitors' well-being knowing that there is a chance that their employment may be time-limited for various reasons (3). High turnover in this population is a study limitation, because if the janitors are

not consistently working in the same position then they may not be available for follow-up over an extended study period.

As noted previously, the janitorial industry employs many immigrants due to few barriers to entry (4); immigrants tend to work in riskier occupations and get injured more often (5). Some of these immigrants may be undocumented and, as such, they fear reporting unsafe work conditions due to anxiety of being deported. Injuries at work are significantly associated with lower English proficiency (6). Lower English proficiency, both written and spoken, also increases the difficulty of conducting research in this population. The current research project was conducted in English, Spanish, and Somali, in hopes of engaging more of the participants.

Other barriers to research among janitors may include a lack of familiarity with the academic research process, a lack of trust in the anonymity of their experiences, and a lack of time for the janitors to participate.

Study Design

This study was a prospective cohort study that involved retrospective data collection. Specifically designed questionnaires, with recall periods of six months for two sequential six-month periods, were used to collect a total of one year of exposure and outcome data. Cohort studies can provide excellent information about the potential causation of injury), i.e., was the exposure present before the outcome? (7). Other general strengths of cohort studies include: allow research to be conducted on rarer exposures; enable analysis of several exposures,

independently, relevant to the outcome of interest; and reduce selection bias in the enrollment stage (as the relation between the exposure and outcome is not known when the exposure classification is stated)(8). General disadvantages of cohort studies include: potential long-term follow up of large numbers of participants (in current study, one year); a large cost of resources and time, not particularly well suited for rare outcomes (thus, Aim 3 uses stress versus injury as an outcome); difficulty in capturing outcomes with a long latency period; and differential loss to follow up that can introduce bias (8). For cohort studies it is crucial to ensure that individuals in the unexposed group are truly unexposed (participants may not remember their exposures or they may not have been well-documented). By virtue of the potential for change in their activities, over time, exposure group members might also change their risk profiles throughout the duration of the project (9). The current research project assumed, from initial participant interviews, that the exposures remained static. To avoid the aforementioned recall bias, the current study questionnaire limited the respective recall periods to a maximum of six-months. Another potential source of bias is loss to follow up. If cohort participants are unwilling or unable to be contacted, or provide data for the duration of the study, then the measurement of effect likely becomes compromised. To limit this potential problem, the current project was participant-driven, because the janitors' union requested and were committed to this project. Further, only full-time janitors were included as subjects to increase the likelihood of their participation for the duration of the study.

Contact Procedures

General

The SEIU L26 approached the University of Minnesota Division of Environmental Health Sciences to request aid in examining janitor workload and the potential for adverse outcomes. The current study was designed to study the population to the degree possible.

Ergonomic Assessment

Using the Rapid Entire Body Assessment (REBA) and the Borg Perceived Exertion Scale (BORG), seven ergonomic assistants under one Certified Professional Ergonomist observed 30 janitors, who were selected across strata of age and gender. SEIU L26 invited janitors for a balance of men and women, and across a wide range of ages. These janitors were assessed as they completed eight janitorial tasks (mopping/sweeping, vacuuming, cleaning mirrors, cleaning sinks, cleaning toilets, dusting, emptying small (<25lb) trash cans, and emptying large (>25lb) trash cans). These tasks were considered to be representative from focus groups, which elicited information about the most common, most dangerous, and most difficult tasks.

Focus Group

Based on a sample of janitors identified by the SEIU L26, a focus group of ~30 janitors was convened. A structured questionnaire to guide focus group discussion that addressed topics on janitorial tasks was developed and administered to this focus group. Questions asked included: What are the most

frequent tasks? What do you believe are the most dangerous tasks? What are the most difficult tasks? How often are each of these performed in a one-week period, and are these representative of longer periods (up to six-month periods)?

Surveys

Initial data to be collected were initially determined through a focus group, followed by administration of specially designed and pre-tested questionnaires to collect occupational injury and exposure data for two sequential six-month recall periods in a one-year longitudinal study. The ~1,200 questionnaires were administered to the entire population of full-time SEIU L26 janitors, initially through the Union Stewards at the participating janitors' workplaces. Questions included those on demographic information, exposures of ergonomic tasks and frequency, and occupational injury outcomes -- specifically how many times in the past six months they had been injured, and information on associated consequences. Detailed descriptions for up to four (due to questionnaire space limitations) injury events were collected for each of the two sequential six-month retrospective recall periods. Task-specific information was collected within the broad job categories of Floor Cleaner, Bathroom Cleaner, and Special Projects (everything else), as established from the focus group discussions. Previous injury history was also ascertained, given prior evidence as a risk factor for future injury (10,11). The questionnaire had an average reading grade level of 6.4, with a Flesch-Kincaid Grade Level of 5.7 (16).

Because a large proportion of the information in this research project came from the comprehensively designed questionnaires, it was important that a high response rate resulted. To address this, the research team, with assistance by union officials, pre-notified the population with text messages to their telephones. The questionnaires were initially distributed by the building stewards who were provided with the pre-created packets of questionnaires in the appropriate languages (English, Spanish, Somali) by the research team; the stewards who had been trained comprehensively in the content, distribution, and questionnaire return to the research team, were responsible for distributing the packets to their janitor team members. Distribution was facilitated by the research team providing surveys to meeting spots near the janitors' workplaces; the Union retained spare questionnaires to provide to eligible janitors. SEIU L26 officials also assisted the members in completing the questionnaires, as necessary, while retaining confidentiality.

Conceptual/Causal Models

Conceptual Model

Conceptual models are tools used to understand the relations among parts of a system. The Epidemiologic Model is used in public health to study health problems. This model is comprised of the Agent/Energy (which causes the injury), a vehicle that transmits the energy, the Host (a person or group of persons that may incur an injury), and the Environment (which in combination with the agent, vehicle, and host may facilitate an adverse outcome or injury) (12). William Haddon Jr postulated a theory of energy control which states that

injury occurs when energy is transferred to a host, resulting in damage (the injury) when the body is not adequately resilient to the energy dose (13,14).

Figure 3-1, below, identifies a Conceptual model of musculoskeletal injury as experienced by the population of janitors. In accordance with Haddon's theory, the agent is kinetic energy. In other cases, such as slip/trip/fall injuries, potential energy may also be appropriate to include. The host is the janitor. Personal characteristics such as the janitors' age, gender, smoking status, Body Mass Index (BMI), tissues exposed to stress, and fitness may all play a role in the ability to absorb the kinetic energy. Work characteristics such as hours worked per week, and years worked as a janitor, and the ergonomic tasks conducted, may also affect the host's resilience. The environmental factor of company size may also make a difference in the host's relation to the agent, as large versus small organizations may have very different levels of controls for potentially hazardous exposures. Many other environmental factors that may affect injury exist but were not measured in the survey.

Potential confounders were selected using Directed Acyclic Graphs (DAGs), which enabled identification of the potential confounders between the exposures and outcome of injury (15). DAGs are a valuable tool used to infer the potential causal direction of the association between two variables.

Specific Aim #1, Hypothesis 1: *Ergonomic workload increases the risk of occupational injury.*

To identify the relation between ergonomic load (E in Figure 3-2) and occupational injury (O in Figure 3-2), adjustments for confounding were for age (16), gender (17), smoking (18), and job title.

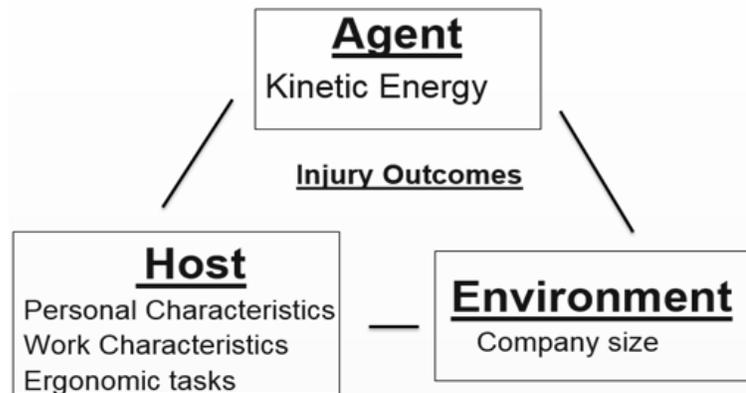


Figure 3-1: Conceptual Model of Musculoskeletal Injury

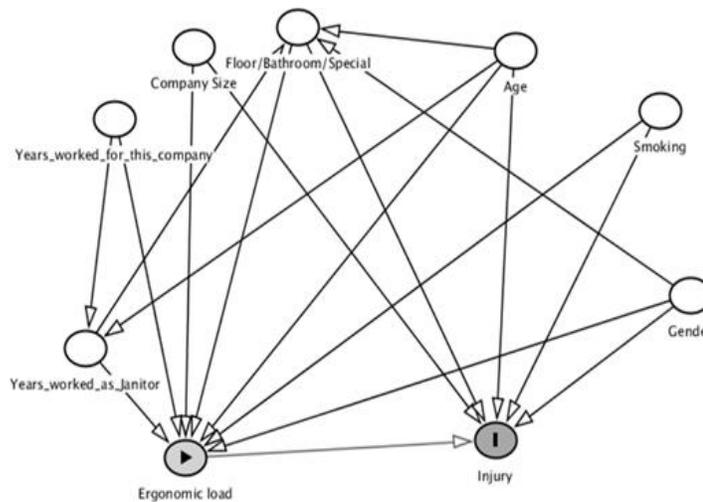


Figure 3-2: Directed Acyclic. Graph of the Relation of Ergonomic Workload and Occupational Injury

Data Analysis

Once the data were collected, they were double-entered into a database for verification. Data management was performed for data cleaning, potential missing and outlier identification, and data structure formation for statistical analysis. Injury events outside the study period were excluded. A descriptive analysis was run to calculate the frequencies and distributions of job tasks and workload measurements. To identify occupational injury incidence and severity, measures were stratified by working group, job task, and the exposures of ergonomic workload tasks, and physical fitness levels. Each of the subsections of workload (mental workload, self-reported fitness, and ergonomic load) were separately analyzed as exposures to detect potential relations with occupational injury.

Each workload exposure was analyzed through regression models to identify their associations with occupational injury counts. Generalized Estimating Equations (GEE) were then used to account for correlated data for a portion of the analysis. If a single janitor completed the two sequential six-month surveys, GEE was used to avoid clustering bias (62).

$$\ln(\text{Injury Rate}) = \beta_0 + \beta_1 * \text{Ergonomic Workload Tasks} + \varepsilon$$

Injury Rate=injury incidence per person, β_0 =intercept, β_1 = β coefficient for each exposure variable, and ε =error term.

Substudies for Bias Evaluation

Potential response bias, resulting from a lower response rate, was minimized by inversely weighting observed responses by probabilities of response, estimated as a function of worker characteristics available from the SEIU L26 (66,67).

Those characteristics included gender, age, and janitorial contracting company associated with the janitors' worksites. This technique used re-weighting of estimates using group response characteristics to account for the potential differences in responses (68).

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Chapter 4 : Janitor Ergonomics and Injuries in the SWEEP Study

Synopsis

Background: A Minnesota union identified to researchers at the University of Minnesota a concern relevant to a possible relation between the daily workload and outcome of occupational injuries among a population of janitors.

Objective: To assess if the ergonomic workload is related to injuries among janitors.

Methods: Following an initial focus-group discussion among janitors, which identified common and hazardous tasks potentially leading to occupational injuries, a specially designed self-administered questionnaire was developed, pre-tested, and distributed to the janitors. Questions addressed various exposures, including workload, and comprehensive information regarding injury occurrence over two six-month sequential periods (May 2016-October, 2016, November 2016-April 2017). Quantitative ergonomic analyses were performed on a sub-group of janitors (n=30); these included data collection to identify Borg Perceived Exertion (Borg) and Rapid Entire Body Assessment (REBA) scores. Descriptive, multivariable with bias adjustment analyses were conducted on the resulting data

Results: Eight tasks were found to be common for janitors. All average REBA scores for the tasks were identified in the high-risk category. The task of repeatedly emptying small trash cans (<25lb) was significantly related to injuries.

Average Borg scores fell between the very light perceived exertion and somewhat difficult perceived exertion categories. Multivariable regression analyses indicated that age-sex-standardized ergonomic workload, measured by task frequencies and REBA or Borg scores, was positively related to injury occurrence.

Conclusions: Standardized ergonomic workload was positively related to injury occurrence. This information serves as a basis for further research and potential intervention efforts.

Keywords: Janitors; Workload; Ergonomics; Injuries; Epidemiology

Background

Janitors are ubiquitous and understudied.(1) In 2016, 2,384,000 people were employed in the field (2). Their work, involving an apparently high physical workload, appeared to place them at risk for days away from work at a rate 2.7 times higher than all other occupations.(3) Reportedly, janitors are exposed to respiratory and dermatologic disorders, psychosocial stressors, mental disorders, infectious diseases, and injuries, particularly involving musculoskeletal disorders.(4)

Greatly concerned about their workload and potential relation to occupational injury, personnel from the Service Employees International Union Local 26 (SEIU L26) approached researchers in the Division of Environmental Health Sciences at the University of Minnesota to investigate this issue. Their existing measure of workload was, “average square feet cleaned per shift;” however, the SEIU L26 wanted to consider other workload ascertainment approaches.

In the Seattle area, workload had been studied relevant to perceived intensity, resulting in identification of a positive relation to injuries.(5) School janitors have been studied by examining motions (pushing, pulling, grasping with the left hand, grasping with the right hand etc.), and demonstrating that musculoskeletal injuries were associated with increasing time spent pushing and pulling.(6) Similar to other service professions, the vast majority of reported janitors’ injuries have involved sprains, strains, and tears, with an incidence rate 2.7 times higher for musculoskeletal disorders than the United States (US)

occupational average for private industry, state government, and local government.(7) This is an important indication that physical workload needs to be examined in janitors to understand the risk of work-related injuries. Other research in different occupations has found relations between physical workload, ergonomics, and injury; (8,9) but no apparent in-depth research has been conducted with janitors involving an ergonomics approach.

Therefore, the objective of this study was to conduct an ergonomic workload assessment of routine tasks in the population of SEIU L26 member janitors, and to examine its association with the outcome of occupational injury.

Methods

Target Population

Following approval by the University of Minnesota Institutional Review Board, a closed prospective cohort study design was initiated. The target population of ~4,000 janitors who are members of SEIU L26 comprises approximately 20% Somali, 60% Hispanic, and 20% other ethnicities. This study was restricted to the ~1200 janitors who reportedly worked full-time due to the higher turnover of the part-time workers. Access to this population was enabled through the invitation of and facilitation by the SEIU L26.

Janitors are reportedly a challenging population to research for several reasons, including turnover, immigrant status, and known lack of reporting of injuries.(10) Turnover, defined as an individual's decision to stay or leave a job, is based on the investments that organizations commit to their employees.(11) Compared to other occupational groups, janitors generally have high turnover

rates.(12) Organizations provide fewer resources for janitors' well-being knowing that there is a chance that their employment may be time-limited for various reasons.(13) High turnover in this population is a study limitation, because if the janitors are not consistently working in the same position, they may not be available for follow-up over an extended study period.

The janitorial industry employs many immigrants due to few barriers to entry;(10) however, immigrants tend to work in riskier occupations and get injured more often.(14) Some of these immigrants may be undocumented and, as such, fear reporting unsafe work conditions due to the potential for being deported.

Injuries at work are significantly associated with lower English proficiency;(15) deficiency in both written and spoken English also increases the difficulty of conducting research in this population. Thus, the current research project incorporated English, Spanish, and Somali language translations to enhance participation.

Study Size

The project was originally designed to include the population of all members of SEIU L26 who were janitors. However, it was decided to include only the full-time janitors (~1,200) in order to obtain optimal participation, longitudinally, over the full study period.

Focus Group

Based on a sample of janitors identified by SEIU L26 representatives, a focus group of approximately 30 janitors was formed. A structured questionnaire that addressed the topic of janitorial tasks was developed to guide focus group discussion and was administered to this focus group. Questions asked included: 'What are the most frequent tasks?', 'What do you believe are the most dangerous tasks?', 'What are the most difficult tasks?', 'How often are each of these performed in a one-week period' and 'Is that representative of longer periods (up to six-month periods)?'

Data Collection Instruments

Following the focus group to collect information important to the questionnaire development, specially designed and pre-tested questionnaires were administered to collect occupational injury outcomes and exposure data for two sequential six-month recall periods in a one-year longitudinal study (May 1, 2016 - October 31, 2016 and November 1, 2016 - April 30, 2017). Work-related injuries are defined as any wounds or damage to the body associated with the job that occur in the working environment; they result from acute traumatic events that involve: restriction of normal activities for at least four hours; and/or the use of professional medical care; and/or loss of consciousness, loss of awareness, or amnesia for any length of time.(16,17). Detailed descriptions for up to four injury events (space limitations) were collected for each of the two sequential six-month retrospective recall periods. Approximately 1,200 questionnaires were initially distributed to the entire population of full-time SEIU

L26 janitors by trained union stewards at the participating janitors' workplaces. Questions included demographic information, exposures to ergonomic tasks, frequency of exposures to musculoskeletal stressors, and occupational injury outcomes; queries, pertinent to injury occurrences, included: how many times in the past six months had they been injured, and information on associated consequences. Previous injury history was also ascertained, given prior evidence it is a risk factor for future injury.(18,19) Task-specific information was collected within the broad job categories of Floor Cleaner, Bathroom Cleaner, and Special Projects (everything else), as established from the focus group discussions. From testing, it was determined that a questionnaire with an average reading grade level of 6.4 and a Flesch-Kincaid Grade Level of 5.7 was appropriate for the study population.(20)

This questionnaire for the janitors included items asking ergonomic task frequency per shift for the eight tasks. For example, janitors were asked for the number of large trash cans they cleaned in an average shift. The questionnaire results regarding ergonomic task frequency data were sometimes unclear. In those cases, where a janitor did not give a numeric answer to a frequency item but, rather, indicated that they did a task (writing an "x", checkmark, or "yes"), the response was imputed to the average value of all janitors who provided a numeric value for that task. Potential outlier responses (a janitor reporting emptying 3,000 small trash cans in an eight hour shift, which would be 6.25/minute, presuming no breaks or travel time) were truncated to industry standard production rates, based on an 8-hour work shift (which was supported

from the questionnaire) (21). Task cycle times were computed for the non-discrete tasks (mopping, vacuuming, dusting).(21) These three time-based variables were standardized to work cycles in order to have a counting measure equivalent to the frequency-based variables.

