CALIFORNIA JANITOR WORKLOAD STUDY REPORT

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Statement of Author Contributions. Dr. Carisa Harris was the principal investigator of this study and coordinated the overall study design, provided operational and financial oversight, oversaw data analysis and interpretation of study findings. Suzanne Teran and Nestor Castillo oversaw the design, implementation, and interpretation of the qualitative study. Melissa Afterman oversaw the field-based data collection and analysis of the time study and ergonomic risk assessment. She was assisted by Jiayin Chang and Matthew Zhang. Dr. Max Blumberg, Dominic Pina, Javiere Freire, and Kevin Ru analyzed and interpreted various aspects of the survey data. We want to acknowledge other students for their assistance in collecting survey and field data.

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List of Terms and Abbreviations

ACGIH: American Conference of Governmental Industrial Hygiene

BORG-CR10: Measures exertion on a scale of 0 to 10

COSI: Composite Strain Index

CLI: Composite Lifting Index

FILI: Frequency Independent Lift Index

GAD-7: Generalized Anxiety Disorder-7

HA-TLV: Hand Activity Threshold Limit Value

HAL: Hand Activity Level

IPAQ: International Physical Activity Questionnaire

ISSA: International Sanitary Supply Association

SF-12: 12-Item Short Form Survey

JCQ: Job Content Questionnaire

LOHP: Labor Occupational Health Program

MCTF: Maintenance Cooperation Trust Fund

MVTA: Multimedia-Video Task Analysis

MSDs: Musculoskeletal Disorders

NPF: Normalized Peak Force

OBWC guidelines: Ohio Bureau of Workers' Compensation

Peak intensity: The highest intensity across all sixteen tasks performed. The intensity of each task of the sixteen tasks was combined to find the maximum intensity

PFI-TLV score: Peak Force Index Threshold Limit Value

PHQ-9: Patient Health Questionnaire-9

PSS4: Perceived Stress Scale

RCRA ratio: Recommended Cumulative Recovery Allowance

REBA: Rapid Entire Body Assessment

RNLE: Revised NIOSH Lifting Equation

RPE scale: Rate of perceived exertion

SEIU: Service Employee International Union

SEIU-USWW: Service Employee International Union-United Servers Workers West

SISS: Single Item Stress Scale

TLV: Threshold Limit Value

Typical intensity: The intensity of the task janitors performed for the most extended duration (minutes)

Workload Index: An arbitrary number that includes each task's frequency, duration, and intensity. It was computed by multiplying intensity by weekly minutes. Once the workload of each task was found, the workload of all tasks was combined to find the maximum workload for the sixteen tasks, giving the total workload

WSMDs: Work-related musculoskeletal disorders

Executive Summary

The primary aim of the California Janitor Workload Study was to: (i) summarize the workload of janitors; (ii) summarize the relationship between workload and health outcomes; (iii) summarize changes in workload due to COVID-19 pandemic; (iv) qualitatively evaluate staffing and training requirements to fulfill changes in workload due to the pandemic; and (v) evaluate the time required to perform tasks and the ergonomic hazard associated with each task. The study included surveys (n=718), interviews (n=7), and direct measurements of workers (n=24) performing janitorial tasks to quantify time allocations and ergonomic hazards associated with common tasks.

This report provides an overview of the physical workload, psychosocial stress, and work climate factors contributing to a high prevalence of adverse health outcomes among a *sample* of California Janitors collected between October of 2021 and January of 2023, after the economy had reopened from the COVID-19 shutdown but before the state of emergency had ended. The executive summary provides an overview of the conclusions highlighted in each section; detailed analyses to support each of the findings are presented in depth in the main report. These findings represent up to 718 janitors working in 25 different types of venues, of which the majority worked in office venues (75%), were subcontractors (71%), and were represented by a union (75%). Nearly half of the respondents had worked as a janitor for over 10 years and 24% held a second job.

The prevalence of adverse health outcomes was high.

- The prevalence of moderate to severe work-related pain was high among janitors. Nearly 85% of respondents reported moderate to severe work-related pain over the prior month in at least one body region, and over half of janitors (57%) had moderate to severe work-related pain in three or four body regions. All body regions were affected similarly.
- Over half of janitors reported using medication more than once a month to manage their pain, and one in five workers missed work at least every other month due to their work-related pain.
- Nearly one in three reported having had at least one work-related injury, and two of five workers reported that their pain had a moderate to extreme impact on their ability to perform activities outside of work.
- The prevalence of anxiety or depression was much lower than the prevalence of musculoskeletal pain. Just less than one in five workers were likely to have either anxiety or depression.

Janitors reported high physical workloads across numerous tasks. High workloads were statistically significantly associated with adverse health outcomes.

- Work intensity was high. The tasks with the highest overall physical workload were collecting trash, sweeping/ mopping, vacuuming, and cleaning bathrooms.
- Across the three job-level exposure measures (peak, typical, workload index), workers in the high-exposure groups had more than a two-fold increase in the prevalence of moderate to severe work-related pain compared to their counterparts in the low-exposure group.
- High physical workload was associated with an increased prevalence of moderate to severe work-related pain impact outcomes, including medication use, missed work, previous injury, and impact on outside work activities; the typical intensity of work had the highest effect estimates.
- Only the peak workload intensity was statistically significantly associated with an increased prevalence of anxiety or depression, though the typical intensity and workload index also had elevated effect estimates suggestive of an association.

There were slight differences in the prevalence of adverse health outcomes by sex and age.

- There was a 6-9% higher prevalence of average and peak work-related pain among women, with no consistent differences in the prevalence of pain by age. Measures of workload were associated with moderate to severe work-related pain in both men and women, though effect estimates were higher among men.
- Measures of workload were statistically significantly associated with measures of pain impact in men and women.
- Measures of workload were statistically significantly associated with the prevalence of anxiety or depression in women.
- Measures of workload were statistically significant with pain severity, and measures of pain impact had slightly higher effect estimates among those younger than 50.

Union status and job tenure were also associated with differences in the prevalence of adverse health outcomes.

- The associations between measures of workload and the prevalence of moderate to severe work-related pain were statistically significant among all workers, both those belonging to a union and those not belonging to a union, with higher effect estimates of association among non-union janitors.
- The associations between measures of workload and measures of pain impact varied by union status, and associations with the prevalence of anxiety or depression were higher among those unionized.
- The associations between workload and the prevalence of moderate to severe work-related pain were statistically significant and slightly higher among those who worked more than 10 years as a janitor.
- The statistically significant associations between workload and measures of pain impact varied by job tenure, and there were no statistically significant associations between measures of workload and the prevalence of anxiety or depression in either job tenure category.

High job strain increased the prevalence of adverse health outcomes, particularly the prevalence of anxiety or depression.

- Those with higher job strain had a higher prevalence of moderate to severe work-related pain, adverse pain impact outcomes, and a higher prevalence of anxiety or depression.
- Overall, higher psychological demand was associated with a higher prevalence of adverse health outcomes, and higher decision latitude was protective, although the confidence intervals varied.

Work Climate also had statistically significant associations with adverse health outcomes, particularly the presence of wage theft and harassment.

- Wage theft was consistently associated with adverse health outcomes, including a 2.4 times higher prevalence of anxiety or depression.
- Harassment of any kind was statistically significantly associated with a nearly four-fold increase in the prevalence of anxiety or depression.

Nearly half of workers reported increased workload, disinfecting tasks, and pressure to work faster during the COVID-19 pandemic, and one-third of workers reported not having the protective equipment needed. Approximately one-quarter of workers reported that they could not stay home when sick without fear of losing a job or pay; the prevalence was higher among those not represented by a union (38.3%) versus those represented by a union (22.4%).

Industry-based time allocations often differed substantially from the actual time required to clean a space.

- The industry-standard time estimates (using International Sanitary Supply Association (ISSA) Cleaning Times & Task Guidelines) varied widely by workspace and work task across venues.
- Most of the top 10 common tasks did not have a clear trend of being over estimated or underestimated across venues. This may be explained by differences in cleaning techniques or expectations specific to venues or employers and thus not captured in the industry-standard time estimates.
- Some observed tasks did not have a corresponding category in the industry-standard time estimates, making a comparison impossible.
- There were numerous limitations to the interpretation and application of industry-standard time estimates. Further research is needed to develop appropriate time on task allocations and should consider including measures of occupancy, volume, and ergonomic hazard.

Most tasks evaluated using direct measurements and validated risk assessment tools indicated high ergonomic hazard and MSD risk.

- Nine of the 11 tasks had average PFI-TLV scores > 1.0, indicating high ergonomic hazard when tasks were grouped by workspace; cleaning in all spaces led to average PFI-TLV scores > 1.0.
- Cleaning tasks that involved lifting were considered safe (CLI < 1.5) except for trashing, which had an average CLI of 1.64, indicating a high ergonomic hazard and risk of low back pain or injury. This was mainly attributed to trashing at the airport (CLI = 2.5). For wet mopping, the average CLI was < 1.5, but the lift index for wet mopping in certain spaces exceeded a CLI of 1.5.
- Push/pull forces associated with all cleaning tasks were considered acceptable for over 80% of the population, except for specific furniture moving tasks in offices and common spaces where heavier loads were moved with and without carts.
- Four of the ten most common cleaning tasks observed in this study had high ergonomic hazard (PFI-TLV score > 1.0) indicating increased upper extremity MSD risk and insufficient time allocated using Industry-based standards. These tasks include washing windows, disinfecting/scrubbing, wiping, and vacuuming. Similarly, the transport task was found to have a moderate risk to the lower back associated with push/pull activities and insufficient time allocated when applying Industry-based standards.
- The time study and risk assessment analyses indicate that some tasks have higher ergonomic hazard and inadequate time allocations to perform those tasks. High hazard tasks should be allocated more time to perform and recover from. More work is needed to explore the best way to organize tasks, allocate the appropriate time for each task, and evaluate any changes in how tasks and time are allocated using a participatory approach to include janitors, management, union representatives, and other stakeholders.
- The analyses of time allocated to performing various tasks and the ergonomic hazards associated with each task indicate that work reorganization and interventions should be prioritized. Further, time allocations should account for the ergonomic hazard associated with performing tasks such that tasks that are more physically demanding are provided more time. Further research is warranted to develop better time allocation approaches that reduce MSD risk.

Conclusion

In conclusion, this report shows that higher workloads are associated with a higher prevalence of severe pain and a higher prevalence of negative functional impacts from pain. Janitors also have high job strain and experience wage theft and harassment that may increase the prevalence of anxiety or depression. A time study and risk assessment of specific tasks show that there is sometimes a mismatch of time allocated to time required to complete tasks that have higher ergonomic hazard and MSD risk.

Recommendations

Based on the report findings, we recommend that California Legislators consider the following recommendations.

Facilitate a multi-stakeholder participatory approach, that includes janitors, supervisors, management, company owners, labor representatives, and scientists, to target intervention efforts that mitigate ergonomic hazards through:

(i) Job analysis: quantify the exposures of various tasks completed by venue and space

(ii) Tool Improvement: Evaluate tools that increase workload and redesign them to reduce strain

(iii) Smart Scheduling: Optimize the time allocated to clean spaces based on venue, space, task, tools used, AND ergonomic hazard scores that indicate MSD risk. Consider adding adjustment factors such as occupancy and volume.

(iv) Collaborate with Washington State Scientists on a Janitor Workload Calculator- a user-friendly web-based tool that helps plan work in a way that mitigates hazard and reduces MSD risk

Given the high prevalence and severity of adverse health outcomes, a formal California regulatory standard analogous to the Hotel Housekeeping Musculoskeletal Injury Prevention Program[1], should be considered.

(i) Implement job analyses using a consistent approach that will allow integration of data into a larger database accessible for tools like the Janitor Workload Calculator

(ii) Improve pain surveillance and medical management programs with strategies to eliminate retaliation for reporting pain and/or injuries

(iii) Provide janitor training on the importance of early reporting and their rights to report with specific steps to protect against and report retaliation

(iv) Provide comprehensive management training to:

   a. Encourage early reporting of symptoms and respond appropriately to symptom reporting to facilitate early and effective symptom management

   b. Decrease workload, as appropriate based on job analyses, by implementing interventions such as tool choice and task allocation approaches that optimize productivity while minimizing ergonomic hazard levels indicative of MSD risk

   c. Improve the work climate by reducing job strain, wage theft, and harassment, among other items

[1] Cal/OSHA. "Hotel Housekeeping Musculoskeletal Injury Prevention." *California Code of Regulations, Title 8, Section 3345.* Accessed April 2025. https://www.dir.ca.gov/title8/3345.html

1. Background

Janitors play a vital role in maintaining cleanliness and hygiene in workplaces, schools, shopping centers, and public buildings. Their importance was further emphasized during the COVID-19 pandemic, as the demand for sanitation and disinfection increased significantly to ensure public safety (U.S. Department of Labor, 2021; Ladou & Harrison, 2021).

In the most recent data from the United States Census, 70% of janitors identified as men and 30% as women. The census had four different age groups janitors could identify with (25-34, 35-44, 45-54, and 55-64 years); 40% of the janitorial population were between ages 25 to 44, while 60% of them were from 45 to 64 years old (U.S. Census Bureau, 2020). According to the Bureau of Labor Statistics, California has the highest employment of Janitors and Cleaners, including 214,640 workers. Janitors are employed in different sectors such as K-12 schools, universities, airports, shopping centers, technology, business buildings, and warehouses to keep up with the cleanliness and maintenance of the building. For the demanding tasks that janitors perform, they are some of the lowest-paid workers, with an annual mean wage of $37,520 in California (Bureau of Labor Statistics, 2021).

Physical Workload. Janitorial work includes a variety of tasks with ergonomic hazards that increase MSD risk. The Minnesota "SWEEP" study identified eight specific high-hazard tasks, such as emptying trash cans, mopping, sweeping, etc. Using a survey, they collected subjective data on perceived exertion (Borg-CR10), mental workload (NASA task load index), and stress (single item stress scale (SISS) and a four-item version of perceived stress scale (PSS4)). An expert observer estimated the workload by applying the semi-quantitative Rapid Entire Body Assessment (REBA) tool to each task. The average REBA scores for janitors in this study were in the high-risk category, and their Borg scores ranged between very light and somewhat difficult categories. There was only one statistically significant association between a task and the prevalence of an injury; every 10 small trash cans (less than 25 pounds) emptied was associated with a 3% increased risk of injury. Although physical workload was not significantly associated with stress (SISS scores or PSS4 scores) after adjustment for age and sex, mental workload was significantly associated with both measures of stress.

Adverse Health Outcomes. The demanding workload inherent in janitorial tasks exposes janitors to significant health risks. Janitors are at a higher risk of developing respiratory and dermal diseases, musculoskeletal disorders, infectious diseases, and psychological disorders (Charles et al., 2009).

Work-related musculoskeletal disorders (WMSDs) are common among janitors. In 2020, janitors reported 247,620 cases of WMSDs, with injuries to the lower extremities (5,140 cases) being as frequent as injuries to the upper extremities (4,590 cases) (Bureau of Labor Statistics, 2021). There were 17.4 thousand recordable cases and 12.6 thousand total cases with days away from work, job, restriction, and transfer in 2021, with an incidence rate of 2.2 for nonfatal occupational injuries and an incidence rate of 2.4 for illness and injuries of janitors (Bureau of Labor Statistics, 2021; Bitzas et al., 2022). Another study by the Minnesota group collected self-reported changes in workload, injuries, and physician-diagnosed depression, as well as physical activity (metabolic equivalents or METs) and sleep using Fitbits. Among this group of janitors, there was a 34% one-year prevalence of work-related injuries, a 12% prevalence of depression, and an increased risk of injuries (RR 1.93) among workers who had depression. They also found an increased risk of injuries (RR 1.91) among workers who experienced increased workload during the prior year.

A group of researchers from Washington state performed a study that included 620 janitors to determine the relationship between work-related injuries, workers' compensation claim filing, and barriers to doing so. They found a 21% prevalence of work-related injuries during the prior year and a 19% prevalence of a positive screening for depression (using the PHQ2 screening tool). They also found an increased risk of injury (RR 1.9) among workers who screened positive for depression. A separate study by Fan and colleagues included 20,000 workers across various occupations in Washington State between 2006 and 2008. They used Behavioral Risk

Factors Surveillance Systems data, a CDC-sponsored population-based random digit-dial survey. They found a 5.2% prevalence of depression and a 7.5% prevalence of frequent mental stress in janitors, which was among the highest rates across occupations. Research conducted in Washington and Minnesota found a moderate effect of physical and mental workloads on stress among janitors and an increase in compensable claims among female janitors (Anderson et al., 2022; Green et al., 2019). The mental workload was measured using the task load index. Scores ranged from 6 to 30; the study had a mean score of 20.60. Janitors had a mean score of 9.04 on the perceived stress scale (ranged 4-20). The study found an association between ergonomic and mental workload exposure and stress (Schwartz et al., 2019).

Demographics. Studies in Washington and Minnesota provide valuable insights into the risks faced by janitors and highlight significant regional demographic differences. For example, 57% of janitors in Minnesota identified as Black or African American, compared to 13% in Washington and 4% in California (SWEEP Study, 2017). Demographics of the workforce in Minnesota consisted of 92.8% White, 3.2% American Indian or Alaska Native. In Washington, 70% of the workforce identified as White, 12% as Hispanic, 4% as Black, and 2% as other. Most California janitors identify as Hispanic. These demographic variations underline the importance of conducting state-specific studies to tailor interventions appropriately.

Sex Disparities. Sex disparities in janitorial work are evident. Women, despite constituting only 30% of the janitorial workforce, account for 55% of workers' compensation claims and have twice the rate of time-loss injuries compared to men (439.5 vs. 187.9 per 10,000 full-time employees) (Washington State Department of Labor and Industries, 2020). Men often associate their tasks with masculinity, viewing their work as "heavy," while women face a disproportionate burden of injuries, particularly musculoskeletal disorders (Green et al., 2019). Both men and women can perform the same tasks, but the rate of exertion will be different due to their strength, different postural angles, or poor tool fit (Borg, 1982). The Washington study investigated the characteristics of work-related injuries in janitorial services in Washington by sex. It identified factors contributing to injury severity (i.e., time loss days) and workers' compensation outcomes. Women had less time off work and lower median claim costs but more compensable musculoskeletal disorder claims than men. Overall, women had higher estimated injury rates and accounted for more than half (55.4%) of the compensable claims in the study (Smith & Anderson, 2017).

Age Disparities. Older janitors are more likely to experience work-related pain and injuries due to the cumulative effects of a lifetime of physical labor. Some studies have found age, an indicator for cumulative lifetime workload, associated with increased risk of musculoskeletal pain (Kadota et al., 2020). Musculoskeletal disorders are particularly prevalent among workers aged 45 and older, who have an incidence rate exceeding 30 cases per 10,000 full-time workers (Bureau of Labor Statistics, 2021). Due to the naturally occurring degenerative changes in elderly adults, the older working population is more likely to experience musculoskeletal injuries (Lim et al., 2022). According to the Bureau of Labor Statistics, workers aged 45 to 65 had the highest incidence rate of musculoskeletal disorders, with over 30 cases per 10,000 full-time workers (Bureau of Labor Statistics, 2021). Degenerative changes associated with aging further increase susceptibility to injuries (Schwartz et al., 2020). A study in Malaysia found a higher prevalence of upper limb musculoskeletal disorders in janitors over the age of 36, corroborating evidence of age-related vulnerability (Charles et al., 2009). Many studies have shown that younger workers under 25 have an increased likelihood to experience non-fatal injuries than older workers (Charles et al., 2009). Age at the time of injury for men resulted in a 2% increase in time loss day rate, whereas for women, age was marginally related to increased rates for time loss days. Among janitors, injured workers have been reported to be younger for both men and women, and there was an increased rate of time loss days for younger women (Smith & Anderson, 2017). These young workers might experience more non-fatal injuries due to their lack of occupational experience, however, it is also possible that that older workers have a reduced rate of injuries because they represent the healthy survivors who have continued to work despite high workloads. The healthy worker survivor effect is a common phenomenon observed in occupational health studies.

The California Janitor Workload Study was the first in California to examine job-level exposures and their associations with pain severity, missed work, and work injuries by sex and age among other characteristics. This study assessed the tasks performed by California janitors to evaluate the associations between peak intensity, typical intensity, and workload with the outcomes of pain severity, missed work, and work injuries. Additionally, the impact of job tenure and union membership status were investigated. This study also evaluated the relationship between workload and mental health using validated survey questions to assess the possible presence of possible anxiety or depression.

A state of emergency was declared in California on March 4, 2020. A mandatory stay-at-home order followed on March 19, 2020, and remained in effect until January 25, 2021. The state's economy was fully reopened on June 15, 2021. Governor Newsom officially ended the COVID-19 State of Emergency in February 2023. The COVID-19 pandemic intensified janitorial workloads due to increased cleaning and disinfection demands. Notably, 97% of the surveys included in this report were collected between October 19, 2021, and January 25, 2023—after the economy had reopened but before the state of emergency was lifted**.** Therefore, this study also evaluated the impact of the pandemic on perceived workload.

Another objective of the California Janitor Workload Study was to understand how the demands of the tasks assigned, and the pace of the work performed impact ergonomic hazard and MSD risk. Therefore, another objective of this study was to quantify ergonomic hazards (exposure) and evaluate the time allocated to each task using quantitative approaches. Thus, this report summarizes self-reported perceptions of workload collected via survey *and* directly measured time allocations and exposures, interpreted using validated risk assessment tools.

2. Specific Aims

The overall aims of this project was to:

1. Summarize California janitors' physical workloads, work psychosocial stress, and work climate.
2. Describe the relationship between physical workload, psychosocial stress, and work climate measures on physical and mental health.
3. Summarize the impact of the COVID-19 pandemic on janitorial workload among California janitors.
4. Describe the experience of contractors and building owners/managers in adjusting contracts to ensure adequate staffing and providing janitors with the time, training, and tools needed to fulfill the cleaning standards requirements.
5. Compare the time required to clean and disinfect different types of spaces to the actual production rates based on tasks per square foot (density) and task duration (rate) by venue.
6. Quantify biomechanical exposures and MSD risk while performing different tasks at four different types of venues.

3. California Janitor Workload Survey

3.1 Survey Methods

3.1.1. Study Design and Participants

This was a cross-sectional study of a sample of California janitors of at least 18 years of age currently working as janitors. There were no other inclusion or exclusion criteria. The survey was available online in English and Spanish between October 2021 and January of 2023. Recruitment materials were available in English and Spanish and distributed by email and SMS text to Service Employee International Union-United Servers Workers West (SEIU-USWW) represented workers. For non-unionized janitors, the link was publicized by posting flyers at four different venues and was available online on the UC Human Factors and Ergonomics Lab webpage. A subset of surveys was administered individually in English or Spanish; the Maintenance Cooperation Trust Fund (MCTF), a nationally recognized statewide watchdog in the janitorial industry in California, provided translation support for surveys administered individually in Spanish.

3.1.2. Survey Development

An initial pilot survey was created and distributed to 20 janitors and supervisors whose feedback, in addition to partners from SEIU and MCTF, informed the final survey. The survey consisted of 75 questions, took approximately 30-45 minutes to complete, and collected information on demographics, work history, work organizational factors, physical workload, work psychosocial stress, work climate, changes due to COVID-19, and adverse health outcomes. No identifying information was collected beyond age, sex, and race/ethnicity.

3.1.3. Demographics, Work History, and Work Organization

Basic demographic data was collected, including sex, age, race/ethnicity, highest level of education attained, and primary language. Participants were asked about their general health and the presence of health co-morbidities such as diabetes mellitus and rheumatoid arthritis. The number of years they worked as a janitor anywhere was recorded, as were the details of their current job, such as their tenure, the type of venue, their job title, the time of their work shift, the number of days they worked, and the number of hours per day. Other factors such as having a second job were also collected.

3.1.4. Physical Workload Measures

Task Level Exposure. The primary exposure of interest was the physical workload experienced among workers. The workload questions in our study included questions from the International Physical Activity Questionnaire (IPAQ) to compare physical activity levels between populations. The scale is a self-reported measure of physical activity and is acceptable for monitoring population levels of physical activity among 18- to 65-year-olds in diverse settings. These questions asked about the frequency, duration, and intensity of sixteen different tasks janitors perform (see Appendix).

The survey assessed workload across 16 common janitorial tasks, which included dusting, cleaning windows, polishing metal, cleaning white/chalkboards, cleaning furniture, moving furniture, sweeping/mopping, buffing floors, carpet shampooing, vacuuming, floor stripping/waxing, collecting trash/recycling/compost, sorting trash/recycling/compost, and cleaning bathrooms. The intensity was evaluated using the Borg-CR-10 scale, where zero indicated no effort, and ten indicated maximal effort. The frequency of each task was measured on a 5-point scale ranging from “less than once per month” (scored as 0) to “every day” (scored as 4). The duration spent on each task per day was measured on a 4-point scale ranging from “never performed” (scored as 0) to “more than 4 hours per day” (scored as 3).

Frequency and duration responses were scored to more accurately reflect the burden of tasks performed most frequently and for longer durations. Subsequently, weekly duration per task was calculated by multiplying the frequency and duration scores. Lastly, each task's workload index score was calculated by multiplying the intensity, frequency, and duration scores. Although the workload index has an arbitrary unit and cannot be interpreted in isolation, it was used to tertile the task-level exposure into low, medium, and high groups for modeling purposes.

Job Level Exposure. Based on the results from the task-level exposures, three different workload measures were used to analyze job-level exposures, including peak intensity, typical intensity, and a workload index. Table 3.1.4. provides an example of how job-level exposures were calculated based on task information using the following definitions:

- **Typical intensity:** The intensity of the task janitors performed for the most extended duration (minutes).
- **Peak intensity:** The highest intensity across all tasks performed.
- **Workload Index:** An arbitrary number that includes each task's frequency, duration, and intensity. It was computed by multiplying the intensity by weekly minutes spent performing each task, then summing the workload index across tasks.

For the example shown in Table 3.1.4, the workers job-level exposure scores would be: (i) Typical Intensity score = 4, (ii) Peak Intensity score = 8, and (iii) Workload Index score = 232.

Table 3.1.4. Example calculation of job level exposure for one individual who performed four tasks

Collected Data						**Calculated data**	
Task	**Intensity (0-10)**	**Frequency** Days per week		**Duration** Hours per day		**Duration per week (hours)**	**Task Workload Index**
		Response	**Score** [a]	**Response**	**Score** [a]		
Dusting	6	daily	5	2-4hr/day	3	15	90
Mopping	5	1/week	3	<2hr/day	2	6	30
Vacuum	**8**[b]	1-2/month	2	<2hr/day	2	4	32
Trash	**4**[c]	daily	5	>4hr/day	4	20[d]	80[e]
						Total Workload Index	**232**[f]

[a] Weighted scores reassigned to frequency and duration responses (See Methods: Task Level Exposure)

[b] Peak exposure = highest intensity across all tasks performed

[c] Typical exposure = intensity for task performed the most minutes per week

[d] Duration/week = frequency score * duration score

[e] Task Workload Index = intensity * duration/week

[f] Total Workload Index = sum of task workload index scores

3.1.5. Work Psychosocial Stress

Secondary exposures such as work psychological demand, decision latitude, and job strain were determined using a modified Job Content Questionnaire (JCQ) survey (Karasek, 1998). In total, eight questions were used to assess for decision latitude (3) and psychological demands (5) (see Appendix). Respondents indicated their agreement with the eight statements on a 4-point scale from strongly disagree to strongly agree, with a fifth option for not applicable. Questions were coded so responses that indicated higher decision latitude and psychological demand received higher points. The plausible range of scores was 3-12 for decision latitude and 5-20 for psychological demands. For each individual, missing responses to decision latitude questions were replaced with the mean of their existing decision latitude responses if only one of the three was missing. If two or more responses were missing, the response was not included in the analysis. The same approach was applied to psychological demand questions. Job strain was calculated by dividing one's psychological demand score by one's decision latitude score.

These three scores for psychological demands, decision latitude, and job strain were each dichotomized at the median to create high and low categories for use in analyses with low strain, low decision latitude, and low psychological demands considered as the referent groups (Landsbergis, 1994).

3.1.6. Work Climate Measures

Work climate was assessed by evaluating financial security, personal safety, and perceived ability to report without retaliation. Financial security evaluated whether salary met basic financial needs, the occurrence of wage theft, working extended hours, working a second job, and the perceptions of job security.

Personal safety evaluated the frequency of physical and verbal harassment to oneself or a colleague. Perceived ability to report without retaliation was evaluated by asking whether workers reported their injuries, experience of harassment, and experience of wage theft.

3.1.7. Health Outcomes

Physical Health. For physical health, questions from the 12-Item Short Form Survey (SF-12) were used to ask questions about the outcomes of interest. The SF-12 was included in the survey; it is designed to measure the general population's health and has been validated as a valuable assessment for large populations.