Ergonomic Workload Tasks

Quantitative data collection was also conducted through ergonomic assessments of janitorial tasks. High force and high repetition lead to increased risk of wrist injury, and the combined interaction (or force and repetition) is greater than either variable alone.(22) Acceleration of the back in the sagittal plane or greater moments (torque) on the L4/L5 vertebrae, lead to increased risk of back injury.(23) As such, this study operationally defined ergonomic workload as a construct containing force, repetitions, and posture, including synergistic effects of those variables.

Using two complementary approaches for examining musculoskeletal and full-body injuries, a substudy was implemented with janitors in this project. For this portion of the SWEEP Study, tasks were assessed for ergonomic workload, using both the Rapid Entire Body Assessment (REBA) and the Borg scale (a measure of perceived exertion). These are both widely-used tools to assess subsections of ergonomic workload. REBA is a practitioner's field tool,(24,25) designed to assess postures. It is "sensitive to musculoskeletal risks in a variety of tasks, divides the body into segments to be coded individually with reference to movement planes, and provides a scoring system for muscle activity caused by static, dynamic, rapidly changing or unstable postures."(26) REBA is

commonly implemented in the world of ergonomics research as well as its use as a tool for ergonomists operating in industry.(27–31) This scale was created by a group of ergonomists, physical and occupational therapists, and nurses who divided the body into segments and coded over 600 different postures commonly found in the health, manufacturing, and electricity industries.(26) It has been validated against the New Zealand Manual Handling Hazard Control Record, the Rapid Upper Limb Assessment, the Manual Task Risk Assessment Tool, and the National Institute of Occupational Safety and Health (NIOSH) lifting equation.(24,32–34) The REBA is also being used in the promising domain of virtual reality in occupational safety.(35) In general, “observation-based assessments [such as the REBA] appear to provide the levels of costs, capacity, versatility, generality and exactness best matched to the needs of occupational safety and health practitioners...who have limited time and resources at their disposal and need a basis for establishing priorities for intervention.”(36)

The Borg scale enables calculation of a psychophysical basis of perceived exertion (37,38). It ranges from 6 (very, very light) to 20 (very, very hard), with data obtained from observer-asked subject self-report. Aside from its use in ergonomics (39–42), the Borg scale is used in medicine for various health outcomes, including respiratory disorders (43,44), perceptual psychology, and exercise science (45–47). The scale has been validated for load weight and physical work capacity (48).

Ergonomic workload was initially determined by observing thirty people, 15 men and 15 women. Balanced (10 in each age group) tertile cut points of the sample were made with groups of ages 21-39, 40-56, and 57-71.

There are different physical stresses, based on age and gender anthropometry.(49,50) The sampling dimensions of age and gender were chosen due to ergonomic workload being posture-driven. The average height for women was 5 feet 2.6 inches and their average weight was 160.5 pounds. On average, men were 5 feet 6 inches tall and weighed 177.8 pounds.

Buchholz determined that a randomly selected worker from a crew performing the same operation is appropriate to measure that operation.(51) Results from field data collection with standardized checklists (such as the REBA and the Borg) have been validated by videotape analysis.(51) David also found that observation-based assessments are appropriate for occupational safety and health research.(36)

In this study, a team of ergonomists independently assessed each person's single-job task with both the REBA and the Borg scales. After categorizing the levels of risk exposure for REBA as negligible, low risk, medium risk, high risk and very high risk, a Fleiss' Kappa of 0.54 was identified, indicating moderate agreement.(52) Multiple snapshot measurements were taken for each task and then combined to obtain a task-specific score. In addition to utilizing individual REBA and Borg scores, a combined additive ergonomic workload score was created to serve as the measurement of ergonomic workload for each task. Task-specific scores were then used with the individual task frequencies

reported on the survey to obtain a task-summed total ergonomic workload measurement for the targeted 1,200 janitors.

Eight tasks were identified from the SEIU L26 janitor focus group, as a result of the participants being asked, “What are the most frequent tasks? What do you believe are the most dangerous tasks? What are the most difficult tasks?” The eight tasks were: emptying trash cans less than 25 pounds; emptying trash cans of more than 25 pounds; mopping/sweeping; vacuuming; dusting; cleaning mirrors; cleaning sinks; and cleaning toilets. These were similar to the University of California Custodial Study which studied the tasks of trash and recycled material handling, mopping, vacuuming, lifting and moving furniture, and cleaning bathrooms.(53) Each of the eight tasks has been reported in the literature to include physical exposures that are risk factors for injury such as neck extension, wrist abduction, trunk bending, raising upper extremities above shoulder level, heavy lifting, spinal torque, and others.(51,54–60)

Due to inability to observe the tasks, *in situ*, simulations of the eight tasks were created in multiple rooms / areas, comparable to their work settings, and janitors were observed as they cleaned. The janitors were asked to complete the tasks as they typically would.

Research with simulations is only realistic if the simulations are as similar as possible to those encountered in the workplace. For example, if one of the tasks is emptying a trash can of less than 25 pounds, it is not sufficient to place a trash can in the middle of the floor to be emptied. Instead, the trash can should be in a representative environment -- for example, under a desk with an office

chair obstructing movement, so that there are realistic obstructions and complications involved in the necessary movement. Ergonomists, union officials, and experienced janitors contributed input for the simulations; then, stations were created to simulate all eight tasks.

Eight observers were trained to use the REBA assessment tool and score the ergonomic load for 30 janitors as they performed the simulated tasks. The task-specific scores were used with the surveyed individual task frequencies to create the task-summed total ergonomic workload measure.

The eight tasks are described below:

1. Emptying large trash cans: Janitors were asked to move two preloaded 40-pound trash cans on rolling platforms for 20 feet, and then empty the cans, after which they were to place new bags in the cans.
2. Emptying small (less than 25 lbs) trash cans: There were four 15-pound trash cans; janitors were asked to grab them from under the desks, tie off and empty the bags, put new liners in the cans, put the small bags into a large (over 25 lbs) bin, and then replace the small bins under the desks.
3. Mopping: A 10 foot x10 foot polished concrete floor was marked off with yellow tape. Inside the area was a table and three folding chairs. Janitors were given a Kentucky string mop and mop bucket with wringer and asked to clean the floor. Janitors either moved the chairs onto the table, out of the 10 foot x10 foot area, or simply mopped around the furniture.
4. Vacuuming: Two 3 foot x 8 foot coarse rugs were placed side by side, creating a 6 foot x 8 foot area. Janitors were asked to plug in a standing-

style vacuum cleaner to an extension cord, vacuum the rugs and, then, unplug the vacuum cord.

5. Dusting: In an office cubical, purple duct tape was placed on several surfaces to provide standardized cleaning areas. The horizontal surfaces were the: top of the cubical walls; top of the monitor and computer tower; and a filing cabinet. Vertical surfaces included a telephone, part of a desk lamp, and several pictures on the wall. Janitors were provided a feather duster for this activity.
6. Cleaning toilets: Janitors were asked to wipe down the toilet outer surface with a cloth, scrub the bowl with a long-handled brush, and refill the toilet paper dispenser.
7. Mirrors: Janitors were asked to clean a mirror that was 2 x 3 feet. They were given a cloth and a spray bottle that weighed five pounds to accomplish this.
8. Sinks: Janitors were asked to clean a white porcelain sink mounted in a cabinet that was 2.5 feet wide, 2 feet deep, and 1 foot tall. To do this, they were given a cloth and a spray bottle that weighed five pounds.

Potential Confounders

Potentially confounding variables were identified, *a priori*, based on peer-reviewed literature and expert knowledge, through the application of Directed Acyclic Graphs (DAGs). DAGs are a valuable tool used to represent the causal direction of the association between sets of variables and can be used to identify

potential confounding variables while excluding extraneous variables that may increase confounding. For each specific research question, the DAGs' pathways were reduced to the smallest logical set of potential confounders to create the simplest, most minimal set of variables to include in the appropriate regression equations between exposures and outcomes. (61,62).

The potential confounders included: resting heart rate; (63,64); body mass index (BMI);(65–69) injury history;(18,19,66) years worked as a janitor;(69) years worked for the company;(69) personal protective equipment use;(70) having a second job;(69) age;(70) SES; (71) gender;(71) United States (U.S.)-born;(72) smoking;(73) race;(74) and marital status.(75) While there is limited literature on the relation between variables such as number of household members, size of company, level of education, and floor/bathroom/special projects cleaners, and the outcome of injury, research team experts also considered their value as potential confounders.

It was hypothesized that an *increased ergonomic workload increases the risk of injury*. To analyze the relation between ergonomic workload and injury, variables of age, gender, smoking, and job title were adjusted, as shown in the DAG in Figure 4-1.

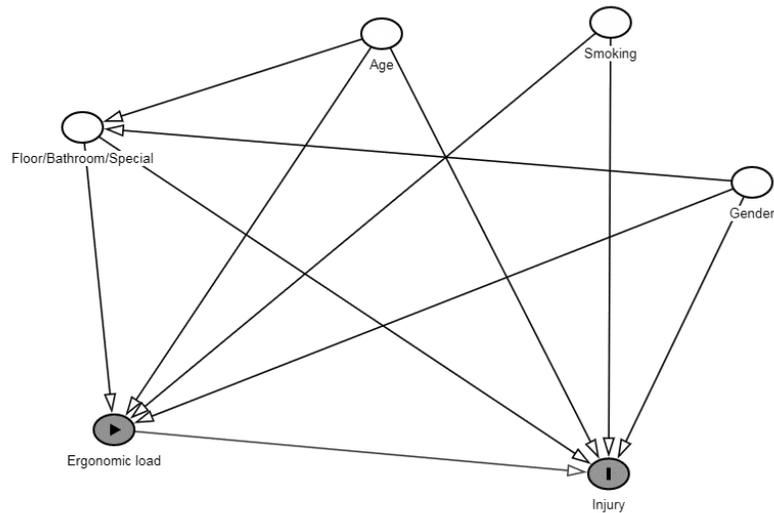


Figure 4-1: Directed Acyclic Graph of the Relation between Ergonomic Workload and Injury among Janitors

Data Management and Analysis

Upon survey completion, data were entered by two research team members into a RedCap database and compared for consistency (76). Data were cleaned, potential missing variables and outliers were identified, and data were structured for statistical analyses. Injuries reported as occurring outside the study period were excluded from analysis.

Descriptive univariate analyses were conducted to calculate the frequencies and distributions of job tasks and workload measurements. Risk of injury occurrence was assessed for different levels of workload exposures.

The workload exposures were analyzed through log binomial regression models to calculate risk ratios that identify associations with occupational injury occurrences. Generalized Estimating Equations (GEE) were used to account for

correlated data for a portion of the analysis. If a single janitor completed the two sequential six-month surveys, GEE was used to avoid clustering bias (77).

$$\ln(\text{Injury Rate}) = \beta_0 + \beta_1 * \text{Ergonomic Workload Tasks} + \beta_2 * \text{Age} \\ + \beta_3 * \text{Gender} + \beta_4 * \text{Smoking} + \beta_5 * \text{Job Title} + \varepsilon$$

Injury Rate=injury incidence per person, β_0 =intercept, $\beta_1-4=\beta$ coefficient for each exposure variable, and ε =error term.

Potential response bias, resulting from a lower response rate, was minimized by inversely weighting observed responses by probabilities of response, estimated as a function of worker characteristics available from the SEIU L26 (78,79). Those characteristics included gender, age, and janitorial contracting company. This technique used re-weighting of estimates using group response characteristics to account for the potential differences in responses (80).

Results

Survey Questionnaire and Janitorial Assessment Data:

As shown in Figure 4-2, there was an overall survey response rate of 32.5%, with 390 janitors responding to at least one of the two sequential questionnaires; 137 janitors responded to both. Of the 390 janitors who responded, 55% were female. Among the janitors, 10% were aged 18-30 years, 30% were 31-40, 30% were 41-50, 23% were aged 51-60, and 6% were over 60 years. According to reported race, 57% were black or African American, 30% were white, and 13% identified as another race.

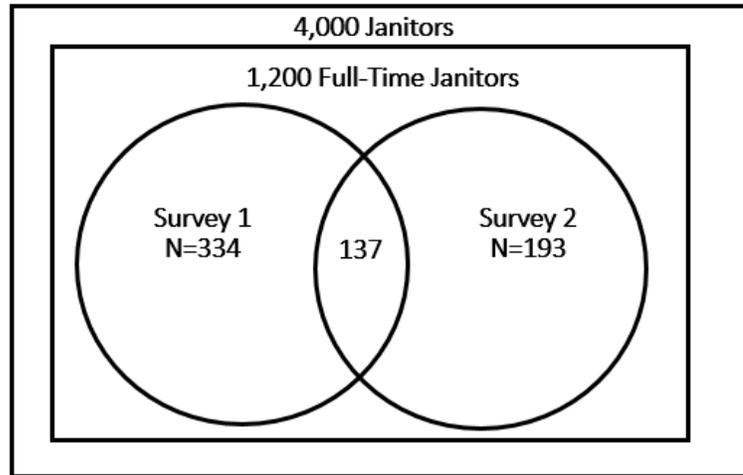


Figure 4-2: Study Size Flow Chart for the SWEEP Study

For the specific janitorial assessment, each task initiated by a janitor was assessed by ergonomists between 72 and 110 times, with at least 23 janitors measured per task (Table 4.1). All average REBA scores, based on task-specific assessments, identified in Table 4-1, were in the high risk category (Table 4-2). Average Borg scores ranged between the very light and somewhat difficult categories (Table 4-2).

Table 4-1: Task-Specific Assessment Data: The SWEEP Study			
Tasks	# Assessments	# Janitors Assessed	Range of Assessments/person
Toilet Cleaning	77	25	1-4
Dusting	110	26	1-11
Large Trash	91	23	1-9
Small Trash	99	25	1-12
Mopping	89	24	1-8
Mirror Cleaning	82	26	1-8
Sink Cleaning	72	25	1-4
Vacuumping	98	25	1-10

REBA Score	REBA Level of Injury Risk	Borg Score	Borg Measure of Intensity
1	Negligible risk, no action required	1-3	Extremely light
2-3	Low risk, change may be needed	4-7	Very light
4-7	Medium risk, further investigation, change soon	8-11	Somewhat difficult
8-10	High risk, investigate and implement change	12-15	Extremely difficult
11+	Very high risk, implement change		

The average REBA and Borg scores are found in Table 4-3. From the questionnaire data, completed by the janitors, the highest number of task cycles, of a task performed, was mopping, with an average of 56.77 cycles a shift (Table 4.4). Only 249 janitors reported cleaning toilets, with an average of 31.86 cleaned per shift.

Tasks	REBA (SD)	Borg (SD)	Combined (SD)
Toilet Cleaning	10.4 (2.11)	8.84 (4.27)	18.84 (5.37)
Dusting	8.92 (2.41)	5.45 (4.18)	14.15 (5.31)
Large Trash	10.49 (1.09)	8.04 (4.92)	18.33 (5.27)
Small Trash	10.68 (1.44)	6.22 (4.35)	16.90 (4.51)
Mopping	9.13 (1.86)	8.37 (4.49)	17.39 (4.78)
Mirror Cleaning	9.27 (1.68)	6.14 (4.51)	15.26 (4.88)
Sink Cleaning	8.96 (2.36)	6.76 (4.20)	15.72 (4.94)
Vacuuming	9.65 (2.08)	7.13 (4.40)	16.79 (4.69)
SD= Standard Deviation			

Table 4-4, shown below, does not include those with zero minutes for a task. Some of the cycle variables may have a minimum of less than one due to partial task cycles.

Tasks	N	Number of Tasks Cycles per Shift			
		Mean	SD	Minimum	Maximum
Mopping	452	56.77	51.61	0.59	288.69
Vacuuming	424	42.12	27.02	0.35	178.32
Dusting	432	27.91	24.96	0.34	182.29
Toilet Cleaning	249	31.86	34.56	1	170.00
Mirror Cleaning	271	17.04	21.24	1	240.00
Small Trash	329	85.01	102.72	1	320.00
Large Trash	364	19.46	27.24	1	120.00
Sink Cleaning	306	17.58	20.69	1	120.00

SD=Standard Deviation

Injuries

From the total of 527 questionnaires completed, there were 78 reported injury events in one of the two six-month periods prior to the respective questionnaire administrations. Repetitive motion (21%) and overexertion (19%) were the main sources of injuries.

Using data obtained from the questionnaires, bivariate log binomial regressions were performed to examine relations between the exposures of task frequencies and injury outcome. Multivariable regression models were adjusted by gender, age, and smoking status. As shown in Table 4-5, the only statistically significant results were identified for the small trash category, with a 3% increase in risk of injury for every 10 small trash cans cleaned.

Table 4-5: Multivariable Regression Analyses of Survey-Based Task Frequency Exposures and the Outcome of Injuries: The SWEEP Study						
Tasks	Unadjusted Analyses			Adjusted Analyses**		
	RR	CI	P. Value	RR	CI	P. Value
Mopping	1.02	0.99, 1.06	0.2329	1.02	0.99, 1.06	0.1990
Vacuuming	1.06	0.99, 1.13	0.1028	1.05	0.98, 1.12	0.1954
Dusting	0.99	0.91, 1.09	0.8556	0.98	0.89, 1.09	0.7660
Toilet Cleaning	1.06	0.99, 1.13	0.1077	1.03	0.96, 1.11	0.4636
Mirror Cleaning	1.01	0.91, 1.13	0.7998	1.00	0.89, 1.12	0.9936
Small Trash*	1.03	1.01, 1.05	0.0117	1.03	1.01, 1.05	0.0118
Large Trash	0.95	0.86, 1.06	0.3627	0.96	0.87, 1.05	0.3528
Sink Cleaning	1.08	0.99, 1.19	0.0948	1.08	0.99, 1.18	0.0930

* Significant at 0.05 level
** Adjusted by gender, smoking, and age.
RR=Risk Ratio per 10 task cycles

Through further analyses, the task-specific REBA and Borg scores from the quantitative ergonomic assessments were then adjusted to the total participants by multiplying the individual task frequencies, identified by the janitors in responses on the questionnaires. Ergonomic exposure scores were standardized by age and gender. Both ergonomic measures (REBA and Borg) were tested for correlation, resulting in a Pearson Correlation Coefficient of 0.99.

Table 4-6: Mean Ergonomic Impact per Shift: The SWEEP Study					
Measures	N	Mean	SD	Minimum	Maximum
REBA	500	2122.40	1434.30	12.18	8167.83
Borg	500	1548.29	988.40	9.97	5879.17
Combined	500	3676.16	2417.55	22.20	14068.39
Standardized REBA	448	2131.25	1433.75	20.23	8019.00
Standardized Borg	448	1616.24	1227.92	16.09	8086.17
Standardized Combined	448	3751.09	2579.13	36.33	16110.48

SD=Standard Deviation

As shown in Table 4-7, data relevant to the relations between ergonomic measures and injury occurrence were identified for both the unadjusted and adjusted analyses. All of the standardized ergonomic workload measures were statistically significantly associated with the outcome of injury occurrence. The Borg score had the largest point estimate.

Table 4-7: Log Binomial Regression Analyses of the Relations between Ergonomic Values and Injury Occurrence: The SWEEP Study								
Measures	Unadjusted Analyses				Adjusted Analyses**			
	RR	95% CI		P.Value	RR	95% CI		P.Value
REBA*	1.10	0.95	1.27	0.2058	1.12	0.97	1.29	0.1138
Borg*	1.16	0.94	1.43	0.1677	1.20	0.98	1.48	0.0747
Combined*	1.06	0.97	1.15	0.1878	1.07	0.99	1.17	0.0954
Stand. REBA*	1.14	0.98	1.34	0.0944	1.20	1.04	1.38	0.0123
Stand. Borg*	1.24	1.07	1.45	0.0061	1.25	1.06	1.47	0.0071
Stand. Combined*	1.10	1.01	1.20	0.0305	1.11	1.02	1.20	0.0110
* Significant at 0.05 level								
**Ergonomic Values were adjusted by gender, smoking, age, and job title.								
**Standardized Ergonomic Values were adjusted by smoking and job title.								
RR=Risk Ratio CI=Confidence Intervals								

Discussion

A key finding of this study was that the average REBA scores for all janitorial tasks were identified in the high-risk category. That not a single one of the eight tasks was identified at even a medium risk level for injury is concerning.(26) As identified, average Borg scores by task fell between the very light and somewhat difficult categories. Overall findings suggest that janitorial work is difficult; equipment design and manner of task implementation should be rigorously evaluated for potential redesign.(7)

Similar to results found in this current study of janitors, Nawi et al.(31), assessed Malaysian palm oil harvesters and found that all seven tasks had REBA scores that ranged from high risk to very high risk.(31) Ansari et al.(32), reported that 53% of studied Indian factory workers were working at high REBA risk levels, with 33% working at medium risk levels.(32) Gentzler (34) used the REBA (among other techniques) to study firefighters and Emergency Medical Technician personnel, finding extreme risk for some of the similar postures (lifting and reaching) that janitors utilize.(34) In Denmark, Jakobsen et al.(41), compared the Borg scale to muscular load in manual laborers, finding that many blue-collar workers reported a moderate exertion level. Janowitz (27). used the REBA to study hospital workers in a wide range of positions; support staffers had higher REBA values than administrators or nurses, which supports the external validity of this tool.(27)

Both the REBA and Borg scales are important and useful for ergonomic and injury epidemiology study analyses (26,31,32,40,41,43,44). However, it has not been common for both scores to be applied in the same study (28,81–83).

This study found that the REBA and Borg scores are highly correlated ($r=0.99$), which is a valuable contribution. The Borg scale is a single-item score and does not require training for its use and, thus, appears to be a good screening tool that might best be used before more advanced tools, such as the REBA.(84) Similar to this current SWEEP Study finding, Kee and Lee (42) found that the Borg is an easier method to calculate “the angular deviation of a body from a neutral position” than objective tools. They also noted that the Borg allows assessment without disrupting the workers.(42)

Individual task frequencies were studied for their relations to injuries. All of the data (janitorial task frequencies for an average shift and injury outcomes) came from the self-reported questionnaires. Braun and Gerberich et al.(85), found that self-reported data tend to have injury prevalence underreported. None of the current SWEEP questionnaire data indicated a relation to injuries (with the notable exception of the small trash can task). Questionnaires (paper, web-based, and interviews) are often one of the main methods used for data collection by epidemiologists,(86) so a strength of this study was the addition of quantifiable ergonomic techniques that enabled identification of more specific results relevant to ergonomic load.

There were increased risks identified in the analyses of the relations between all standardized ergonomic scores and injury outcome. However, there

was not a demonstrated risk for the non-standardized ergonomic scores. This indicates the value of standardizing ergonomic scores within the dimensions of age and gender. The Borg score was noted to have the highest point estimates. These results are expected, as Dennis et al.(9), and Krause et al.(8), reported that an increase in workload should logically lead to an increase in injuries(8,9).

Advantages and Limitations

In studies of this type, there is always a potential for bias; however, numerous efforts were incorporated to minimize bias. One of the limitations of this study was the low response rate (32.5%). Potential response bias was reduced by inversely weighting observed responses by probabilities of response, estimated as a function of janitor characteristics provided by SEIU L26 (80). Lack of reporting of occupational injury outcome is a potential issue with the research process. Workers may be unclear about when and where to report outcomes and, instead, rely on their own perceptions of when to report, based on event circumstances (87) or severity. Underreporting may also be related to unwillingness to reveal incidence (85,88) due to fear of retribution. Research has found “considerable evidence of fear of reprisal for reporting injuries.”(89) Other potential barriers to reporting include having too much time pressure to take time to report, fears of the report never being read, and the mindset that injuries are part of the job. In addition, questionnaire facilitation by union stewards, in the current study, may have potentially introduced information bias in the responses; however, these stewards received targeted training from the research team

relevant to the questionnaire administration in an attempt to ameliorate this potential bias.

The SWEEP study questionnaire's cross-sectional collection of data could have introduced incidence-prevalence bias (or Neyman bias) (90–92). This bias is caused by potential early drop out before the study is initiated or before the data is collected which can lead to differential drop outs between people prone to injury and those who are not (93). Neyman bias may be minimized by the short recall period of the study and the reduced likelihood of job-changing injuries. Similarly, this shortened recall period may reduce the healthy worker effect -- a concern with many occupational studies (94). Recall bias was minimized through the study design, in which the total study period of one year was divided into two six-month recall periods to limit this error (95–98).

There were many advantages associated with the SWEEP study. This involved participant-driven research, in that the subjects were enthusiastic about the project and requested assistance to study the potential effect of their workload on injury. The number (n=720) of ergonomic assessments conducted is unusually large and advantageous for a study of this type. Access to the janitors, through facilitation by the SEIU L26, greatly assisted the feasibility and conduct of the research. Being able to consult with active janitors enabled the research team to design a study that was responsive to the needs of the target population.

Conclusions

This study identified heavy ergonomic workload levels among janitors as being positively related to injury occurrence. It is important to note that, while the

REBA and Borg scores are very highly correlated, analysis demonstrated that the Borg should be used first as a screening tool before the more labor-intensive REBA is applied.

Directions for future research include further studies of larger populations and development of potential interventions to reduce injuries. Disrupting either the frequency of the janitorial tasks or their intensity, as well as consideration relevant to equipment redesign and alteration of task conduct, are potentially fruitful avenues. Unlike the Borg, the REBA has many components. It is possible to see which factors have the largest impact on the REBA score. This current study involved a cross-sectional design, enabling comparisons between the workload exposures and the outcome of injury. It will also be important to examine relations between various combinations of task frequencies and intensity (as measured by REBA and Borg) and injury outcome. Other understudied occupational populations, with exposures similar to janitors, are also important to address in a comparable manner.

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Chapter 5 : Mental Workload, Psychosocial Factors, Physical Fitness, and Injury in the SWEEP Study

Synopsis

Background: In 2016, there were 2,384,600 people employed as janitors. Their work, involving a reportedly high physical workload, appeared to place them at risk for days away from work with a rate 2.7 times higher than all other occupations. However, little is known about non-physical workload factors for janitors and their relations to injuries.

Objective: To determine if there is a relation between exposures of mental workload, job satisfaction, stress, physical fitness, and the outcome of injuries in janitors.

Methods: For this retrospective cross-sectional study, specially designed, pre-tested questionnaires were distributed to full-time janitor members of a Minnesota union for two six-month sequential intervals (May 2016-October, 2016, November 2016-April 2017). Questions addressed mental workload (modified NASA Task Load Index), job satisfaction (Andrews and Withey Job Satisfaction Scale), stress (Perceived Stress Scale-4 [PSS-4], and the Single Item Stress Scale [SISS]), physical fitness, and occupational injury experiences. Descriptive and multivariable, with bias adjustment, analyses were conducted on the resulting data.

Results: A decreased risk of injury was associated with both increased job satisfaction (0.91, [0.83, 0.97]) and increased physical fitness (0.89, [0.83, 0.96]).

A highly suggestive increased risk of injury was associated with increased mental workload (1.07, [1.00, 1.15]).

Conclusions: This study expands the understanding of the relations between mental workload, job satisfaction, stress, physical fitness, and occupational injury burdens among janitors. These findings are important for targeting areas for development of prevention efforts.

Keywords: Janitors, Ergonomics, Injuries, Epidemiology

Background

In 2016, there were 2,384,600 people employed as janitors (1). Their work, involving a reportedly high physical workload, appeared to place them at risk for days away from work with a rate 2.7 times higher than all other occupations (2). However, little is known about non-physical workload factors for janitors and their relations to injuries. Workload is a complex construct; there are many potential elements, including not only mental workload but, also, psychosocial factors, which may be related to work-related injuries.(3)For example, mental workload has been shown to increase task errors and injury rates.(4) Elo et al.(5), Frankenhaeuser (6), and Littman et al.(7),have reported that other psychosocial factors, including job satisfaction (8,9)and stress (5,7,10) were related to workload which, in turn, may be related to injury outcome. In addition, physical fitness has reportedly been related to workload and injury. (11,12)

While the janitors' Service Employees Union International Local 26 (SEIU L26) currently uses the industry standard for a measure of workload that is a group measure of average square feet cleaned per person per shift(13), it is not known how this industry standard relates to measurements of mental workload, psychosocial factors, physical fitness, and outcome of injury. Thus, to take this to the next step, the *objective of this* study was to identify the relations between mental workload, job satisfaction, stress, physical fitness, and the outcome of injury occurrence in janitors.

Methods

Target Population

Following approval by the University of Minnesota Institutional Review Board (Human Subjects Protection Case No. 1605P87861), the Safe Workload Ergonomic Exposure Project (SWEEP) Study, involving a closed prospective cohort study design, was initiated. The target population was the approximately 4,000 janitors who were members of SEIU L26. However, this study was restricted to a closed population of approximately 1,200 individuals who were identified by the union as full-time janitors. Approximately 60 percent of this population was Hispanic, 20 percent Somali, and 20 percent other ethnicities. The SEIU L26 collaborated with the research team to facilitate participation of its members.

Data Collection Instruments

Data were collected through administration of specially designed and pre-tested questionnaires to collect occupational injury outcomes and exposure data for two sequential six-month recall periods in a one-year longitudinal study (May 2016-October, 2016, November 2016-April 2017). The questionnaires were distributed to the entire population of full-time SEIU L26 janitors by trained union stewards at the participating janitors' worksites. Survey items included demographic information, mental workload, psychosocial factors of job satisfaction and stress, physical fitness, and occupational injury outcomes. It was determined that the questionnaire involved an average reading grade level of 6.4.(14)

Definitions and Measures

Mental Workload

“Workload is a term that represents the cost of accomplishing mission requirements for the human operator.”(15) In the literature, one of the most cited measures of mental workload is the NASA Task Load Index (TLX) (15). This is a scale that uses six dimensions of workload to “provide diagnostic information about the nature and relative contribution of each dimension in influencing overall operator workload.”(16) TLX subscales are Likert-type scales with 21 selection points. The dimensions assessed are mental demand, physical demand, temporal demand, performance, effort, and frustration. The ratings indicate how a person “appraises their interaction with the task environment” (17) which is consistent with the operational definition for this study. Because the full weighted scale adds participant burden and is highly correlated to the unweighted scale ($r = 0.94$), a raw (unweighted) TLX scale was used in this study to measure mental workload.(18)

Psychosocial Factors

Among psychosocial factors, job satisfaction and stress were measured in this study. They are identified in the following:

Job satisfaction

Job satisfaction, operationally defined as “the global content a worker experiences about their employment,” was measured by the Andrews and Withey Job Satisfaction Scale (8). The five items measure general feelings about a job,

and add resolution on co-workers, the nature of the work, resources (equipment, information, supervision), and work quality (surroundings, hours, work load). This scale has been validated with the Job Descriptive Index(19) and the Minnesota Satisfaction Questionnaire(20), as well as with job performance, organizational commitment, and intent to turnover.(8) Each individual's response to the Andrews and Withey scale(8) was used to measure job satisfaction in this study.

Job-related stress

Two instruments were used to evaluate job-related stress. 1) Stress was measured by the Elo single-item stress scale (SISS), which has been used since 1970 to monitor perceived well-being for occupational health professionals.(5) The item is worded as, "Stress means a situation in which a person feels tense, restless, nervous or anxious or is unable to sleep at night because his/her mind is troubled all the time. Do you feel this kind of stress these days?" Individual responses were measured on a 5-item Likert scale. The SISS has been validated in comparison to the Nordic Questionnaire for Psychological and Social Factors at Work (21) and the emotional exhaustion scale of the Maslach Burnout Inventory (22). 2) Stress was also measured by the 4-item version of the Perceived Stress Scale (PSS-4). This version, known as the PSS-4, contains 4 of the 14 items of the original PSS-14(23). Both scales, the SISS and the PSS-4, approach "stress" in slightly different ways. Psychological stress can be considered a "particular relationship between the person and the environment, which is appraised by the individual as taxing or exceeding his(/her) resources, and endangering his(/her) well-being,"(24) the definition utilized by the PSS

series.(9,25) However, the SISS defines stress as a form of situational anxiety. Yet, both of these definitions focus on the essence that resources for daily life situations are not sufficient. The operational definition of stress for this study is a simplified version of that of the PSS-4: The extent to which people perceive that demands are greater than their ability to cope with those demands. Individuals' responses to the SISS and PSS-4 scales were used in this study as the measure of stress.

Physical Fitness

Physical fitness is defined as the ability to conduct "daily tasks with vigor and alertness, without undue fatigue and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies."(26) Consistent with that definition, fitness was measured in this study with a self-reported physical fitness item on the general survey for all janitors. This fitness question was adapted from the 2010 NIOSH Long Haul Truck Driver Survey (27,28), and the National Health Interview Survey (29). It was worded on the SWEEP questionnaires as: "During either your work or free time, in the past 7 days, on how many days did you do moderate or vigorous physical activities like fast walking, pushing a lawn mower, or moving heavy boxes by hand for at least 30 minutes at a time?"(28) The response to this question was used in this study as the measure of physical fitness.

Work-Related Injury Outcome

"Work-related" includes any activities, including travel, associated with the job or events that occur in the work environment. Work-related injuries are

defined as any wounds or damage to the body associated with the job that occur in the working environment; they result from acute traumatic events that involve: restriction of normal activities for at least four hours; and/or the use of professional medical care; and/or loss of consciousness, loss of awareness, or amnesia for any length of time.”(30,31) Participants could identify up to four possible injury events for each of the respective six-month data collection periods.

Data Analysis

For this study the exposure variables of mental workload, the psychosocial factors of job satisfaction and stress, physical fitness, and the outcome of occupational injury were individually measured by survey. Data were independently entered by two researchers into a Redcap database.(32) The Redcap software enabled comparisons for consistency of entries; any conflicts were resolved by the research team.

Descriptive analyses of the frequencies and distributions of non-physically measured workload factors was conducted. Logbinomial regressions were used to examine relations between exposures and outcomes. This study had a non-rare binary outcome (injury) so risk ratios (determined by logbinomial regressions) were preferred to odds ratios determined by logistic regressions. Generalized Estimating Equations (GEE) were then used to account for correlated data (i.e., repeated measures from the same janitor) for the multivariable regressions.(33) Potential confounders (age, smoking, and having a second job), were identified, based on the literature and research team

expertise, using Directed Acyclic Graphs (DAGs) (34–36) (Figure 5-1). Potential response bias was minimized by inversely weighting observed responses by probabilities of response, estimated as a function of characteristics available from the SEIU L26.(37,38) Those characteristics were gender, age, and janitorial contracting company. This technique used re-weighting of estimates using group response characteristics to account for the potential differences in responses.(39)



Figure 5-1: Directed Acyclic Graph Demonstrating the Relation between the Exposure of Physical Fitness and Outcome of Injury, with Adjustment for Age, Smoking, and Having a Second Job.

Results

Questionnaire Response

There was an overall response rate of 32.5% among the initial 1,200 individuals who were to have received the questionnaires. This involved 390

janitors who responded to one of the two surveys; 137 (11.4%) janitors responded to both surveys (Figure 5-2).