Participants were asked to rate their worst work-related pain over the past month in each of four body regions, including the neck/shoulder, elbow/hand/wrist, upper/lower back, and hips/legs/knees/ankles, using the 0 to 10 numeric pain scale. Two pain scores were generated, including (i) peak pain and (ii) average pain. Peak pain was the highest pain score of the four body regions. The average pain was the average of the four body region pain scores. Individuals with an average work-related pain score of 5 or greater were considered to have moderate to severe work-related pain in the statistical models.

The impact of the work-related pain over the past year was evaluated by, (i) the number of missed workdays due to the work-related pain; (ii) the number of days that medications were taken for the work-related pain, (iii) the number of work-related injuries in the past year, and (iv) the impact of work-related pain on outside activities.

Regularly missing work due to work-related pain was considered present if respondents reported missing work at least once every other month due to their pain. Medication use for work-related pain (either over the counter or prescribed) was considered regular if respondents reported taking them at least one work week per month. Injury incidence was a binary measure assessing whether a worker reported a work-related injury over the last year. The impact of pain on outside activities was assessed as a binary measure, with individuals reporting a score of two or higher (Moderate to Extreme Interference) categorized as having a negative impact.

Mental Health. The prevalence of anxiety and depression was determined using the standardized Patient Health Questionnaire-9: PHQ-9 (Kroenke, 2001) and Generalized Anxiety Disorder-7: GAD-7 (Spitzer, 2006) surveys, respectively, with a total score of 10 or more indicating the presence of anxiety or depression (see Appendix). Missing responses to the PHQ-9 and GAD-7 questions were replaced with the mean of the existing responses if less than three were missing per measure. If three or more were missing, the analysis did not include the response. For analytical purposes, anxiety and depression were coalesced into a joint mental health outcome.

3.1.8. COVID-19 Assessment

The survey included questions addressing workers' experiences during the COVID-19 pandemic. Specifically, it evaluated workers' perceptions of employer preparedness, communication, and their risk perceptions while working. Additionally, respondents were asked about changes in their workload and/or responsibilities due to the pandemic, comparing them to pre-pandemic conditions. Workers were asked to rate their agreement with several statements addressing the changes in intensity, expansion, and pace of their work compared to pre-pandemic work.

3.1.9. Data Analysis

The data was analyzed using the statistical program R (v.4.4.2). Descriptive statistics were performed to provide an overview of respondent demographics, work characteristics, and adverse health outcomes. All adverse health outcomes of interest were treated as binary variables with categorical exposures. For most models, the total workload index score and typical intensity were split into tertiles, whereas the median split was used for the peak intensity models due to a skewed distribution. To examine associations between physical workload and adverse health outcomes, Poisson models adjusted for categorical age and sex with robust standard errors were run to obtain prevalence ratios and 95% confidence intervals. Poisson models were chosen due to the high prevalence of most adverse health outcomes within our study population. Confounding by education, comorbidities, and smoking was evaluated but did not change the effect estimates by more than 10% and, therefore, were not included in the final models.

For stratified models assessing physical workload and adverse health outcomes, the total workload index score and typical intensity were split by the median and categorized into low and high-intensity exposure groups due to insufficient cases in each stratum when tertiles were used. Similarly, age was treated as two groups (<50 years and ≥50 years) for adjustment within these models, while individuals who responded "Prefer Not to Answer" for sex were excluded from the analysis (N=17). To assess for effect modification by sex, age, union status, and total years worked as a janitor, analyses were stratified. Each stratification variable was included as an interaction term in the respective models to assess for significant differences.

Similarly, to assess the association of psychosocial factors and work climate with adverse health outcomes, Poisson models adjusted for categorical age (two groups) and sex with robust standard errors were run to obtain prevalence ratios and 95% confidence intervals. Models for psychosocial exposures could not be stratified due to their small sample size. Stratified models by age, sex, and tenure were performed for work climate exposures where individuals who responded "Prefer Not to Answer" for sex were excluded from the analysis. Models could not be stratified by union status due to issues with model convergence. To evaluate the statistical significance of effect modification by sex and age, interaction terms were included for each model, and p-values were assessed.

3.2 Demographics, Work Organization, and Health Outcomes

3.2.1. Demographic Summary

718 respondents completed the CA Janitor Workload Survey, with 432 responding to the demographic questions of interest (Table 3.2.1). Most workers reported being in either the 50-65 age group (48%) or the 30-49 age group (43%). Nearly three-fourths of the study population were female (74%), and most of the study participants self-reported as Hispanic (96%). Most workers (84%) reported having up to some high school learning as their highest level of education. Among comorbidities, cardiometabolic disorders (54%) and diabetes (34%) were the most prevalent among respondents.

Table 3.2.1. Demographic characteristics of study participants

	N (%)
Age (N=432)	
18-29 years	11 (2.5%)
30-49 years	184 (42.6%)
50-65 years	206 (47.7%)
>65 years	31 (7.2%)
Gender (N=431)	
Male	97 (22.5%)
Female	317 (73.5%)
Prefer not to Say	17 (3.9%)
Race/Ethnicity (N=434)	
Hispanic	417 (96.1%)
Other	17 (3.9%)
Education (N=406)	
Less than high school	143 (35.2%)
Finished some high school/GED	199 (49.0%)
Some college or professional training	44 (10.8%)
Finished college or more	20 (4.9%)
Comorbidities (N= 186)	
Cardiometabolic Disorders	100 (53.8%)
Asthma	17 (9.1%)
Diabetes	64 (34.4%)
Hypo/Hyper Thyroid Disease	5 (2.7%)

3.2.2. Work Organization Summary

Among the 712 janitors who provided information about the venue they worked in, the most common work venue type among respondents was an office space (75%), followed by schools (4%), airports (4%), and shopping malls (4%). Most workers were employed through a subcontractor (71%) rather than direct employment through the venue (13%). Approximately three-fourths of the study population (75%) reported being union members. Over half of respondents reported working as a janitor for any employer (i.e., work tenure) for 0-10 years (53%), followed by 11-20 years (27%). Most respondents (92%) worked 40 hours a week or less (Table 3.2.2).

Table 3.2.2. Work organization summary of participants

	N (%)
Current Work Venue (N = 712)	
Airport	28 (3.9%)
Biotech/Hi-Tech	16 (2.2%)
Higher Education	2 (0.3%)
Manufacturing	10 (1.4%)
Office	533 (74.9%)
Public Venue	17 (2.4%)
School	31 (4.4%)
Shopping mall	27 (3.8%)
Library	3 (0.4%)
Residential/Kitchen	8 (1.1%)
Hospital/ Clinic/Dentist	12 (1.7%)
Warehouse	5 (0.7%)
Grocery /Retail Store	4 (0.6%)
Movie Theater/Studio	7 (1.0%)
Gymnasium	2 (0.3%)
Refinery	1 (0.1%)
Other	6 (0.8%)
Employment Type (N = 639)	
Direct Employment	81 (12.7%)
Subcontractor	456 (71.3%)
Other	102 (16.0%)
Union Status (N = 675)	
Yes	505 (74.8%)
No	170 (25.9%)
Job Tenure (N=694)	
0–10 years	363 (52.3%)
11-20 years	192 (27.7%)
21-30 years	117 (16.9%)
31-40 years	22 (3.1%)
Total Hours Worked (N = 718)	
≤ 40	659 (91.8%)
> 40	59 (8.2%)
Worked a Second Job (N=718)	
No	545 (76%)
Yes	173 (24%)

The majority of respondents worked in office venues (75%), were subcontractors (71%), and represented by a union (75%). Nearly half of respondents had worked as a janitor for more than 10 years.

3.2.3. Physical Health Summary

Pain was highly prevalent among the study population, with nearly every participant reporting at least mild work-related pain. When evaluating the highest pain score across the four-body regions (peak pain), over four-fifths (84%) of respondents reported moderate to severe work-related pain (Table 3.2.3.A; Figure 3.2.3.A). Using the average pain score across all four body regions, (56%) had moderate to severe work-related pain.

Across the four individual body regions, the upper/lower back and leg regions reported the highest pain proportion (67%) or janitors reporting moderate to severe work-related pain followed by the neck/shoulder (62%) and the upper extremity (60%) (Table 3.2.3.B). Figure 3.2.3.B provides the distribution of pain scores for each of the four-body regions. The number of people with moderate to severe work-related pain in multiple body regions was high. Approximately 57% of janitors had moderate to severe work-related pain in three or four body regions (Figure 3.2.3.C).

Table 3.2.3.A. Summary of work-related pain scores by average and peak pain

	All N (%)	Mean (SD)
Average Pain Severity	**416**	**5.4 (2.9)**
mild (<5)	182 (43.8%)	
moderate to severe (≥5)	234 (56.3%)	
Peak Pain Severity	**416**	**7.3 (2.7)**
mild (<5)	65 (15.6%)	
moderate to severe (≥5)	351 (84.4%)	

Figure 3.2.3.A. Distribution of work-related pain scores summarized by average and peak pain

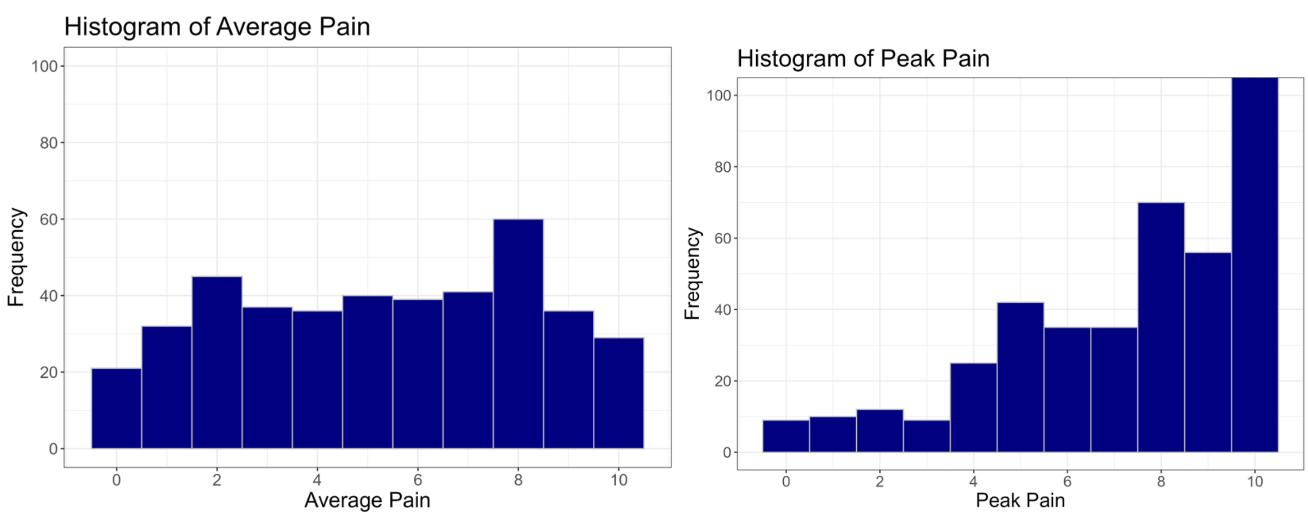


Table 3.2.3.B. Prevalence of work-related pain by body region

Work-Related Pain Body Region	All N (%)[a]	Mean (SD)
Neck/Shoulder	**416**	**5.2 (3.5)**
mild (<5)	158 (38.0%)	
moderate to severe (≥5)	258 (62.0%)	
Upper Extremity	**416**	**5.2 (3.5)**
mild (<5)	166 (39.9%)	
moderate to severe (≥5)	250 (60.1%)	
Upper and Lower Back	**416**	**5.5 (3.5)**
mild (<5)	138 (33.2%)	
moderate to severe (≥5)	278 (66.8%)	
Legs	**416**	**5.7 (3.5)**
mild (<5)	140 (33.7%)	
moderate to severe (≥5)	276 (66.3%)	

[a] Missing percentages indicate missing data

Figure 3.2.3.B. Distribution of work-related pain scores by body region

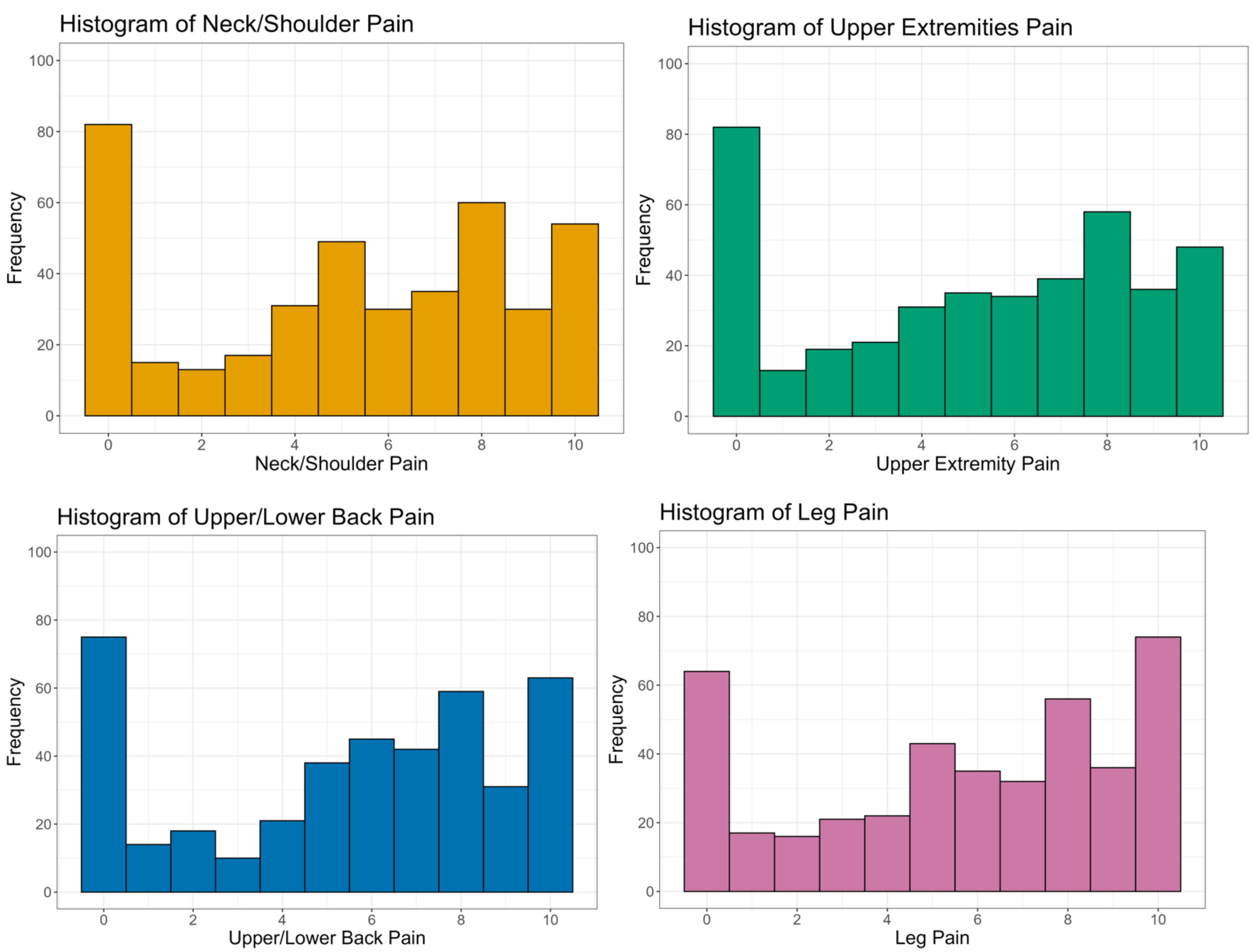
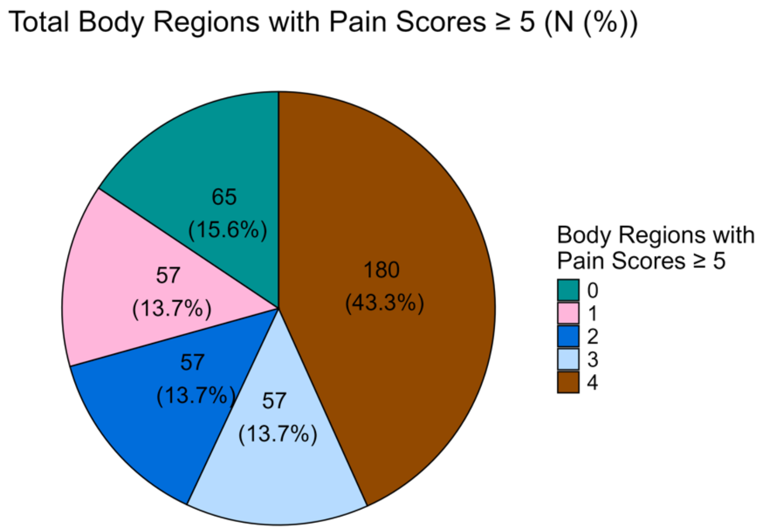


Figure 3.2.3.C. The number of body regions with moderate to severe work-related pain.



The prevalence of moderate to severe work-related pain over the prior month was high among janitors. Nearly 85% of respondents reported moderate to severe work-related pain in at least one body region, and over half of janitors (57%) had moderate to severe work-related pain in three or four body regions. All body regions were affected similarly.

The impact of a worker's pain was assessed across four measures, as described in Section 3.1.7. A majority of janitors (58%) reported regularly using pain medication (at least once a work week), while one-fifth of workers (20%) stated that they regularly missed work due to pain (at least one day every other month). Nearly one-third of respondents (29%) reported one or more work injuries in the past year, with over two-fifths (41%) indicating that their pain has a moderate to extreme impact on their outside activities.

Table 3.2.3.B. Prevalence of pain impact outcomes

	N (%)
Medication Use	**412**
Rarely Uses	172 (41.7%)
Regularly Uses (>1 a month)	240 (58.3%)
Missed Days at Work	**408**
Rarely Misses	328 (80.4%)
Regularly Misses (at least once every other month)	80 (19.6%)
Injury Incidence	**424**
None	301 (71.0%)
At least one	123 (29.0%)
Impact on Outside Activities	**408**
Not at all	146 (35.8%)
Slightly	94 (23.0%)
Moderately	88 (21.6%)
Quite a bit	65 (15.9%)
Extremely	15 (3.7%)

Over half of janitors used medication more than once a month to manage their pain and one in five workers missed work at least every other month due to their pain.

Nearly one in three reported having had at least one work-related injury, and two of five workers reported that their work-related pain had a moderate to extreme impact on their ability to perform activities outside of work.

3.2.4. Mental Health Summary

Respondents rated how often they have been bothered by specific symptoms such as feeling nervous, anxious, or on edge, worrying too much about different things, or trouble relaxing over the past two weeks (GAD-7), and whether they had been bothered by problems such as having little interest or pleasure in doing things, a poor appetite, and trouble concentrating over the last two weeks (PHQ-9). Among respondents, nearly one-fifth (17%) were likely experiencing anxiety or depression based on their answers to the GAD-7 or PHQ-9 survey questions (Table 3.2.4.A).

Table 3.2.4.A. Prevalence of anxiety or depression

	N (%)
Likelihood of Anxiety or Depression	**381**
Both absent	317 (83.2%)
At least one present (>10 for either GAD-7 or PHQ9)	64 (16.8%)
GAD-7 >10	22
PHQ9 >10	42

Approximately one in five workers were likely to have either anxiety or depression over the prior two weeks. The prevalence of anxiety or depression was much lower than the prevalence of musculoskeletal pain.

3.3. Association between Physical Workload and Health Outcomes

3.3.1 Job and Task Level Exposure Summary

Job-level workload measures were high for workers' most typical task and peak task (Table 3.3.1.A).

Tasks varied in intensity, frequency, duration, and workload, with cleaning bathrooms having the highest workload score, followed closely by sweeping/mopping and collecting trash (Table 3.3.1.B). Vacuuming and sorting trash showed similarly high intensities but varied in frequency and duration. Tasks such as floor stripping/waxing and buffing floors had lower intensity, frequency, and workload. Overall, cleaning-related tasks involving high-frequency activities such as kitchens, bathrooms, and trash management demonstrated the highest workloads, reflecting their perceived intensity and sustained duration of tasks.

Table 3.3.1.A. Job level exposure summary

Workload Measure	**N**	**All Mean (SD)**
Peak Intensity (0-10)	468	8.4 (1.8)
Typical Intensity (0-10)	468	7.5 (2.4)
Workload Index	464	611.2 (385.1)

Table 3.3.1.B. Intensity, frequency, duration, and workload by task

Task	N	Intensity Mean (SD)	Frequency Mean (SD)	Duration Mean (SD)	Workload Index Mean (SD)
Floor stripping/waxing	219	4.90 (2.9)	0.81 (1.5)	0.73 (1.3)	6.98 (24.7)
Carpet shampooing	220	4.82 (2.8)	0.70 (1.4)	0.68 (1.3)	8.79 (30.3)
Buffing Floors	282	2.62 (3.1)	1.38 (1.8)	0.78 (1.3)	11.74 (30.8)
Cleaning white/chalk boards	293	4.29 (2.6)	1.92 (2.2)	1.01 (1.1)	20.43 (37.0)
Cleaning windows	357	5.24 (2.7)	2.08 (2.0)	1.73 (1.1)	25.83 (35.4)
Moving Furniture	337	5.82 (2.6)	2.18 (2.1)	1.46 (1.2)	29.82 (39.3)
Polishing	364	5.00 (2.70	3.00 (2.1)	1.63 (1.0)	33.91 (37.2)
Dusting	461	5.71 (2.6)	3.17 (1.9)	2.46 (0.83)	49.77 (48.6)
Cleaning Furniture	395	3.61 (1.9)	3.61 (1.9)	2.28 (0.94)	53.83 (46.2)
Cleaning Kitchens	405	5.94 (2.7)	4.22 (1.6)	1.97 (1.0)	58.52 (45.6)
Disinfecting related to COVID	383	6.09 (2.7)	3.90 (1.9)	2.10 (1.1)	61.73 (52.3)
Sorting Trash	379	6.21 (2.6)	4.21 (1.6)	2.20 (1.1)	65.86 (48.9)
Vacuuming	416	6.90 (2.6)	3.88 (1.7)	2.31 (0.90)	70.35 (51.9)
Collecting Trash	417	6.59 (2.6)	4.65 (1.1)	2.56 (0.90)	82.50 (49.1)
Sweeping/Mopping	446	6.89 (2.5)	4.47 (1.3)	2.53 (0.82)	83.07 (51.9)
Cleaning Bathrooms	427	6.96 (2.5)	4.60 (1.1)	2.57 (0.91)	88.15 (51.7)

Overall, regardless of whether work was quantified by peak or typical workload, the intensity of work was high. The tasks with the highest overall workload were collecting trash, sweeping/mopping, vacuuming, and cleaning bathrooms.

3.3.2. Associations between physical exposure and prevalence of work-related musculoskeletal pain

Four hundred thirty-two individuals answered survey questions relevant to this analysis and the characteristics of this subset group were similar to the overall cohort. Nearly all respondents were Hispanic, and three in four were female. Most respondents (90%) were between age 30 and 65. About half (54%) reported at least one comorbidity, while less than 15 individuals (4%) reported being current smokers. 85% of respondents had, at most, a high school education.

After adjusting for categorical age and sex, a higher workload exposure was associated with a higher prevalence of severe pain, regardless of how exposure was characterized (workload index, typical intensity, peak intensity). Across each measure, higher exposures were associated with an increased prevalence of severe pain in any body region, indicating a statistically significant exposure-response relationship (Table 3.3.2.A).

Table 3.3.2.A. Associations between physical workload and moderate to severe work-related average pain

	All N	Cases (n)	Prevalence Ratio (95% CI)[a]
Severe Pain	**379**	**216**	
Peak Intensity			
Low (< 9)	220	92	1.00
High (≥ 9)	159	124	**1.77 (1.49, 2.11)**
Typical Intensity			
Low (< 7)	118	35	1.00
Medium (≥ 7 & < 9)	148	88	**1.99 (1.47, 2.70)**
High (> 9)	113	93	**2.66 (2.00, 3.55)**
Workload Index			
Low (≤ 396)	118	40	1.00
Medium (> 396 & ≤ 726)	125	65	**1.50 (1.11, 2.02)**
High (> 726)	136	111	**2.37 (1.83, 3.08)**

[a] Estimated in Poisson regression model with robust standard errors, adjusting for categorical age (4 groups) and sex (male/female/prefer not to say).

Across the three measures, workers in the high exposure groups had more than a two-fold increase in the prevalence of moderate to severe pain compared to their counterparts in the low exposure group.

Higher workloads, regardless of how exposure was characterized (workload index, typical intensity, peak intensity), were also associated with an increased prevalence of all adverse pain impact outcomes (Table 3.3.2.B). Effect estimates trended highest for missed work and outside activity impact, with workers in the high-exposure group reporting double the prevalence of these outcomes compared to workers in the low-exposure group.

Table 3.3.2.B. Associations between physical workload and pain impact outcome measures

	All N	Cases (n)	Prevalence Ratio (95% CI)[a]
Medication Use (N = 379)	**379**	**218**	
Peak Intensity			
Low (< 9)	223	109	1.00
High (≥ 9)	156	109	**1.42 (1.20, 1.68)**
Typical Intensity			
Low (< 7)	117	49	1.00
Medium (≥ 7 & < 9)	153	87	**1.37 (1.06, 1.75)**
High (> 9)	109	82	**1.80 (1.42, 2.28)**
Workload Index			
Low (≤ 396)	116	50	1.00
Medium (> 396 & ≤ 726)	129	67	1.21 (0.93, 1.57)
High (> 726)	134	101	**1.73 (1.38, 2.18)**
Missed Work (N = 378)	**378**	**73**	

Peak Intensity			
Low (< 9)	222	38	1.00
High (≥ 9)	156	35	1.29 (0.85, 2.00)
Typical Intensity			
Low (< 7)	117	14	1.00
Medium (≥ 7 & < 9)	152	32	1.77 (1.00, 3.16)
High (> 9)	109	27	**2.04 (1.13, 3.70)**
Workload Index			
Low (≤ 396)	114	16	1.00
Medium (> 396 & ≤ 726)	128	22	1.26 (0.70, 2.27)
High (> 726)	136	35	**1.86 (1.08, 3.20)**
Injury Incidence (N = 388)	**388**	**108**	
Peak Intensity			
Low (< 9)	230	53	1.00
High (≥ 9)	158	55	**1.49 (1.08, 2.05)**
Typical Intensity			
Low (< 7)	124	24	1.00
Medium (≥ 7 & < 9)	155	42	1.39 (0.89, 2.16)
High (> 9)	109	42	**1.94 (1.27, 2.97)**
Workload Index			
Low (≤ 396)	127	25	1.00
Medium (> 396 & ≤ 726)	131	36	1.38 (0.88, 2.15)
High (> 726)	130	47	**1.82 (1.20, 2.76)**
Outside Activity Impact (N=375)	**375**	**150**	
Peak Intensity			
Low (< 9)	223	70	1.00
High (≥ 9)	152	80	**1.65 (1.29, 2.11)**
Typical Intensity			
Low (< 7)	122	32	1.00
Medium (≥ 7 & < 9)	143	54	**1.46 (1.01, 2.09)**
High (> 9)	110	64	**2.16 (1.54, 3.02)**
Workload Index			
Low (≤ 396)	121	35	1.00
Medium (> 396 & ≤ 726)	123	33	0.91 (0.61, 1.37)
High (> 726)	131	82	**2.14 (1.57, 2.91)**

[a]Estimated in Poisson regression model with robust standard errors, adjusting for categorical age (4 groups) and sex (male/female/prefer not to say)

High physical workload was associated with an increased prevalence of pain impact outcomes including, medication use, missed work, previous injury, and impact on outside work activities; typical intensity of work had the highest effect estimates.

For the joint mental health outcome of anxiety and depression, a statistically significant association was observed for workers with a high peak intensity workload but not for a high typical intensity workload or a high workload index (Table 3.3.2.C). However, all point estimates suggest an overall exposure-response trend across the tertile groups despite wider confidence intervals.

Table 3.3.2.C. Associations between physical workload and anxiety or depression

	All N	Cases (n)	Adj PR (95% CI)[a]
Anxiety or Depression (N = 364)	**364**	**62**	
Peak Intensity			
Low (< 9)	217	30	1.0
High (≥ 9)	147	32	**1.59 (1.01, 2.52)**
Typical Intensity			
Low (< 7)	112	16	1.0
Medium (≥ 7 & < 9)	144	20	0.94 (0.52, 1.71)
High (> 9)	108	26	1.69 (0.96, 2.99)
Workload Index			
Low (≤ 396)	112	13	1.0
Medium (> 396 & ≤ 726)	124	22	1.50 (0.79, 2.82)
High (> 726)	128	27	1.79 (0.97, 3.29)

[a]Estimated in the Poisson regression model with robust standard errors, adjusting for categorical age (4 groups) and sex (male/female/prefer not to say)

Only peak intensity was statistically significantly associated with an increased prevalence of anxiety or depression, though typical intensity and workload index also had elevated effect estimates suggestive of an association.

3.4 Effect Modification by Sex and Age

3.4.1. Descriptive summary of exposure and health outcomes by sex and age

When stratified by sex, women, on average, reported far higher average peak intensity scores compared to men, while typical intensity remained similar regardless of sex (Table 3.4.1.A). The inverse was true for workload, where men, on average, reported higher scores compared to women. Differences by age were less pronounced but were most notable for workload, where individuals younger than 50 reported higher scores compared to those 50 years and older (Table 3.4.1.A).

Similar trends were observed when pain severity was stratified by sex and age. A higher proportion of women reported moderate to severe work-related pain peak pain (86%) compared to men (78%), with smaller differences for average pain (58% and 52%, respectively). Across all four body regions, a higher percentage of women reported pain compared to men as well. Differences by age were again less notable, with relatively similar proportions across the four body regions and peak/average pain (Table 3.4.1.B).

Measures of pain impact saw more women reporting use of pain medication (59%) and missing work due to pain (21%) compared to men (50% and 16%) (Table 3.4.1.C). However, men were more likely to experience a work injury (32%) and have pain impact their outside activities (42%) compared to women (28% and 36%).

Women reported a slightly higher likelihood of anxiety or depression (20%) compared to men (17%), while there were no distinguishable differences found between age groups(Table 3.4.1.D). Men were marginally more likely to report the prevalence of anxiety or depression (20%) compared to women (16%) among the study population (Table 3.4.1.D). Across age groups, prevalence remained similar (16-17%).

Table 3.4.1.A. Summary of job level exposures stratified by sex and age

	Sex				Age			
	Women		Men		<50 years		≥50 years	
	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)
Workload Index	309	594.2 (372.2)	96	670.6 (444.9)	191	632.6 (424.7)	232	597.3 (360.0)
Typical Intensity (0-10)	310	7.4 (2.3)	97	7.6 (2.2)	191	7.5 (2.4)	234	7.5 (2.3)
Peak Intensity (0-10)	310	8.4 (1.8)	97	5.6 (1.6)	191	8.5 (1.7)	234	8.4 (1.8)

Table 3.4.1.B. Prevalence of moderate to severe work-related pain by average pain, peak pain, and pain by body region

	Sex [i]		Age [a]	
	Men N (%)	**Women N (%)**	**Age <50 N (%)**	**Age ≥50 N (%)**
Average Pain Severity	**88**	**283**	**175**	**213**
mild pain (<5)	42 (47.7%)	118 (41.7%)	77 (44.0%)	94 (44.1%)
moderate to severe pain (≥5)	46 (52.3%)	165 (58.3%)	98 (56.0%)	119 (55.9%)
Continuous, Mean (SD)	4.9 (2.8)	5.5 (2.9)	5.4 (2.8)	5.3 (3.0)
Peak Pain Severity	**88**	**283**	**175**	**213**
mild pain (<5)	19 (21.6%)	39 (13.8%)	27 (15.4%)	35 (16.4%)
moderate to severe pain (≥5)	69 (78.4%)	244 (86.2%)	148 (84.6%)	178 (83.6%)
Continuous, Mean (SD)	6.7 (2.8)	7.4 (2.6)	7.3 (2.5)	7.2 (2.8)
Neck/Shoulder	**88**	**283**	**175**	**213**
mild pain (<5)	39 (44.3%)	102 (36.0%)	72 (41.1%)	78 (36.6%)
moderate to severe pain (≥5)	49 (55.7%)	181 (64.0%)	103 (58.9%)	135 (63.4%)
Continuous, Mean (SD)	4.7 (3.1)	5.4 (3.6)	5.0 (3.4)	5.4 (3.6)
Upper Extremity	**88**	**283**	**175**	**213**
mild pain (<5)	40 (45.5%)	109 (38.5%)	65 (37.1%)	91 (42.7%)
moderate to severe pain (≥5)	48 (54.5%)	174 (61.5%)	110 (62.9%)	122 (57.3%)
Continuous, Mean (SD)	4.8 (3.2)	5.2 (3.6)	5.4 (3.4)	5.0 (3.5)
Upper or Lower Back	**88**	**283**	**175**	**213**
mild pain (<5)	35 (39.8%)	87 (30.7%)	53 (30.3%)	76 (35.7%)
moderate to severe pain (≥5)	53 (60.2%)	196 (69.3%)	122 (69.7%)	137 (64.3%)
Continuous, Mean (SD)	5.0 (3.5)	5.7 (3.4)	5.8 (3.2)	5.3 (3.7)
Lower Extremity	**88**	**283**	**175**	**213**
mild pain (<5)	35 (39.8%)	92 (32.5%)	62 (35.4%)	72 (33.8%)
moderate to severe pain (≥5)	53 (60.2%)	191 (67.5%)	113 (64.6%)	141 (66.2%)
Continuous, Mean (SD)	4.9 (3.5)	5.8 (3.5)	5.6 (3.4)	5.6 (3.6)

[a] Missing percentages indicate missing data

There was a 6-9% higher prevalence of average and peak pain among women with no consistent differences in the prevalence of pain by age.

Table 3.4.1.C. Measures of pain impact stratified by sex and age

		Sex		Age	
	N (%)	**Men**	**Women**	**<50 years**	**≥50 years**
Pain Medication Use	**412**	**88**	**283**	**186**	**203**
Rarely uses	172 (41.7%)	44 (50.0%)	117 (41.3%)	90 (48.6%)	75 (36.9%)
Regularly uses (at least one work week/month)	240 (58.3%)	44 (50.0%)	166 (58.7%)	96 (51.6%)	128 (63.1%)
Missed Work due to Pain	**408**	**89**	**280**	**183**	**203**
Rarely misses	328 (80.4%)	75 (84.3%)	221 (78.9%)	146 (79.8%)	166 (81.8%)
Regularly misses (at least once every other month)	80 (19.6%)	14 (15.7%)	59 (21.1%)	37 (20.2%)	37 (18.2%)
Work Injuries in Last Year	**424**	**88**	**294**	**180**	**219**
None	301 (66.9%)	60 (68.2%)	213 (72.4%)	123 (68.3%)	166 (75.8%)
One or more	123 (29.1%)	28 (31.8%)	81 (27.6%)	57 (31.7%)	53 (24.2%)
Pain Interferes with Activity	**408**	**89**	**278**	**175**	**209**
No	146 (35.7%)	37 (41.6%)	101 (36.3%)	60 (34.3%)	81 (38.8%)
Yes	262 (64.4%)	52 (58.4%)	177 (63.7%)	115 (65.7%)	128 (61.2%)

Table 3.4.1.D. Prevalence of anxiety or depression stratified by sex and age

		Sex		Age	
	N (%)	**Men**	**Women**	**<50 years**	**≥50 years**
Likelihood of Anxiety or Depression	**381**	**84**	**270**	**178**	**193**
Both absent	317 (83.2%)	67 (79.8%)	227 (84.1%)	149 (83.7%)	160 (82.9%)
At least one present (>10 for either GAD-7 or PHQ9)	64 (16.8%)	17 (20.2%)	43 (15.9%)	29 (16.3%)	33 (17.1%)
GAD-7 >10	22	6	16	10	11
PHQ9 >10	42	8	30	22	17

3.4.2. Association between physical workload and physical outcomes by sex

Women reported a higher effect estimate for the association of severe pain and peak intensity, but typical intensity and workload suggested an inverse relationship (Table 3.4.2.A). Men in the high workload group had nearly three times the prevalence of severe pain compared to their reference group, while women in the high workload group had nearly two times the prevalence compared to the reference. Effect modification by sex could not be statistically concluded as the p-values for interaction terms were greater than 0.5 for all three measures of physical workload.

Table 3.4.2.A. Associations between physical workload and moderate to severe work-related pain by sex

	Men			Women		
	N	Cases (n)	Prevalence Ratio (95% CI) [i]	N	Cases (n)	Prevalence Ratio (95% CI)[a]
Severe Pain (N=363)	**88**	**46**		**275**	**162**	
Peak Intensity						
Low (< 9)	53	23	1.00	158	66	1.00
High (≥ 9)	35	23	**1.52 (1.03, 2.25)**	117	96	**1.96 (1.60, 2.41)**
Typical Intensity						
Low (<8)	32	8	1.00	116	39	1.00
High (≥8)	56	38	**2.70 (1.44, 5.06)**	159	123	**2.30 (1.76, 3.01)**
Workload Index						
Low (<540)	38	10	1.00	130	55	1.00
High (≥540)	50	36	**2.76 (1.57, 4.86)**	145	107	**1.74 (1.40, 2.18)**

[a]Estimated in Poisson regression models with robust standard errors, adjusting for categorical age (<50/≥50).

Results varied across the measures of pain impact when stratified by sex across the three workload measures (Table 3.4.2.B). On average, men had higher effect estimates when assessed by workload index than women across all outcomes besides injury incidence. Women were nearly two times more likely to be prevalent for injury compared to the reference group. The inverse was seen for missed work, which displayed higher effect estimates across all workload measures in men than women.

Women reported higher effect estimates for anxiety or depression compared to men for all three measures of workload (Table 3.4.2.C). Women with high physical workload had two times the prevalence of adverse mental health outcomes compared to their respective reference groups.

Table 3.4.2.B. Associations between physical workload and pain impact outcomes by sex

	Men			Women		
	N	Cases (n)	Prevalence Ratio (95% CI)[a]	N	Cases (n)	Prevalence Ratio (95% CI)[a]
Medication Use (N=363)	**88**	**44**		**275**	**162**	
Peak Intensity						
Low (< 9)	54	21	1.00	159	82	1.00
High (≥ 9)	34	33	**1.76 (1.18, 2.65)**	116	80	**1.34 (1.11, 1.63)**
Typical Intensity						
Low (<8)	32	12	1.00	120	55	1.00
High (≥8)	56	32	1.49 (0.91, 2.44)	155	107	**1.51 (1.22, 1.89)**
Workload Index						
Low (<540)	37	11	1.00	132	62	1.00
High (≥540)	51	33	**2.12 (1.22, 3.67)**	143	100	**1.49 (1.21, 1.84)**

Table 3.4.2.B. Associations between physical workload and pain impact outcomes by sex (continued)

	Men			Women		
	N	Cases (n)	Prevalence Ratio (95% CI)[a]	N	Cases (n)	Prevalence Ratio (95% CI)[a]
Missed Work (N=362)	**89**	**14**		**273**	**57**	
Peak Intensity						
Low (< 9)	54	7	1.00	158	29	1.00
High (≥ 9)	35	7	1.52 (0.59, 3.89)	115	28	1.33 (0.84, 2.10)
Typical Intensity						
Low (<8)	33	3	1.00	119	17	1.00
High (≥8)	56	11	2.31 (0.67, 7.98)	154	40	**1.82 (1.09, 3.04)**
Workload Index						
Low (<540)	37	4	1.00	130	18	1.00
High (≥540)	52	10	2.15 (0.62, 7.51)	143	39	**1.97 (1.19, 3.27)**
Injury Incidence (N = 371)	**88**	**28**		**283**	**76**	
Peak Intensity						
Low (< 9)	54	17	1.00	166	34	1.00
High (≥ 9)	34	11	1.00 (0.54, 1.83)	117	42	**1.74 (1.19, 2.56)**
Typical Intensity						
Low (<8)	33	10	1.00	126	22	1.00
High (≥8)	55	18	1.09 (0.58, 2.04)	157	54	**1.96 (1.27, 3.03)**
Workload Index						
Low (<540)	40	12	1.00	143	28	1.00
High (≥540)	48	16	1.28 (0.68, 2.40)	140	48	**1.74 (1.12, 2.61)**
Outside Activity Interference (N = 369)	**89**	**33**		**280**	**108**	
Peak Intensity						
Low (< 9)	54	18	1.00	160	47	1.00
High (≥ 9)	35	15	**1.60 (1.10, 2.32)**	110	61	**1.83 (1.29, 2.59)**
Typical Intensity						
Low (<8)	34	10	1.00	119	28	1.00
High (≥8)	55	23	**2.17 (1.36, 3.47)**	151	80	**1.92 (1.28, 2.90)**
Workload Index						
Low (<540)	38	11	1.00	132	32	1.00
High (≥540)	51	22	**2.41 (1.57, 3.72)**	138	76	**1.86 (1.25, 2.77)**

[a] Estimated in Poisson regression models with robust standard errors, adjusting for categorical age (<50/≥50).

Table 3.4.2.C. Association between physical workload and anxiety or depression by sex

	Men			Women		
	N	Cases (n)	Prevalence Ratio (95% CI) [i]	N	Cases (n)	Prevalence Ratio (95% CI) [i]
Anxiety or Depression (N = 348)	**84**	**17**		**264**	**42**	
Peak Intensity						
Low (< 9)	53	11	1.00	155	17	1.00
High (≥ 9)	31	6	0.93 (0.38, 2.27)	109	25	**2.09 (1.19, 3.69)**
Typical Intensity						
Low (<8)	32	8	1.00	114	9	1.00
High (≥8)	52	9	0.69 (0.30, 1.61)	150	33	**2.79 (1.39, 5.61)**
Workload Index						
Low (<540)	36	7	1.00	128	13	1.00
High (≥540)	48	10	1.09 (0.42, 2.78)	136	29	**2.10 (1.14, 3.86)**

[i] Estimated in Poisson regression model with robust standard errors, adjusting for categorical age (<50/≥50).

Measures of workload were associated with moderate to severe work-related pain in both men and women, though effect estimates were higher among men.

Measures of workload were statistically significantly associated with measures of pain impact in men and women.

Measures of workload were statistically significantly associated with the prevalence of anxiety or depression in women.

3.4.3. Association between physical workload and physical health outcomes by age

For all three measures of physical workload, workers younger than 50 reported higher effect estimates associated with severe pain than workers 50 and older (Table 3.4.3.A). For typical intensity, workers younger than 50 had three times the prevalence of severe pain compared to their reference, while workers 50 and older reported two times the prevalence.

Table 3.4.3.A. Associations between physical workload and moderate to severe work-related pain by age

	< 50 years			≥ 50 years		
	N	**Cases (n)**	**Prevalence Ratio (95% CI)** [i]	**N**	**Cases (n)**	**Prevalence Ratio (95% CI)** [i]
Severe Pain (N=363)	**161**	**92**		**202**	**116**	
Peak Intensity						
Low (< 9)	91	35	1.00	120	54	1.00
High (≥ 9)	70	57	**2.11 (1.59, 2.80)**	82	62	**1.68 (1.33, 2.12)**
Typical Intensity						
Low (<8)	65	17	1.00	83	30	1.00
High (≥8)	96	75	**2.99 (1.97, 4.55)**	119	86	**2.02 (1.49, 2.74)**
Workload Index						
Low (<540)	77	28	1.00	91	37	1.00
High (≥540)	84	64	**2.08 (1.51, 2.86)**	111	79	**1.77 (1.35, 2.33)**

[i] Estimated in Poisson regression model with robust standard errors, adjusting for sex (male/female).

Table 3.4.3.B. Associations between physical workload and pain impact by age

	< 50 years			≥ 50 years		
	N	**Cases (n)**	**Prevalence Ratio (95% CI)** [i]	**N**	**Cases (n)**	**Prevalence Ratio (95% CI)** [i]
Medication Use (N=363)	**171**	**87**		**192**	**119**	
Peak Intensity						
Low (< 9)	98	41	1.00	115	62	1.00
High (≥ 9)	73	46	**1.50 (1.12, 2.01)**	77	57	**1.37 (1.10, 1.69)**
Typical Intensity						
Low (<8)	72	25	1.00	80	42	1.00
High (≥8)	99	62	**1.81 (1.27, 2.56)**	112	77	**1.33 (1.04, 1.70)**
Workload Index						
Low (<540)	86	35	1.00	83	38	1.00
High (≥540)	85	52	**1.48 (1.09, 2.02)**	109	81	**1.67 (1.29, 2.16)**

Table 3.4.3.B. Associations between physical workload and pain impact by age (continued)

	< 50 years			≥ 50 years		
	N	**Cases (n)**	**Prevalence Ratio (95% CI)** [i]	**N**	**Cases (n)**	**Prevalence Ratio (95% CI)** [i]
Missed Work (N=362)	**169**	**35**		**193**	**36**	
Peak Intensity						
Low (< 9)	97	17	1.00	115	19	1.00
High (≥ 9)	72	18	1.43 (0.79, 2.57)	78	17	1.30 (0.73, 2.33)
Typical Intensity						
Low (<8)	72	8	1.00	80	12	1.00
High (≥8)	97	27	**2.51 (1.21, 5.19)**	113	24	1.49 (0.79, 2.80)
Workload Index						
Low (<540)	85	9	1.00	82	13	1.00
High (≥540)	84	26	**2.94 (1.45, 5.97)**	111	23	1.39 (0.74, 2.63)
Injury Incidence (N=371)	**163**	**53**		**208**	**51**	
Peak Intensity						
Low (< 9)	94	23	1.00	126	28	1.00
High (≥ 9)	69	30	**1.79 (1.15, 2.78)**	82	23	1.26 (0.78, 2.03)
Typical Intensity						
Low (<8)	68	14	1.00	91	18	1.00
High (≥8)	95	39	**1.97 (1.17, 3.32)**	117	33	1.43 (0.86, 2.38)
Workload Index						
Low (<540)	83	20	1.00	100	20	1.00
High (≥540)	80	33	**1.77 (1.12, 2.80)**	108	31	1.45 (0.88, 2.39)
Outside Activity Interference (N=359)	**159**	**65**		**200**	**76**	
Peak Intensity						
Low (< 9)	92	30	1.00	122	35	1.00
High (≥ 9)	67	35	**1.60 (1.10, 2.32)**	78	41	**1.83 (1.29, 2.59)**
Typical Intensity						
Low (<8)	66	16	1.00	87	22	1.00
High (≥8)	93	49	**2.17 (1.36, 3.47)**	113	54	**1.92 (1.28, 2.90)**
Workload Index						
Low (<540)	79	19	1.00	91	24	1.00
High (≥540)	80	46	**2.41 (1.57, 3.72)**	109	52	**1.86 (1.25, 2.77)**

[i] Estimated in Poisson regression model with robust standard errors, adjusting for sex (male/female)

Table 3.4.3.C. Association between physical workload and anxiety or depression by age

	<50 years			≥ 50 years		
	N	Cases (n)	Prevalence Ratio (95% CI) [i]	N	Cases (n)	Prevalence Ratio (95% CI) [i]
Anxiety or Depression (N=348)	**163**	**26**		**185**	**33**	
Peak Intensity						
Low (< 9)	94	12	1.00	114	16	1.00
High (≥ 9)	69	14	1.58 (0.78, 3.20)	71	17	1.73 (0.94, 3.19)
Typical Intensity						
Low (<8)	70	10	1.00	76	7	1.00
High (≥8)	93	16	1.21 (0.59, 2.49)	109	26	2.57 (1.16, 5.73)
Workload Index						
Low (<540)	82	9	1.00	82	11	1.00
High (≥540)	81	17	1.98 (0.94, 4.17)	103	22	1.57 (0.79, 3.13)

[i] Estimated in Poisson regression model with robust standard errors, adjusting for sex (male/female).

Measures of workload were statistically significant with having moderate to severe pain and measures of pain impact with slightly higher effect estimates among those younger than 50 years of age.

3.5 Effect Modification by Union Status and Job Tenure

3.5.1. Descriptive summary of exposure and health outcomes by union status and job tenure

Workload remained high across the three workload exposure measures when stratified by union status, with non-union workers reporting marginal increases in typical and peak intensity compared to union workers, and union workers having a slightly higher average workload index than non-union workers (Table 3.5.1.A). When stratified by job tenure, those who have worked 10 years or more as a janitor reported a higher workload index than those under 10 years.

A higher proportion of union workers (58%) reported average moderate to severe work-related pain compared to non-union workers (53%), with similar levels of prevalence for peak moderate to severe work-related pain (Table 3.5.1.B). When stratified by job tenure, both groups reported similar proportions of average moderate to severe work-related pain. Workers who have worked 10 years or more reported a minor increase in peak moderate to severe work-related pain (87% vs. 82%).

The prevalence of measures of pain impact was similar by union status and job tenure (Figure 3.5.1.C).

Prevalence of anxiety or depression remained similar when stratified by union status and job tenure, though union workers reported a marginally higher proportion (18%) compared to their non-union (16%) counterparts (Table 3.5.1.D).

Table 3.5.1.A. Job level exposure summary stratified by job tenure and union status.

			Union Status				Job Tenure			
	N	**All** Mean (SD)	**N**	**Union** Mean (SD)	**N**	**Non-Union** Mean (SD)	**N**	**<10 years** Mean (SD)	**N**	**≥10 years** Mean (SD)
Peak Intensity (0-10)	468	8.4 (1.8)	310	8.4 (1.8)	153	8.5 (1.7)	206	8.4 (1.8)	255	8.4 (1.9)
Typical Intensity (0-10)	468	7.5 (2.4)	310	7.4 (2.5)	153	7.6 (2.2)	206	7.4 (2.5)	255	7.5 (2.4)
Workload Index	464	611.2 (385.1)	306	616.3 (395.1)	153	607.4 (367.6)	206	599.9 (385.4)	251	618.5 (376.5)

Table 3.5.1.B. Summary of physical health outcomes by union status and job tenure

	Union Status		Job Tenure	
	Union N (%)	**Non-Union N (%)**	**Tenure <10 N (%)**	**Tenure ≥10 N (%)**
Average Pain Severity	**276**	**137**	**186**	**223**
mild pain (<5)	116 (42.0%)	65 (47.4%)	83 (44.6%)	97 (43.5%)
moderate to severe pain (≥5)	160 (58.0%)	72 (52.6)	103 (55.4%)	126 (56.5%)
Peak Pain Severity	**276**	**137**	**186**	**223**
mild pain (<5)	43 (15.6%)	21 (15.3%)	34 (18.3%)	30 (13.5%)
moderate to severe pain (≥5)	233 (84.4%)	116 (84.7%)	152 (81.7%)	193 (86.5%)

Table 3.5.1.C. Measures of pain impact stratified by union status and job tenure

	Union Status		Job Tenure	
	Union N (%)	Non-Union N (%)	Tenure < 10 N (%)	Tenure > 10 N (%)
Pain Medication Use	**271**	**137**	**190**	**215**
Rarely uses	108 (39.9%)	62 (45.3%)	84 (44.2%)	87 (40.5%)
Regularly uses (at least one work week/month)	163 (60.1%)	75 (54.7%)	106 (55.8%)	128 (59.5%)
Missed Work due to Pain	**265**	**139**	**187**	**216**
Rarely misses	213 (80.4%)	112 (80.6%)	152 (81.3%)	172 (79.6%)
Regularly misses (at least once every other month)	52 (19.6%)	27 (19.4%)	35 (18.7%)	44 (20.4%)
Injury Incidence	**270**	**149**	**192**	**226**
None	179 (66.3%)	118 (79.2 %)	130 (67.7%)	168 (74.3%)
One or more	91 (33.7%)	31 (20.8%)	62 (32.3%)	58 (25.7%)
Outside Pain Interference	**277**	**126**	**179**	**223**
Yes	182 (65.7%)	77 (61.1%)	123 (68.7%)	135 (60.5%)
No	95 (34.3%)	49 (38.9%)	56 (31.3%)	88 (39.5%)

Table 3.5.1.D. Measures of anxiety or depression stratified by union status and job tenure

N, %	Union	Non-Union	Tenure <10 Yrs	Tenure >10 Yrs
Anxiety/Depression	**236**	**140**	**171**	**206**
Neither	194 (82.2%)	118 (84.3%)	142 (83.0%)	172 (83.5%)
Either or both	42 (17.8%)	22 (15.7%)	29 (17.0%)	34 (16.5%)

3.5.2. Association between physical workload and physical health outcomes by union status

For severe pain, effect estimates trended higher in non-union workers for typical intensity and workload index (Table 3.5.2.A). Non-union workers with high workload exposure had nearly three times the prevalence of severe pain compared to the reference group for typical intensity and workload index. Both union and non-union workers in the high peak intensity group reported nearly two times the prevalence of severe pain compared to their respective reference groups. Like sex and age, effect modification by union status could not be statistically concluded as the p-values for interaction terms were greater than 0.5 for all three physical workload measures.

Non-union workers in the high workload index and peak intensity groups reported a higher prevalence of all pain impact outcomes except outside activity interference (Table 3.5.2.B). When assessing physical workload by typical intensity, results were more varied. Medication usage saw marginally elevated prevalence among union workers, but for missed work and injury incidence, larger increases in effect estimates were observed among non-union workers. Non-union workers with high typical intensity reported over two times the prevalence of injury incidence compared to union workers, though confidence intervals were wide.

For anxiety or depression, effect estimates remained similarly elevated in both groups for typical intensity and workload index (Table 3.5.2.C). However, when assessing peak intensity, union workers reported two times the prevalence of anxiety or depression. In contrast, non-union workers with high peak intensity reported a null difference compared to their reference group.

Table 3.5.2.A. Associations between physical workload and moderate to severe work-related pain by union status

	Union			Non-Union		
	N	Cases (n)	Prevalence Ratio (95% CI) [b]	N	Cases (n)	Prevalence Ratio (95% CI)[b]
Moderate to Severe Pain[a] (N=361)	**241**	**143**		**120**	**64**	
Peak Intensity						
Low (< 9)	143	63	1.00	67	26	1.00
High (≥ 9)	98	80	**1.83 (1.49, 2.25)**	53	38	**1.83 (1.30, 2.59)**
Typical Intensity						
Low (<8)	101	36	1.00	46	11	1.00
High (≥8)	140	107	**2.14 (1.62, 2.81)**	74	53	**3.00 (1.74, 5.16)**
Workload Index						
Low (<540)	111	48	1.00	56	17	1.00
High (≥540)	130	95	**1.70 (1.34, 2.14)**	64	47	**2.41 (1.58, 3.67)**

[a] Average pain score of four body regions
[b]Estimated in Poisson regression model with robust standard errors, adjusting for categorical age (<50/≥50) and sex (male/female)

Table 3.5.2.B. Associations between physical workload and pain impact outcomes by union status

	Union			Non-Union		
	N	Cases (n)	Prevalence Ratio (95% CI) [a]	N	Cases (n)	Prevalence Ratio (95% CI) [a]
Medication Use (N=360)	**241**	**146**		**119**	**59**	
Peak Intensity						
Low (< 9)	141	75	1.00	70	28	1.00
High (≥ 9)	100	71	**1.32 (1.09, 1.61)**	49	31	**1.58 (1.11, 2.23)**
Typical Intensity						
Low (<8)	102	44	1.00	48	23	1.00
High (≥8)	139	102	**1.71 (1.34, 2.17)**	71	36	1.03 (0.70, 1.50)
Workload Index						
Low (<540)	113	53	1.00	54	20	1.00
High (≥540)	128	93	**1.54 (1.24, 1.92)**	65	39	**1.60 (1.07, 2.39)**
Missed Work (N=359)	**237**	**47**		**122**	**24**	
Peak Intensity						
Low (< 9)	138	24	1.00	72	12	1.00
High (≥ 9)	99	23	1.31 (0.79, 2.19)	50	12	1.44 (0.71, 2.98)
Typical Intensity						

Low (<8)	101	15	1.00	49	5	1.00
High (≥8)	136	32	1.58 (0.90, 2.74)	73	19	**2.65 (1.07, 6.56)**
Workload Index						
Low (<540)	110	16	1.00	55	6	1.00
High (≥540)	127	31	1.73 (0.99, 3.00)	67	18	**2.49 (1.06, 5.84)**
Injury Incidence (N=367)	**237**	**79**		**130**	**24**	
Peak Intensity						
Low (< 9)	140	39	1.00	77	11	1.00
High (≥ 9)	97	40	**1.47 (1.03, 2.10)**	53	13	1.73 (0.85, 3.50)
Typical Intensity						
Low (<8)	103	28	1.00	53	3	1.00
High (≥8)	134	51	1.39 (0.95, 2.04)	77	21	**4.64 (1.45, 14.81)**
Workload Index						
Low (<540)	114	31	1.00	66	8	1.00
High (≥540)	123	48	**1.44 (1.00, 2.10)**	64	16	2.04 (0.95, 4.36)
Outside Activity Interference (N=356)	**247**	**96**		**109**	**44**	
Peak Intensity						
Low (< 9)	147	42	1.00	65	23	1.00
High (≥ 9)	100	54	**1.89 (1.38, 2.58)**	44	21	1.34 (0.85, 2.09)
Typical Intensity						
Low (<8)	107	24	1.00	44	14	1.00
High (≥8)	140	72	**2.29 (1.56, 3.38)**	65	30	1.41 (0.85, 2.35)
Workload Index						
Low (<540)	119	30	1.00	49	13	1.00
High (≥540)	128	66	**2.06 (1.44, 2.93)**	60	31	**1.90 (1.12, 3.22)**

[a] Estimated in Poisson regression model with robust standard errors, adjusting for categorical age (<50/≥50) and sex (male/female)

Table 3.5.2.C. Associations between physical workload and anxiety or depression by union status

	Union			Non-Union		
	N	**Cases (n)**	**Prevalence Ratio (95% CI) [a]**	**N**	**Cases (n)**	**Prevalence Ratio (95% CI) [a]**
Anxiety or Depression (N=344)	**221**	**39**		**123**	**20**	
Peak Intensity						
Low (< 9)	132	16	1.00	73	12	1.00
High (≥ 9)	89	23	**2.22 (1.25, 3.94)**	50	8	1.00 (0.44, 2.27)
Typical Intensity						
Low (<8)	94	11	1.00	49	6	1.00
High (≥8)	127	28	**1.93 (1.04, 3.60)**	74	14	1.64 (0.66, 4.10)
Workload Index						
Low (<540)	104	13	1.00	57	7	1.00
High (≥540)	117	26	1.81 (0.98, 3.33)	66	13	1.69 (0.72, 3.94)

[a] Estimated in Poisson regression model with robust standard errors, adjusting for categorical age (<50/≥50) and sex (male/female)

The associations between measures of workload and the prevalence of moderate to severe work-related pain was statistically significant among workers belonging to a union and those not belonging to a union with higher effect estimates of association among non-union janitors. The associations between measures of workload and measures of pain impact varied by union status, and associations with the prevalence of anxiety or depression were higher among those unionized. Janitors who are members of a Union may be more willing to report hazards and pain without fear of retaliation. Early reporting is critical to reducing the prevalence and severity of pain and musculoskeletal injuries.