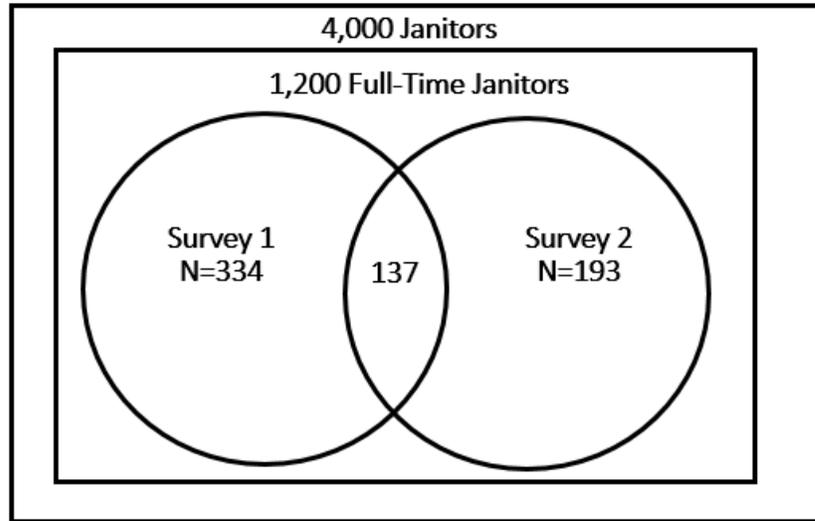


Figure 5-2: Study Size Flow Chart for the SWEEP Study

Mental Workload Results

To assess mental workload, the NASA Task Load Index (TLX) was utilized (Table 5-1). There were 444 responses to the TLX section of the survey (approximately 100 were from the same people over both survey periods). No partially answered scores were counted. The TLX scores range from six to 30, with 30 marking the highest mental workload. The TLX score used was the sum of the six domain items. The mean score was 20.60 with a standard deviation of 4.08. Table 5-1 presents a description of the results.

Table 5-1: Mental Workload Distribution of Janitors as Assessed by NASA Task Load Index: The SWEEP Study

Survey Questions												
	How mentally demanding has it been working as a janitor?		How physically demanding has it been working as a janitor?		How rushed have you been working as a janitor?		How successful were you in completing what you were asked to do?		How hard did you have to work to do your job?		How frustrated have you been with your work as a janitor?	
Demand Level	N	%	N	%	N	%	N	%	N	%	N	%
Very Low Demand	26	5.86	10	2.25	8	1.8	3	0.68	25	5.63	41	9.23
Low Demand	59	13.29	43	9.68	41	9.23	31	6.98	45	10.14	83	18.69
Medium Demand	185	41.67	148	33.33	156	35.14	140	31.53	145	32.66	168	37.84
High Demand	125	28.15	172	38.74	165	37.16	199	44.82	165	37.16	103	23.2
Very High Demand	49	11.04	71	15.99	74	16.67	71	15.99	64	14.41	49	11.04

Job Satisfaction Results

To assess job satisfaction, the Andrews and Withey Job Satisfaction Questionnaire was utilized. Job satisfaction scores are presented in Table 5-2. There were 386 responses to the job satisfaction scale; no partially answered scores were counted. The scores range from five to 25, with 25 marking the

highest job dissatisfaction. The mean score was 12.85 with a standard deviation of 3.00.

	Survey Questions									
	How did you feel about your job?		How did you feel about the people you worked with- your coworkers ?		How did you feel about the work you did on your job- the work itself?		How did you feel about where you worked- the physical surroundings, the hours, the amount of work you were asked to do?		How did you feel about the resources (equipment, tools, information, supervision etc.) you had available for doing your job?	
Response	N	%	N	%	N	%	N	%	N	%
Terrible/Unhappy	14	3.63	29	7.51	27	6.99	15	3.89	18	4.66
Mostly Dissatisfied	135	34.97	214	55.44	188	48.7	165	42.75	178	46.11
Mixed Feelings	196	50.78	110	28.5	139	36.01	161	41.71	131	33.94
Mostly Satisfied	28	7.25	24	6.22	25	6.48	39	10.1	47	12.18
Pleased/Delighted	13	3.37	9	2.33	7	1.81	6	1.55	12	3.11

Stress Results

To assess stress, the Single Item Stress Scale (SISS) (Table 5-3) was utilized. There were 438 responses to the SISS, with the highest number of respondents (N=138) reporting that they were sometimes stressed.

Table 5-3: Stress Distribution of Janitors as Assessed by the Single Item Stress Scale: The SWEEP Study		
Survey Question		
Stress means a situation in which a person feels tense, restless, nervous or anxious or is unable to sleep at night because his/her mind is troubled all the time. Do you feel this kind of stress these days?		
Response	N	%
Not at all	69	15.75
Very Little	66	15.07
Sometimes	158	36.07
Often	101	23.06
Very Much	44	10.05
Missing	89	16.89

In addition, the Perceived Stress Scale-4 (PSS-4) was utilized. There were 310 responses to the PSS-4 (Table 5-4). No partially answered scores were counted. The PSS-4 ranged from four to 20, with 20 identifying the highest stress level. The mean for this population was 9.04, with a standard deviation of 2.51.

The median score was 10. A moderate correlation of 0.35 was found between the PSS-4 and the SISS.

Table 5-4: Stress Distribution of Janitors as Assessed by the Perceived Stress Scale-4: The SWEEP Study								
	Survey Questions							
	In the past month how often have you felt that you were unable to control the important things in your life?		In the past month how often have you felt confident about your ability to handle your personal problems?		In the past month, how often have you felt that things were going your way?		In the past month, how often have you felt difficulties were piling up so high that you could not overcome them?	
Response Level	N	%	N	%	N	%	N	%
Never	61	19.68	55	17.74	38	12.26	52	16.77
Almost Never	60	19.35	107	34.52	95	30.65	92	29.68
Sometimes	129	41.61	103	33.23	141	45.48	125	40.32
Fairly Often	41	13.23	20	6.45	21	6.77	33	10.65
Very Often	19	6.13	25	8.06	15	4.84	8	2.58

Physical Fitness Results

For the physical fitness item (Table 5-5), there were 204 responses, with a majority of respondents (median) reporting that they exercised five days a week (mean = 3.61; standard deviation, 2.43).

Table 5-5: Survey-Based Distribution of Physical Fitness: The SWEEP Study		
Survey Question		
During either your work or free time, in the past seven days, on how many days did you do moderate or vigorous physical activities like fast walking, pushing a lawn mower, or moving heavy boxes by hand for at least 30 minutes?		
Days Exercised	N	%
0	37	7.02
1	21	3.98
2	17	3.23
3	13	2.47
4	5	0.95
5	70	13.28
6	14	2.66
7	27	5.12
Missing	323	61.29

Injury Results

From the total of 527 questionnaires completed, there were 78 reported injury events in the two six-month data collection periods for the respective questionnaire administrations. Repetitive motion (21%) and overexertion (19%) were the main sources of injuries.

In Table 5-6, the point estimates are reported as risk ratios. Of importance is a decreased risk of injury associated with both increased job satisfaction and increased physical fitness. Increased mental workload was associated with an increased risk of occupational injury. Stress, examined with either the PSS-4 or the SISS, was not found to be associated with injury occurrence.

Table 5-6: Logbinomial Regressions of Workload Exposures to Injury Outcomes in Janitors: The SWEEP Study								
Measures	Unadjusted				Adjusted			
	RR	95% CI		P.Value	RR	95% CI		P.Value
Mental Workload^{1*}	1.07	1.01	1.14	0.0205	1.07	1.00	1.15	0.0425
Job Satisfaction^{2*}	0.89	0.84	0.95	<.0001	0.91	0.83	0.97	0.0245
PSS-4^{3*}	1.01	0.90	1.14	0.8737	1.01	0.88	1.17	0.8423
SISS³	1.04	0.96	1.13	0.3070	1.06	0.92	1.22	0.3969
Physical Fitness^{4*}	0.88	0.83	0.93	<.0001	0.89	0.83	0.96	0.0027

1. Adjusted by gender, age, and physical fitness
2. Adjusted for mental workload and stress
3. Adjusted for age, gender, physical fitness, mental workload
4. Adjusted for age, smoking status, and second job status

Adjusted mental workload and PSS-4 did not converge with Logbinomial regression; Poisson regression was used (40)

RR=Risk Ratios CI=Confidence Intervals

Discussion

Slappendel et al.(41) and Yurko et al.(4), reported that increased mental workload can increase task errors and injury rates. The findings from the current study, indicating a positive association between mental workload and injury, is consistent with this literature.

Rentsch and Steel indicated that the scale used for the SWEEP study to examine job satisfaction, the Andrews and Withey Job Satisfaction Questionnaire, was significantly correlated with job performance, organizational commitment, and turnover intentions.(8)Data reported by van Saane et al.(52), upheld the reliability and validity of this scale. The current study identified that low job satisfaction, or dissatisfaction, as measured by the Andrews and Withey Job Satisfaction Questionnaire, was associated with an increased risk of occupational injury occurrence.

As noted, previously, the current study used the 4-item version of the PSS, which is a derivative of the 14-item PSS. There is also a 10-item form of the PSS. Using psychometric tests such as Cronbach's alpha, Pearson's/Spearman's Correlation, or interclass correlation coefficient (ICC), examinations of test-retest reliability of the PSS series found that the PSS-14 and the PSS-10 were both superior to the PSS-4.(42) However, the ease of application of the PSS-4 allows greater application of this stress scale.(42–44) The other stress scale, the SISS, indicated the expected non-significant results.

Analyzed in relation to injury outcome, physical fitness demonstrated a protective effect. As noted, previously, Knapik et al.(12),and Twitchett et

al.(11),documented similar relations of fitness to workload and injury. Heir (45) also noted that military conscripts who were less physically active experienced a higher rate of injuries. In contrast, Gabbett(46) and Hootman et al.(47),each reported that the risk of injury may be increased with higher duration of physical activity and higher fitness levels. McGill and Anderson (48)determined that fitness and injuries were not related in college athletes. Lee (49) discovered that injury risk is more likely related to types of fitness activities than overall fitness levels. This is indicative of a complicated relation between physical fitness and injury.

Advantages and Limitations

Potential biases of this study include reliance on self-reported questionnaire data.(50) The response rate of 32.5% was also lower than anticipated, given the extensive effort in study development and pre-testing and the fact that the SEIU L26 had approached the research team to establish a collaborative effort because of their concerns relevant to their working conditions. However, this potential response bias was reduced by inversely weighting observed responses by probabilities of response, estimated as a function of janitor characteristics provided by SEIU L26.(39)

Another concern is that, even though janitors participated in this study, there may have been barriers relevant to reporting of injury incidents. Azaroff and Levenstein et al.(51), documented barriers limiting the collection of accurate injury data: fear of reporting to supervisors; fear of lost [payable] time; deficient recognition of work-related injuries and illnesses; the complicated reporting for

Workers Compensation, and others. Pompeii (52) reported that workers may be unclear about when and where to report incidents, and instead rely on their own personal threshold of when to report, based on situational events. Underreporting may also be related to unwillingness to reveal incidence which can also be related to “fear of reprisal for reporting injuries.”(53–55)

Questionnaire facilitation by union stewards may possibly have introduced information bias in the responses. However, the stewards were provided with comprehensive training on the content and required distribution and collection of the questionnaires to ideally ameliorate this potential bias.

This study involved cross-sectional data collection which can introduce temporal bias (56). While the cross-sectional design provided efficiency in the data collection, it does not allow inferences of etiologic associations.(57)

Recall bias, among participants, can lead to differential misclassification of the relevant variables.(58) Raphael (59) observed that recall bias is especially problematic for cross-sectional studies which include retrospective components. Zwerling et al.(60) reported that, researchers must “choose between a shorter recall period to minimize recall bias and a longer period to maximize the precision of rate estimates.” Braun et al.(54), reported that the “sensitivity and specificity of self-reported injury was highest within six months of the examination date.” As such, the SWEEP’s study period of one year was divided into two six-month periods to minimize this recall error.(61–64) Teschke et al.(65), reported that open-ended versus specific exposure questions were more frequently

subjected to recall bias; however, the SWEEP study did not rely on open-ended items.(65)

There were many advantages associated with this project! The SWEEP Study involved participant-driven research, in that the subjects were enthusiastic about the project and requested assistance to study the potential effect of their workload on injury. Being able to consult on appropriate study design with active janitors allowed the research team to design a study that was responsive to the needs of the target population. Further important is that this was also among the first studies to address the important population of janitors that has not typically been open or accessible to such research team efforts.

Conclusions

Results from this study identified decreased risks of injury for both increased job satisfaction and increased physical fitness. Increased mental workload was associated with an increased risk of occupational injury. These findings serve as a basis for further research and opportunities for development of relevant intervention efforts.

Extension of this research to populations such as hotel housekeepers and construction workers could provide important findings where there are similar but not identical exposures that also place these workers at high risk of injury. It will also be important to involve large participating populations, using study designs that will optimize reporting and identification of risks associated with injury outcomes.

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Chapter 6 : The Relation between Janitor Physical Workload, Mental Workload, and Stress: the SWEEP Study

Synopsis

Background: Approximately 2.38 million people are employed as janitors. A high physical workload may explain why their rate of days away from work is 2.7 times higher than for other occupations. Little is known about the relation between janitors' physical workload, mental workload, and stress.

Objective: To assess the relations between exposures of physical (ergonomic) and mental workload and the outcome of stress in a population of janitors.

Methods: Questionnaire data regarding ergonomic workload, mental workload and stress were collected from Minnesota unionized janitors during a one-year period (May 2016 -October, 2016, November 2016-April 2017). Physical workload was assessed with Borg Scales and Rapid Entire Body Assessments (REBA). Mental workload was assessed using the NASA Task Load Index (TLX). Stress was assessed with a single-item stress scale (SISS) and the Perceived Stress Scale-4 (PSS-4). Descriptive and multivariable, including bias adjustment, analyses were conducted on the resulting data.

Results: Multivariable regression identified a relation between physical workload and stress. The Odds Ratios (OR) and 95% confidence intervals (CI) for ergonomic workload (based on task frequency) and SISS were: REBA (1.18 OR, 1.02-1.37 CI) and combined REBA and Borg (1.10 OR, 1.01-1.20 CI). The Borg-

SISS relation suggested importance (1.25 OR, 1.00-1.56 CI). No relation was seen for the PSS-4 and physical workload. A risk of stress was identified for mental workload with both the PSS-4 (0.15 MD, 0.08, 0.22 CI) and the SISS (1.03 OR, 1.01-1.05 CI).

Conclusions: This research increases understanding of the relations between exposures to ergonomic and mental workloads, and the outcome of stress among janitors. These findings are important to identify potential work-related improvements.

Keywords: Janitors, Ergonomics, Mental Workload, Stress, Injury Epidemiology

Background

Approximately 2.38 million persons work as janitors in the United States.(1) Due to concerns about janitors' workload and injuries, the Service Employees International Union Local 26 (SEIU L26) approached researchers in the Division of Environmental Health Sciences at the University of Minnesota for help in better defining this workload. Janitors experience work-related injuries, particularly musculoskeletal disorders and other adverse occupational outcomes.(2) Their work, involving an allegedly high physical workload, appeared to place them at risk for days away from work with a rate 2.7 times higher than all other occupations.(3)

It has been reported that workload factors are potentially related to stress.(4–8) Further, psychosocial stress may be problematic due to its negative effects on mental health (9,10); it also has been reported as deleterious to physical health.(9,11)

Seixas et al., reported a relation between an increase of perceived work intensity and corresponding stress in janitors in Washington State.(12) From a review of the literature between 1981 and 2005, Charles noted that janitors experienced psychosocial stressors, and that these stressors are associated with musculoskeletal disorders.(2) Some international labor unions recognize the problem of occupational stress and are implementing programs to address it.(13)

Janitorial work is a blend of physical and mental demands.(14) Metzger and Parasuraman found reduced mental workload to be a desirable goal for increased performance of air traffic controllers.(15) Yurko and Scerbo et al.,

found that higher mental workload is associated with poorer performance of laparoscopic surgery.(16)

The objective of this study was to assess routine tasks conducted by janitors of SEIU L26, with regard to the relations between physical and mental workload of these janitors, and the outcome of stress.

Methods

Study Design

Ergonomic workload, mental workload, and the outcome of stress were measured through a longitudinal prospective cohort study. Questionnaire data regarding ergonomic workload, mental workload and stress were retrospectively collected from Minnesota unionized janitors during a one-year period (May 2016 - October, 2016, November 2016-April 2017).

Target Population

Following approval by the University of Minnesota Institutional Review Board, a closed prospective cohort study design was initiated. The target population was the approximately 4,000 janitors who were members of the SEIU L26. This group is comprised of approximately 60 percent Hispanic, 20 percent Somali, and 20 percent other ethnicities. This study was restricted to the approximately 1,200 janitors who reported that they worked full time. Access to this population was facilitated by the SEIU L26.

Data Collection Instruments

Initial data were collected through a focus group, followed by administration of specially designed and pre-tested questionnaires. The questionnaires were used to collect data regarding occupational outcomes and exposure data for two sequential six-month recall periods in a one-year longitudinal study (May 2016-October, 2016, November 2016-April 2017). Approximately 1,200 questionnaires were initially distributed to the entire population of full-time SEIU L26 janitors by union stewards at the participating janitors' workplaces. Questions included demographic information (age, gender, smoking status, etc.), ergonomic task exposures, mental workload exposures, and stress outcomes. Task-specific information was collected within the broad job categories of Floor Cleaner, Bathroom Cleaner, and Special Projects (everything else), as established from the focus group discussions. From testing, it was determined that the questionnaire involved an average reading grade level of 6.4, with a Flesch-Kincaid Grade Level of 5.7.(17)

Focus Group

A focus group of approximately 30 janitors was convened, based on a sample of janitors identified by the SEIU L26. To guide the focus group discussion, a structured questionnaire was used which addressed the topic of janitorial tasks. Questions asked included: 'What are the most frequent tasks?' 'What do you believe are the most dangerous tasks?' 'What are the most difficult tasks?' 'How often are each of these performed in a one-week period' and 'Is that estimate of the number of times a job is performed during a week representative of longer periods (up to six-month periods)?'

Ergonomic Workload

This project operationally defined ergonomic workload as a construct of exerting force, repetition of movements, and posture, including synergistic effects. Janitorial tasks were examined for ergonomic workload using the Rapid Entire Body Assessment (REBA) and the Borg scale (a measure of perceived exertion). Both of these are widely-used tools to assess domains of ergonomic workload. The REBA is a practitioner's field tool,(18,19) designed to assess non-neutral working postures. The Borg scale is a 15 point scale of self-reported perceived exertion.(20,21) Ergonomic measures such as the REBA and Borg scales have also been used to measure stress as a marker.(22–25)

Ergonomic workload initially was determined by observing thirty people, 15 men and 15 women. Balanced tertile cut points of this sample were made, based on age, with age groups of 21-39, 40-56, and 57-71. On average, men were 5 feet 6 inches tall and 177.8 pounds in weight; for women these values, respectively, were 5 feet 2.6 inches and 160.5 pounds. The sampling dimensions of gender and age were selected due to the posture-driven nature of ergonomic workload.(26,27) Buchholz determined that a randomly selected worker from a larger crew performing the same operation is appropriate to measure that operation.(28)

A team of ergonomists and trained assistants assessed each janitor's task with both the Borg and REBA instruments. After categorizing the level of risk exposure on REBA as negligible, low, medium, high, and very high, a Fleiss' Kappa of 0.54 was identified for ratings performed by a sub-sample of the

evaluators, indicating moderate agreement.(29)Multiple point samples (snapshot measurements) were taken for each task and then averaged to obtain a task-specific score. The REBA and Borg were combined to create an additive ergonomic workload score to serve as another measurement of ergonomic workload for each task. Task-specific scores were utilized with the questionnaire-based individual task frequencies to obtain a task-summed total ergonomic workload measurement for the targeted 1,200 janitors.

Eight tasks were identified from the focus group as a result of the janitors being asked, “What are the most frequent tasks? What do you believe are the most dangerous tasks? What are the most difficult tasks?” The eight tasks identified were: emptying trash cans less than 25 pounds; emptying trash cans of more than 25 pounds; mopping/sweeping; vacuuming; dusting; cleaning mirrors; cleaning sinks; and cleaning toilets. Realistic simulations of these tasks were created in a working environment to enable assessment of the janitors’ workloads using the REBA and Borg scales; 720 assessments with each scale were conducted.

Questionnaire results regarding ergonomic task frequency data were unclear. In cases where janitors did not give a numeric answer to a frequency item but, rather, indicated that they did a task (writing an “x”, checkmark, or “yes”), their response was imputed to the average value of all respondents who answered a numeric value for that task. Potential outlier responses were truncated to International Sanitary Supply Association standard production rates, based on an 8-hour work shift (which was supported from the

questionnaire).(30)Task cycle times were computed for the three nondiscrete tasks of mopping, vacuuming, and dusting.(30)These time-based variables were standardized as counts of work cycles to have an integer measurement consistent with the discrete, frequency-based variables such as cleaning a sink or emptying a trash can. The task-specific REBA and Borg scores from the ergonomic assessments were then multiplied by the individual task frequencies for the eight tasks as determined from the questionnaire to give an estimate of daily exposure. Standardized versions of these ergonomic exposure scores were calculated by multiplying REBA and Borg scores by task frequencies within age and gender strata.

Mental Workload

“Workload is a term that represents the cost of accomplishing mission requirements for the human operator.”(31) One of the most cited measures of mental workload is the NASA Task Load Index (TLX), which is a multidimensional rating scale that uses six dimensions of workload to “provide diagnostic information about the nature and relative contribution of each dimension in influencing overall operator workload.”(32) TLX subscales are Likert-type scales with 21 selection points. The six dimensions assessed are mental demand, physical demand, temporal demand, performance, effort, and frustration. The ratings indicate how a person “appraises their interaction with the task environment.”(33) This is consistent with the operational definition of workload used in this study. A raw-TLX scale was used because the weighted scale adds participant burden and is correlated to the unweighted scale with an r

= +0.94.(34) In this study, the standard TLX form was simplified to a five-item Likert scale, based on janitor feedback during questionnaire development. Since 1986, the TLX has been extensively modified for research, globally.(31,35,36) Mental workload measures such as the TLX can be used to measure stress.(31,37–39)

Stress

Validated single-item or short-item scales were used to collect participant data on stress. Stress was measured by a single-item stress scale (SISS) created for occupational health professionals to monitor perceived well-being.(40) The item is measured on a 5-item Likert scale and presented as: “Stress means a situation in which a person feels tense, restless, nervous or anxious or is unable to sleep at night because his/her mind is troubled all the time. Do you feel this kind of stress these days?”

The SISS was validated through comparison with the Nordic Questionnaire for Psychological and Social Factors at Work which includes the emotional exhaustion scale of the Maslach Burnout Inventory.(40) This comparison facilitates analysis of construct validity (i.e., does the measure capture the trait), and concurrent criterion of validity (does the measure give the same answer as another, trusted, measure).(40)

Stress was also measured by the 4-item version of the Perceived Stress Scale (PSS-14). This version, known as the PSS-4, contains 4 of the 14 items of the original PSS-14 (41). The PSS-4 was chosen in preference to the 14 item version to limit participant burden.

The SISS and the PSS-4 approach a definition of “stress,” differently. Psychological stress can be considered a “particular relationship between the person and the environment, which is appraised by the individual as taxing or exceeding his resources, and endangering his well-being.”(42) This is the definition of stress that the PSS series utilizes.(43,44) The SISS defines stress as situational anxiety.(40) Both of these definitions focus upon the assumption that resources for coping with life situations are not sufficient. The operational definition of stress for this study is a simplified version of that of the PSS-4, i.e., the extent to which people perceive that demands are greater than their ability to cope with those demands.

Data Analysis

The REBA and Borg were used to assess ergonomic workload. Ergonomic task frequency, mental workload, and stress were measured, individually, based on data reported in the respective questionnaires. Data were independently entered by two researchers into a Redcap database.(45) The Redcap software enabled comparisons for consistency of entries; any conflicts were resolved by the research team. Descriptive analyses were conducted to identify the frequencies and distributions of survey responses and ergonomic workload scores, respectively.

Results of the PSS-4 were treated as a continuous variable and linear regression was used to find any associations across each exposure category. Ordinal logistic regression was used for the SISS outcome. Potential confounders were identified *a priori* using relevant literature and research team

expert knowledge. Then, a master Directed Acyclic Graph (DAG), was created with causal pathways between each of the exposures, confounders and outcome of stress.(46) For each specific research question, the DAG's pathways were reduced to the smallest logical set of potential confounders to create the minimal, set of variables for inclusion in the appropriate regression equations between exposures and outcome (see Figure 6-1).(47,48) DAGs are a valuable tool used to infer the causal direction of the association between two variables while excluding extraneous variables which are unnecessary for the regression.(47) Generalized Estimating Equations (GEE) were used to account for potentially correlated data: If individual janitors completed two surveys over the respective study time periods, GEE was used to limit clustering bias.(49) Potential response bias, resulting from a lower response rate, was minimized by inversely weighting observed responses by probabilities of response, estimated as a function of characteristics available from the SEIU L26.(50,51); those characteristics were gender, age, and janitorial contracting company. This technique used re-weighting of estimates using group response characteristics to account for the potential differences in responses.(52)

As shown in the example of a DAG in Figure 6-1, it was hypothesized that ergonomic workload is positively associated with stress. To analyze the relation between ergonomic workload and stress, the multivariable model was adjusted for smoking, gender, job title, age, and non-response.

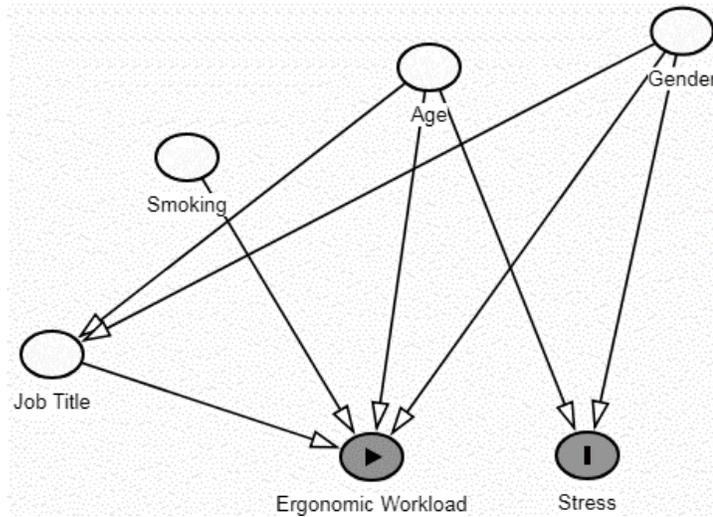


Figure 6-1: Directed Acyclic Graph of the Relation between Ergonomic Workload and Stress.

Results

There was a response rate of 32.5%, with 390 janitors responding for one of the two surveys; 137 janitors responded to both surveys (Figure 6-2).

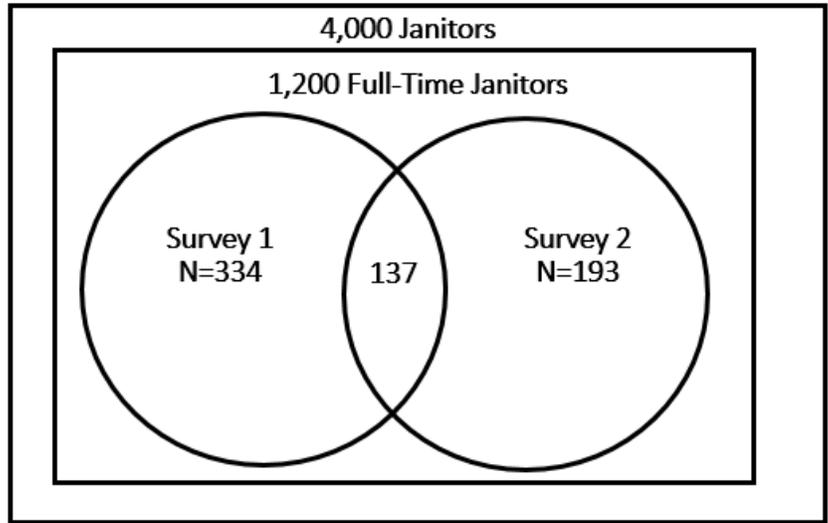


Figure 6-2: Study Size Flow Chart for the SWEEP Study

Of the 390 janitors who responded, 55% were female. 45% identified as male, 10% of the janitors were aged 18-30, 30% were 31-40, 30% were 41-50, 23% were aged 51-60, and 6% janitors were over 60 years of age. By racial classification, 57% of janitors were black or African American, 30% were white, and 13% identified as another race.

Ergonomic Workload

Both ergonomic measures (REBA and Borg) were tested for correlation, resulting in a Pearson Correlation Coefficient of 0.99. The means of the shift-based ergonomic impact are shown in Table 6-1.

Measures	N	Mean	SD	Minimum	Maximum
REBA	500	2122.40	1434.30	12.18	8167.83
Borg	500	1548.29	988.40	9.97	5879.17
Combined	500	3676.16	2417.55	22.20	14068.39
Standardized REBA	448	2131.25	1433.75	20.23	8019.00
Standardized Borg	448	1616.24	1227.92	16.09	8086.17
Standardized Combined	448	3751.09	2579.13	36.33	16110.48
SD=Standard Deviation					

Mental Workload

There were 444 responses to the TLX (Table 6-2); approximately 100 were from the same people over both survey periods. Partially answered scores were not counted. The TLX scores ranged from six to 30, with 30 identifying the highest mental workload. The mean score was 20.60 with a standard deviation of 4.08.

Table 6-2: Mental Workload Distribution of Janitors Assessed by NASA Task Load Index: The SWEEP Study

Survey Questions												
	How mentally demanding has it been working as a janitor?		How physically demanding has it been working as a janitor?		How rushed have you been working as a janitor?		How successful were you in completing what you were asked to do?		How hard did you have to work to do your job?		How frustrated have you been with your work as a janitor?	
Demand Level	N	%	N	%	N	%	N	%	N	%	N	%
Very Low Demand	26	5.86	10	2.25	8	1.8	3	0.68	25	5.63	41	9.23
Low Demand	59	13.29	43	9.68	41	9.23	31	6.98	45	10.14	83	18.69
Medium Demand	185	41.67	148	33.33	156	35.14	140	31.53	145	32.66	168	37.84
High Demand	125	28.15	172	38.74	165	37.16	199	44.82	165	37.16	103	23.2
Very High Demand	49	11.04	71	15.99	74	16.67	71	15.99	64	14.41	49	11.04

Stress

There were 438 responses to the SISS; approximately 100 janitors provided responses for both survey periods. The most common response (N=158) was that they were sometimes stressed. The distribution is seen on Table 6-3.

Table 6-3: Stress Distribution of Janitors Assessed by the Single Item Stress Scale: The SWEEP Study		
Survey Question		
Stress means a situation in which a person feels tense, restless, nervous or anxious or is unable to sleep at night because his/her mind is troubled all the time. Do you feel this kind of stress these days?		
Response	N	%
Not at all	69	15.75
Very Little	66	15.07
Sometimes	158	36.07
Often	101	23.06
Very Much	44	10.05
Missing	89	16.89

There were 310 responses to the PSS-4 (Table 6-4). No partially answered scores were counted. The PSS-4 responses ranged from four (“Never” response for all questions) to 20 (“very Often” response for all questions), with 20 establishing the highest stress level. The most frequent responses for all four questions in the PSS-4 were “Almost Never” or “Sometimes”. The mean score for this population was 9.04, with a standard deviation of 2.51. A moderate correlation of 0.35 was found between the PSS-4 and the SISS.(53)

Table 6-4: Stress Distribution of Janitors Assessed by the Perceived Stress Scale-4: The SWEEP Study								
	Survey Questions							
	In the past month how often have you felt that you were unable to control the important things in your life?		In the past month how often have you felt confident about your ability to handle your personal problems?		In the past month, how often have you felt that things were going your way?		In the past month, how often have you felt difficulties were piling up so high that you could not overcome them?	
Response Level	N	%	N	%	N	%	N	%
Never	61	19.68	55	17.74	38	12.26	52	16.77
Almost Never	60	19.35	107	34.52	95	30.65	92	29.68
Sometimes	129	41.61	103	33.23	141	45.48	125	40.32
Fairly Often	41	13.23	20	6.45	21	6.77	33	10.65
Very Often	19	6.13	25	8.06	15	4.84	8	2.58

For all bivariate results (regression with one independent and one dependent variable) (Table 6-5), a positive relation was found between the exposures of mental workload and stress. Mental workload was statistically significant for both stress scales. Ergonomic workload was statistically associated with SISS for the REBA, the Borg, the combined REBA and Borg, the standardized REBA, and the standardized combined REBA and Borg, but not for the standardized Borg. Ergonomic workload was not important for the PSS-4.

Measures	PSS-4				SISS			
	MD	95% CI		P.Value	OR	95% CI		P.Value
REBA*	0.15	-0.04	0.34	0.1246	1.20	1.04	1.40	0.0126
Borg*	0.22	-0.07	0.50	0.1397	1.29	1.04	1.60	0.0227
Combined (REBA + Borg)*	0.09	-0.03	0.20	0.1295	1.11	1.02	1.21	0.0158
Standardized REBA*	0.22	-0.01	0.45	0.0578	1.17	1.01	1.35	0.0316
Standardized Borg	0.21	-0.08	0.49	0.1554	1.17	0.99	1.39	0.0601
Standardized Combined*	0.12	-0.01	0.25	0.0817	1.09	1.01	1.18	0.0359
Mental Workload*	0.17	0.09	0.24	<.0001	1.16	1.10	1.22	<.0001

* Significant at 0.05 level
OR=Odds Ratios CI=Confidence Intervals MD=Mean Differences

For all multivariable results (Table 6-6), positive relations were found between the exposures of ergonomic workload and mental workload, and the outcome of stress. While not statistically significant, ergonomic workload suggested potential importance in relation to the PSS-4 in all categories. Ergonomic workload was statistically significant for the SISS in the individual REBA and the combined individual REBA and Borg scales. While the individual Borg was not statistically associated with the SISS, it indicated potential importance. Mental workload had a statistically significant positive relation with stress on both stress scales.

Table 6-6: Multivariable Regressions of the Relations between Exposures and Stress among Janitors

Measures	PSS-4			SISS				
	MD	95% CI		P. Value	OR	95% CI		P. Value
REBA‡*	0.16	-0.02	0.35	0.0853	1.18	1.02	1.37	0.0279
Borg‡	0.24	-0.05	0.52	0.1015	1.25	1.00	1.56	0.0525
Combined (REBA+Borg)‡*	0.10	-0.02	0.21	0.0906	1.10	1.01	1.20	0.0359
Standardized REBA‡	0.21	-0.00	0.43	0.0549	1.15	1.00	1.33	0.0578
Standardized Borg‡	0.25	-0.06	0.56	0.1186	1.13	0.94	1.36	0.1940
Standardized Combined‡	0.12	-0.01	0.25	0.0714	1.07	0.99	1.17	0.0929
Mental Workload*	0.15	0.08	0.22	<.0001	1.03	1.02	1.05	0.0002

* Significant at 0.05 level

•Adjusted for SES

‡Adjusted for gender, age, smoking and job title

OR=Odds Ratios CI=Confidence Intervals MD=Mean Differences

Discussion

Average REBA scores for the janitors' eight tasks were identified in the high-risk category. This is similar to Nawi's Malaysian palm oil harvesters whose study of seven tasks reported that all seven tasks resulted in REBA scores ranging from high risk to very high risk.(54) Gentzler used REBA to study

emergency medical technicians and firefighters, finding extreme risk for some of the similar postures (lifting and reaching) that janitors utilize.(55) Ansari reported that 53% of studied Indian factory workers were working at high REBA risk levels while 33% were working at medium risk levels.(56)

Average Borg scores ranged between the very light and somewhat difficult categories. This is similar to data reported by Jakobsen et al., in their comparison between the Borg scale and muscular load in Danish manual laborers, finding that many blue-collar workers reported a moderate level of exertion.(57)

From multivariable regression analyses, it was identified that ergonomic workload (measured by task frequencies, REBA, and Borg scores), was positively related to the PSS-4. The outcome of stress, measured by the SISS, was significantly associated with the ergonomic measures of the REBA and combined REBA and Borg; but, there was no association with the individual Borg. This is analogous to Hess's finding of a relation between perceived stress and development of repetitive strain injury symptoms in computer users.(58) In addition, Chen et al. (59), reported an association between musculoskeletal pain and psychosocial factors in Chinese offshore workers.