3.5.3. Association between physical workload and physical health outcomes by job tenure

All workload measures were associated with an increased prevalence of moderate to severe work-related pain, regardless of tenure. There was an approximately two-fold increase in the prevalence of moderate to severe work-related pain in both job tenure groups, regardless of the way exposure was summarized (Table 3.5.3.A).

The associations between measures of exposure and measures of pain impact varied by job tenure, with a higher association with medication use among those older than 50 years of age and a higher injury incidence among those who worked less than 10 years. Similar statistically significant associations with impact on outside activities in both job tenure categories (Table 3.5.3.B).

Although effect estimates were elevated, there was only one statistically significant association between typical exposure and increased prevalence of anxiety or depression among workers older than 50 years of age (Table 3.5.3.C).

Table 3.5.3.A. Associations between physical workload and moderate to severe work-related pain by job tenure

	< 10 Years			**≥ 10 Years**		
	N	**Cases (n)**	**Prevalence Ratio (95% CI)** [b]	**N**	**Cases (n)**	**Prevalence Ratio (95% CI)**[b]
Moderate to Severe Pain (N=359)	**162**	**92**		**197**	**113**	
Peak Intensity						
Low (< 9)	93	38	1.00	117	50	1.00
High (≥ 9)	69	54	**1.93 (1.47, 2.54)**	80	63	**1.84 (1.45, 2.33)**
Typical Intensity						
Low (<8)	66	21	1.00	81	25	1.00
High (≥8)	96	71	**2.31 (1.59, 3.36)**	116	88	**2.49 (1.77, 3.48)**
Workload Index						
Low (<540)	81	33	1.00	85	30	1.00
High (≥540)	81	59	**1.82 (1.36, 2.44)**	112	83	**2.17 (1.60, 2.92)**

[a] Average pain score of four body regions
[b] Estimated in Poisson regression model with robust standard errors, adjusting for categorical age (<50/≥50) and sex (male/female)

Table 3.5.3.B. Associations between physical workload and pain impact outcomes by job tenure

	<10 Years			≥10 Years		
	N	Cases (n)	Prevalence Ratio (95% CI)[a]	N	Cases (n)	Prevalence Ratio (95% CI)[a]
Medication Use (N = 359)	**168**	**92**		**191**	**111**	
Peak Intensity						
Low (< 9)	97	47	1.00	115	55	1.00
High (≥ 9)	71	45	1.45 (0.84, 2.51)	76	56	**1.37 (1.10, 1.69)**
Typical Intensity						
Low (<8)	69	32	1.00	82	34	1.00
High (≥8)	99	60	1.76 (0.92, 3.37)	109	77	**1.33 (1.04, 1.70)**
Workload Index						
Low (<540)	88	42	1.00	79	29	1.00
High (≥540)	80	50	1.68 (0.84, 3.36)	112	82	**1.67 (1.29, 2.16)**
Missed Work (N = 362)	**169**	**31**		**193**	**39**	
Peak Intensity						
Low (< 9)	95	17	1.00	116	19	1.00
High (≥ 9)	71	14	1.45 (0.84, 2.51)	77	20	1.09 (0.51, 2.31)
Typical Intensity						
Low (<8)	69	10	1.00	82	10	1.00
High (≥8)	97	21	1.76 (0.92, 3.37)	111	29	2.97 (0.95, 9.28)
Workload Index						
Low (<540)	87	11	1.00	79	11	1.00
High (≥540)	79	20	1.68 (0.84, 3.36)	114	28	2.07 (0.72, 6.00)
Injury Incidence (N = 371)	**163**	**51**		**208**	**51**	
Peak Intensity						
Low (< 9)	97	23	1.00	122	28	1.00
High (≥ 9)	69	28	**1.79 (1.15, 2.78)**	79	23	1.26 (0.78, 2.03)
Typical Intensity						
Low (<8)	69	14	1.00	89	18	1.00
High (≥8)	97	37	**1.97 (1.17, 3.32)**	112	33	1.43 (0.86, 2.38)
Workload Index						
Low (<540)	87	20	1.00	94	19	1.00
High (≥540)	79	31	**1.77 (1.12, 2.80)**	107	32	1.45 (0.88, 2.39)

Table 3.5.3.B. Associations between physical workload and pain impact outcomes by job tenure (continued)

	<10 Years			≥10 Years		
	N	**Cases (n)**	**Prevalence Ratio (95% CI)[a]**	**N**	**Cases (n)**	**Prevalence Ratio (95% CI)[a]**
Outside Activity Interference (N = 355)	**156**	**65**		**199**	**74**	
Peak Intensity						
Low (< 9)	93	34	1.00	120	31	1.00
High (≥ 9)	63	31	**1.60 (1.10, 2.32)**	79	43	**1.83 (1.29, 2.59)**
Typical Intensity						
Low (<8)	66	19	1.00	86	19	1.00
High (≥8)	90	46	**2.17 (1.36, 3.47)**	113	55	**1.92 (1.28, 2.90)**
Workload Index						
Low (<540)	81	25	1.00	87	17	1.00
High (≥540)	75	40	**2.41 (1.57, 3.72)**	112	57	**1.86 (1.25, 2.77)**

[a] Estimated in Poisson regression model with robust standard errors, adjusting for categorical age (<50/≥50) and sex (male/female)

Table 3.5.3.C. Associations between physical workload and anxiety or depression by job tenure

	<10 years			≥ 10 years		
	N	**Cases (n)**	**Prevalence Ratio (95% CI)[a]**	**N**	**Cases (n)**	**Prevalence Ratio (95% CI)[a]**
Anxiety or Depression (N = 348)	**163**	**26**		**185**	**33**	
Peak Intensity						
Low (< 9)	94	12	1.00	114	16	1.00
High (≥ 9)	69	14	1.58 (0.78, 3.20)	71	17	1.73 (0.94, 3.19)
Typical Intensity						
Low (<8)	70	10	1.00	76	7	1.00
High (≥8)	93	16	1.21 (0.59, 2.49)	109	26	**2.57 (1.16, 5.73)**
Workload Index						
Low (<540)	82	9	1.00	82	11	1.00
High (≥540)	81	17	1.98 (0.94, 4.17)	103	22	1.57 (0.79, 3.13)

[a] Estimated in Poisson regression model with robust standard errors, adjusting for categorical age (<50/≥50) and sex (male/female)

The associations between workload and the prevalence of moderate to severe work-related pain were statistically significant and slightly higher among those who worked more than 10 years. The statistically significant associations between workload and measures of pain impact varied by job tenure, and there were no statistically significant associations between measures of workload and the prevalence of anxiety or depression in either job tenure category.

3.6. Psychosocial Exposures

3.6.1. Psychosocial Exposure Summary

181 janitors responded to survey questions about both job strain and at least one health outcome. The mean decision latitude and psychological demand scores were consistent by sex, age, union status, and job tenure (Tables 3.6.1.A-C). The job strain ratio, which summarizes the psychological demand, and the decision latitude scores, was also consistent. Since the mean values were consistent across these groups, and there were fewer janitors with job strain data, the associations between psychosocial measures of job strain and health outcomes stratified by sex, age, union status, and job tenure were not estimated.

Table 3.6.1.A. Summary of job strain scale and scores

	N	Mean (SD)
Decision Latitude (3-12)	181	7.8 (1.6)
Psychological Demand (5-20)	181	13.3 (4.1)
Job Strain Ratio	181	1.8 (0.8)

Table 3.6.1.B. Summary of job strain scale and scores stratified by sex and age

Mean (SD)	N	Women	N	Men	N	Age <50	N	Age >50
Decision Latitude	127	7.8 (1.6)	44	8.2 (1.6)	79	7.9 (1.7)	97	7.7 (1.6)
Psychological Demand	127	13.4 (4.2)	44	13.4 (4.3)	79	13.4 (4.0)	97	13.2 (4.3)
Job Strain Ratio	127	1.8 (0.9)	44	1.7 (0.6)	79	1.8 (0.9)	97	1.8 (0.8)

Table 3.6.1.C. Summary of job strain scale and scores stratified by union status and job tenure

Mean (SD)	N	Union	N	Non-Union	N	< 10 Years	N	≥ 10 Years
Decision Latitude	140	7.9 (1.5)	39	7.5 (1.8)	81	7.6 (1.8)	97	8.0 (1.5)
Psychological Demand	140	13.9 (3.9)	39	11.2 (4.4)	81	12.8 (4.6)	97	13.7 (3.7)
Job Strain Ratio	140	1.8 (0.7)	39	1.7 (1.1)	81	1.8 (1.0)	97	1.8 (0.6)

3.6.2. Association between work psychosocial exposure and health outcomes

All three measures of psychosocial factors were associated with the prevalence of moderate to severe pain (Table 3.6.2.A). Workers with high psychological demand had over two times the prevalence of moderate to severe work-related pain compared to those with low psychological demand. In contrast, workers with high decision latitude had a lower prevalence of moderate to severe pain compared to those with low decision latitude, indicating a protective effect. Lastly, high job strain was associated with an increased prevalence of moderate to severe work-related pain.

The results were more varied for the pain impact outcomes with wider confidence intervals. Compared to those in the low psychological demands group, janitors with high psychological demands were more likely to have reported using medication for pain, missed work, and having a prior injury. However, the results were not statistically significant (Table 3.6.2.B). However, for outside activity interference, those with high psychological demand had 1.5 times the prevalence of activity interference compared to those with low psychological demand.

Janitors in the high decision latitude group had reduced associations with the prevalence of all pain impact outcomes with statistically significant associations for all but having a prior injury. For job strain ratio, workers with high job strain had a 21 to 34% increased prevalence of all pain impact outcomes compared to workers with low job strain.

Though confidence intervals were wide, janitors with high psychological demands had nearly five times the prevalence of anxiety or depression compared to those with low psychological demands (Table 3.6.2.C). Like other associations, workers with high decision latitude demonstrated a potential protective effect, though it was not statistically significant. Workers with high job strain had nearly two times the prevalence of anxiety or depression as those with low job strain.

Table 3.6.2.A. Association of psychosocial factors with moderate to severe work-related pain

Moderate to severe work-related pain[a]	N	Cases (n)	Prevalence Ratio[b] (95% CI)
Psychological Demands			
Low	82	28	1.00
High	78	55	**2.06 (1.48-2.87)**
Decision Latitude			
Low	107	63	1.00
High	53	20	**0.64 (0.02-0.93)**
Job Strain Ratio			
Low	77	25	1.00
High	83	58	**1.30 (1.15-1.47)**

[a] Average pain score of four body regions
[b] Estimated in Poisson regression model with robust standard errors, adjusting for categorical age (<50/≥50) and sex (male/female)

Table 3.6.2.B. Association of psychosocial factors with pain impact outcomes

	N	Cases (n)	Prevalence Ratio[a] (95% CI)
Medication Use			
Psychological Demands			
Low	84	46	1.00
High	75	49	1.19 (0.93-1.52)
Decision Latitude			
Low	104	69	1.00
High	55	26	**0.73 (0.54-0.99)**
Job Strain Ratio			
Low	80	37	1.00
High	79	58	**1.21 (1.09-1.33)**

[a] Estimated in Poisson regression model with robust standard errors, adjusting for categorical age (<50/≥50) and sex (male/female)

Table 3.6.2.B. Association of psychosocial factors with pain impact outcomes (continued)

	N	Cases (n)	Prevalence Ratio[a] (95% CI)
Missed Work			
Psychological Demands			
Low	86	14	1.00
High	76	20	1.61 (0.88-2.94)
Decision Latitude			
Low	105	28	1.00
High	57	6	**0.39 (0.17-0.90)**
Job Strain Ratio			
Low	82	12	1.00
High	80	22	**1.34 (1.10-1.63)**
Injury Incidence			
Psychological Demands			
Low	87	23	1.00
High	72	26	1.38 (0.86-2.20)
Decision Latitude			
Low	105	33	1.00
High	54	16	0.93 (0.56-1.52)
Job Strain Ratio			
Low	82	20	1.00
High	77	29	**1.26 (1.06-1.51)**
Outside Activity Interference			
Psychological Demands			
Low	81	27	1.00
High	79	43	**1.61 (1.12-2.32)**
Decision Latitude			
Low	105	53	1.00
High	55	17	**0.60 (0.39-0.93)**
Job Strain Ratio			
Low	79	24	1.00
High	81	46	**1.27 (1.14-1.41)**

[a]Estimated in Poisson regression model with robust standard errors, adjusting for categorical age (<50/≥50) and sex (male/female)

Table 3.6.2.C. Association of Psychosocial Factors with anxiety or depression

Anxiety/Depression	N	Cases (n)	Prevalence Ratio[a] (95% CI)
Psychological Demands			
Low	80	5	1.00
High	74	23	**4.97 (1.98-12.47)**
Decision Latitude			
Low	101	20	1.00
High	53	8	0.75 (0.36-1.58)
Job Strain Ratio			
Low	76	4	1.00
High	78	24	**1.62 (1.42-1.86)**

[a] Estimated in Poisson regression model with robust standard errors, adjusting for categorical age (<50/≥50) and sex (male/female)

Those with higher job strain had a higher prevalence of moderate to severe work-related pain, adverse pain impact outcomes, and a higher prevalence of anxiety or depression. Overall, higher psychological demand was associated with a higher prevalence of adverse health outcomes, and higher decision latitude was protective, although the confidence intervals varied.

3.7. Work Climate

3.7.1. Work Climate Summary

Among workers who reported on their work climate (N=457), most workers (57%) indicated that their income did not cover their monthly expenses, even though over two-thirds (69%) reported being responsible for providing care/support for their families. Additionally, nearly a quarter of respondents (24%) reported working hours that they were not paid, with the same proportion (24%) expressing that they had worked an additional job. Only 8.2% of workers reported working more than 40 hours per week.

Many workers (51%) reported that it was “not at all easy” to find a job with another employer should they lose their current employment (Table 3.7.1.A). Nearly a quarter of workers (23%) reported working hours with no pay at least 3-4 times per year, and a third of workers do not believe they can report an injury to their supervisor without fear of retaliation. Lastly, over one-fifth of workers (22%) reported working extended hours.

Over one-third (37%) of respondents reported experiencing workplace harassment (Table 3.7.1.B). Verbal harassment was the most common form of provocation reported (33%), followed by physical (26%) and sexual (14%) harassment.

Table 3.7.1.A. Summary of work climate measures

	N, %
Job Security	**202**
Very easy to switch jobs	46 (22.8%)
Somewhat easy	53 (26.2%)
Not at all easy	103 (51.0%)
Wage Theft	**425**
Weekly	19 (4.5%)
1-2 times / Month	50 (11.8%)
Every Other Month	8 (1.9%)
3-4 times / year	21 (4.9%)
Rarely to Never	327 (76.9%)
Under Reporting of Injuries	**196**
Strongly Disagree	40 (20.4%)
Somewhat Disagree	26 (13.3%)
Somewhat Agree	41 (20.9%)
Strongly Agree	86 (43.9%)
N/A	3 (1.5%)
Working Extended Hours	**457**
No	358 (78.3%)
Yes	99 (21.7%)

Table 3.7.1.B. Summary of Harassment

	N, %
Physical Harassment	**391**
Never	289 (73.9%)
Monthly	38 (9.7%)
Weekly	15 (3.8%)
Daily	49 (12.5%)
Sexual Harassment	**385**
Never	333 (86.5%)
Monthly	22 (5.7%)
Weekly	9 (2.3%)
Daily	21 (5.5%)
Verbal Harassment	**396**
Never	265 (66.9%)
Monthly	61 (15.4%)
Weekly	25 (6.3%)
Daily	45 (11.4%)
Any Harassment	**390**
No	244 (62.6%)
Yes	146 (37.4%)

More than half of the janitors who responded indicated that (i) their income did not meet their household expenses (57%); (ii) that it would not be easy to change jobs (51%); and (iii) that they would not report an injury (65%). One third (37%) of respondents reported experiencing some form of workplace harassment and one quarter reported wage theft (24%) and having a second job (24%).

3.7.2. Association between work climate and physical outcomes

Fewer workers responded to both work climate and health outcome questions. Therefore, confidence intervals were wide in the unstratified analyses, and models could not be stratified by sex, age, union status, or job tenure (Tables 3.7.2.A-C). Overall, among the smaller subset of workers who responded to both work climate and health outcome questions, wage theft was consistently associated with adverse health outcomes such as the prevalence of moderate to severe work-related pain, medication use, missed workdays, and interference with outside activities. Those experiencing wage theft had a 2.4 times higher prevalence of anxiety or depression.

Experiencing any form of harassment was also associated with all adverse health outcomes, though confidence intervals were wide for some of the analyses. Harassment of any kind was statistically significantly associated with an increased prevalence of severe pain and interference with outside activities. Most notably, there was a nearly four-fold increase in the prevalence of anxiety or depression among those experiencing any form of harassment.

Table 3.7.2.A. Association of Work Climate with moderate to severe work-related pain

Moderate to Severe Pain[a]	N	Cases (n)	Prevalence Ratio[b] (95% CI)
Job Security			
Easy to replace job	63	28	1.00
Difficult to replace job	73	43	1.30 (0.94-1.80)
Wage Theft			
No hours unpaid	107	49	1.00
Hours worked without pay	29	22	**1.58 (1.18-2.11)**
Under Reporting of Injuries			
No fear or retaliation	91	45	1.00
Fear of retaliation for reporting	45	26	1.19 (0.87-1.62)
Working Extended Hours			
1 job & < 40 hours/week	108	58	1.00
2+ jobs & 40+ hours/week	28	13	0.82 (0.53-1.25)
Harassment			
Not concerned about bullying	82	37	1.00
Concerned about any harassment	54	34	**1.40 (1.04-1.90)**

[a] Estimated in Poisson regression model with robust standard errors, adjusting for categorical age (<50/≥50) and sex (male/female)

Table 3.7.2.B. Association of Work Climate with pain impact outcomes

	N	Cases (n)	Prevalence Ratio[a] (95% CI)
Medication Use			
Job Security			
Easy to replace job	67	38	1.00
Difficult to replace job	73	45	1.04 (0.80-1.37)
Wage Theft			
No hours unpaid	112	60	1.00
Hours worked without pay	28	23	**1.59 (1.24-2.03)**
Under Reporting of Injuries			
No fear or retaliation	94	53	1.00
Fear of retaliation for reporting	46	30	1.14 (0.87-1.50)
Working Extended Hours			
1 job & < 40 hours/week	110	70	1.00
2+ jobs & 40+ hours/week	30	13	0.67 (0.44-1.00)
Harassment			
Not concerned about bullying	87	49	1.00
Concerned about any harassment	53	34	1.20 (0.92-1.55)
Missed Work			
Job Security			
Easy to replace job	66	16	1.00
Difficult to replace job	76	15	0.80 (0.433-1.50)
Wage Theft			
No hours unpaid	112	19	1.00
Hours worked without pay	30	12	**2.31 (1.27-4.19)**
Under Reporting of Injuries			
No fear or retaliation	94	19	1.00
Fear of retaliation for reporting	48	12	1.27 (0.67-2.38)
Working Extended Hours			
1 job & < 40 hours/week	112	23	1.00
2+ jobs & 40+ hours/week	30	8	1.22 (0.61-2.47)
Harassment			
Not concerned about bullying	87	17	1.00
Concerned about any harassment	55	14	1.31 (0.71-2.41)

Table 3.7.2.B. Association of Work Climate with pain impact outcomes (continued)

	N	Cases (n)	Prevalence Ratio[a] (95% CI)
Injury Incidence			
Job Security			
Easy to replace job	64	22	1.00
Difficult to replace job	72	24	0.99 (0.62-1.60)
Wage Theft			
No hours unpaid	107	35	1.00
Hours worked without pay	29	11	1.12 (0.67-1.89)
Under Reporting of Injuries			
No fear or retaliation	94	32	1.00
Fear of retaliation for reporting	42	14	0.98 (0.59-1.61)
Working Extended Hours			
1 job & < 40 hours/week	107	38	1.00
2+ jobs & 40+ hours/week	29	8	0.74 (0.39-1.43)
Harassment			
Not concerned about bullying	83	25	1.00
Concerned about any harassment	53	21	1.30 (0.82-2.07)
Outside Interference of Activities			
Job Security			
Easy to replace job	63	27	1.00
Difficult to replace job	73	29	0.94 (0.63-1.41)
Wage Theft			
No hours unpaid	108	38	1.00
Hours worked without pay	28	18	**1.80 (1.24-2.61)**
Under Reporting of Injuries			
No fear or retaliation	92	33	1.00
Fear of retaliation for reporting	44	23	1.43 (0.97-2.10)
Working Extended Hours			
1 job & < 40 hours/week	109	48	1.00
2+ jobs & 40+ hours/week	27	8	0.66 (0.34-1.21)
Harassment			
Not concerned about bullying	82	27	1.00
Concerned about any harassment	54	29	**1.67 (1.13-2.46)**

[a] Estimated in Poisson regression model with robust standard errors, adjusting for categorical age (<50/≥50) and sex (male/female)

Table 3.7.2.C. Association of work climate with anxiety or depression

Anxiety or Depression	N	Cases (n)	Prevalence Ratio[a] (95% CI)
Job Security			
Easy to replace job	63	13	1.00
Difficult to replace job	71	9	0.64 (0.29-1.41)
Wage Theft			
No hours unpaid	108	14	1.00
Hours worked without pay	26	8	**2.40 (1.11-5.19)**
Under Reporting of Injuries			
No fear or retaliation	89	15	1.00
Fear of retaliation for reporting	45	17	0.91 (0.40-2.08)
Working Extended Hours			
1 job & < 40 hours/week	105	18	1.00
2+ jobs & 40+ hours/week	29	4	0.83 (0.30-2.31)
Harassment			
Not concerned about bullying	80	6	1.00
Concerned about any harassment	54	16	**3.83 (1.57-9.33)**

[a] Estimated in Poisson regression model with robust standard errors, adjusting for categorical age (<50/≥50) and sex (male/female)

Wage theft was consistently associated with negative health outcomes including a 2.4 times higher prevalence of anxiety or depression.

Harassment of any kind was statistically significantly associated with a nearly four-fold increase in the prevalence of anxiety or depression.

3.8. COVID-19 Summary

3.8.1. Descriptive summary of COVID-19 workplace measures

Only 60% of workers reported that their employer had shown them their written COVID-19 exposure protection plans, with the remaining 40% reporting that they had not seen the written plan (Table 3.8.1.A). One-quarter of workers (27%) disagreed that they were able to stay home if symptomatic without fear of job loss or less pay. A large majority of workers (83%) agreed that they were taking on increased risks of exposure due to their work, and over three-fourths of workers (77%) agreed that their employers were following all state/local orders. However, when asked if their employer would notify them if someone in the building contracted COVID-19, nearly half (49%) of respondents disagreed, and over one-third (34%) expressed that their employer did not provide the necessary supplies (i.e., PPE) to protect themselves. A quarter (26%) of workers felt they did not have enough time to use protective measures at work.

When stratified by union status, more union members reported seeing a written plan provided by their employer that described protective measures. A higher proportion of unionized workers (77.6%) reported being able to stay home if sick due to COVID-19 symptoms compared to non-unionized workers (61.7%). A higher percentage of workers belonging to a union reported that their employer was following state order (85%) compared to workers who were not union members (65.9%). Other measures, such as getting notified if someone in their building was sick with COVID-19, providing PPE, and having time to use protective measures, were similar by union status.

Most workers (91%) received at least two doses of the COVID-19 vaccination shot at the time of the study (Table 3.8.1.B). There were only minor differences in vaccination status by union status.

Table 3.8.1.A. Summary of workers' perception of employer COVID-19 prevention measures

N (%)	All	Union	Non-Union
Has your employer shown you their written plan to protect you from exposure to COVID-19? (N=632)			
No	255 (40.3%)	161 (35.0%)	91 (54.8%)
Yes	377 (59.7%)	299 (65.0%)	75 (45.2%)
I can stay home if I have symptoms and not fear job loss or less pay. (N=629)			
Strongly Agree	353 (56.1%)	265 (58.1%)	83 (49.7%)
Somewhat Agree	109 (17.3%)	89 (19.5%)	20 (12.0%)
Somewhat Disagree	82 (13.0%)	60 (13.2%)	22 (13.2%)
Strongly Disagree	85 (13.5%)	42 (9.2%)	42 (25.1%)
I am taking on increased risks of getting sick because of my work. (N=581)			
Strongly Agree	404 (68.1%)	296 (69.6%)	104 (64.2%)
Somewhat Agree	87 (14.7%)	67 (15.8%)	19 (11.7%)
Somewhat Disagree	42 (7.1%)	30 (7.1%)	11 (6.8%)
Strongly Disagree	60 (10.1%)	32 (7.5%)	28 (17.3%)
My employers are following all of the state or local orders. (N=581)			
Strongly Agree	325 (55.9%)	226 (54.6%)	94 (58.4%)
Somewhat Agree	124 (21.3%)	111 (26.8%)	12 (7.5%)
Somewhat Disagree	75 (12.9%)	50 (12.1%)	25 (15.5%)
Strongly Disagree	57 (9.8%)	27 (6.5%)	30 (18.6%)
If someone in my building gets sick with COVID-19, my employer will notify me. (N=580)			
Strongly Agree	214 (36.9%)	152 (36.5%)	59 (37.6%)
Somewhat Agree	79 (13.6%)	61 (14.7%)	17 (10.8%)
Somewhat Disagree	107 (18.4%)	75 (18.0%)	30 (19.1%)
Strongly Disagree	180 (31.0%)	128 (30.8%)	51 (32.5%)
My employer provides with the supplies needed to protect myself. (N=577)			
Strongly Agree	266 (46.1%)	173 (41.8%)	88 (56.4%)
Somewhat Agree	111 (19.2%)	99 (23.9%)	12 (7.7%)
Somewhat Disagree	97 (16.8%)	74 (17.9%)	21 (13.5%)
Strongly Disagree	103 (17.9%)	68 (16.4%)	35 (22.4%)
I have the time I need to use protective measures. (N=572)			
Strongly Agree	299 (52.3%)	201 (49.1%)	95 (60.5%)
Somewhat Agree	125 (21.9%)	105 (25.7%)	20 (12.8%)
Somewhat Disagree	82 (14.3%)	65 (15.9%)	14 (8.9%)
Strongly Disagree	66 (11.5%)	38 (9.3%)	28 (17.8%)

Table 3.8.1.B. Summary of COVID-19 Vaccination Status

N (%)	All	Union	Non-Union
How many COVID vaccination shots have you received to protect yourself against illness? (N=638)			
One	21 (3.3%)	18 (3.9%)	3 (1.8%)
Two	243 (38.1%)	166 (35.8%)	73 (44.0%)
Three	339 (53.1%)	256 (55.2%)	79 (47.6%)
None, I have not been vaccinated	15 (2.4%)	6 (1.3%)	9 (5.4%)
I prefer not to answer	20 (3.1%)	18 (3.9%)	2 (1.2%)

Workers were asked about differences in their workload compared to before the pandemic; approximately half reported that their workload increased due to COVID-19 and that they were required to do more disinfecting tasks in conjunction with their regular workload (Table 3.8.1.C). 43% of workers reported feeling pressured to work faster and do more because of the pandemic. When stratified by union status, there were only minor differences in associations.

Table 3.8.1.C. Summary of workers' perception of workload changes due to COVID-19

N (%)	All	Union	Non-Union
My workload has increased. (N=449)			
Strongly Agree	158 (35.2%)	100 (34.4%)	58 (37.9%)
Somewhat Agree	67 (14.9%)	51 (17.5%)	16 (10.5%)
Somewhat Disagree	62 (13.8%)	39 (13.4%)	21 (13.7%)
Strongly Disagree	78 (17.4%)	34 (11.7%)	42 (27.5%)
Not Applicable	84 (18.7%)	67 (23.0%)	16 (10.5%)
I am now required to do more disinfecting tasks in addition to my regular tasks. (N=433)			
Strongly Agree	151 (34.9%)	86 (30.8%)	65 (43.6%)
Somewhat Agree	64 (14.8%)	52 (18.2%)	12 (8.1%)
Somewhat Disagree	47 (10.9%)	29 (10.4%)	17 (11.4%)
Strongly Disagree	69 (15.0%)	43 (15.4%)	24 (16.1%)
Not Applicable	102 (23.6%)	69 (24.7%)	31 (20.8%)
I feel pressured to work faster and do more. (N=581)			
Strongly Agree	121 (28.1%)	78 (28.2%)	43 (29.1%)
Somewhat Agree	66 (15.3%)	55 (19.9%)	11 (7.4%)
Somewhat Disagree	50 (11.6%)	35 (12.6%)	14 (9.5%)
Strongly Disagree	91 (21.2%)	40 (14.4%)	48 (32.4%)
Not Applicable	102 (23.7%)	69 (24.9%)	32 (21.6%)

Nearly half of workers reported an increase in their workload, disinfecting tasks, and pressure to work faster during the COVID-19 pandemic, and one-third of workers reported not having the protective equipment needed. Approximately, one quarter of workers reported that they could not stay home when sick without fear of loss of job or pay; the prevalence was higher among those who were not represented by a union (38.3%) versus those represented by a union (22.4%).

4. Qualitative Study of California Janitorial Workload

4.1 Qualitative Study Background

In the spring of 2023, the Labor Occupational Health Program (LOHP) conducted key informant interviews with janitors and representatives of janitorial industry employers to understand experiences with workload and its impact on safety and health. Specific goals included:

For Janitors: Describe janitor's experiences with the COVID-19 modified tasks, work culture, and impact on physical and mental health to understand how workload and expectations changed due to the pandemic.

For Employers: Describe the experiences of contractors and building owners/managers in adjusting contracts to ensure adequate staffing and providing janitors with the time, training, and tools needed to fulfill the cleaning standards requirements.

The findings from these interviews and the Time Study are meant to inform recommendations for safer and more effective workloads for California janitors.

4.2 Qualitative Study Methods

4.2.1. Study Design and Recruitment

The planned methodology included four to five interviews with employer representatives, six with workers, and one focus group with workers, totaling 18 estimated participants. The goal of the worker and employer interviews was to identify relevant themes, while the worker interview findings were to be used to develop worker stories/case studies that would complement the study's final report.

LOHP conducted outreach through SEIU-USWW, primarily through union representatives and staff. Because of outreach challenges, such as being unable to contact and recruit workers directly, LOHP interviewed three employer representatives and four workers. All the workers were women. A focus group was not conducted.

Though we initially sought to include workers based on different characteristics, the outreach challenges limited our ability to do so. We had sought to include a diversity that would include janitors hired directly and others hired by a contractor and from different venues such as airports, malls, offices, and events. We also aimed to consider experiences with injury and staffing or workload concerns.

4.2.2 Data Collection and Analysis

Semi-structured interviews were conducted virtually, and a bilingual researcher downloaded and transcribed audio recordings in Spanish. Those transcripts were reviewed in conjunction with the researcher's facilitator notes taken during each one of the interviews. The researcher developed a network of themes using a coding system based on significant phrases that arose in the interviews. These codes were then clustered into basic themes and then further organized into the six themes that emerged in the summary of findings.

4.3 Qualitative Study Results

Table 4.3.1: Summary of participants interviewed

Participant Type	Description
Employer	Director of Operations overseeing 25 workers
Employer	General Manager responsible for 13 site managers, each overseeing 40 to 60 sites with an average of 15 to 20 workers
Employer	An executive of a company with 2,500 employees and contracts across the country
Janitor	Union janitor who works the night shift at a University from 6:00 pm to 2:30 am.
Janitor	Union janitor who has been working the night shift from 6:00 pm - 2:30 am for nearly 20 years of the total 23 years she has worked in the industry. She works at the offices of a large healthcare provider.
Janitor	Union Janitor who has worked in the industry for over 15 years and works the night shift from 6:00 pm - 2:30 am at a large tech company campus.
Janitor	Union Janitor with 26 years of experience in the industry. Serves as an executive board member for the union and as a *promotora*. Works in an office building.

Our study revealed key themes from the interviews related to the experiences of janitors and employers. Overall, the findings underscore how productivity pressures and evolving scopes of work compounded work-related stress and health concerns for janitors, who bore the brunt of the pandemic as frontline workers. Additionally, it highlights the experiences of employers, who described that, at the request of clients and building owners, they adjusted contracts to ensure adequate staffing while providing janitors with the time, training, and tools needed to meet evolving cleaning standards due to the pandemic.

The COVID-19 Pandemic initially created a demand for more disinfection as part of the cleaning services.

- The employer representatives all reported a demand for disinfection services, in addition to routine cleaning, from clients at the start of the pandemic. In some cases, contractors introduced newer technology acquired pre-pandemic, such as an Electrostatic Sprayer for specialized sanitation, or utilized enhanced cleaning practices beyond routine cleaning. Disinfection remained in practice throughout the pandemic. As the pandemic waned, “enhanced cleaning” was no longer a top priority, but disinfection remained a task performed by janitorial staff.
- The pandemic created a demand for more disinfection but did not introduce new cleaning supplies, specifically disinfectants, for COVID-19. Though one employer talked about adding a new chemical product, the disinfectants had already been used. At the time, very few, if any, viral disinfectants were tested against specific SARS-COV-2 pathogens.
- Janitors described that COVID-related tasks, such as disinfection, were added to the workload, adding time pressure. Additionally, janitors commented that cleaning happened even in places that were not being used or were being lightly used. They perceived that hazards had not changed due to the pandemic, besides the added risk of exposure to COVID and the more frequent use of disinfectants.

The amount of labor required was reduced due to the COVID-19 Pandemic.

- Though more workers were needed at the start of the pandemic, all employers reported experiencing a reduction in labor. Labor reductions were attributed to the shelter-in-place order and the shift to telecommuting, which kept the number of tenants and their use of facilities low.
- Some of the employers also reported a labor shortage. At the start of the pandemic, more workers were needed for disinfection, but janitorial crews were reportedly smaller throughout the pandemic. The pandemic itself created a reduction in the labor pool. For example, workers contracting the COVID-19 virus and being out of work for long periods or calling out for various reasons, including COVID-19, on short notice.

Janitors interviewed also noted a reduction in staff and that the lack of workers due to COVID-19 sick leave resulted in heavier workloads for janitors who remained on the crew. Janitors referenced the value of seniority on the job as it impacted their work assignments. For janitors with seniority, their hours and type of work did not change significantly as a result of the pandemic. Janitors mentioned that coworkers were let go or heard of other janitors being let go.

The types of cleaning tasks changed over the course of the pandemic.

- All employers reported a shift in the intensity of the level of cleaning, from a higher intensity at the start of the pandemic to a much lower intensity throughout the pandemic. This lightened workload meant a shift from enhanced or detailed cleaning to spot cleaning. Employers reported that janitors continued to clean touch points, which are points in common areas frequently touched, such as door handles and elevator buttons, and wipe down surfaces. However, they also stated that those tasks were winding down.
- Some employers reported adjusting according to the client's needs, which could impact the workload.
- Employers reported that this shift early in the pandemic created stress for workers. For example, one employer stated: "Initially it was [more stressful], as [janitors] got more familiar with what to do, there was a training element, new training on tasks that they did not do before. And there was a lot of focus and visibility, prior to COVID we were the ship that passed in the night, [...] and now, almost overnight, there was a huge spotlight on what we did."
- Some janitors expressed a desire for more training on hazards such as chemicals and lifting, especially with new staff. They noted that there used to be training on the job before work and while "on the clock."

Productivity guidelines are shaped by the need for efficiency and the scope of work.

- Employers reported that work is often assigned to the scope of work (density, square footage, and tasks clients demand) and the hours needed for a worker to complete such a task.
- Decisions around productivity guidelines are often determined by management, though employers state that they receive input from workers to make sure that the scope is reasonable.
- Some employers stated that factors such as age or gender influenced the type of work assignments—for example, more strenuous work given to men or younger people.

Janitors commented that older workers have trouble keeping up with the workload, often comparing themselves with young workers and their ability to work at a faster pace. Janitors also mentioned ongoing favoritism from supervisors for younger women. Another dynamic that emerged was the combative relationship that can exist with supervisors and how some workers may undermine solidarity between workers to score points with supervisors. Restructuring janitor work areas, for example, can lead to problems if not done fairly and without worker input.

Recognition that janitors faced the brunt of the pandemic as frontline workers

- All employers stated that janitors are an essential part of the workforce who adjusted overnight to the demands created by the pandemic. The overnight shift posed a challenge for workers and employers who had to ensure the safety and health of all amid the COVID-19 pandemic.

In the janitor interviews, a couple of themes emerged related to janitors' perspectives on how work impacted their health and their ability to speak up about concerns or take action to resolve problems:

Concerns about work stress and health

Janitors expressed having sleep routines that are off due to the nature of their work or not being able to sleep due to anxiety/stress. Some janitors expressed that their chronic health issues, such as Diabetes, were a result of her work and work schedule. The cumulative impact of physically demanding work was a factor highlighted in many of the interviews.

Women often have the double role of housewife and provider, which can be an additional stressor.

Validating janitors' voices and feelings of being scrutinized

One janitor expressed feeling confident speaking out because they knew their rights or held leadership positions within the union. Others expressed wanting the union and management to be more in touch with the day-to-day reality of the worker so they could better understand their workload.

A few janitors expressed their worries about retaliation if they spoke up about their workload or other health and safety issues. For example, supervisors will say it is not cleaned well or would retaliate by adding more to their workload.

Janitors felt that human resources was unreliable and that they were not comfortable voicing their opinions to supervisors. They stated that they needed space to be heard without the presence of supervisors.

Janitors described their interactions with building tenants and worries about complaints about missing an area to clean. In other cases, janitors were worried about touching computers or other personal property while cleaning or a lack of respect from tenants, such as tenants using the restrooms while they were being cleaned.

Profiles of Workers

The following four stories describe workers' experiences as told during their interviews. The names of the janitors have been changed to protect their identity.

Mélida

Mélida works as a janitor at a prestigious private university in the Bay Area. Her shift starts at 6:00 pm and ends at 2:30 am. Mélida's hours had not changed throughout the COVID-19 pandemic, though she stated her workload had increased. "Well, they let workers go supposedly because there weren't many people or students at the university, this was during the [height of the] pandemic, and we were left to do the work they [the janitors who were let go] did. It is supposed to be just dusting and other things but it is extra work."

Though the type of work Mélida performs nightly did not change drastically with the pandemic, additional smaller tasks such as disinfecting touch point areas have been added and are tasks that continue to be performed. "After we sweep and dust" Mélida states "we have to disinfect the areas that have been touched such as the bathrooms, the door and window handles, the kitchen – small things but they take time away from our regular tasks."

Although some employers state that there is less work due to building tenants working from home, janitors like Mélida stated that the workload remains the same. "As workers, we have to take the initiative. If it is dirty, we have to make sure it is clean. Even if it is not a vacuum day but it is dirty and there is a complaint – it can result in a write-up from the employer."

Mélida said she feels most anxious when the tasks are more demanding and feels time pressure to finish all her assigned tasks. "Vacuuming the stairs is difficult and I carry the motor on the back which is what weighs the most," Mélida stated. "We have to go step by step and sometimes there are many stairs. I worry that I'll miss a step and fall with the vacuum on top of me." While the task of carrying a vacuum on her back is not a new task associated with the pandemic, it contributes to the overall stress and anxiety felt by workers.

Ana Maria

Ana Maria has been working as a janitor for 23 years and has been working the night shift for nearly two decades. Ana Maria mentioned in her interview that the pandemic did not change her hours or days of work but that disinfecting was prioritized. "The moment came when we finished disinfecting and the [tenants] left and went to work at home and we were by ourselves, but it was the same, [we continued] disinfecting."

Ana Maria mentioned that there was no reduction in her hours or the amount of work but that at the height of the pandemic, nearly half of her coworkers remained; the rest were sick with COVID. The workload dropped significantly when all the office tenants transitioned to work from home. "The good thing was, they didn't send us home, because they sent other [janitors] home because the buildings were left empty. Only a few remained, to disinfect." Ana Maria stated that the janitorial crew was eventually cut in half to accommodate the lack of demands and that the remaining jobs were distributed by seniority. This created a sense of fear that when tenants returned to their offices, and workloads increased, employers would be incentivized to keep the same number of janitors to keep costs low. "The company is going to want us to do the work with the same amount [of workers], and that's where we can't because with the excessive workload, we get stressed, we get sick, we can have an accident, and anything else." Ana Maria also expressed the stress she felt due to needing to stay busy at work even when there was not much to do. "I couldn't go rest because security was there... if I was sitting tucked away in some corner, that is something that wasn't good for us if we were caught [by management.]"

Tania

Tania has been working in the janitorial industry for over 15 years. Her shift starts at 6:00 pm and ends at 2:30 am. In her interview, Tania stated that though her hours were not cut nor her work days changed, she had coworkers who were let go and heard of others being laid off due to the pandemic. Tania spoke about seniority's importance in deciding how work assignments are distributed. While this can be advantageous for those who have seniority because they get first choice of which areas to clean, she said this can also be stressful for her coworkers because "they [supervisors] add one or two more [tasks] to one area to maximize [the work] of a person."

Tania mentioned that the employer restructured how tasks were delegated to micromanaged workers and that, this time, restructuring was not welcomed by her coworkers. It was too much work compared to the tasks delegated before. She stated the following regarding the change in work schedule, "From 6 to 6:10 you'll do this [task], from 6:10 to 6:30 you'll do this [task]. They are creating the schedule of what we need to do. We're no longer going to have the routine that we had. You came to work and you organized yourself. For example, I always knew where I would start and where I would finish." This loss of worker autonomy, in exchange for maximum efficiency, can result in poor health outcomes for workers.

Tania also spoke about how the workload did not match the required tasks. For example, she stated the following about the new color-coded work structure, “all the areas in yellow are to be [cleaned] every day, whether or not you want to [clean them], you have to mop or vacuum… but there are areas that you do not have to vacuum every day.” Tania said she would tell her coworkers to be strategic and find ways to keep the areas clean without needing to perform heavier tasks.

Milagros

Milagros has been a janitor in the industry for 26 years, is a member of the executive board for her union, and is a *promotora* who also conducts workshops to raise awareness about sexual harassment protections on the job. Milagros’s hours have remained the same since the pandemic, 5:30 pm to 2:00 am Monday through Friday. She stated that there have not been layoffs at her worksite but that there are coworkers whose work time has been reduced to five and a half hours. The only change in their workload during the pandemic was adding disinfection to their list of work tasks: “during the pandemic there weren’t many [changes], but we continue to disinfect. We’re still doing that.”

Milagro mentioned that an additional change that was instituted was the changing of waste receptacle bags. “We change the bags daily. Before, we would empty the bin, and we could leave the same bag. Now we take out the bag and add a new bag. So it can be much cleaner.” Milagro estimated that this small task added 20 minutes of work to her shift and that the repetitive motion of emptying the bins and replacing the bag increased the danger of hurting her back. This task, along with others, such as unlocking and opening multiple office doors, strains body parts that lead to wear and tear over the decades of her employment. “When we are finishing – on Fridays– your body says no more. It gave everything it had to give. In reality, I'm not stressed, but tired.”

Although Milagro mentioned that the pandemic did not put a strain on her mental health, she did speak about how COVID-19 impacted her and her family. “I got COVID and brought it to my family […] and since my husband worked in a restaurant, he couldn’t work because he got sick.” While Milagro stated that there was no mental stress related to the pandemic, she mentioned the additional pressure of losing an economic provider to her family.

4.4. Qualitative Study Discussion

The findings of this study reveal how the COVID-19 pandemic reshaped janitorial work due to client-driven demands, placing additional pressures on an already burdened group of frontline workers. This shift was influenced by workforce availability, exacerbating stress and health concerns among janitors. Workplace power dynamics, particularly with gender and age, further complicated efforts to address workload challenges and reinforce existing disparities. More research is needed to examine how cultural, social, and gender norms intersect with workload distribution and the resulting health and safety concerns. Additionally, continued qualitative research involving janitors from diverse backgrounds and work settings is essential to fully understand the pandemic's impact on workload and its relationship to health and safety.

4.5 Limitations

The study’s scope was limited to Spanish-speaking Latina immigrant women of a similar age and years of experience, predominantly working in office settings and all active union members. It did not capture the experiences of non-union janitors or those working in other venues outside of the ones captured. Additionally, conducting focus groups may have allowed additional themes to emerge through shared discussions. Finally, not interviewing supervisory-level janitorial staff limited our insights into the tensions between employer-driven changes and workload distribution.

4.6 Recommendations from Qualitative Study

1. **Participatory Workload Management:** Create opportunities for janitors to contribute to determining scope and assignments. This may promote manageable workloads and offer opportunities to address age and gender disparities in task distribution.
2. **Ongoing Health and Safety Training:** Provide ongoing training on chemical safety, ergonomics, new cleaning technologies, and other topics. Employers should emphasize injury prevention, particularly with hazards that workload concerns can exacerbate.
3. **Staffing Buffers:** Implement measures to safeguard against excessive workloads during labor shortages and ensure manageable workloads when demand fluctuates.
4. **Enhanced Communication:** Foster collaboration and communication between employers, supervisors, and janitors to align productivity goals with worker capacity and well-being. These can occur through union-sponsored channels.
5. **Stress Management and Recognition:** Implement programs to support workers' mental health and stress, such as access to mental health services and stress reduction resources. There should be continued recognition and value of janitors as essential frontline workers through additional resources and benefits that protect workers and their families. This can range from increased sick leave, compensation, and enhanced protections to keep them and their families healthy.

5. California Janitor Time Study

5.1 Time Study Background

Some studies have suggested that the workload among commercial cleaning workers has increased in recent years, which may be contributing to the increase in workers' compensation claims among janitors (Simcox, Dominguez, Stover, & Seixas, 2013; Teran & vanDommelen-Gonzalez, 2017). One component of workload is the time allocated for assigned cleaning tasks (Bao, 2023). This time factor, sometimes called the rate of work or work pace, is commonly set by cleaning industry companies or managers who assign tasks to be completed during a shift (Washington State Janitorial Workload Study, 2022b). Standard work times, which are generally based on time studies, are often used to develop "acceptable" janitorial workloads in the cleaning industry (J. Walker, 2018). Many janitorial companies use the International Sanitary Supply Association (ISSA) standard cleaning time data (ISSA, 2023) to allocate time to clean different spaces and perform different cleaning tasks.

In a recent study from The Washington State Legislature provided by the Department of Labor & Industries, Safety & Health Assessment & Research for Prevention (SHARP) Program (i.e., the Washington State study), the accuracy of such time allocations for janitorial tasks was shown to vary for cleaners working in office-building venues (Washington State Janitorial Workload Study, 2022a) and has not been evaluated in other types of venues. The research team determined a 'standard' work pace using primarily the ISSA Cleaning Standards (2021), which was compared to the actual measured time that a janitor took to complete each task.

A percent deviation was calculated to determine the difference between the observed time and the standard time, and an absolute value of the magnitude of the percentage deviation (MAPD) was used to evaluate the magnitude from which the observed work pace deviated from the estimated work pace. The study found that janitors' work paces most often deviated from the standard work pace when scrubbing floors, restocking supplies, and dust mopping. Across all tasks, the MAPD was 48.7%, but the MAPD for floor scrubbing, supply restocking, dust mopping, and vacuuming tasks exceeded 50%.

This misallocation of time allotted to clean spaces could contribute to higher workloads for janitors. The Washington State study found positive correlations between heart rate reserve (the percent difference between resting heart rate and maximum heart rate) and work pace for restroom cleaning, trashing, and vacuuming (Washington State Department of Industries, 2022a), and prior research (Houtman et al., 1994; Seixas et al., 2013) demonstrated that fast work pace was associated with musculoskeletal pain or discomfort among janitors.

The Washington State team used the data from their study to develop a janitors' workload calculator (Bao et al., 2023) that the industry can use to estimate the workload of janitorial jobs. The estimated workload provided with the calculator is based on (1) time allowance for an assigned task (2) overall workload such as walking distances (steps) and energy expenditure demands for performing a task, (3) hand/wrist biomechanical exposures, (4) shoulder biomechanical exposures, and (5) low back biomechanical exposures. As of 2024, the cleaning task data used to develop the calculator was only measured in office-building work venues.

In this study of California janitors, we use a similar time study method to compare the actual and predicted time on task when cleaning three different types of commercial venues.

5.2 Time Study Methods

5.2.1. Study design and recruitment

Based on input from the Service Employees International Union (SEIU), four venue types were identified for inclusion in the study: shopping mall, conference center, airport, and office building; however, due to scheduling obstacles, the office building venue type was dropped from this study. A sample of convenience, including janitorial companies with SEIU membership (Service Employees International Union), who provide services at those venues, were contacted. During the initial recruitment phase, an overview of the study was provided to the local SEIU union representatives, the janitorial company, and the venue business owners. The overview was later presented to janitors at each venue during recruitment for study participation.

To be included in the study, participants must have worked as janitors for at least 6 months, be at least 18 years of age, and not currently have any severe pain that would prevent them from completing their normal tasks, or a worker's compensation claim. The janitor would be excluded if he or she was currently serving in a managerial role with minimal assigned cleaning tasks. Informed consent was obtained and most janitors who participated in the time study also completed the California Janitor Workload survey (section 3).

5.2.2. On-site data collection

Janitors were video recorded performing their regular tasks for up to 4 hours to capture a representative sample of tasks and work cycles. The camera recorded the janitor continuously throughout the observation period; each cleaning task was repeated at least three times. Subjects were instructed to perform tasks at their normal pace. The video captured natural rest breaks and only stopped during scheduled breaks (i.e. lunch). The only exception was replacing the camera's battery, which was documented in the time/task log and later adjusted during video processing using the overlay timestamp. The video was recorded at 30 frames per second (GoPro, San Mateo, CA), with an overlay of the actual date and time. A written log recorded each task, its start time, and the start and end times of breaks.

Additional direct measurements of task exposures were collected after the conclusion of the video recording. The distances for pushing carts were measured using a distance wheel in linear footage. Dimensions of tools, furniture, fixtures, spaces, carts, and items lifted, pushed, or pulled were measured using a measuring tape. The weights of tools and items lifted were measured using a digital scale. Push/pull forces of carts or other items were measured using a digital force gauge (Chatillon, Ametek, Largo, FL). The number of fixtures or items in the area, such as chairs, tables, toilets, and sinks, were recorded. The cleaning tools or machines used by the janitor were documented with pictures and model numbers, if applicable.

5.2.3. Video processing

A single combined video file was compiled for each subject, reflecting their entire observation period. The raw video clips were combined and edited chronologically using Adobe Premiere Pro (version 22.5.0), with reference to the timestamps in the format of hours, minutes, and seconds. If the timestamp on the original video did not reflect the actual time, a new timestamp was added to the bottom center of the video to ensure all time was accounted for. When the janitor was on break, and the camera stopped recording, a blank black video clip was created, matching the duration of the break to represent the time that elapsed accurately. A note describing the event and the break's start and end times were added to the video as a text block. Similarly, if the janitor performed a cleaning task that was not captured on video, a black video clip of the same duration as the task was inserted, with descriptions of the task and the time duration included.

5.2.4. Video analysis of actual time spent on task

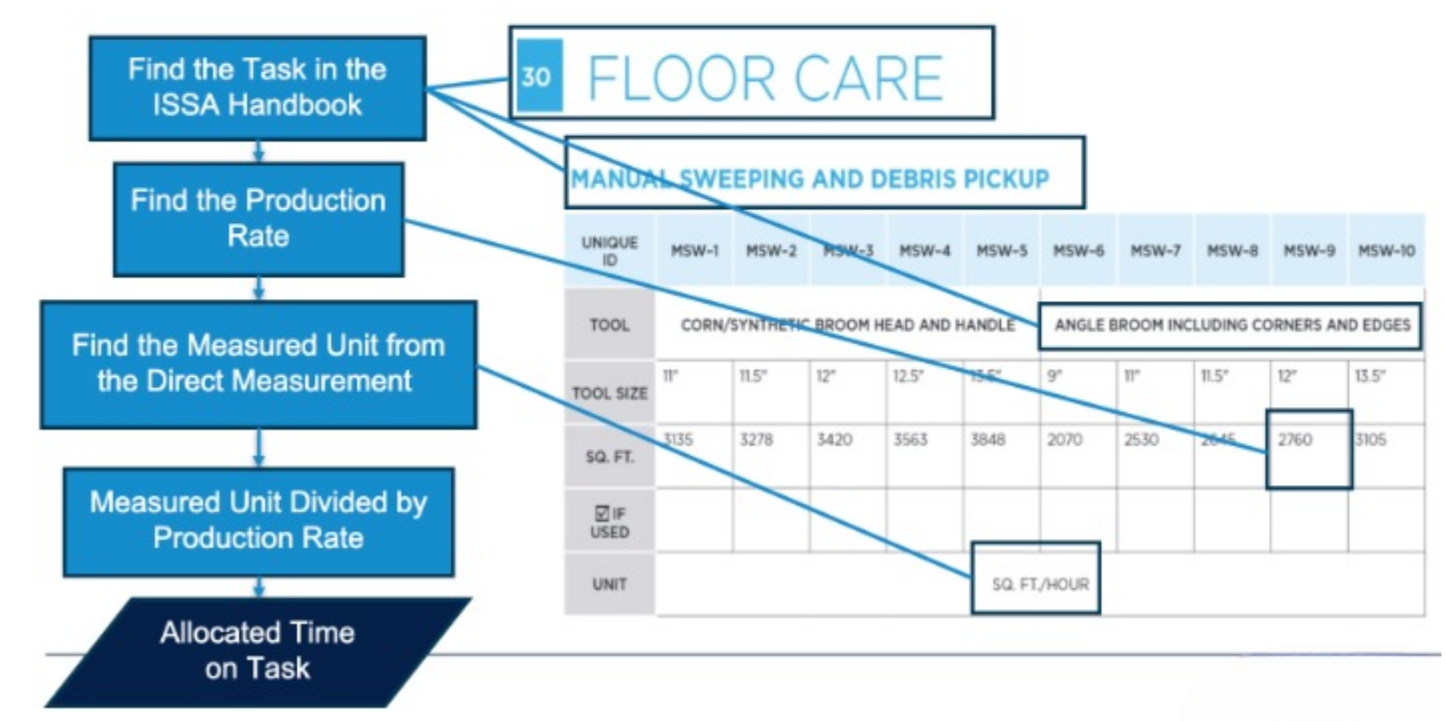
Each video was analyzed frame by frame using Multimedia-Video Task Analysis (MVTA) software (NexGen, Inc., University of Wisconsin, IL, Version 3.1.0). MVTA allows each frame to be allocated to a particular category of interest. Two levels of analysis were used to allocate each frame to different categories of interest: space (e.g., restroom, shared space, elevator) and the task (e.g., disinfecting/scrubbing, trashing, resupply). The entire video was coded for both space and task. A comprehensive list of spaces and tasks was developed by venue type (see Appendix) to maintain consistency across multiple video analysts. MVTA screenshots with lists of items in each category are included in the Appendix. For quality assurance across analysts, random frames were spot-checked by a senior team member for accuracy of space and task coding. Any issues were corrected and analyst training was adjusted as needed.

The reports exported from the MVTA software provided information about the duration of each task by space. The “breakpoint” and “time study” reports were exported for each subject and generated independently for both space and task. The detailed time study report included the mean, standard deviation, count, total time, and percent of total time of each event (i.e., the type of task or space). The breakpoint report listed the event's name and segment duration chronologically. The breakpoint reports for each participant for space and task were imported into a custom Python script to determine the total duration of tasks performed in each space. After cleaning the reports for duplicate time values, a Space x Task report was generated, combining the spaces' names, the tasks' names, and the corresponding duration for each interaction of space and task (e.g., bathroom/scrubbing, common space/trashing).

5.2.5. Industry standard time allocation calculations

To compare the actual task times from the video analysis to estimations of industry standard allocated cleaning times were calculated for all tasks with durations greater than 5% of the total video time (ISSA Clean Standards 7th edition, 2021). For the cleaning categories assessed in this study, the standard times in the 8th edition (ISSA, 2023) are comparable to those in the 7th edition (ISSA, 2021). Throughout this report, these estimations of allocated cleaning times are referred to as ‘allocated times’ and are compared to actual, measured times of cleaning work. The following flowchart (Figure 5.2.5.A.) illustrates how allocated times were calculated. The general steps to calculate the allocated time for a task were (i) identify the task in the ISSA handbook; (ii) locate the production rate; (iii) determine the measured unit through direct measurement; and (iv) divide the measured unit by the production rate. Variations in allocated time calculations were applied to each task depending on the measured unit provided (ISSA, 2021).