Mental workload was significantly associated with both the PSS-4 and the SISS. This is supported by the similarities of the constructs of mental workload and stress. While researchers use both stress scales and the TLX together, there is an element of overlap in the constructs of stress and mental workload.(60)

All psychometric scales require standardizing before they are useful; the best scales are standardized to a specific population.(61) This project enabled standardizing of the PSS-4, the modified TLX, and the SISS to a metropolitan population of janitors.

Advantages and Limitations

Because much of the data for this study was questionnaire-based, requiring self-reporting, the low response rate of 32.5% is a limitation. However, potential response bias was reduced by inversely weighting observed responses by probabilities of response, estimated as a function of janitor characteristics provided by SEIU L2.(52)

Another potential limitation is that there is evidence of a fear of reprisal with reporting of injuries and adverse occupational outcomes.(62) There is also a perceived stigma for reporting stress outcomes.(63) Underreporting may also be related to an unwillingness to reveal activities associated with injury incidence (64,65).

A strategy to mitigate recall bias was considered in the study design; thus, the study period of one year was divided into two sequential six-month periods to lessen recall error.(65) While questionnaire distribution by union stewards may have introduced potential information bias in the responses, the research team ensured that stewards received comprehensive training on the questionnaire content and distribution in an attempt to ameliorate the potential bias. In addition, while the cross-sectional study design is efficient (66) and provides important

information on a population that has been difficult to access, the results cannot be interpreted as causal. Rather, they serve as a basis for further research and potential evaluation of relevant prevention strategies.

There were many advantages associated with this project. In particular, it involved participant-driven research, in that the subjects were enthusiastic about the project and requested assistance to study the potential effect of their workload on injury. Access to the janitors greatly assisted the feasibility and conduct of the research; thus, the ability to consult relevant to appropriate study design with active janitors allowed the research team to design a study that was responsive to the needs of the target population. In addition, the number (n=720) of individual ergonomic assessments conducted on the participating janitors is unusually large for a study of this type and enabled analyses of data important not only to this population but, also, potentially to other similarly active occupational populations.

Conclusions

To reduce the amount of stress that janitors experience, it would appear important to test strategies that could reduce both ergonomic workload and mental workload. Expansion of this work should involve investigations of the relations between ergonomic workload and stress in different populations. Such populations might include hotel housekeepers and construction workers. Aside from examining different occupational burdens, it will be particularly important to develop relevant interventions that can be implemented and transformed into practice to ensure reduction of the burdens on such occupations.

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Chapter 7 : Discussion and Conclusions

This study examined the relations between work exposures and work-related injuries among janitors. The findings in the SWEEP study were based on the population of SEIU L26 janitors in the Greater Twin Cities in Minnesota and involved three phases: Focus group discussions, questionnaire development and dissemination, and analyses. The focus groups were designed to obtain the janitors concerns, pretest the questionnaire, and identify the janitors' perceptions of their 'difficult, dangerous, and common' tasks. The questionnaires enabled one-year (two sequential six-month periods, May 2016-October, 2016, November 2016-April 2017) of retrospective data collection on the janitors' demographics, health status and history, injury experience, physical workload, physical fitness, mental workload, stress, and job satisfaction. The ergonomic analyses (REBA and Borg assessments), collected through a sub-study, were used to analyze physical and non-physical risks associated with janitorial work.

Study 1- Janitor Ergonomics and Injuries in the SWEEP Study

The aim of this study was to examine the relation between ergonomic workload and injury. To this end, focus groups were convened, questionnaires were completed, and ergonomic assessments were conducted. The ergonomic assessments used were the Rapid Entire Body Assessment (REBA), a checklist-form for studying task cycle angles, musculoskeletal stresses, and postures, and the Borg scale, which measures perceived exertion. Eight tasks (mopping, vacuuming, dusting, emptying small [<25lb] trash cans, emptying large

[>25pound] trash cans, cleaning mirrors, sinks, and toilets) were found to be common among janitors. Some key findings included that all average task-based REBA scores were identified in the high risk category. Of those eight tasks, the task of repeatedly emptying small trash cans (<25lb) was significantly related to injuries. Average Borg scores ranged between the very light perceived exertion and somewhat difficult perceived exertion categories. From multivariable regression analyses, it was determined that ergonomic workload, measured by task frequencies and REBA and Borg scores, was positively related to injury occurrence.

Study 2- Mental Workload, Psychosocial Factors, Physical Fitness, and Injury in the SWEEP Study

The aim of this study was to identify the potential relations between mental workload, job satisfaction, stress, physical fitness, and the outcome of injury occurrence in janitors. To this end, janitors completed questionnaires which included questions about mental workload (modified NASA Task Load Index), job satisfaction (Andrews and Withey Job Satisfaction Scale), stress (Perceived Stress Scale-4, and the Elo Single Item Stress Scale), physical fitness and injury experience. Some important results included: the exposures of low job satisfaction and low physical fitness were statistically significantly associated with increased risk of injury occurrence. High mental workload was positively associated with injury occurrence.

Study 3- The Relation between Janitor Physical Workload, Mental Workload, and Stress: the SWEEP Study

The aim of this study was to identify the relation between ergonomic and mental workload and stress in a population of janitors. Using the specially designed and tested questionnaire, data relevant to exposures of ergonomic and mental workload and the outcome of stress were collected over two six-month sequential periods. The Elo Single Item Stress Scale (SISS), the Perceived Stress Scale-4 (PSS-4), and the NASA Task Load Index were included in the questionnaire. In addition to the survey process, Borg and REBA ergonomic assessments were conducted on a subset of janitors and extrapolated to population data. Results of the PSS-4 were treated as a continuous variable and linear regression was used to identify potential associations between each exposure and outcome. Ordinal logistic regression was used for the SISS outcome. Key results from multivariable regression analyses identified a relation between ergonomic workload and stress. Ergonomic workload was statistically significant for the SISS in the individual REBA and the combined individual REBA and Borg scales. Mental workload demonstrated significantly increased risks for stress, measured by both the PSS-4 and the SISS.

Limitations and Advantages of the SWEEP Study

Because much of the data for this study was questionnaire-based, requiring self-reporting, the low participation rate of 32.5% is a limitation. However, potential response bias was reduced by inversely weighting observed responses

by probabilities of response, estimated as a function of janitor characteristics provided by SEIU L2.(1)

Another potential limitation was the fear of reprisal with reporting of injuries and adverse occupational outcomes.(2) Azaroff and Levenstein et al. (3), documented barriers limiting the collection of accurate injury data: fear of reporting to supervisors; fear of lost [payable] time; deficient recognition of work-related injuries and illnesses; the complicated reporting for Workers' Compensation, and others. Pompeii (4) reported that workers may be unclear about when and where to report incidents and, instead, rely on their own personal threshold of when to report, based on situational events. There is also a perceived stigma for reporting stress outcomes.(5) Underreporting may also be related to an unwillingness to reveal activities associated with injury incidence (6,7). Other potential barriers to reporting include having work-related pressures that limit time to complete reports, fears of the report never being read, and the mindset that injuries are part of the job.

Questionnaire facilitation by union stewards, in the current study, may also have potentially introduced information bias in the responses; however, these stewards received targeted training from the research team relevant to the questionnaire content and administration in an attempt to ameliorate this potential bias.

The SWEEP study questionnaire's cross-sectional collection of data could have introduced incidence-prevalence bias (or Neyman bias) (8–10). This bias is caused by potential early drop out before the study is initiated or before the data

are collected that can lead to differential dropout between people prone to injury and those who are not (11). Neyman bias may be minimized by the short recall period of the study and the reduced likelihood of job-changing injuries. Similarly, this shortened recall period may reduce the healthy worker effect -- a concern with many occupational studies (12).

Recall bias, among participants, can lead to differential misclassification of the relevant variables.(13) Raphael (14) observed that recall bias is especially problematic for cross-sectional studies which include retrospective components. Zwerling et al.(15), reported that, researchers must “chose between a shorter recall period to minimize recall bias and a longer period to maximize the precision of rate estimates.” Braun et al. (7), reported that the “sensitivity and specificity of self-reported injury was highest within six months of the examination date.” As such, the SWEEP’s study period of one year was divided into two six-month periods to minimize this recall error.(16–19)Teschke et al.(20), reported that open-ended versus specific exposure questions were more frequently subjected to recall bias; however, the SWEEP study did not rely on open-ended items.(20)

In addition, while the cross-sectional study design is efficient (9) and provides important information on a population that has been difficult to access, this design can introduce temporal bias (8). While this does not allow inferences of etiologic associations (21), the study findings serve as a basis for further research and potential evaluation of relevant prevention strategies.

There were many advantages associated with this project. In particular, it involved participant-driven research, in that the subjects were enthusiastic about the project and requested assistance to study the potential effect of their workload on injury. Access to the janitors greatly assisted the feasibility and conduct of the research; thus, the ability to consult relevant to appropriate study design with active janitors allowed the research team to design a study that was responsive to the needs of the target population. In addition, the number (n=720) of individual ergonomic assessments conducted on the participating janitors is unusually large for a study of this type and enabled analyses of data important not only to this population but, also, potentially to other similarly active occupational populations. Further important is that this was also among the first studies to address the important population of janitors that has not typically been open or accessible to such research team efforts.

Future Studies

Directions for future research include studies of larger populations and development of potential interventions to reduce injuries. Disrupting either the frequency of the janitorial tasks or their intensity, as well as consideration relevant to equipment redesign and alteration of task conduct, are potentially fruitful avenues. Unlike the Borg, the REBA has many components. It is possible to see which factors have the largest impact on the REBA score. This current study involved a cross-sectional design, enabling comparisons between the workload exposures and the outcome of injury. It will also be important to

examine relations between various combinations of task frequencies and intensity (as measured by REBA and Borg) and injury outcome.

Extension of this research to populations such as hotel housekeepers and construction workers could provide important findings where there are similar but not identical exposures that also place these workers at high risk of injury. It will also be important to involve large participating populations, using study designs that will optimize reporting and identification of risks associated with injury outcomes. Aside from examining different occupational burdens, it will be particularly important to develop relevant interventions that can be implemented and transformed into practice to ensure reduction of the burdens on such occupations.

Conclusions

The magnitude of workload exposures and potential risk factors in an occupational population of janitors are identified in this comprehensive study. From the Janitor Ergonomics and Injuries in the SWEEP study results, ergonomic workload appears to have an effect on the risk of work-related injuries. From the Workload, Fitness, Psychosocial Factors and Injury in the Janitor SWEEP Study, job satisfaction, physical fitness, and mental workload also appear to have effects on the risk of work-related injuries. The Janitor Ergonomics, Mental Workload, and Stress in the SWEEP Study also identified that ergonomic workload and mental workload appear to affect the risk of stress. The information from these study results contribute to the understanding of the

relations between workload and injuries in janitors. This research serves as a basis for future research and interventions for this underserved population.

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APPENDICES

Appendix A: Janitor Questionnaire

Appendix B: Questionnaire Consent Form

Appendix C: Ergonomic Assessment Consent Form

Appendix D: UMN IRB Approval Notice

Appendix A: Janitor Questionnaire



CONSENT FORM

Janitors' Workload and Injury Study

You are invited to join a cooperative project between the University of Minnesota and the SEIU Local 26 that is planned to assess workload, health, and injury experience as well as injury reporting, using the attached questionnaire. You were selected for this opportunity because the SEIU L26 identified you as a janitor. We ask you to read this form and ask any questions you may have before agreeing to join this project. This project is being conducted by Deirdre Green and Adam Schwartz, graduate students in Environmental Health Sciences, University of Minnesota, together with a faculty research team from the University of Minnesota.

Background Information

The purpose of this project is to: identify factors that may contribute to injuries. To identify the injury problem, the following questionnaire asks about your employment, health status, injuries, workload, sleep quality, and your work environment. To address issues with injury reporting, this questionnaire asks about your experience with injuries and reporting; for some, this will be followed with information about how to recognize and report work-related injuries. Six months later, you will be asked to complete a second questionnaire that asks the same questions. This is important so there will be a complete year of information about your workload and injury experience - for the best results! *To provide accurate information, that is not unfair, it is important to complete the questionnaire whether or not you had any injuries during the reporting period.*

Approximately one hundred janitors will be asked to participate in a smaller portion of the project that measures workload using FitBit bands. Another small portion of janitors will also be observed on the job to assess physical workload.

Procedures:

If you agree to join in this project, you will be asked to do the following things:

- Complete the following questionnaire, both at the beginning of the project and 6-months later, for follow-up.
- Review the information. If information is unclear or you have additional questions, please contact Adam Schwartz and Deirdre Green [contact information below].
- *If you are participating in the workload assessment projects, including the FitBit study, separate information will be provided to you for your review, before you participate in those assessments.*

Risks and Benefits of Participating in the Project

The project has minimal risks and several benefits:

You will be asked to remember information about injuries that happened during the six-month period, identified, while employed as a janitor. You are NOT required to answer any questions with which you are uncomfortable; just mark an "X" on any question number you do not wish to answer, and continue to the next question. All of your responses will remain confidential and will never be identified with you.

The benefits of participating this project are:

Janitors will benefit directly from the knowledge gained, including new information, about janitors' workload and potential risk of injury.

Compensation:

All participating janitors will have an opportunity to be entered into a drawing for a \$50 Target gift card, providing them at least a 1 in 20 opportunity of receiving a gift card. A total of 110 gift cards will be available for this opportunity and will be provided following completion of the second questionnaire. All janitors who indicate that they want to be included in the drawing, whether or not they participate, will be among those randomly selected by the research team following completion of the study.



Confidentiality:

Your questionnaire records will be kept completely private. In any report or paper that is published, only group information is provided; no individual person can ever be identified. Project records will be stored securely at the University of Minnesota and only the research team will have access to the records. Project data will be coded according to current University of Minnesota policy for protection of confidentiality.

Voluntary Nature of the Project:

Participation in this project is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota or the SEIU Local 26. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:

The persons conducting this project are: Deirdre Green (gree1982@umn.edu) and Adam Schwartz (schw1562@umn.edu) (612-624-1296) and Dr. Susan Gerberich (gerbe001@umn.edu), together with other members of the research team. You may ask any questions you have now. If you have questions later, you are encouraged to contact them at the University of Minnesota, through the email addresses or telephone number identified above. Rony Arauz is the Spanish language team member, who can be reached by telephone at 612-625-5887 or by email (arauz005@umn.edu).

If you have any questions or concerns regarding this project and would like to talk to someone other than those identified above, you are encouraged to contact the Research Subjects' Advocate Line, D528 Mayo, 420 Delaware St. Southeast, Minneapolis, Minnesota 55455; (612) 625-1650.

You will be given a copy of this information to keep for your records.

Statement of Consent:

I have read the above information. I have asked questions and have received answers. I agree to participate in this project.

Full Name: _____

Signature: _____ Date: _____

Mailing Address: _____

Email Address: _____

Telephone Number: _____

Signature of Investigator: _____ Date: _____



Janitor Workload Health and Injury Project: Phase I

Today's Date: _____

Confidentiality: The information that you provide will be kept strictly confidential and no information that could personally identify you or the facility in which you work(ed) will ever be made public. Only investigators at the University of Minnesota will ever have direct access to the information: any report or published paper will include only grouped information. If there is any question you do not wish to answer, please mark an X on the question number and continue to the next question.

Questionnaire and Envelope: When you have completed the questionnaire, please place it in the envelope and seal the envelope that includes the University of Minnesota address on the front. Then, return it to your Steward or the SEIU L26 representative who gave this to you. The Steward or representative who gave it to you, will return it to the SEIU L26 office where it will be placed in a large locked box until it is picked up by a member of the University of Minnesota research team member.

Gift Card Drawing: Remember! We are providing Target gift cards valued at \$50, each, to a minimum of 110 randomly selected individuals. You are not required to complete the questionnaire to be eligible for this drawing; however, if you have not already indicated your interest, YOU DO NEED TO CHECK YES OR NO BELOW.

- | |
|--|
| <input type="checkbox"/> <i>YES, include me in the gift card drawing</i>
<input type="checkbox"/> <i>NO, do not include me in the gift card drawing</i> |
|--|



Remember to fill in the consent form on Page 2 before starting the following questions!

THE FOLLOWING QUESTIONS ASK ABOUT YOUR JOB AS A JANITOR.
PLEASE ANSWER THE FOLLOWING QUESTIONS **IN ORDER BY NUMBER.**

1. OVER YOUR LIFETIME, how long have you been employed as a janitor? (Please indicate the number of years and/or months)

If Less than one year:

Number of months? _____

If One or More years:

Number of years? _____

2. HOW LONG HAVE YOU WORKED with your current company? (Please indicate the number of years and/or months)

If Less than one year:

Number of months? _____

If One or More years:

Number of years? _____

3. What was your JOB TITLE at the building where you worked most of the time in the 6 months between May 1 and October 31, 2016? (Check all that apply)

- Bathroom Cleaner
- Floor Cleaner
- Special Projects
- Other Job Title
Please Describe _____

4. Did you work FULL-TIME OR PART-TIME, or other: (Check one)?

- Full-Time
- Part-Time
- Other
Please Describe _____

5. About HOW MANY HOURS PER WEEK did you work in the 6 months between May 1 and October 31, 2016?
_____ hours per week

6. What were your USUAL WORK TIMES in the 6 months between May 1 and October 31, 2016? (Please fill in start and end times and circle a.m. or p.m.).

a.m. is midnight to noon; p.m. is noon to midnight.