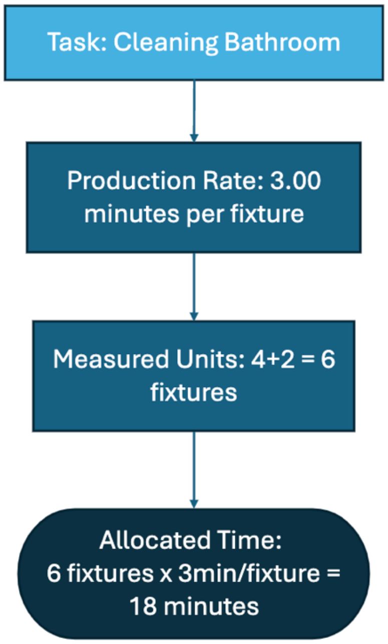
Figure 5.2.5.A. Calculation of allocated time on task



The methods used for calculating cleaning times were based on the unit specified: per fixture, per item, or square footage (see Appendix for a list of all ISSA terms used and definitions). The “per-fixture” method was used for all tasks in the bathroom, where the number of plumbed units (toilets, urinals, sinks) was counted and multiplied by the production rate in fixtures per minute (Figure 5.2.5.B.). This meant the task referred to as ‘all-bathroom’ included all cleaning tasks that occurred in the bathroom, like trashing, disinfecting/scrubbing surfaces (sinks, toilets, mirrors, and walls), and floor care (sweeping, vacuuming, and mopping). For tasks like trashing, where the unit was "each," trash cans were counted, and the productivity rate was applied to the total time spent in the bathroom. Specific production rates provided by the ISSA were applied for certain tasks based on square footage and tool measurements. For example, to determine the time needed to mop 2,000 square feet with a 12” angle mop, the ISSA code MSW-9 (Manual Sweeping and Debris Pickup) production rate of 2,760 sq. ft./hour was used (Figure 5.2.5.C.).

Figure 5.2.5.B. Example of calculating allocated time for a restroom task

Example 1. How long does it take to clean a restroom with 4 toilets and 2 sinks?



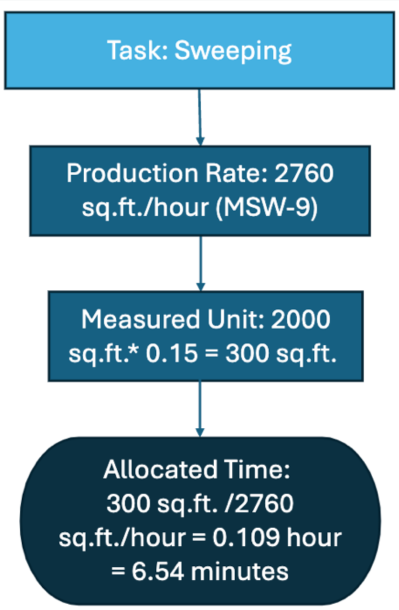
RESTROOMS 43

RESTROOM CLEANING

UNIQUE ID	TASK	TOOL	TIME unit	TIME minutes	TIME seconds	☑ IF USED
RCL-1	Empty feminine hygiene disposal and replace bag	Grabber device and replacement bag	Each	0.27	16.20	
RCL-2	Clean standard restroom mirror	Extension tool, chemical, and microfiber cloth	Each	0.50	30.00	
RCL-3	Clean toilet, urinal, or sink	500 psi spray-and vacuum machine	Per fixture	0.75	45.00	
RCL-4	Clean toilet, urinal, or sink	500 psi spray-and vacuum machine and chemical	Per fixture	1.00	60.00	
RCL-5	Empty trash, clean and disinfect fixtures, wipe mirrors, replace supplies, and sweep floor	Restroom cart, trash liners, consumable supplies, chemical, cleaning cloths, broom, and dustpan	Per fixture	1.64	98.33	
RCL-6	Empty trash, clean and disinfect fixtures, wipe mirrors, replace supplies, dust, sweep, and wet mop floor	Spray-and-vacuum machine, trash liners, consumable supplies, chemical, cleaning cloths, broom, and duster	Per fixture	2.32	139.00	
RCL-7	Empty trash; clean and disinfect fixtures, mirrors, and partitions; replace supplies; dust; sweep; and wet mop floor	Restroom cart, trash liners, consumable supplies, chemical, cleaning cloths, broom, duster, dustpan, mop and bucket, and squeegee and applicator	Per fixture	3.00	180.00	

Figure 5.2.5.C. Example of calculating allocated time for a sweeping task

Example 2. How long does it take to sweep an area in preparation for wet mopping, using an estimated 12" angle broom? Assume the wet mop area is 2000 sq ft, and the spot-swept area is 15% of the wet mopped area.



30 FLOOR CARE

MANUAL SWEEPING AND DEBRIS PICKUP

UNIQUE ID	MSW-1	MSW-2	MSW-3	MSW-4	MSW-5	MSW-6	MSW-7	MSW-8	MSW-9	MSW-10
TOOL	CORN/SYNTHETIC BROOM HEAD AND HANDLE					ANGLE BROOM INCLUDING CORNERS AND EDGES				
TOOL SIZE	11"	11.5"	12"	12.5"	13.5"	9"	11"	11.5"	12"	13.5"
SQ. FT.	3135	3278	3420	3563	3848	2070	2530	2645	2760	3105
☑ IF USED										
UNIT	SQ. FT./HOUR									

The venue's floor plans were used to calculate the estimated area when square footage was the ISSA unit of measurement; the janitor's walking path was plotted based on the video. The estimated distance, or linear feet walked, was calculated by counting the steps from the video and multiplying by stride length, which was estimated based on the participant's height. A multiplier based on measured square footage was used to estimate the area for tasks where direct measurements were unavailable. For example, for litter pick-up prior to mopping, a 0.15 multiplier was applied to the measured area for wet mopping to estimate the area where the broom was used, as that area was estimated to be 15% of the total mopped area.

All units, whether measured per item, per fixture, or per square footage, were based on the total number of units in the area rather than those cleaned. For example, with wiping and disinfecting/scrubbing tables and chairs in common areas, the total number of chairs and tables was counted as this was assigned to the janitor, even though they may have only cleaned a portion of them due to the space being occupied. Similarly, the restroom "per-fixture" method and the "each" method focused on the number of fixtures or items in the space rather than just those cleaned.

The ISSA rate that best reflected the task and tool used, based on observations in the field and video analysis, were selected for each space and task. Depending on the task demand, different ISSA rates were applied for the same task. For example, cleaning bathrooms during the evening shift involved additional, deeper cleaning, tasks like wet mopping, vacuuming, and more detailed cleaning of fixtures. Different production rates were applied to reflect the increasing demand: the daytime shift was 1.6 min/fixture (ISSA code RCL-5), and the evening shift was 3 min/fixture (ISSA code RCL-7).

However, some tasks observed were not listed in ISSA. In these cases, the time spent on these tasks was added to related tasks described by ISSA. The relationship between the tasks was typically sequential or concurrent. For example, the time spent on a task called "furniture moving", which was not specifically included in ISSA, was combined with wet mopping because the janitor needed to clear the space before and after mopping. The time for walking and transporting trash/supply carts was also combined, and it was estimated that the walking pace was 'slow' at 20 minutes per mile per ISSA.

Some cleaning tools used were not described in the ISSA task categories. For example, one janitor used a broom to deep clean the trashcan instead of the ISSA-documented method of "spot wipe inside and out" (ISSA code TBC-5). The closest matching terms, including tools with similar sizes or functions, were chosen in these cases.

5.2.6. Actual time versus allocated time comparison

Using Microsoft Excel (Version 16.87), a ratio was calculated comparing the allocated time to the actual time for each space and task combination. The percent deviation was calculated to determine the differences between allocated and actual time, and the difference in minutes for each task was also calculated. The observed time on task was normalized into an 8-hour working shift, assuming a 30-minute break time.

The results were aggregated by space and task and categorized by venue type. Data points were divided into two groups: those where actual time was less than allocated time and those where it was more. Mean percent deviation, time differences in minutes, and standard deviations were calculated for each task and space combination within each group.

5.3 Time Study Results

Twenty-four janitors were included in the time motion analyses (Table 5.3.A.). The survey had a response rate of 87.5% (21 out of 24 participants). The remaining three participants did not complete the survey due to loss to follow up. Demographic and work history data were based on the 21 survey respondents, while building-type data included all 24 participants' work locations. Among those who completed the survey, the average tenure as a janitor was 22.7 years (SD = 10.3), with the majority (~62%) were between 50 and 65 years of age.

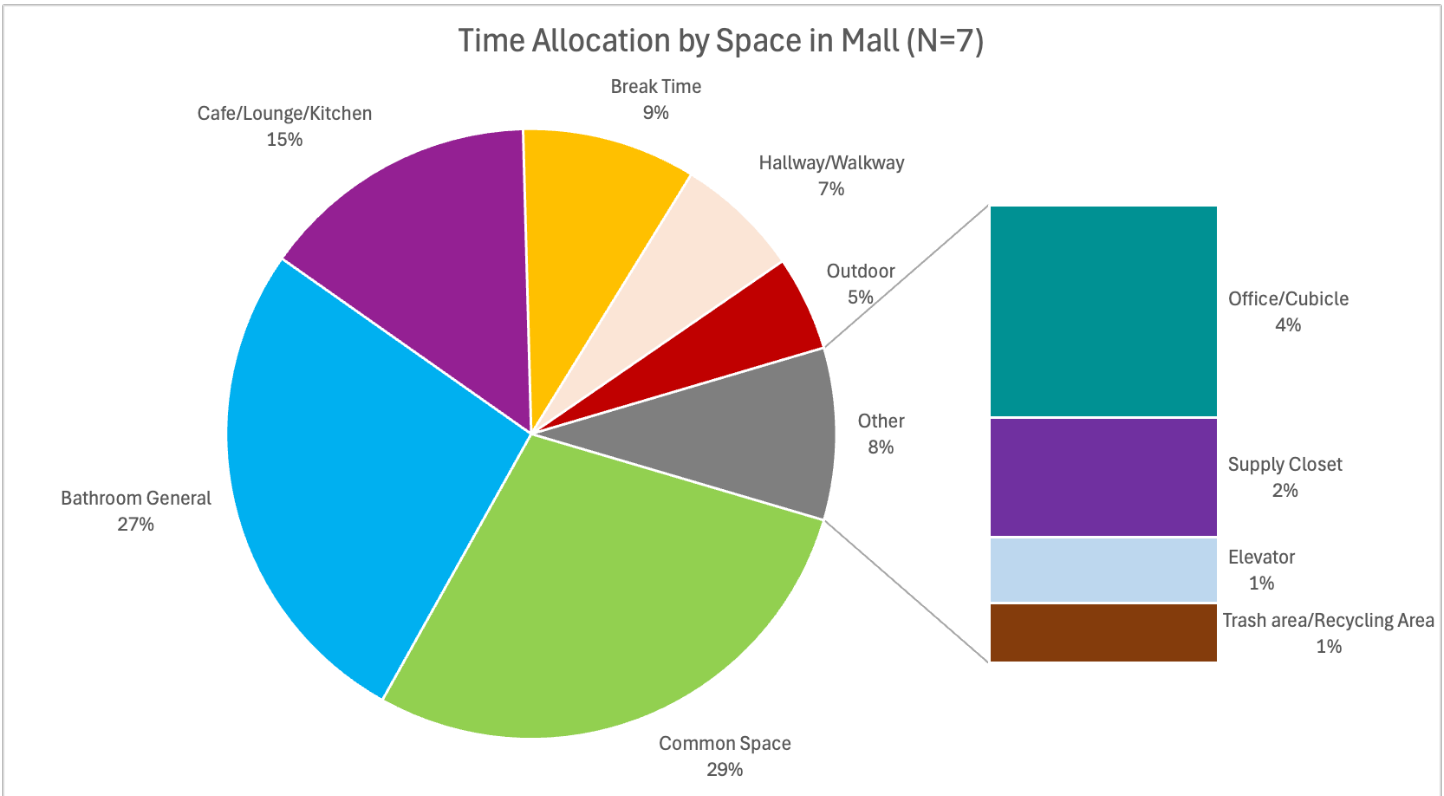
Regarding sex, 11 participants identified as male, nine as female, and one chose not to answer. Hispanic workers were the largest racial/ethnic group, comprising 13 of the 21 respondents (~62%). Workplace distribution of the 24 participants showed that 13 janitors worked in public venues or convention/event centers, seven in shopping malls, and four at airports. Of the 21 respondents who completed the survey, 11 worked in public venues or convention/event centers, six in shopping centers or malls, and four at airports.

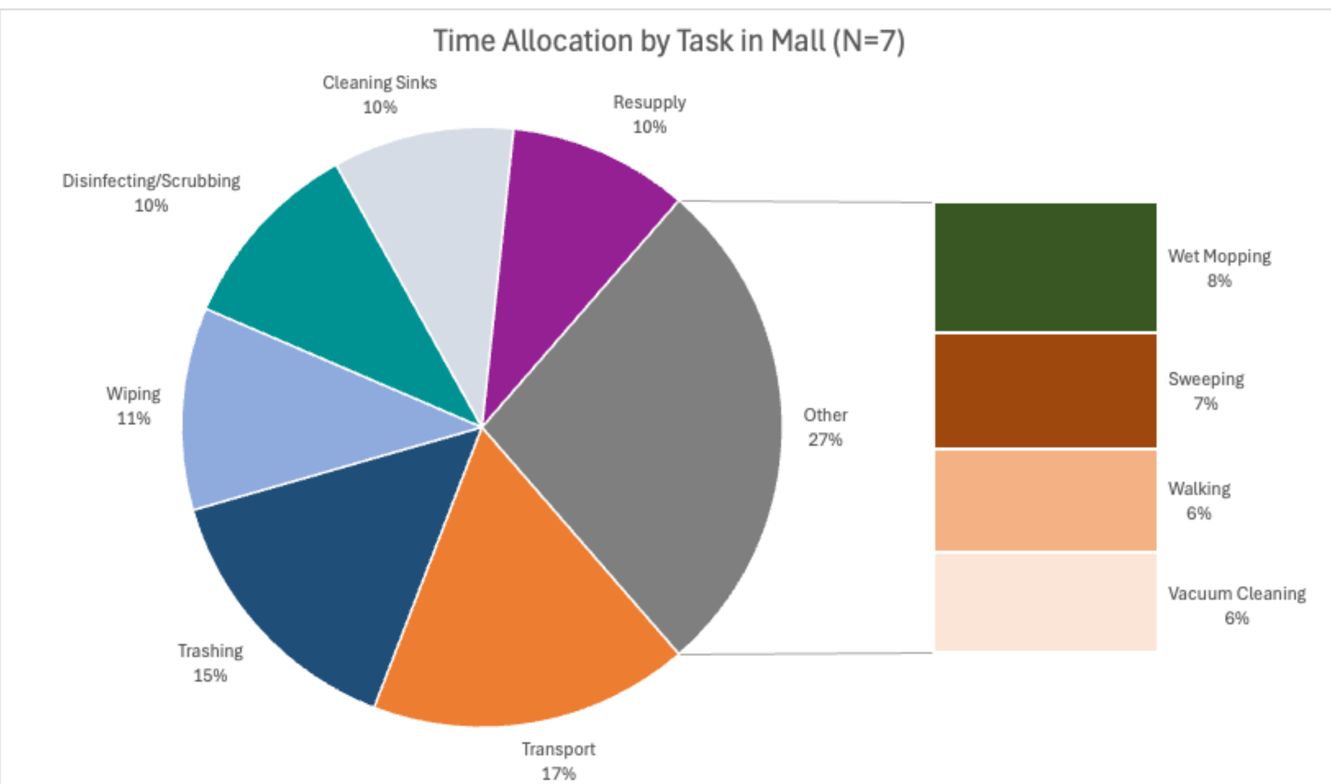
Table 5.3.1.A. Sample Characteristics

N = 21	n (%)
Total Years as a Janitor	
0-10	4 (21.1%)
11-20	3 (14.3%)
21-30	8 (38.1%)
31-40	6 (28.6%)
Demographics	
Age	
30-49	6 (28.6%)
50-65	13 (61.9%)
>65	2 (9.52%)
Sex	
Male	11 (52.4%)
Female	9 (42.9%)
Prefer not to say	1 (4.76%)
Race & Ethnicity	
Hispanic	13 (61.9%)
Black or African American	3 (14.3%)
Asian	3 (14.3%)
Native Hawaiian or Pacific Islander	1 (4.76%)
White/Caucasian	1 (4.76%)

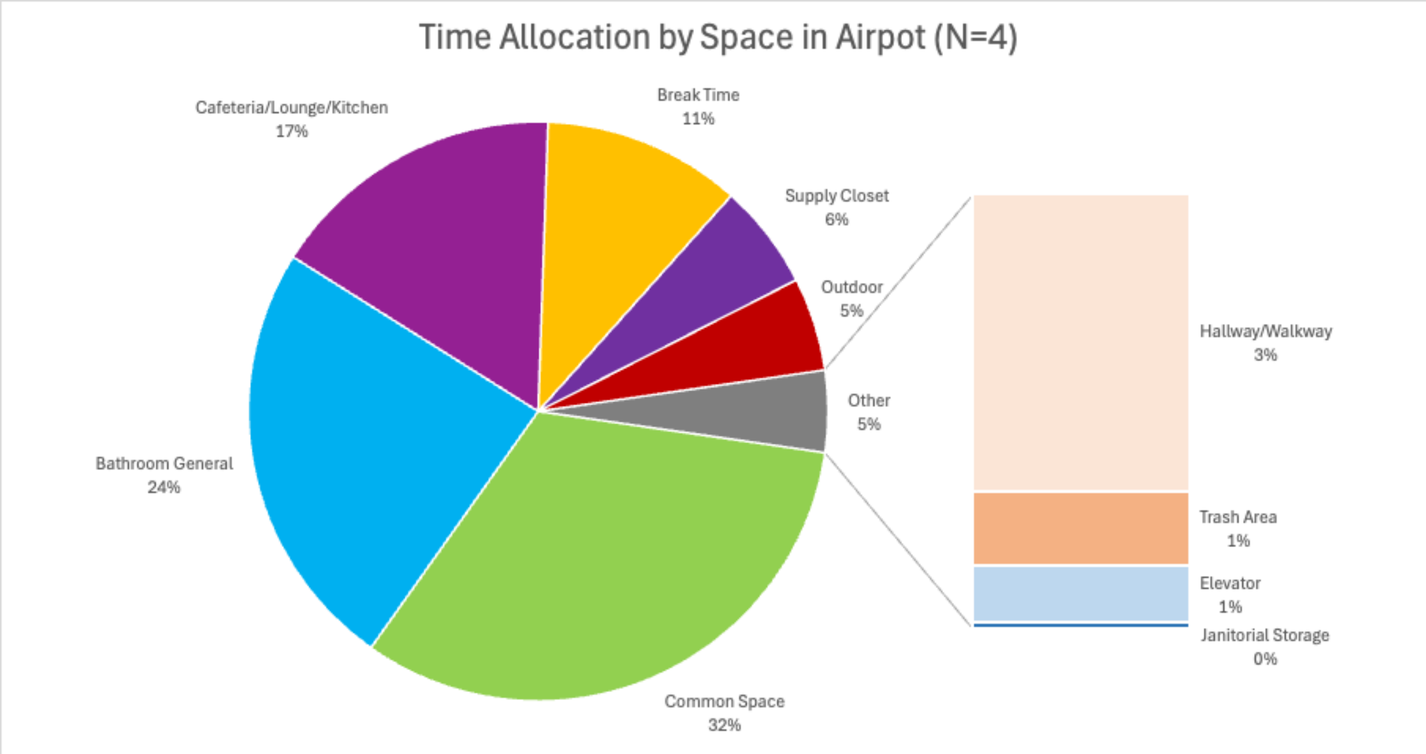
According to their survey responses, the janitors in this study spent most of their time cleaning common spaces (29-47% of the time, based on the venue) and bathrooms (24-27%, based on the venue). The shopping mall and airport janitors performed similar primary tasks, including trashing, transporting, and wiping or disinfecting. In contrast, at the event center, janitors primarily performed tasks like washing windows, moving furniture, and vacuuming. The pie charts in Figure 5.3.A. illustrate the breakdown of the janitors' work time in different spaces and performing different cleaning tasks at each of the three venues.

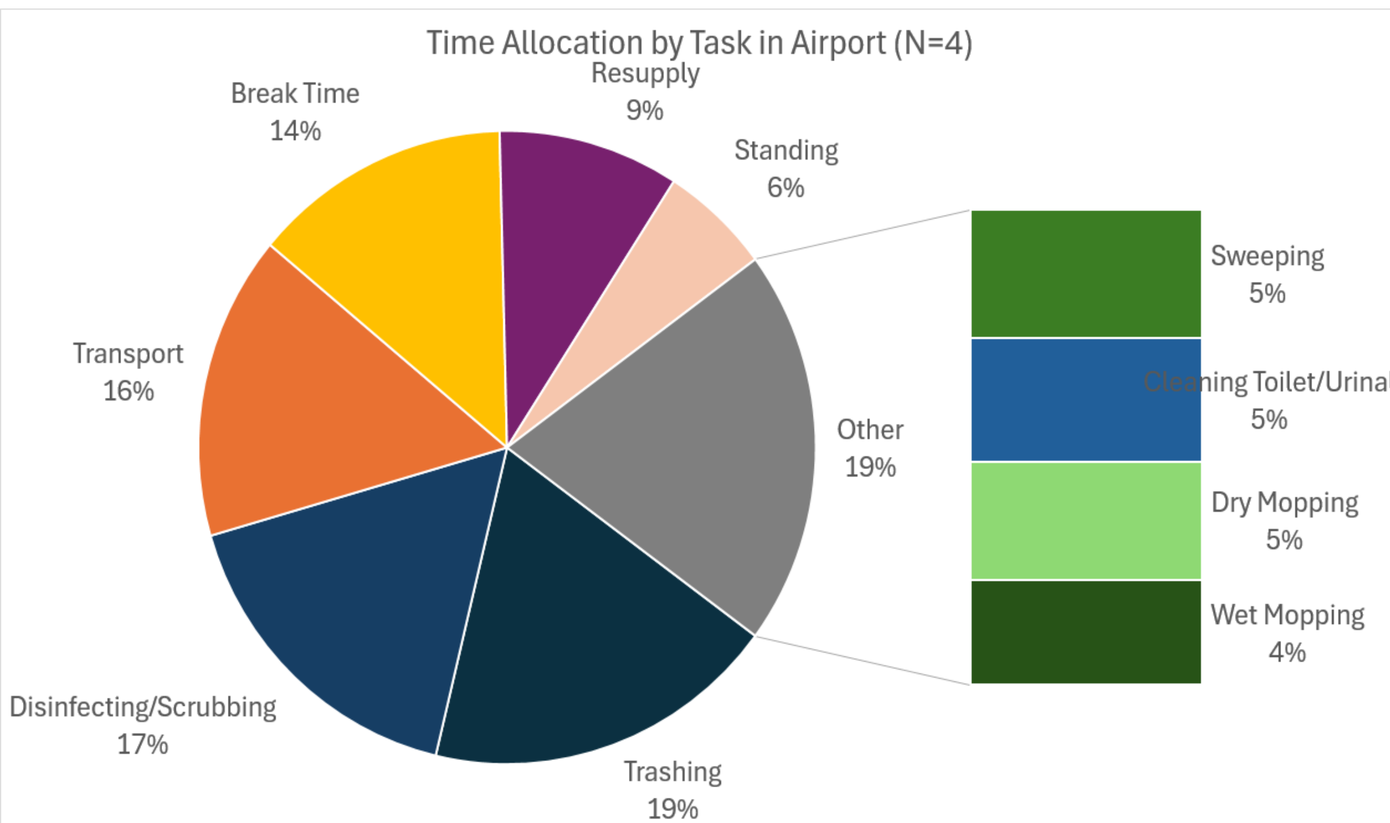
Figures 5.3.1.A-B. Time allocations by space and task for the mall



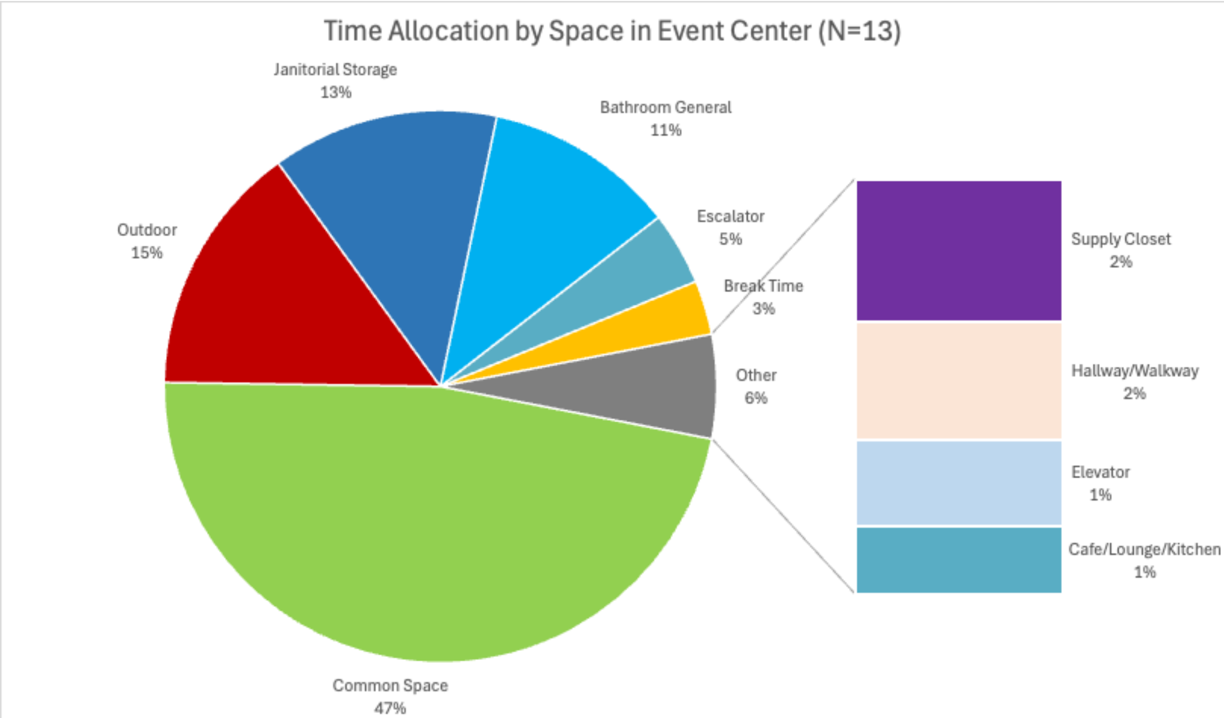


Figures 5.3.1.C-D. Time allocations by space and task for the airport





Figures 5.3.1.E-F. Time allocations by space and task for the event center



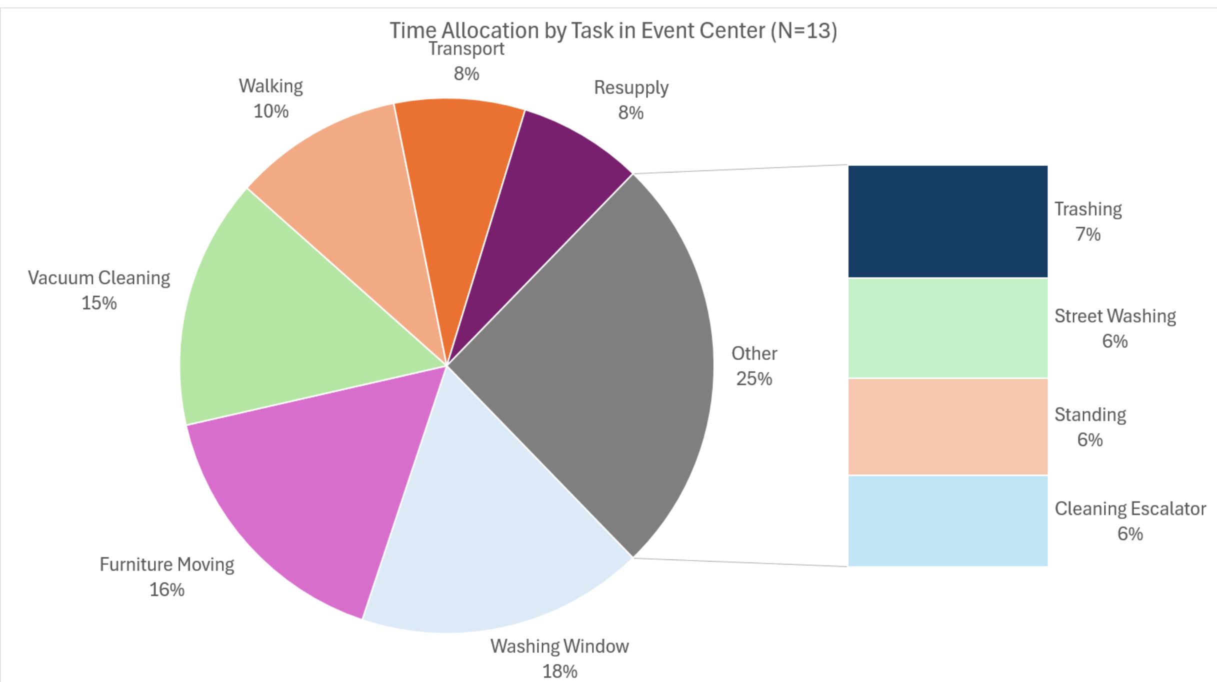


Table 5.3.1.B. lists the top ten tasks and spaces by duration across all venues combined. The number of samples in the time study is shown for each space and task. A single sample represents when one subject performed a particular task or worked in a particular space. In other words, the 41 samples (18+23) noted for common space in Table 5.3.1.B. include individual video segments of janitors performing various tasks (e.g., sweeping, wiping) in the shared space across all venues. The table summarizes the differences between the actual time and the time allocated using the ISSA standard cleaning time data. These results are grouped into two categories: the left side includes the samples when the measured time was less than the allocated time (the janitor worked faster than the standard time) and the opposite when the actual measured time was longer than the allocated time. The average differences are shown as a percent deviation and a time difference in minutes.