____:____ (a.m./p.m.)

to

____:____ (a.m./p.m.)

7. During those 6 months, did you have OTHER JOBS besides this job? (Check one)

Yes No → (if NO, skip to question 9)

8. HOW MANY OTHER JOBS did you have?
_____ number of other jobs

For these other jobs, in the 6 months between May 1 and October 31, 2016, about HOW MANY HOURS per week did you work?

_____ hours per week



For the following questions, think about YOUR WORKLOAD in the 6 months between May 1 and October 31, 2016:

9. On an AVERAGE SHIFT how many SMALL TRASH/RECYCLING CANS (up to 25lbs) did you empty? _____

10. On an AVERAGE SHIFT how many LARGE TRASH/RECYCLING CANS (over 25lbs) did you empty? _____

11. On an AVERAGE SHIFT how much TIME DID YOU SPEND VACUUMING?

If less than 1 hour, how many minutes? _____ MINUTES

If 1 hour or more, how many hours? _____ HOURS

12. On an AVERAGE SHIFT how much TIME DID YOU SPEND SWEEPING or MOPPING?

If less than 1 hour, how many minutes? _____ MINUTES

If 1 hour or more, how many hours? _____ HOURS

13. On an AVERAGE SHIFT how much TIME DID YOU SPEND DUSTING?

If less than 1 hour, how many minutes? _____ MINUTES

If 1 hour or more, how many hours? _____ HOURS

14. On an AVERAGE SHIFT how many SINKS did you clean? _____

15. On an AVERAGE SHIFT how many TOILETS did you clean? _____

16. On an AVERAGE SHIFT, how many MIRRORS did you clean? _____

17. How did your WORKLOAD CHANGE in the 6 months between May 1 and October 31, 2016? (Check one)

- Increased
- Decreased
- No change



If workload increased, which of the following caused CHANGES in your workload? (Check all that apply)

- | | |
|--|---|
| <input type="checkbox"/> Fewer staff | <input type="checkbox"/> New equipment |
| <input type="checkbox"/> More job duties | <input type="checkbox"/> Intensity of work |
| <input type="checkbox"/> Training other employees | <input type="checkbox"/> Complaints from customers, coworkers, management |
| <input type="checkbox"/> Less funding | <input type="checkbox"/> Other, please describe _____ |
| <input type="checkbox"/> Lack of supplies or equipment (resources) | |



The next questions are about MODERATE OR VIGOROUS PHYSICAL ACTIVITY you did in the past 7 days as part of your PAID OR UNPAID WORK. This does not include traveling to and from work.

18. During YOUR WORK TIME, in the past 7 days, ON HOW MANY DAYS did you do moderate or vigorous physical activities like heavy lifting, vacuuming, cleaning, walking, or climbing up stairs? Think about only those physical activities that you did for at least 10 minutes at a time.

_____ days per week

_____ No vigorous job-related physical activity → Skip to question 20.

19. On average, HOW MUCH TIME DID YOU SPEND on one of those days doing moderate or vigorous physical activities as part of your work?

_____ hours per day

_____ minutes per day



An **ACCIDENT** or **INJURY, INCLUDING PAIN**;

Is one that involves any of the following:

- (1) Restricted normal activities for at least 4 hours
and/or
- (2) Resulted in loss of consciousness/being knocked out/,
and/or
- (3) Required professional healthcare, including care by doctors, nurses, chiropractors, dentists or other healthcare professionals.

20. Did you have ANY WORK-RELATED INJURIES in the 6 months between May 1 and October 31 2016?

YES

No ---> If NO, skip to Question 39, Page 12

21. How **MANY TIMES** in the 6 months between May 1 and October 31, 2016 were you injured at work? _____ #

Please provide the following information for EACH work-related injury/pain event that happened to you between May 1 and October 31 2016. Please fill in the date of injury/pain (if unsure of exact month, please give your best guess) and check the work shift time(s) of injury/pain. If you had one or more injuries/pains – up to 4 events, please tell us about EACH event (1-4) below.

DURING THE PAST 6-MONTHS (between May 1 and October 31, 2016):	Injury/Pain 1	Injury/Pain 2	Injury/Pain 3	Injury/Pain 4
22. Date(s) of injury(s) (Fill in month and year. If unsure of exact month, please give your best guess)	___/___/___ Month/Year	___/___/___ Month/Year	___/___/___ Month/Year	___/___/___ Month/Year
23. Time(s) of injury(s) (Check all that apply for each event)				
Beginning of Shift	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Middle of Shift	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
End of Shift	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please DESCRIBE how each event occurred. What were you doing just before the event? What started the event?
Please use the back of this paper if needed.

24. Injury/Pain 1: _____

25. Injury/Pain 2: _____

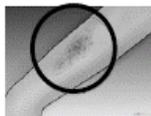
26. Injury/Pain 3: _____

27. Injury/Pain 4: _____



28. What was (were) the TYPE(S) of injury? CHECK ALL THAT APPLY FOR EACH EVENT.

See picture examples below also	Injury/Pain 1	Injury/Pain 2	Injury/Pain 3	Injury/Pain 4
A. Abrasion/Bruise	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
B. Amputation/loss of body part	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
C. Asphyxia/loss of breath/loss of oxygen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
D. Bite	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
E. Burn	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
F. Concussion (Loss of consciousness / "knocked out")	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
G. Crushing/mangling	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
H. Cut/laceration/scratch	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I. Fracture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
J. Dislocation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
K. Nerve injury	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
L. Pain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
M. Penetration injury, including puncture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
N. Poisoning	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
O. Sprain/strain/rupture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
P. Torn ligament	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q. Varicose Veins	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
R. Other (Specify _____)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



A. Abrasion/Bruise



B. Loss of Body Part



C. Loss of breath



D. Bite



E. Burn



F. Concussion



G. Crushing/Mangling



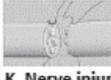
H. Cut/Scratch



I. Fracture



J. Dislocation



K. Nerve injury



L. Pain



M. Puncture



N. Poisoning



O. Sprain/Strain



P. Torn ligament



Q. Varicose veins



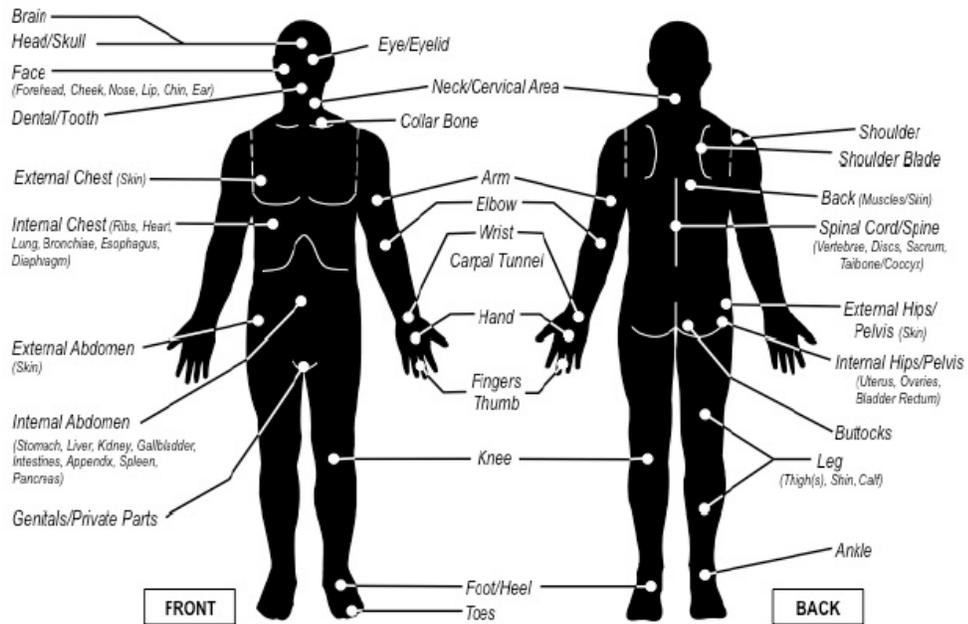
R. Other type





29. What BODY PART(S) were injured? CHECK ALL THAT APPLY FOR EACH EVENT.

	Injury/Pain 1	Injury/Pain 2	Injury/Pain 3	Injury/Pain 4
Head/skull/brain	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Face (forehead, cheek, nose, lip, jaw, ear)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Eye/eyelid	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Teeth	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Neck/cervical area	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Back (muscles, skin)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Chest	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Spinal cord/spine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Abdomen/Stomach	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Shoulder	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Arm/elbow/wrist	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hand/fingers/thumb(s)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hips	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Buttocks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Genitalia/private body parts	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leg (thigh, shin, calf, knee, ankle)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Foot/heel, toes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other (Specify _____)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



Includes internal and external injuries



30. What CAUSED your injury event? CHECK ALL THAT APPLY

	Injury/Pain 1	Injury/Pain 2	Injury/Pain 3	Injury/Pain 4
A. Contact with object, equipment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
B. Overexertion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
C. Struck by object	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
D. Struck against object	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
E. Caught in object, equipment, material	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
F. Fall to lower level	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
G. Fall to same level	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
H. Slip, trip	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I. Repetitive Motion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
J. Exposed to Harmful Substance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
K. Fires, explosions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
L. Other Cause (specify)_____	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



A. Contact with object/equipment



B. Overexertion:
Injuries related to pulling, pushing, holding, carrying and throwing.



C. Struck by object:
Objects that fall from shelves or dropped by another person



D. Struck against an object:
When a person runs into concrete objects such as walls, doors cabinets, tables, chairs, etc.



E. Caught in object or equipment



F. Fall to lower level:
Falling to a level below one that you walk or stand on (i.e. ladder, stairs, etc.)



G. Fall to same level:
Falling to a surface you are walking on



H. Slip, Trip



I. Repetitive motion:



J. Exposed to harmful substance:



K. Fires, explosions:



L. Other cause



31. Were you TREATED BY any of the following as a result of this (these) events?

CHECK ALL THAT APPLY FOR EACH INJURY/PAIN EVENT

	Injury/Pain 1	Injury/Pain 2	Injury/Pain 3	Injury/Pain 4
A. No treatment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
B. Physician (non-Psychiatrist)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
C. Dentist	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
D. Chiropractor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
E. Nurse/Nurse Practitioner/Nurse Clinician/Physician's Assistant	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
F. Psychiatrist/Psychologist/Therapist	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
G. Paramedics/Emergency Medical Technician	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
H. Holistic, Alternative, or Non-traditional medical provider	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I. Treated yourself	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
J. Other (Specify) _____	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



A. No treatment



B. Physician



C. Dentist



D. Chiropractor



E. Nurse/Nurse practitioner /
Nurse clinician/ Physician
assistant



F. Psychiatrist/
Psychologist/
Therapist



G. Paramedics/
Emergency medical
technician



H. Holistic, Alternative, OR
Non-traditional medical
provider



I. Treated yourself



J. Other not listed



32. Were you ADMITTED TO A HOSPITAL as a result of this (these) event(s)? (Check <u>one</u> for each event)	Injury/Pain 1	Injury/Pain 2	Injury/Pain 3	Injury/Pain 4
No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Yes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If YES, for how many days?	_____ days	_____ days	_____ days	_____ days
33. Did you have LOST WORK DAYS as a result of this (these) event(s)? (Check <u>one</u> for each event)	Injury/Pain 1	Injury/Pain 2	Injury/Pain 3	Injury/Pain 4
No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Yes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If YES, how many days?	_____ days	_____ days	_____ days	_____ days
34. Were your REGULAR WORK ACTIVITIES RESTRICTED as a result of this (these) event(s)? (Check <u>one</u> for each event)	Injury/Pain 1	Injury/Pain 2	Injury/Pain 3	Injury/Pain 4
No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Yes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If YES, for how long?				
Less than 4 hours	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4 hours to less than 1 day	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1 day to less than 3 days	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3 days to less than 7 days	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7 days to less than 14 days	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14 days to less than 1 month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1 month to less than 3 months	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3 months or more	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
35. Were your REGULAR NON-WORK ACTIVITIES RESTRICTED as a result of this (these) event(s)? (Check <u>one</u> for each event)	Injury/Pain 1	Injury/Pain 2	Injury/Pain 3	Injury/Pain 4
No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Yes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If YES, for how long?				
Less than 4 hours	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4 hours to less than 1 day	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1 day to less than 3 days	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3 days to less than 7 days	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7 days to less than 14 days	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14 days to less than 1 month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
1 month to less than 3 months	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3 months or more	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
36. Are your regular ACTIVITIES STILL RESTRICTED as a result of this (these) event(s)? (Check <u>one</u> for each event)	Injury/Pain 1	Injury/Pain 2	Injury/Pain 3	Injury/Pain 4
No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Yes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



37. Do you HAVE ANY <u>CONTINUING PROBLEMS OR SYMPTOMS</u> related to this (these) event(s)? (Check <u>one</u> for each event)	Injury/Pain 1	Injury/Pain 2	Injury/Pain 3	Injury/Pain 4
No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Yes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
38. Did you file a WORKERS' COMPENSATION CLAIM for this problem?	Injury/Pain 1	Injury/Pain 2	Injury/Pain 3	Injury/Pain 4
No	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Yes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

39. Before May 1, 2016, did you have ANY INJURIES AT WORK? (Check one) Yes No

40. Before May 1, 2016, did you have ANY INJURIES NOT AT WORK? (Check one) Yes No

41. Between May 1 and October 31, 2016, did you usually experience pain while working? (Check one)

Yes No



If YES, check the box that shows your usual level of pain while working.

<input type="checkbox"/> No Pain	<input type="checkbox"/> Little Pain	<input type="checkbox"/> Some Pain	<input type="checkbox"/> Medium Pain	<input type="checkbox"/> Lots of Pain	<input type="checkbox"/> Extreme Pain

42. IF YES, Did you take medicine, either from a doctor or over the counter, for this pain? (Check one)

Yes No



PLEASE ANSWER THE NEXT QUESTIONS ABOUT INJURY/PAIN REPORTING

43. In the 6 months between May 1 and October 31, 2016, DID YOU REPORT ANY injury or illness or pain to your employer? (Check ONE)

- Yes No



If NO, did any of the following prevent you from reporting your injury or illness or pain to your employer? (Check ALL THAT APPLY)

I don't feel confident that the form is kept anonymous (private)	<input type="radio"/>
I am too busy to fill out the form	<input type="radio"/>
I am afraid of the consequences	<input type="radio"/>
I don't want to get into trouble	<input type="radio"/>
I am worried about legal action	<input type="radio"/>
I feel I will be blamed for raising concerns	<input type="radio"/>
I believe it's pointless (worthless) and nothing will be done about it	<input type="radio"/>
I am afraid it will affect my career and reputation	<input type="radio"/>
I am unsure who to report the incident to	<input type="radio"/>
If I discuss the incident with the person involved, nothing else needs to be done	<input type="radio"/>
I never get any feedback on action taken	<input type="radio"/>
Reporting takes too much time	<input type="radio"/>
The incident was too not that bad	<input type="radio"/>
Injuries are a part of the job	<input type="radio"/>
The incident form takes too long to fill out	<input type="radio"/>
I am unaware of the reporting process	<input type="radio"/>
Other (Please describe) _____	<input type="radio"/>

44. Do you know what an OSHA 300 log is? (Check one)

- Yes No

45. Have you ever seen the OSHA 300, which is the Log Summary of Occupational Injuries and Illnesses for your establishment/workplace? (Check one)

- Yes No

If YES, did you see it by (Check one)?

- Viewing the summary portion of the log posted by the employer
 Requesting access to see the entire OSHA log

46. Did you ever have an injury recorded on the OSHA log? (Check one)

- Yes No

47. Do you know what WORKERS' COMPENSATION is? (Check one)

- Yes No

48. Have you or your employer filed for Workers' Compensation FOR ANY INJURY OR ILLNESS YOU HAD? (Check one)

- Yes No



For your work in the 6 months between May 1 and October 31, 2016, please circle one answer:

49. How MENTALLY DEMANDING has it been working as a janitor? (Circle one)

1	2	3	4	5
Very Low Demand	Low Demand	Medium Demand	High Demand	Very High Demand

50. How PHYSICALLY DEMANDING has it been working as a janitor? (Circle one)

1	2	3	4	5
Very Low Demand	Low Demand	Medium Demand	High Demand	Very High Demand

51. How HURRIED OR RUSHED have you been working as a janitor? (Circle one)

1	2	3	4	5
Very Low Rush	Low Rush	Medium Rush	Highly Rushed	Very Highly Rushed

52. How SUCCESSFUL were you in completing what you were asked to do? (Circle one)

1	2	3	4	5
Very Low Success	Low Success	Medium Success	High Success	Very High Success

53. How HARD DID YOU HAVE TO WORK to do your job? (Circle one)

1	2	3	4	5
Not Very Hard	Somewhat Hard	Medium Hard	Hard	Very Hard

54. How FRUSTRATED have you been with your work as a janitor? (Circle one)

1	2	3	4	5
Very Low Frustration	Low Frustration	Medium Frustration	High Frustration	Very High Frustration

The next question is about moderate or vigorous physical activity during the WHOLE day (DURING WORK OR IN YOUR FREE TIME) that caused at least light sweating or a slight increase in your breathing or heart rate.

55. During either YOUR WORK OR FREE TIME, in the past 7 days, ON HOW MANY DAYS did you do moderate or vigorous physical activities like fast walking, pushing a lawn mower, or moving heavy boxes by hand for at least 30 minutes at a time?

_____ Days per week



PLEASE ANSWER THE NEXT QUESTIONS ABOUT STRESS YOU MAY HAVE HAD IN THE 6 MONTHS BETWEEN MAY 1 AND OCTOBER 31, 2016.

56. STRESS means a situation in which a person feels tense, restless, nervous or anxious or is unable to sleep at night because his/her mind is troubled all the time. Did you feel any STRESS? (*Check one*)

- Not at all Very little Sometimes Often Very Much

57. How did you feel about YOUR JOB? (*Check one*)

- Terrible/Unhappy Mostly Dissatisfied Mixed Feelings Mostly Satisfied Pleased/Delighted

58. How did you feel about the PEOPLE YOU WORKED WITH -- your co-workers? (*Check one*)

- Terrible/Unhappy Mostly Dissatisfied Mixed Feelings Mostly Satisfied Pleased/Delighted

59. How did you feel about the WORK YOU DID ON YOUR JOB -- the work itself? (*Check one*)

- Terrible/Unhappy Mostly Dissatisfied Mixed Feelings Mostly Satisfied Pleased/Delighted

60. How did you feel about WHERE YOU WORKED --- the physical surroundings, the hours, the amount of work you were asked to do? (*Check one*)

- Terrible/Unhappy Mostly Dissatisfied Mixed Feelings Mostly Satisfied Pleased/Delighted

61. How did you feel about the RESOURCES (equipment, tools, information, supervision, etc.) you had available for doing your job? (*Check one*)

- Terrible/Unhappy Mostly Dissatisfied Mixed Feelings Mostly Satisfied Pleased/Delighted

PLEASE ANSWER THE NEXT QUESTIONS ABOUT THE PAST MONTH (October 2016).

62. In the PAST MONTH, how often have you felt that you were unable to control the important things in your life? (*Check one*)

- Never Almost Never Sometimes Fairly Often Very Often

63. In the PAST MONTH, how often have you felt confident about your ability to handle your personal problems? (*Check one*)

- Never Almost Never Sometimes Fairly Often Very Often

64. In the PAST MONTH, how often have you felt that things were going your way? (*Check one*)

- Never Almost Never Sometimes Fairly Often Very Often

65. In the PAST MONTH, how often have you felt difficulties were piling up so high that you could not overcome them? (*Check one*)

- Never Almost Never Sometimes Fairly Often Very Often



PLEASE ANSWER THE NEXT QUESTIONS ABOUT YOUR SLEEP EXPERIENCE AND QUALITY

The following questions refer to sleep quality DURING THE PAST 7 DAYS.

66. On average, I got _____ HOURS OF SLEEP in a 24-hour period.
67. On average, my sleep quality was (*Check one*)
 Very Poor Poor Fair Good Very Good
68. On average, my sleep was refreshing (*Check one*)
 Not at All A little bit Somewhat Quite a Bit Very Much
69. On average, I had a problem with my sleep (*Check one*)
 Not at All A little bit Somewhat Quite a Bit Very Much
70. On average, I had difficulty falling asleep (*Check one*)
 Not at All A little bit Somewhat Quite a Bit Very Much

Was your SLEEP IN THE PAST 7 DAYS SIMILAR TO YOUR SLEEP IN THE 6 MONTHS between May 1st and October 31st, 2016?

Yes → IF YES, SKIP TO PAGE 17 NO - IF NO, PLEASE ANSWER QUESTIONS BELOW:

The following questions refer to sleep quality IN THE 6 MONTHS between May 1st and October 31st, 2016.

71. On average, I got _____ HOURS OF SLEEP did you get in a 24-hour period.
72. On average, my sleep quality was (*Check one*)
 Very Poor Poor Fair Good Very Good
73. On average, my sleep was refreshing (*Check one*)
 Not at All A little bit Somewhat Quite a Bit Very Much
74. On average, I had a problem with my sleep (*Check one*)
 Not at All A little bit Somewhat Quite a Bit Very Much
75. On average, I had difficulty falling asleep (*Check one*)
 Not at All A little bit Somewhat Quite a Bit Very Much



76. Has a doctor, nurse, or other health professional EVER told you that you had any of the following?
(Check all that apply)

	<u>Yes</u>	<u>No</u>	<u>Unsure</u>
a. Heart Attack (i.e., myocardial infarction)?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Angina or Coronary Heart Disease?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. Stroke?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. Asthma? ↓	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>If YES, do you still have asthma?</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. Cancer?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f. Lung Disease (e.g., emphysema or chronic bronchitis)?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g. Arthritis?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
h. Depression? ↓	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>If YES, are you currently being treated for depression, for example, taking medication or seeing a health professional for counseling?</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
i. Diabetes?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

77. In general, how would you RATE YOUR PHYSICAL HEALTH (PAST 7 DAYS AND FOR 6-MONTH PERIOD)?

- a. In the PAST 7 DAYS (Check one) AND → b. BETWEEN MAY 1 AND OCTOBER 31, 2016
(Check one)
- | | |
|------------------------------------|------------------------------------|
| <input type="checkbox"/> Poor | <input type="checkbox"/> Poor |
| <input type="checkbox"/> Fair | <input type="checkbox"/> Fair |
| <input type="checkbox"/> Good | <input type="checkbox"/> Good |
| <input type="checkbox"/> Very Good | <input type="checkbox"/> Very Good |
| <input type="checkbox"/> Excellent | <input type="checkbox"/> Excellent |

78. In general, how would you RATE YOUR MENTAL HEALTH, including your mood and your ability to think?

- a. In the PAST 7 DAYS (Check one) AND → b. BETWEEN MAY 1 AND OCTOBER 31, 2016
(Check one)
- | | |
|------------------------------------|------------------------------------|
| <input type="checkbox"/> Poor | <input type="checkbox"/> Poor |
| <input type="checkbox"/> Fair | <input type="checkbox"/> Fair |
| <input type="checkbox"/> Good | <input type="checkbox"/> Good |
| <input type="checkbox"/> Very Good | <input type="checkbox"/> Very Good |
| <input type="checkbox"/> Excellent | <input type="checkbox"/> Excellent |

79. In general, how would you RATE YOUR SATISFACTION with your social activities and relationships?

- a. In THE PAST 7 DAYS (Check one) AND → b. BETWEEN MAY 1 AND OCTOBER 31, 2016
(Check one)
- | | |
|------------------------------------|------------------------------------|
| <input type="checkbox"/> Poor | <input type="checkbox"/> Poor |
| <input type="checkbox"/> Fair | <input type="checkbox"/> Fair |
| <input type="checkbox"/> Good | <input type="checkbox"/> Good |
| <input type="checkbox"/> Very Good | <input type="checkbox"/> Very Good |
| <input type="checkbox"/> Excellent | <input type="checkbox"/> Excellent |



80. During your ENTIRE LIFE HAVE YOU SMOKED AT LEAST 100 CIGARETTES, which is about 5 packs? (Check one)

- Yes No Unsure

81. Do you NOW SMOKE CIGARETTES? (Check one)

- Everyday Some Days Not at all

82. What is YOUR GENDER? (Check one)

- Male Female Other

83. As of today's date, what is YOUR AGE?

_____ (years)

84. Which of the following best describes YOUR ETHNIC BACKGROUND? (Check one)

- Hispanic Not Hispanic

85. Which of the following best describes YOUR RACE? (Check all that apply)

- American Indian
- Alaska Native
- Asian
- Black or African American
- Native Hawaiian or Other Pacific Islander
- White

86. What is YOUR HIGHEST LEVEL OF EDUCATION COMPLETED? (Check one)

- No Schooling Completed
- Less Than grade 12
- High School Graduate (High school diploma, GED or alternative credential)
- College or Some College
- Graduate or Professional School

87. What is your CURRENT MARITAL STATUS? (Check one)

- Married
- Living as Married
- Living with a domestic partner
- Never married
- Separated
- Divorced
- Widowed

88. What category best describes your ANNUAL HOUSEHOLD INCOME? (Check one)

- Less than \$25,000
- \$25,000 to \$34,999
- \$35,000 to \$49,999
- \$50,000 to \$74,999
- \$75,000 or more

89. Do you SPEAK a LANGUAGE OTHER THAN ENGLISH? (Check one)

- Yes No

If yes, what is this language? (Check all that apply)

- Spanish Somali Arabic
- French Amharic
- Other (please describe below)

90. HOW WELL do you speak English? (Check one)

- Very well Well Not well
- Not at All

91. What is the total number of PERSONS WHO LIVE IN YOUR HOUSEHOLD, INCLUDING YOURSELF?

_____ persons

92. ARE YOU THE PRIMARY WAGE EARNER in your household? (Check one)

- Yes No

93. For WHICH COMPANY do you work? (Check one)

- Aramark ISS Managed Services
- ABLE Marsden
- ABM Peterson
- Best Way Preferred
- Capital SBM
- Contract Cleaners SCC
- F&F Triangle
- Harvard Turtle Bay
- Mid-City Other (Specify)_____

94. What is your height?

_____ feet _____ inches OR _____ centimeters

95. What is your current body weight?

_____ pounds OR _____ kilograms

This is the end of the questionnaire. Thank you for participating in this important effort!

Appendix B: Questionnaire Consent Form

CONSENT FORM
Janitors' Workload and Injury Study

You are invited to join a cooperative project between the University of Minnesota and the SEIU Local 26 that is planned to assess workload, health, and injury experience as well as injury reporting, using the attached questionnaire. You were selected for this opportunity because the SEIU L26 identified you as a janitor. We ask you to read this form and ask any questions you may have before agreeing to join this project. This project is being conducted by Deirdre Green and Adam Schwartz, graduate students in Environmental Health Sciences, University of Minnesota, together with a faculty research team from the University of Minnesota.

Background Information

The purpose of this project is to: identify factors that may contribute to injuries. To identify the injury problem, the following questionnaire asks about your employment, health status, injuries, workload, sleep quality, and your work environment. To address issues with injury reporting, this questionnaire asks about your experience with injuries and reporting; for some, this will be followed with information about how to recognize and report work-related injuries. Six months later, you will be asked to complete a second questionnaire that asks the same questions. This is important so there will be a complete year of information about your workload and injury experience - for the best results! *To provide accurate information, that is not unfair, it is important to complete the questionnaire whether or not you had any injuries during the reporting period.*

Approximately one hundred janitors will be asked to participate in a smaller portion of the project that measures workload using FitBit bands. Another small portion of janitors will also be observed on the job to assess physical workload.

Procedures:

If you agree to join in this project, you will be asked to do the following things:

- Complete the following questionnaire, both at the beginning of the project and 6-months later, for follow-up.
- Review the information. If information is unclear or you have additional questions, please contact Adam Schwartz and Deirdre Green [contact information below].
- *If you are participating in the workload assessment projects, including the FitBit study, separate information will be provided to you for your review, before you participate in those assessments.*

Risks and Benefits of Participating in the Project

The project has minimal risks and several benefits:

You will be asked to remember information about injuries that happened during the six-month period, identified, while employed as a janitor. You are NOT required to answer any questions with which you are uncomfortable; just mark an "X" on any question number you do not wish to answer, and continue to the next question. All of your responses will remain confidential and will never be identified with you.

The benefits of participating this project are:

Janitors will benefit directly from the knowledge gained, including new information, about janitors' workload and potential risk of injury.

Compensation:

All participating janitors will have an opportunity to be entered into a drawing for a \$50 Target gift card, providing them at least a 1 in 20 opportunity of receiving a gift card. A total of 110 gift cards will be available for this opportunity and will be provided following completion of the second questionnaire. All janitors who indicate that they want to be included in the drawing, whether or not they participate, will be among those randomly selected by the research team following completion of the study.

Confidentiality:

Your questionnaire records will be kept completely private. In any report or paper that is published, only group information is provided; no individual person can ever be identified. Project records will be stored securely at the University of Minnesota and only the research team will have access to the records. Project data will be coded according to current University of Minnesota policy for protection of confidentiality.

Voluntary Nature of the Project:

Participation in this project is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota or the SEIU Local 26. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:

The persons conducting this project are: Deirdre Green (gree1982@umn.edu) and Adam Schwartz (schw1562@umn.edu) (612-624-1296) and Dr. Susan Gerberich (gerbe001@umn.edu), together with other members of the research team. You may ask any questions you have now. If you have questions later, you are encouraged to contact them at the University of Minnesota, through the email addresses or telephone number identified above. Rony Arauz is the Spanish language team member, who can be reached by telephone at 612-625-5887 or by email (arauz005@umn.edu).

If you have any questions or concerns regarding this project and would like to talk to someone other than those identified above, you are encouraged to contact the Research Subjects' Advocate Line, D528 Mayo, 420 Delaware St. Southeast, Minneapolis, Minnesota 55455; (612) 625-1650.

You can keep this copy of the information for your records.

Appendix C: Ergonomic Assessment Consent Form

CONSENT FORM
Janitors' Workload and Injury Project – Ergonomic Assessment

You are invited to join a cooperative project between the University of Minnesota and the SEIU Local 26 that is planned to measure janitor workload and exposures. You were selected for this opportunity because you were identified as a janitor by the SEIU. We ask you to read this form and ask any questions you may have before agreeing to join this project.

This project is being conducted by: Adam Schwartz, Environmental Health Sciences, University of Minnesota doctoral student, together with a research team from the University of Minnesota.

Background Information

The purpose of this project is to: identify factors that may contribute to injuries such as workload. To measure workload some janitors will have their everyday tasks observed by trained ergonomists. The ergonomists will measure perceived exertion, postures, repetitive motion and physical stress.

Procedures:

If you agree to join in this project, we ask you to do the following thing:

- Be comfortable with ergonomists watching you do specific tasks. Each observation will take around 4 minutes. The only interaction you need to have with them is when they ask you how difficult each task is.

Risks and Benefits of Participating in the Project

The project has minimal risks and several benefits:

Participants may be uncomfortable being observed by ergonomists. If you are, you will be able to withdraw from this portion of the project without any penalty. You will also be able to continue in the overall project that collects other information on your work activities and possible injuries.

The benefits to joining this project are:

The janitors will benefit directly from the knowledge gained, **including new information** about janitors' workload and potential risk of injury. There is no additional compensation for participating in the ergonomic [assessments](#).

Confidentiality:

Your ergonomic assessment will be kept completely private. In any report or paper that is published, only group information is provided; no individual person can ever be identified. Project records will be stored securely at the University of Minnesota and only Adam Schwartz and his research team will have access to the records. Project information will be coded according to current University of Minnesota policy for protection of confidentiality.

Voluntary Nature of the Project:

IRB Code #
Version Date:

1 of 2

Participation in this project is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota or the SEIU Local 26. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:

The persons conducting this project are: Adam Schwartz (schw1562@umn.edu) and Dr. Susan Gerberich (gerbe001@umn.edu, 612-625-5934). You may ask any questions you have now. If you have questions later, **you are encouraged** to contact them at the University of Minnesota, through the email addresses or telephone numbers identified above.

If you have any questions or concerns regarding this project and would like to talk to someone other than Adam Schwartz or Dr. Susan Gerberich, **you are encouraged** to contact the Research Subjects' Advocate Line, D528 Mayo, 420 Delaware St. Southeast, Minneapolis, Minnesota 55455; (612) 625-1650.

You will be given a copy of this information to keep for your records.

Statement of Consent:

I have read the above information. I have asked questions and have received answers. I agree to participate in this portion of the project that involves assessment of work tasks.

Signature: _____ Date: _____

Signature of Investigator: _____ Date: _____

Appendix D: UMN IRB Approval

UNIVERSITY OF MINNESOTA

Twin Cities Campus

*Human Research Protection Program
Office of the Vice President for Research*

*D528 Mayo Memorial Building
420 Delaware Street S.E.
MMC 820
Minneapolis, MN 55455
Office: 612-626-5654
Fax: 612-626-6061
E-mail: irb@umn.edu or ibc@umn.edu
Website: <http://research.umn.edu/subjects/>*

July 1, 2016

Adam Schwartz

RE: "Janitors' Workload and Injury Study"

IRB Code Number: **1605P87861**

Dear Mr. Schwartz:

The Institutional Review Board (IRB) received your response to its stipulations. Since this information satisfies the federal criteria for approval at 45CFR46.111 and the requirements set by the IRB, final approval for the project is noted in our files. Upon receipt of this letter, you may begin your research.

IRB approval of this study includes the ergonomic assessment consent form, consent form and recruitment materials received May 18, 2016.

The IRB would like to stress that subjects who go through the consent process are considered enrolled participants and are counted toward the total number of subjects, even if they have no further participation in the study. Please keep this in mind when calculating the number of subjects you request. This study is currently approved for 4000 subjects. If you desire an increase in the number of approved subjects, you will need to make a formal request to the IRB.

On June 22, 2016 the IRB approved the referenced study through June 21, 2017 inclusive.

The Assurance of Compliance number is FWA00000312 (Fairview Health Systems Research FWA00000325, Gillette Children's Specialty Healthcare FWA00004003). Research projects are subject to continuing review and renewal. You will receive a report form two months before the expiration date. If you would like us to send certification of approval to a funding agency, please tell us the name and address of your contact person at the agency.

As Principal Investigator of this project, you are required by federal regulations to inform the IRB of any proposed changes in your research that will affect human subjects. Changes should not be initiated until written IRB approval is received. Unanticipated problems or serious unexpected adverse events should be reported to the IRB as they occur. Notify the IRB when you intend to close this study by submitting the Study Inactivation Request Form.

Driven to DiscoverSM

The IRB wishes you success with this research. If you have questions, please call the IRB office at 612-626-5654.

Sincerely,

**Clinton
Dietrich**

Digitally signed by Clinton Dietrich,
DN: c=US, o=Minnesota, i=Minneapolis,
ou=Human Research Protection Program,
email=cdiet@uic.edu, cn=University of
Minnesota, ou=Clinton Dietrich
Date: 2016.07.28 14:28:14 -0500 for

Jeffery Perkey, MLS, CIP
Research Compliance Supervisor
JP/bw

CC: Susan Gerberich, Deirdre Green, Hyun Kim, Patricia McGovern, Andrew Ryan