Table 5.3.1.B. Summary of the comparison of time allocation across all venues by space and task

All Venues		Actual < Allocated (worker pace faster)			Actual > Allocated (worker pace slower)		
	Name	**n**	**Average percent deviation (%) ± SD**	**Average difference (min) ± SD**	**n**	**Average percent deviation (%) ± SD**	**Average difference (min) ± SD**
Space	Common Space	18	-0.37±0.21	-12.3±9.29	23	0.65±0.46	12.5±14.7
	Bathroom General	8	-0.2±0.21	-25.5±40.6	4	0.22±0.19	7.39±6.94
	Cafe/Kitchen	4	-0.3±0.19	-15.5±15.8	2	1.05±1.38	40.5±48.8
	Outdoor	6	-0.42±0.29	-48.8±102.2	1	0.44±0	24.2±0
	Janitorial Storage	1	-0.21±0	-7.48±0	3	0.31±0.18	5.71±7.27
	Escalator	2	-0.44±0.22	-14.1±11.8	1	12.2±0	59.1±0
	Office/Cubicle	2	-0.28±0.13	-1.77±0.13	1	0.45±0	8.5±0
	Elevator		NA		1	2.95±0	14.2±0
	Supply Closet		NA			NA	
	Hallway/Walkway		NA		1	0.98±0	4.08±0

There was no general pattern of time deviations across most spaces except for the outdoor workspace. Time allocated to cleaning outdoor areas was consistently overestimated by an average of 42%, equivalent to 48 minutes. As allocated times were not calculated based on space, except for bathrooms, this result indicates that the time allocated to the primary outdoor cleaning tasks was consistently overestimated for cleaning tasks performed in this space. The primary tasks for outdoor work were trashing (shopping mall and airport) and street washing (event center), which were found to be typically overestimated by the allocated times as well.

When comparing the observed and allocated times by cleaning tasks, most of the top 10 most common tasks did not have a clear trend, except for transport/walking and trashing. The allocated times were consistently underestimated transport/walking times by 61% or 8 minutes. Trashing was more frequently overestimated (allocated > observed), however, by an average of 40%, or 12.4 minutes.

There were some tasks at the shopping mall (Table 5.3.1.C.) that had consistently overestimated allocated time (litter pick up, wet mopping, sweeping, trashing) and some when the actual time was longer than the allocated time (vacuuming, elevator cleaning, wiping). At the airport (Table 5.3.1.D.), the tasks with underestimated time allocations included trashing, dry mopping, dusting, and vacuuming, while the tasks where actual time was longer than allocated time included disinfecting, sweeping, and transport/walking. At the event center (Table 5.3.1.E.), the only task where the actual work took longer than what was estimated was walking/transport, which could be attributed to the aforementioned factors. The event center tasks that had consistently higher allocated times include all-bathroom, carpet cleaning, street washing, wet mopping, and dry mopping.

Table 5.3.1.C. Comparison of time allocation in shopping mall venue by space and task

Mall		Observed < Allocated (worker pace faster)			Observed > Allocated (worker pace slower)		
	Name	**N[a]**	**Average percent deviation (%) ± SD**	**Average difference (min) ± SD**	**N[a]**	**Average percent deviation (%) ± SD**	**Average difference (min) ± SD**
Task	Disinfecting/Scrubbing	2	-0.27±0.12	-21.4±24.0	2	0.59±0.12	3.92±2.54
	Litter Pick Up	1	-0.11±0	-3.5±0	0	NA	NA
	Trashing	5	-0.47±0.2	-18.3±10.6	0	NA	NA
	Transport + Walking	1	-0.62±0	-10.3±0	7	0.53±7.58	0.35±5.45
	All Bathroom	5	1.28±0.33	-0.18±0.19	2	0.38±0.07	10.05±8.7
	Wet Mopping	2	-0.42±0.07	-14.7±18.2	0	NA	NA
	Sweeping	3	-0.24±0.07	-4.38±2.45	0	NA	NA
	Trashing	5	-0.47±0.2	-18.3±10.6	0	NA	NA
	Vacuum	0	NA	NA	2	0.42±0.37	5.21±3.33
	All Elevator	0	NA	NA	1	2.95±0	14.16±0
	Wiping	0	NA	NA	2	1.51±0.73	48.1±38.2
Space	Café/Kitchen	3	-0.22±0.12	-16.1±19.4	1	2.03±0	75.13±0
	Common Space	7	-0.4±0.21	-15.9±11.3	19	0.52±0.31	8.44±6.45
	Outside	2	-0.55±0.1	-8.99±1.79	0	NA	NA
	Bathroom	5	-0.18±0.19	-14.4±14.9	2	0.38±0.07	10.05±8.7
	Office/Cubicle	2	-0.28±0.13	-1.77±0.13	1	0.45±0	8.5±0
	Hallway/Walkway	0	NA	NA	1	0.98±0	4.08±0
	Elevator	0	NA	NA	1	2.95±0	14.16±0

[a] number of 5-minute video samples

Table 5.3.1.D. Comparison of time allocation in airport venue by space and task

Airport		Observed < Allocated (worker pace faster)			Observed > Allocated (worker pace slower)		
	Name	N[a]	Average percent deviation (%) ± SD	Average difference (min) ± SD	N[a]	Average percent deviation (%) ± SD	Average difference (min) ± SD
Task	Trashing	4	-0.38±0.2	-9.36±6.46	0	NA	NA
	All Bathroom	1	-0.1±0	-6.67±0	2	0.07±0.1	4.72±6.36
	Dry Mopping	2	-0.23±0.0	-5.97±2.08	0	NA	NA
	Dusting	1	-0.54±0	-13.64±0	0	NA	NA
	Vacuum Cleaning	1	-0.26±0	-4.73±0	0	NA	NA
	Disinfecting	0	NA	NA	2	0.31±0.33	6.34±0.45
	Sweeping	0	NA	NA	1	0.27±0	3.18±0
	Transport + Walking	0	NA	NA	3	0.62±0.38	7.69±6
Space	Bathroom General	1	-0.1±0	-6.67±0	2	0.07±0.1	4.72±6.36
	Common Space	6	-0.34±0.1	-8.32±4.65	5	0.53±0.3	6.58±4.67
	Supply Closet	0	NA	NA	0	NA	NA
	Outdoor		-0.28±0.37	-6.78±9.38	0	NA	NA
	Cafeteria/Kitchen	0	NA	NA	2	0.07±0	6.02±0

[a] number of 5-minute video samples

Table 5.3.E. Comparison of time allocation in the event center by space and task

Event Center		Observed < Allocated (worker pace faster)			Observed > Allocated (worker pace slower)		
	Name	N[a]	Average percent deviation (%) ± SD	Average difference (min) ± SD	N[a]	Average percent deviation (%) ± SD	Average difference (min) ± SD
Task	Trashing	1	-0.21±0	-7.48±0	2	0.26±0.23	7.57±9.22
	Washing Window	1	-0.14±0	-4.26±0	3	0.62±0.48	32.4±33.4
	All Bathroom	2	-0.3±0.36	-62.8±83.2	0	NA	NA
	Vacuum Cleaning	1	-0.39±0	-27.9±0	2	1.38±1.28	28.1±7.24
	Carpet Cleaning	1	0±0	-0.29±0	0	NA	NA
	Cleaning Escalator	3	-0.49±0.19	-12.6±8.74	1	12.2±0	59.1±0
	Street Washing	1	-0.74±0	-257.4±0	0	NA	NA
	Wet Mopping	1	-0.18±0	-9.57±0	0	NA	NA
	Dry Mopping	1	-0.65±0	-13.2±0	0	NA	NA
	Walking + Transport	0	NA	NA	6	0.7±0.21	8.7±6.35
Space	Bathroom General	1	-0.21±0	-7.48±0	3	0.31±0.18	5.71±7.27
	Common Space	5	-0.37±0.28	-12.1±10.0	8	0.88±0.63	21.3±21.9
	Supply Closet	2	-0.44±0.42	-130.8±178.9	1	0.44±0	24.27±0
	Outdoor	2	-0.3±0.36	-62.8±83.2	0	NA	NA
	Cafeteria/kitchen	2	-0.43±0.22	-14.1±11.8	1	12.2±0	59.1±0

[a] number of 5-minute video samples

The differences in allocated to actual cleaning time could disproportionately affect janitors based on their tasks. When the overestimates and underestimates are combined by worker and normalized to a 7.5-hour workday, the impact varies by venue. Based on an 8-hour day shift, the janitors would have been allocated between 96.0 minutes less and 65.1 minutes more, depending on the tasks and venues performed. The allocated time for six of the seven workers measured at the shopping mall was greater than the actual time measured (Table 5.3.F.). This overestimation ranged from 8.9 to 225.6 minutes per worker across the work shift. Similar results were found for the airport (Table 5.3.G.), where three of four workers had allocated time overestimates ranging from 18.6 to 95.4 minutes across the work shift. The results were less consistent at the event center (Table 5.G.H.), with four of the 12 workers having overestimated allocated time ranging from 2.2 to 1250.0 minutes and eight of the 12 having underestimates ranging from 22.6 to 189.5 minutes across the work shift.

Table 5.3.F. Summary of impact on work shift at the mall venue by worker

Worker (N=7)	Total Allocated Job Cycle Time (min)	Total Job Cycle Time (min)	Worker Impact Across Observation (min)	Worker Impact Across Shift (min)
A	179.17	153.5 0	-25.7	-75.3
B	174.73	117.30	-57.4	-220.3
C	162.66	138.90	-23.76	-77.0
D	208.93	181.92	-27.01	66.81
E	234.71	248.35	13.64	-24.71
F	68.33	137.00	68.67	-225.55
G	251.20	256.29	5.05	-8.87

Table 5.3.G. Summary of impact on work shift at the airport venue by worker

Worker (N=4)	Total Allocated Job Cycle Time (min)	Total Job Cycle Time (min)	Worker Impact Across Observation (min)	Worker Impact Across Shift (min)
A	153.54	126.68	-26.87	-95.44
B	116.70	109.98	-6.72	-27.48
C	140.04	143.64	3.60	11.29
D	137.84	132.38	-5.46	-18.56

Table 5.3.H. Summary of impact on work shift at the event center venue by worker

Worker (N=13)[a]	Total Allocated Job Cycle Time (min)	Total Job Cycle Time (min)	Worker Impact Across Observation (min)	Worker Impact Across Shift (min)
A	57.16	69.16	12.00	78.11
B	106.50	181.93	75.43	186.58
C	113.48	119.47	5.99	22.58
D	222.00	100.40	-121.60	-545.03
E	119.49	114.61	-4.88	-19.17
F	58.91	58.62	-0.29	-2.19
G	38.04	54.12	16.08	133.68
H	86.49	105.00	18.51	79.33
I	350.00	92.65	257.36	-1250.04
J	95.58	126.45	30.87	109.86
K	11.97	20.67	8.70	189.45
L	92.89	106.01	13.12	55.70

[a] one worker did not have time estimates due to tasks not included in ISSA standard times

5.4 Time Study Discussion

This time study compared actual cleaning time to the allocated time using ISSA time standards for various janitorial tasks in three different venues: a shopping mall, an airport, and an event center. The results varied by workspace across venues. Common space cleaning time was over and underestimated by similar average magnitudes in both directions. Overall, allocated time for cleaning bathrooms, cafés/kitchens, and outdoor spaces was more frequently overestimated (allocated > observed), while time working in janitorial supply closets was more frequently underestimated (allocated < observed).

The time allocations also varied by work task across venues. The majority of the top 10 most common tasks did not have a clear trend, however, two tasks were found to be more frequently overestimated (allocated > observed): trashing and cleaning escalator. In contrast, the time observed for walking/transport was frequently underestimated meaning that the actual time taken was greater than the allocated time.

We observed something that may have contributed to the overestimation of trashing time. Janitors commonly skipped trash cans that were less than half full, visually inspecting them and choosing to move on to the next one instead of emptying each one. This may have contributed to overestimating the time needed to perform the trashing task since the ISSA time allocated to each trash can was calculated equally. This indicates two key factors that should be considered when allocating time on task, (i) occupancy to the percentage of the space that is in use; and (ii) volume which is the amount of activity or traffic within that space.

A potential explanation for the underestimation in walking/transport was the absence of an ISSA category for transporting carts or supplies. We added the time spent on this type of task to the walking task category.

Although the slowest walking pace referenced in the ISSA book (ISSA, 2021) was used, it did not account for the additional effort required to transport carts or supplies while walking, which may have increased the predicted time for walking/transport.

At the event center, two tasks were found to have overestimated time allocations: bathroom-all tasks and street washing. The overestimate for the bathroom may be attributed to the difference in the definition of bathroom deep cleaning across venues, and the overestimate for street washing may be due to varying techniques or efficiency of the street washing machine.

Overall, differences between actual and allocated times may also be explained by differences in cleaning techniques or requirements of janitors that differ by venue or employer, or the absence of occupancy and volume considerations. Further, it is possible that the ISSA time standards were not properly interpreted to capture important work characteristics that may have affected allocated times. As mentioned, this study used the instructions provided in the ISSA handbook. Although an educational course which offers a detailed approach to using the ISSA standard times for Workloading can be taken, its cost could be prohibitive to many companies.

5.4.1. Limitations in time comparison methods

Some values were estimated using video footage and building floorplans (with dimensions) to obtain the measurements for the work areas. These included some surface areas disinfected or wiped and distances transported or walked. As described in the methods section, best estimates were derived from video footage and floorplans, using multipliers for portions of cleaned areas, drawing on floor plans for distances, or counting steps for walked distances. This could lower the accuracy of the predicted time on task.

Since multiple researchers have been performing video analyses of actual time spent on tasks, inter-rater reliability of the video analysis was assessed through random spot checks for seven subjects, ensuring at least one check per analyst. Systematic errors from each analyst identified during these checks were corrected. Only a sample of video analyses were reviewed.

The differences between actual and allocated time estimates varied widely by workspace and work task across venues.

Most of the top 10 most common tasks did not have a clear trend across venues, which may be explained by differences in (i) cleaning techniques; (ii) cleaning expectations that are specific to venues or employers; or (iii) occupancy and volume of each space.

Some tasks that were observed, did not have a corresponding category in the ISSA standards time, making a time allocation and comparison impossible.

Further research is needed to improve time allocations of janitorial tasks.

5.4.2. Challenges in determining allocated times

It was unclear from the instructions provided in the ISSA guidelines if the predicted times accounted for the time required to prepare for tasks, such as walking back and forth to the cleaning cart and wrapping vacuum cords. One study (Washington State Department of Labor and Industries, 2022b) mentioned that the ISSA guidelines consider non-primary tasks such as travel and bucket-filling time. In our study, we included the time for these non-primary tasks in the actual task time measured; therefore, if ISSA production rates do not account for those, this may have led to an underestimation of allocated times.

Three tasks observed only at the event center, transporting and setting up furniture, supply warehousing, and folding tablecloths, were not found in the ISSA and were excluded from the time comparison. The current version of the ISSA (ISSA, 2023) has been updated to include sections for additional business types such as dorms, health care, correctional, manufacturing, retail, schools, and transportation. The event or convention center is not currently included, but perhaps this type of work venue, with high volumes of venue-specific tasks, will be included in a future edition.

5.4.3. Suggestions for future improvements to time estimates

The Washington State researchers identified similar limitations with industry-standard references. Not all tasks or combinations of tasks/space/tools were included in the documented standards (Washington State Department of Labor and Industries, 2022a). They suggest that the janitorial industry collaborate to create a more comprehensive, detailed listing of cleaning techniques and definitions to capture all the tasks janitors must complete. As described above, our findings support this conclusion and recommendation. Time allocations should consider occupancy, volume, and resupplying detail (e.g., location of storage closets and number of trips per hour). It should also include categories for tasks specific to unique spaces such as event or convention centers. Additionally, providing specific algorithms for how production rates are determined would be beneficial for transparency and flexibility for its use. Finally, ergonomic hazard should be considered in any approach that provides time estimates for janitorial tasks; those tasks with higher ergonomic hazard should be provided additional time to complete the task.

5.4.3. Applications to work scheduling in practice

Using the methods outlined in this study and the work rate information provided in the ISSA handbook led to under and over-estimation of cleaning time depending on the task, space, and venue (between 96.0 minutes less to 65.1 minutes more time than needed based on an 8-hour shift). This may indicate some inaccuracies with the standards or simply issues with the methods used to apply the standards. The ISSA was selected as the standard for determining predicted cleaning times due to recommendations from the janitorial industry and labor parties. According to the 8th edition (ISSA, 2023), it has been adopted as the standard in the United States government, health care, education, and other industry segments. The handbook provides general instructions on "workloading," which ISSA defines as analyzing work environments and processes to determine staffing levels for a task. However, it refers users to an ISSA Workloading Certificate Program run by ISSA's CMI (Cleaning Management Institute), where workloading specialists are trained to apply the information in practice.

When using the ISSA guidelines for workload, it is essential also to consider the ergonomic risks associated with each task. Many cleaning tasks, such as elevator cleaning, mopping, vacuuming, trashing, and wiping furniture, can lead to work-related musculoskeletal injuries if not properly managed (Washington State Department of Labor and Industries, 2022a). Knowing the spaces, tasks, and tools used, managers can prioritize ergonomic evaluations for activities that occur most frequently and are perceived as the most physically demanding. Detailed assessments of ergonomic risk factors such as awkward postures, forceful exertions, and repetitive motions should be conducted for these tasks to estimate the risk of upper extremity and low back injury. This important aspect of workload is not explicitly mentioned in the ISSA handbook, however, we address it in Section 6 of this report.

The Workload Calculator (Bao et al., 2023) created by the Washington State Department of Labor and Industries team is an alternative to the workload methods taught by the ISSA/CMI. This Workload Calculator incorporates the estimation of ergonomic risk exposures in the workload scheduling for cleaning commercial office buildings. Results from our study of actual cleaning times in a shopping mall, event center, and airport could be integrated into the Workload Calculator to enhance the calculator's applicability in additional work venues.

Environmental factors like heat must also be factored into the workload. Any job site that raises workers' core temperatures above 100.4°F increases the risk of heat stress (OSHA, 2024). Further, the risk of injuries increases with increasing heat stress (Spector et al., 2013; Xiang et al., 2014). Sacramento experienced 23 days over 100.4°F in 2023 (NWS, 2024), which puts outdoor workers at a higher risk of heat stress. Our results show that janitors performing outdoor cleaning tasks spent an average of 33.89 minutes per shift working outside. Managers should reference the CDC work/rest schedules (CDC/NIOSH, 2017) and schedule work to provide adequate recovery time based on the demands of the task and the outdoor temperature. For example, suppose a worker performs cleaning tasks requiring moderate physical demands (e.g., scrubbing tables, washing windows, power washing sidewalks). In that case, 15 minutes of rest should be provided for every 45 minutes of work. Providing workers with adequate hydration, shade, and rest breaks is crucial for maintaining their health and safety when working in elevated temperatures. It is critical to prevent heat stress and the injuries that often accompany heat stress, something of interest for Janitors as well as the company who employe them.

6. Janitor Workload Risk Assessment

6.1 Risk Assessment Background

Janitorial work is labor intensive and involves diverse tasks that expose workers to various physical and ergonomic risk factors like working in awkward postures, repetitive forceful hand movements, and lifting heavy objects. Scientific evidence from published, peer-reviewed workplace and laboratory studies demonstrates conclusively that workplace bodily exposures to physical work factors, such as high rates of repetitive movements and exertion of high physical forces, especially while in non-neutral postures, causes musculoskeletal pain and MSDs (NRC, 2001; Hagberg et al., 2012; Bernard et al., 1997; Neto et al., 2020). Additionally, disorders of the lower back, such as low back pain, spinal nerve impingements, and sciatica, are associated with repeated lifting of loads, especially loads that are heavy or low to the ground (Bernard et al., 1997; Heneweer et al., 2011; Kuijer et al., 2018).

In addition to biomechanical exposures, physiological responses, including heart rate, energy expenditure, steps, and trunk posture measurements, have been used as indicators of the risk of high workload and work-related musculoskeletal disorders in janitorial research as well (Balogh et al., 2004; Green et al., 2019; Hultman et al., 1984).

Numerous studies have assessed exposure to estimate the risk of upper extremity MSDs and low back pain and injury for various janitorial tasks. A recent review of methods for measuring physical workload among commercial cleaners (Lee et al., 2022) presented 48 research papers and the measurement tools used in each study. These peer-reviewed journal articles assessed physical workload at the job or task level using validated direct measurements, observational methods, and/or self-reports.

The Washington State study (Washington State Department of Labor and Industries, 2022a) used the composite Strain Index (COSI) and the Recommended Cumulative Recovery Allowance (RCRA) ratio to assess risk to the hand/wrist and lower back, respectively, during 60 unique task/space/tool combinations (Lin et al., 2024). Their analysis found the top five highest COSI scores to range from 31.21 to 20.63 for tasks including (in order from highest to lowest COSI) elevator cleaning, mopping locker room, other cleaning locker room, upright vacuuming, and backpack vacuuming. COSI scores > 10 are considered hazardous (Garg et al., 2016). They found the top five highest RCRA ratios to range from 7.74 to 3.74 for tasks including (in order from highest to lowest RCRA ratio) trashing in the office, trashing in the kitchen, backpack vacuuming, wiping furniture, and elevator cleaning. RCRA ratios >1.0 indicate insufficient recovery time for a task. Results from this study support previous high-risk findings associated with common janitorial tasks.

In this study of California janitors, we used a similar methodology of assessing observed janitorial task/space combinations to assess the risk of upper extremity MSD and low back pain or injury. To assess upper extremity MSD risk, we used the ACGIH Hand Activity Threshold Limit Value (HA-TLV), and for the lower back in lifting tasks, we used the Revised NIOSH Lift Equation (RNLE). In addition to upper extremity work and lifting tasks, we assessed the potential risk associated with pushing and pulling tasks using the Ohio Bureau of Workers' Compensation (OBWC) Guidelines.

6.1.1. The ACGIH Hand Activity Threshold Limit Value (HA-TLV)

The ACGIH is a North American, nongovernmental, non-profit organization that promulgates voluntary limits of workplace exposures, i.e., Threshold Limit Values (TLVs), for chemicals and physical agents (e.g., noise and lifting) that are intended to protect nearly all workers from adverse health effects. According to the ACGIH, "TLVs refer to…conditions under which it is believed that nearly all workers may be repeatedly exposed, day after day, over a working lifetime, without adverse health effects" (ACGIH, 2022).

The ACGIH Hand Activity TLV (HA TLV) sets an upper workplace limit of exposure to repeated hand exertions to protect most workers from distal upper extremity (finger-hand-wrist-elbow) MSDs (ACGIH, 2022). The HA TLV is based on physiological, biomechanical, and epidemiological studies. The ACGIH HA TLV was designed to protect workers from injury and persistent work-related pain.

Because both (i) forceful exertions of the hand and (ii) how such exertions are made over time contribute to the risk of distal upper extremity MSD, the ACGIH HA TLV requires the use of both exposure characteristics to calculate the final TLV value. Specifically, the TLV uses Normalized Peak Force (NPF) to quantify forceful exertions applied by the hand and Hand Activity Level (HAL) to quantify the timing of such exertions. Increased NPF and increased HAL both contribute to increased MSD risk.

The operationalization of this approach, leading to the calculation of the Peak Force Index Threshold Limit Value score (PFI-TLV score), is provided in the following paragraph. The PFI-TLV score is calculated as the ratio of a worker's observed NPF to the maximum NPF permitted by the HA TLV for that worker's observed HAL. For example, at the HA TLV, a HAL of 3 has a maximum permissible NPF of 3.9 (Figure 1, Page 185, ACGIH 2022). If the observed NPF were 7.8, then the Peak Force Index (PFI-TLV score) would be 2.0, meaning that the NPF exerted by a worker was two times greater than the maximum allowable NPF at a HAL of 3. As noted above, a PFI-TLV score of 1.0 or less poses an acceptable MSD risk, and a PFI-TLV score greater than 1.0 poses an unacceptable MSD risk (ACGIH, 2022). Although jobs should be designed under the PFI-AL, a score indicating minimal risk for most workers, the PFI-TLV score represents the maximum acceptable risk.[1]

The results of a recently published study help put the meaning of the observed PFI-TLV score value into context (Yung et al., 2019). Specifically, the study's authors explored the relationship between the PFI-TLV score value and carpal tunnel syndrome risk among 4,321 manufacturing workers. Workers performing tasks with a PFI-TLV score greater than 1.0 (i.e., an exposure greater than the TLV) had twice the risk of carpal tunnel syndrome than workers in the lowest exposure strata. This means that carpal tunnel syndrome occurred twice as often among workers performing jobs with a PFI-TLV score greater than 1.0 than among workers in the lowest exposure strata. Analyses of an international cohort (Yung et al., 2019) provide additional details on the exposure-response associations (Table 1.3.1, Harris-Adamson et al., paper under review).

Table 6.1.1. Exposure-response associations between PFI-TLV score and relative risk (i.e., Hazard Ratio) of carpal tunnel syndrome

PFI-TLV score	Hazard Ratio (95%CI)	Interpretation
0.5	1.5 (0.9-2.4)	Acceptable risk – provide surveillance
1.0	2.0 (1.1-4.1)	Maximum acceptable risk
1.5	2.8 (1.6-5.1)	Unacceptable risk
2.0	3.2 (1.8-5.7)	Unacceptable Risk

[1] In addition to the PFI-TLV score, the ACGIH HA TLV defines a more protective Peak Force Index Action Limit (PFI-AL). While all jobs should be designed to ensure exposures below the PFI-TLV score of 1.0 to minimize the risk of MSDs, more susceptible workers are protected by designing jobs to ensure exposure below the PFI-AL.

6.1.2. Revised NIOSH Lifting Equation (RNLE) Limits

The RNLE was published in 1991 to identify safe and unsafe lifts based on lift characteristics. In this context, safe and unsafe refer to the risk of a low back MSD resulting from the lifting activity. Inputs to the equation include the locations of the hands during a lift, the coupling of the hands to the item lifted, the asymmetry (twisting of the torso) of the lift, the weight lifted, and the frequency of the lift. The lifting equation calculation produces a numerical Lifting Index (LI). A LI <1.0 indicates that most workers can safely perform the lift, whereas a Lift Index >1.0 indicates some workers would be at risk for low back MSDs. The higher the LI value, the higher the risk of low back pain or injuries to workers.

For lifting tasks with varying lifting conditions, the Composite Lifting Index (CLI) was developed (Application Manual for the Revised NIOSH Lifting Equation, 2021). CLI methods are used in this report. The CLI is an approved hazard assessment method by the International Standards Organization (ISO 11228-1, 2021) and is used widely by North American industries and safety professionals.

Table 6.1.2. Risk implications for "low back pain duration > 7 days or low back injury" by Lifting Index (LI and CLI) value (Fox et al., 2019)

Lifting Index Value	Risk Implications	Recommended Actions
< 1.0	Very Low	None
1.0 to 1.5	Low	Attention to low frequency/high load functions
1.5 to 2.0	Moderate	Redesign tasks according to priorities
> 2.0	High	Changes to the task should be a high priority

The CLI calculations also output the Frequency Independent Lift Index (FILI). The FILI provides a lift index based only on the biomechanical criterion of the lifts and not on the frequency of lifts. FILI scores help evaluate the risk due solely to the hazard created by the body posture at the origin and destination of the lifts and the weight of the lifts, ignoring the frequency of the lifting activity.

6.1.3. Ohio Bureau of Workers' Compensation (OBWC) Guidelines for Pushing and Pulling

The OBWC guidelines provide force limits for pushing and pulling activities; forces over those limits constitute an unacceptable risk of injuries to the lower back (OBWC, 2022; Weston et al., 2018). The guidelines are based on the relationship between biomechanical loads on the spine, and forces applied through the hands when pushing or pulling. The corresponding risk limits for those forces are based on well-established spine loading thresholds (Gallagher & Marras, 2012). The OBWC guidelines address the limitations of the Liberty Mutual Tables (Snook & Ciriello, 1991), which are based solely on psychophysical criteria. The OBWC Guidelines are primarily based on biomechanical criteria, and thresholds in the OBWC guidelines are up to 30% lower than the psychophysical limits reported by Snook and Ciriello (1991).

The methods and interpretation followed "An Objective Set of Guidelines for Pushing and Pulling" by Weston et al., published by the Ohio Bureau of Workers' Compensation (OBWC).
http://www.bwc.ohio.gov/Default.aspx

6.2 Risk Assessment Methods

The videos analyzed for the Time Study were included in the risk assessment analysis. Therefore, the sample selection, onsite data collection, and video processing outlined in section 5.2 also pertain to this section. Exposure measurements were interpreted using validated risk assessment tools as described below.

6.2.1. Video Analysis of Hand Exertions

Portions of each video were analyzed frame by frame using Multimedia-Video Task Analysis (MVTA) software (NexGen, Inc, University of Wisconsin, IL, Version 3.1.0), which allows each frame to be allocated to a particular category. For this analysis, frames were allocated to two categories: type of tool (e.g., broom, rag, trash, mop) and type of hand exertion (e.g., grip handle, squeeze bottle, scrub), to evaluate the frequency and duration of each exertion. The analysis focused on the dominant hand unless the non-dominant hand was holding the tool and performing the exertion for the entire analysis length. The tool analysis provided context for interpreting the exertion analysis and was not used as an independent measure for stratifying results. Five types of hand exertions were identified in the video analysis (Appendix 11.5.2). A single analyst performed all the exertion video analyses to optimize inter-rater reliability according to the tool and exertion definitions listed in Appendix 11.6. Another research team member checked a random selection of videos to ensure video analysis quality.

The tool and exertion analyses were performed across all workspaces on tasks that involve repetitive upper extremity work, including disinfecting (aka scrubbing), wiping, wet mopping, vacuuming, and sweeping. We performed the tool and exertion analyses for five minutes of each task/space combination (e.g., disinfecting/common space). The sampling process was as follows: for each subject, the time-motion MVTA reports for Space x Task were filtered to identify task/space combinations with cumulative durations greater than five minutes. The video segments within that duration were then sorted from longest to shortest, and the exertion analysis included enough of those segments to achieve a total of at least five minutes of analysis per task in a particular space. However, video segments where the hand was clearly in view were prioritized over longer segments with an obscured view. By subject, a Breakpoint report was exported from MVTA for the exertion analysis, generating exertion frequency and duration information. To determine the total frequency and duration of exertions performed for each task/space combination, the Breakpoint report for exertion was imported into a custom Python script along with the Breakpoint report for the Space x Task generated in the time motion analysis. After cleaning the reports for duplicate entries, a Space x Task x Exertion report was generated, combining the names of the spaces, tasks, and exertions, and the corresponding duration for each 3-way interaction (e.g., bathroom/disinfecting/squeeze trigger, common space/mopping/grip handle).

6.2.2. Upper Extremity Analysis using ACGIH Hand Activity TLV

Data exported from MVTA was used to calculate the following time-based measures that are used in the calculation of PFI-TLV scores using the ACGIH Hand Activity TLV:

- Frequency (F): the sum of the number of exertions over the total video segments analyzed divided by the total seconds of analysis
    - F = (Σ number of forceful hand exertions/ duration (seconds) of video)
- Duty Cycle (DC): the sum of the duration of each hand exertion (seconds) divided by the total number of seconds in the video segments analyzed
    - DC = (Σ duration of forceful hand exertions/duration (seconds) of video analyzed) * 100
- Hand Activity Level (HAL): calculated using the estimated repetition rate and duty cycle
    - $HAL = 6.56 \ln DC * [F^{1.31} / (1 + 3.18 F^{1.31})]$

Consensus-based observer-rated NPF ratings were used in PFI-TLV calculations. Four researchers independently rated the NPF for each video segment. When different ratings for the same video segment varied by only one point, an average was assigned as the NPF for that task. When observer ratings varied by more than one point, a group discussion convened on the assigned NPF for the task.

A PFI-TLV score of one or less was used to define acceptable risk jobs (PFI-TLV score ≤1.0) and unacceptable risk jobs (PFI-TLV score > 1.0) (Kapellusch et al., 2014; Yung et al., 2019).

6.2.3. Lifting Analysis using Revised NIOSH Lifting Equation

The Revised NIOSH Lifting Equation (RNLE) was used to estimate work-related low back pain risk associated with lifting tasks observed during trashing, moving furniture, and mopping at two venues. A CLI score was calculated and compared to a limit of 1.5 based on a systematic review of prospective and cross-sectional studies (Fox et al., 2019). Inputs for the RNLE were based on direct measurements of hand position during lifting and weights of items lifted. For one-handed lifting tasks, a 0.60 modifier was applied per the European Standard EN 1005-2 "Safety of machinery - Human physical performance - Part 2: Manual handling" (CEN,

2009) by multiplying the measured item weight by 1.67. Hand coupling ratings were assigned based on guidelines in the RNLE Applications Manual (2021). The lifting frequency was calculated from video analysis, and the work duration was based on worker self-report or input from the manager.

6.2.4. Pushing/Pulling Analysis using Ohio Bureau of Workers Compensation (OBWC) Guidelines

The risk of low back injury associated with the pushing and pulling carts, furniture, and machines at all three venues was assessed using the Ohio Bureau of Workers' Compensation (OBWC) Guidelines for Pushing and Pulling. The limits defined by the guidelines classify the hazard level of the measured push or pull forces into three categories (Figure 6.2.4.). For this report, a push or pull task was identified as acceptable if at least 80% of workers were protected (i.e., the push or pull force was in the green zone of Figure 6.2.4.).

Figure 6.2.4. Interpretation of OBWC Guidelines for Pushing and Pulling are organized by color.

Green. The exertion is safe for at least 80% of the working population. This exertion may be viewed as acceptable.
Yellow. The exertion is safe for 50-80% of the working population. It is *recommended* that changes to the task be made to make it safer for more people.
Red. The exertion is safe for less than 50% of the working population. It is *strongly recommended* that changes to the task be made to make it safer for more people.

6.3 Risk Assessment Results

6.3.1. Upper Extremity Risk Assessment Results

81 five-minute video segments, contributed by 19 subjects and covering 11 different tasks, were analyzed for risk of upper extremity injury using the ACGIH Hand Activity TLV. Video from the other five subjects was not included because it did not meet the 5-minute duration threshold for any task/space combination (see Section 6.2.1). Some tasks were assessed at all three venues, including wet mopping, dust mopping, sweeping, disinfecting/scrubbing, and vacuuming; while dusting was only assessed at the airport, wiping and rug moving was only assessed at the mall and washing windows were only assessed at the event center. Average PFI-TLV scores are summarized by venue and across all venues in Table 6.3.1.A. This summary combines the results for a particular task (e.g., sweeping, disinfecting/scrubbing) across all observed workspaces (e.g., bathroom, common space). Eight of the 11 tasks had average PFI-TLV scores greater than 1.0, indicating a high risk of developing a work-related upper extremity musculoskeletal disorder for these tasks; these tasks include washing windows, carpet/rug moving, wiping, wet mopping, disinfecting/scrubbing, street washing, cleaning escalator, and vacuuming. These high PFI-TLV scores may be attributed to higher hand forces and/or movement frequencies with less recovery time in the work cycle. Three tasks, dust mopping, sweeping, and dusting, had PFI-TLV scores less than 1.0, indicating an acceptable level of risk.

Table 6.3.1.A. Summary of upper extremity risk assessment by task

	Average PFI-TLV Score							
	ALL VENUES		Mall		Airport		Event Center	
TASK	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)
Washing Windows	4	1.69 (0.09)					4	1.69 (0.09)
Carpet/Rug Moving	1	1.64	1	1.64				
Wiping	6	1.51 (0.25)	6	1.26 (0.25)				
Wet Mopping	11	1.48 (0.08)	4	1.45 (0.43)	3	1.63 (0.17)	4	1.35 (0.10)
Disinfecting/Scrubbing	32	1.41 (0.06)	18	1.35 (0.29)	6	1.60 (0.09)	8	1.27 (0.17)
Street Washing	1	1.36					1	1.36
Cleaning Escalator	2	1.28 (0.06)					2	1.28 (0.06)
Vacuuming	9	1.12 (0.01)	6	1.13 (0.08)	1	1.26	2	0.97 (0.04)
Dust Mopping	9	0.95 (0.02)	1	0.91	5	0.89, (0.10)	3	1.05 (0.19)
Sweeping	10	0.87 (0.01)	6	0.88 (0.10)	3	0.98 (0.07)	1	0.75
Dusting	1	0.74			1	0.74		

The cleaning tasks included in this part of the analysis were observed in six different workspaces across the three venues: office, bathroom, outside, common space, elevator, and cafeteria/kitchen. When combining the various tasks in these spaces, average PFI-TLV scores were greater than 1.0 for all workspaces (Table 6.3.1.B.). The highest average PFI-TLV score was during the cleaning of office spaces (PFI-TLV = 1.41) in the shopping mall venue. The highest score for a workspace cleaned at all venues was found for cleaning bathrooms, with an average PFI-TLV score of 1.37. Common spaces and cafeterias/kitchens, the other two spaces assessed at all three venues, had average PFI-TLV scores of 1.19 and 1.09, respectively.

Table 6.3.1.B. Summary of upper extremity risk assessment by workspace

	Average PFI-TLV Score							
	ALL VENUES		Mall		Airport		Event Center	
SPACE	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)
Office	2	1.41 (0.53)	2	1.41 (0.53)				
Bathroom	40	1.37 (0.06)	21	1.36 (0.33)	8	1.51 (0.25)	11	1.23 (0.22)
Outside	5	1.23 (0.02)	2	0.92 (0.06)			3	1.53 (0.16)
Common Space	29	1.19 (0.05)	12	1.23 (0.26)	7	1.06 (0.34)	10	1.28 (0.34)
Elevator	2	1.12 (0.12)	2	1.12 (0.12)				
Cafeteria	8	1.09 (0.18)	3	0.92 (0.18)	4	1.07 (0.37)	1	1.28 (0.00)

6.3.2. Lifting Risk Assessment Results

Seven subjects, across two venues (shopping mall and airport), were observed performing lifting work that was assessed using the Revised NIOSH Lifting Equation (RNLE). The lifts were part of three different tasks, including wet mopping (lifting the wet mop and the mop bucket with one hand), trashing (lifting trash bags between trash cans, utility carts, dumpsters, and compactor machines with one hand), and furniture moving (lifting chair and sofa cushions and barstools; with two hands).

The results are summarized in Table 6.3.2.A. The average Composite Lifting Index (CLI) for furniture moving and wet mopping across both venues was less than 1.5, indicating an acceptable level of risk. At the shopping mall, however, the highest individual Frequency Independent Lifting Index (FILI) when lifting the full mop bucket from the floor to the cart was 2.05, presenting a high level of risk to the lower back for this individual lift regardless of lifting frequency. In this case, the high FILI is primarily due to the heavy weight of the bucket lifted with one hand and the observed body posture. While the overall risk associated with mopping appears to be acceptable, this particular task should be addressed by reducing the weight of the bucket or modifying the bucket-filling technique to avoid lifting.

The average CLI for trashing across both venues was 1.64. The average CLI at the shopping mall was less than 1.5, but at the airport, it was 2.5, which indicates a high risk of low back pain or injury (Table 6.1.2.) and should be addressed by modifying the workstation or reducing the weight of the loads. Two types of trashing lifts were observed at the airport: lifting bags out of trash cans to change out the bags and lifting heavier bags (comprised of multiple smaller bags) into a large open-top dumpster (hand is overhead at the destination of lift). The highest FILI associated with trashing was found for the overhead lifts into the dumpster, with FILI ranging from 1.6 to 2.2 depending on the weight of the trash bag.

Lifting tasks observed at the event center venue were not analyzed using the RNLE due to the widespread use of material handling carts and tilt-push-slide techniques when moving chairs and tables. The tilting of chairs off stacks and tilting chair carts when restacking chairs reduced the lifted loads. Therefore, only the push forces associated with furniture moving are summarized below.

Table 6.3.2.A. Summary of low back risk assessment related to lifting by task

	Average CLI								
	ALL VENUES			Mall			Airport		
TASK	n	Mean (SD	Highest FILI	n	Mean (SD)	Highest FILI	n	Mean (SD)	Highest FILI
Trashing	5	1.64 (0.12)	2.17	4	0.78 (0.24)	1.14	1	2.50	2.17
Wet Mopping	2	1.45 (1.34)	2.05	2	1.45 (1.34)	2.05			
Furniture Moving	2	0.80 (0.57)	0.98	2	0.80 (0.57)	0.98			

These cleaning tasks that involved lifting were observed in four different workspaces across the two venues: outside, common space, office, and cafeteria/kitchen. When assessing the lifting tasks by workspace, average CLI scores were less than 1.5 for all spaces except outside (Table 6.3.1.B.), where the average CLI was 2.5. As described above, this is attributed solely to trashing at the airport venue, which involved lifting heavy bags overhead.

Table 6.3.2.B. Summary of low back risk assessment related to lifting by space

	Average CLI								
	ALL VENUES			Mall			Airport		
SPACE	n	Mean (SD)	Highest FILI	n	Mean (SD)	Highest FILI	n	Mean (SD)	Highest FILI
Outside	1	2.50 (0.00)	2.17				1	2.50 (0.00)	2.17
Common Space	4	1.33 (0.76)	2.05	4	1.33 (0.76)	2.05			
Office	2	0.52 (0.21)	0.71	2	0.65 (0.21)	0.71			
Cafeteria	2	0.50 (0.10)	0.60	2	0.50 (0.14)	0.60			

6.3.3. Push/Pull Risk Assessment Results

47 push or pull force measurements were assessed across all three venues using the Ohio Bureau of Workers Compensation (OBWC) Guidelines. Seven different janitorial tasks were represented in this analysis: wet mopping (pushing the mop cart), trashing (pushing or pulling the trash cart), transport (pushing supplies on a cart), furniture moving (pushing or pulling furniture along the floor or on a cart), vacuuming (pushing the vacuum), street washing (pushing or pulling the power washer machine on the sidewalk), and escalator cleaning (pushing the special machine used for cleaning the escalator steps). Table 6.3.3.A. shows that all but one of these tasks was safe for at least 80% of the population. These results likely indicate that the carts and machines are designed with efficient wheels and castors that minimize the manual force required to move them. The push/pull forces for moving furniture were unacceptable, with an average of only 66% of the population capable of performing the observed and measured work. Similar results for furniture moving were found at both the shopping mall and the event center venue.

Table 6.3.3.A. Summary of low back risk assessment related to pushing/pulling by task

	Average % Capable							
	ALL VENUES		Mall		Airport		Event Center	
TASK	N[a]	Mean (SD)	N[a]	Mean (SD)	N[a]	Mean (SD)	N[1]	Mean (SD)
Wet Mopping	4	80%	4	80%				
Trashing	16	80%	5	80%	2	80%	9	80%
Transport	2	80%					2	80%
Vacuuming	2	80%	2	80%				
Street Washing	2	80%					2	80%
Cleaning Escalator	1	80%					1	80%
Furniture Moving	20	66% (8%)	12	68% (24%)			20	65% (28%)

[a] number of push/pull force measurements assessed

When grouping the pushing and pulling tasks by the workspace they were observed in, the push/pull forces measured in the cafeteria/kitchen (moving lighter-weight furniture and trash bins) were acceptable for over 80% of the population. However, the percentage of the population capable of doing the push/pull tasks in offices and common spaces was less than 80% (Table 6.3.3.B.). These results are attributed to unacceptable push/pull forces measured during furniture moving in office spaces at the mall and in common spaces at the event center. Both venues moved furniture differently, but in both scenarios, the % capable could be increased by reducing the weight of the load and/or decreasing the coefficient of friction with a more efficient caster and wheel combination.

Table 6.3.3.B. Summary of low back risk assessment related to pushing/pulling by space

	Average % Capable							
	ALL VENUE		Mall		Airport		Event Center	
SPACE	**n**	**Mean % (SD)**	**n**	**Mean % (SD)**	**n**	**Mean % (SD)**	**n**	**Mean% (SD)**
Office	6	60% (31%)	6	60% (31%)				
Common Space	37	77% (2%)	10	77% (9%)	2	80% (0%)	25	75% (17%)
Cafeteria/Kitchen	5	80% (0%)	5	80% (0%)				

Eight of the 11 tasks had average PFI-TLV scores > 1.0, indicating a high risk of upper extremity musculoskeletal disorder. When tasks were grouped by workspace, cleaning in all spaces led to average PFI-TLV scores > 1.0.

Cleaning tasks that involved lifting were considered safe (CLI < 1.5) except for trashing, which had an average CLI of 1.64, indicating a high risk of low back pain or injury. This was mainly attributed to trashing at the airport (CLI = 2.5). For wet mopping, the average CLI was < 1.5, but the lift index for certain individual lifts exceeded a CLI of 1.5.

Push/pull forces associated with all cleaning tasks were considered acceptable for over 80% of the population, except for certain furniture moving tasks in offices and common spaces where heavier loads were moved with and without carts.

6.4. Risk Assessment Discussion

The janitorial tasks observed in this study were assessed for risk of upper extremity and low back injury. The results of these analyses should be addressed when risk scores exceed acceptable levels and should be considered along with the results of the Time Study when planning work schedules.

Interventions for upper extremity tasks resulting in PFI-TLV scores > 1.0 should be implemented to reduce risk. Since PFI-TLV is based on two factors, the HAL (which is a function of exertion frequency and duty cycle) and the NPF (the peak exertion force), those components of the high-risk tasks should be investigated to determine ways to reduce either component and achieve a PFI-TLV score less than 1.0. If changes cannot be made to reduce the forces exerted during the task (NPF), additional recovery time should be provided to reduce the HAL and the overall PFI-TLV score.

Table 6.4.A. summarizes the average HAL and NPF for each task assessed for upper extremity risk across all three venues. For all high-risk tasks (PFI-TLV score > 1.0), the average NPF≥ 5 appeared to be a significant factor in the PFI-TLV score. The upper extremity risk for these eight tasks could be reduced by finding ways to reduce hand exertion force. For example, to reduce the NPF for disinfecting/scrubbing, janitors could use lower-force squeeze bottles for disinfecting solutions or investigate alternative methods or tools to reduce the force needed to clean a surface. For washing windows, alternative methods or tools could be used, or the body could be positioned to reduce the forces exerted by the hands. Street washing and cleaning escalators had an average NPF > 5 and an average HAL > 4, meaning both factors likely impacted the higher PFI-TLV score for these tasks. In addition to the hand force required to use the specialized street and escalator cleaning machines, the techniques should be investigated and optimized for minimal hand exertion frequency and duty cycle.

Interventions should be considered for lifting tasks when CLI scores exceed 1.5. The lifting tasks analyzed in this study were all of relatively low frequency. Therefore, the biomechanical factors of the lifts (e.g., the weight of the load, the forward or vertical reach, or the spine twist) should be minimized to reduce the CLI. The only lifting task with a CLI found to be greater than 1.5 was for trashing, which was attributed to the CLI of 2.5 for trashing at the airport. A CLI > 2.0 indicates a high risk of low back pain or injury and should be addressed by modifying the workstation or reducing the weight of the load. Two types of trashing-related lifts were observed at the airport: lifting bags out of trash cans to change out the bags and lifting heavier bags of combined bags into a sizeable open-top dumpster (hand is overhead at the destination of lift). The highest frequency independent lifting index (FILI) was found for the overhead lifts into the dumpster, with a FILI greater than 1.5. This result is attributed to the weight of the load and the body postures measured, which could be improved as interventions to lower the risk of low back injury.

Table 6.4.A. Average PFI-TLV score, hand activity level (HAL), and normalized peak force (NPF) by task across all venues

	All Venues		
	Average PFI-TLV	Average HAL	Average NPF
Washing Windows	1.69	1.97	8.13
Carpet/rug Moving	1.64	1.29	8.00
Wiping	1.51	2.29	5.33
Wet Mopping	1.48	1.42	6.96
Disinfecting/Scrubbing	1.41	2.08	6.46
Street washing	1.36	5.90	7.50
Cleaning escalator	1.28	4.22	6.75
Vacuuming	1.12	0.50	5.97
Dust Mopping	0.95	0.22	4.93
Sweeping	0.87	0.66	4.60
Dusting	0.74	0.37	4.00

Finally, regarding cleaning tasks that involve pushing or pulling, moving furniture was the only task that exceeded the acceptable limits. Similar results were found for moving furniture at the shopping mall and event center. At the event center, two pushing tasks were safe for only 20% of the population. These were moving a heavy cart loaded with tables and pushing a sliding wall panel to lock into a configuration. When pushing tasks using carts exceed acceptable risk thresholds, it is recommended that the wheels and caster design be investigated and optimized to minimize the required push force. Two tasks at the shopping mall, pushing a large armchair and pushing a metal bench, had similar high-risk results. Moving large or heavy items, like these pieces of furniture, without a cart required increased forces that would be unacceptable to most of the population.

6.4.1. Using risk assessment results when scheduling work

Understanding the ergonomic hazards of different tasks can help managers assign jobs or combinations of tasks that would be safer for janitors to perform. Howard (Howard, 2023) found that 84.7% of janitors completed all cleaning tasks in a single area rather than performing the same task across multiple areas. Given the nature of job planning, there is an opportunity to alternate between tasks with varying physical demands within a particular space. Table 6.4.1.A. summarizes the average risk assessment results for all tasks included in our analysis. Combining tasks with varying levels of risk can benefit janitors by allowing for active recovery, as transitioning from a high-risk task to a low-risk task helps reduce stress in specific body regions. For example, alternating between trashing and wiping tables provides recovery time for the lower back during wiping tables and for the hands and arms while lifting trash bags. Another example of balancing risk and promoting active recovery is alternating between wet mopping, which has a higher upper extremity risk, and dusting, which has a lower upper extremity risk due to the low hand forces used with the lightweight microfiber tool to clean surfaces.

Table 6.4.1.A. Summary of average risk assessment findings by task across all venues

Cleaning Task	Upper Extremity Risk (Average PFI-TLV Score[1])	Lift Risk (Average CLI[2])	Push/Pull Risk (Average % capable[3])
Washing Windows	1.69		
Carpet/Rug Moving	1.64		
Wiping	1.51		
Wet Mopping	1.48	1.15	80%
Disinfecting/Scrubbing	1.41		
Street washing	1.36		
Cleaning escalator	1.28		
Vacuuming	1.12		80%
Dust Mopping	0.95		
Sweeping	0.87		
Dusting	0.74		
Trashing		1.54	80%
Transport			60%
Furniture Moving		0.80	68%
Street Washing			80%
Cleaning Escalator			80%

1 PFI-TLV score ≤ 1.0 is acceptable
2 CLI < 1.5 is acceptable
3 % Capable ≥ 80% is acceptable

Another way to summarize the risk assessment results is by workspace. Table 6.4.1.B. summarizes the average risk assessment findings for different cleaning tasks by the spaces they were observed in. While we do not have an easy mathematical way to combine the PFI-TLV score (upper extremity risk), the CLI (lifting risk), and the % Capable (push/pull risk), we can see how the results stack up for different spaces. For instance, cleaning in the cafeteria/kitchen appears to be the safest space with low risk associated with lifting and pushing/pulling tasks and a PFI-TLV score just above 1.0. Whereas cleaning outside appears to be a relatively high risk, with upper extremity and lifting risks exceeding the respective thresholds (PFI-TLV score > 1.0 and CLI > 1.5).

Summarizing risk by space can be helpful when planning work assignments for janitors. For example, based on these results, if a janitor is assigned to clean an outside space for a portion of the work shift, a lower-risk workspace, such as a cafeteria/kitchen, should be assigned for the rest of the shift.

It is important to note that the results summarized in Table 6.4.1.B. are based on the tasks observed in this study and are not necessarily comprehensive for all tasks that may be performed in these workspaces. Additional analysis may be needed by a particular venue that desires to incorporate risk assessment results into work assignments and scheduling.

Table 6.4.1.B. Summary of average risk assessment findings by workspace across all venues

Work Space	Upper Extremity Risk (Average PFI-TLV score[1])	Lifting Risk (Average CLI[2])	Push/Pull Risk (Average % capable[3])
Office	1.41	0.65	60%
Bathroom	1.37		
Outside	1.23	2.50	
Common Space	1.19	1.33	77%
Elevator	1.12		
Cafeteria / Kitchen	1.09	0.50	80%

1 PFI-TLV score ≤ 1.0 is acceptable
2 CLI < 1.5 is acceptable
3 % Capable ≥ 80% is acceptable

6.4.2. Combining risk assessment and time allocation findings for scheduling work

Nine of the 10 most common tasks measured in this study (based on overall duration from video analysis) were assessed for upper extremity risk and/or low back risk associated with lifting or pushing/pulling. When the results from the risk assessments are aligned with the results of the time allocation analysis (Table 6.4.2.), we see that four of the tasks with high risk for upper extremity injury (PFI-TLV score > 1.0) were found to have insufficient time allocated to them. These tasks include washing windows, disinfecting/scrubbing, wiping, and vacuuming. Similarly, the transport task was found to have a moderate risk to the lower back associated with push/pull movements and insufficient time allocated. These are important results that should be considered when scheduling these four tasks, as inadequate rest and recovery between tasks can further increase injury risk. Risk assessment results may have been influenced by a shortage of time, where janitors may have worked faster than if they were provided adequate time to complete the work. Janitors must be allocated sufficient time to complete tasks safely and effectively. Time-constrained tasks with higher ergonomic risks may increase workers' likelihood of injury and pain. Additional time should be considered for these four tasks when scheduling work to allow adequate recovery time during the work shift.

Escalator cleaning was found to have a PFI-TLV greater than 1.0 but was allocated adequate time according to ISSA standards. Moreover, the remaining tasks with PFI-TLV scores greater than 1.0 (washing windows, disinfecting/scrubbing, wet mopping, wiping, street washing, and vacuuming) were not included in the time allocation analysis due to the low overall duration in this study. As previously mentioned, the high-risk results for these tasks should not be ignored; however, the exposures should be investigated to determine ways to reduce force or hand activity levels.

Table 6.4.2. Average risk assessment results and corresponding time allocation analysis results by task

Task	Upper Extremity Risk (PFI TLV[1])	Lift Risk (CLI[2])	Push/Pull Risk (% capable[3])	Observed < Allocated (% time deviation	Observed > Allocated (% time deviation	Summary of Combined Findings
Washing Windows	1.69			14%	62%	High UE risk Insufficient time
Carpet/Rug Moving	1.64					High UE risk Time not compared
Wiping	1.51				151%	High UE risk Insufficient time
Disinfecting/Scrubbing	1.41			27%	45%	High UE risk Insufficient time
Wet Mopping	1.48	1.15	80%			High UE risk Low LIFT risk Low PUSH/PULL risk Time not compared
Street washing	1.36					High UE risk Time not compared
Cleaning escalator	1.28			50%		High UE risk Sufficient time allocated
Vacuuming	1.12		80%	33%	88%	High UE risk Low PUSH/PULL risk Insufficient time
Dust Mopping	0.95					High UE risk Time not compared
Sweeping	0.87					Low UE risk Time not compared
Dusting	0.74					Low UE risk Time not compared
Trashing		1.54	80%	40%	27%	High LIFT risk Low PUSH risk Sufficient time allocated
Transport			60%	62%	61%	Moderate PUSH risk Insufficient time
Furniture Moving		0.80	68%			Low LIFT risk Mod PUSH risk Time not compared
Street Washing			80%			Low PUSH risk Time not compared
Cleaning Escalator			80%	50%		Low PUSH risk Sufficient time allocated

1 PFI-TLV score ≤ 1.0 is acceptable
2 CLI < 1.5 is acceptable
3 % Capable ≥ 80% is acceptable

Of the ten most common cleaning tasks observed in this study, four had high risk for upper extremity injury (PFI-TLV score > 1.0) and insufficient time allocated to them. These tasks include washing windows, disinfecting/scrubbing, wiping, and vacuuming. Similarly, the transport task was found to have moderate level of risk to the low back associated with push/pull activities, and insufficient time allocated.

The results from the Washington State study (Washington State Department of Labor and Industries, 2022b) assessed associations between work-related MSD risks (assessed by physiological responses and trunk posture) and work pace (a ratio of observed work time to standard predicted time) in five common cleaning tasks (dusting/wiping, bathroom-all, trashing, and vacuuming). They found positive correlations between physical exposures and work pace for all five tasks. These findings further support the need for more detailed and accurate work scheduling tools so that janitors can finish the assigned tasks with minimal or distributed MSD risks.

Ergonomic hazards and MSD risk level data could be integrated into the ISSA by including risk assessment scores for each task. For example, adding a column to the cleaning timetables that specified the body region(s) affected during a particular task (e.g., shoulder, hand, wrist, back) and highlighting the highest-risk areas, along with a normalized risk score on a scale of 0 to 5. This could be done at a site or industry level to support all companies' job planning. Highlighting such tasks could also alert managers to monitor the cumulative stress that builds up by the end of a work shift for each worker, as this stress can carry over to the next day for labor-intensive jobs like janitors, potentially increasing injury risks. Finally, understanding the risks of each task can lead to identifying best practices for low-risk techniques, which can be disseminated during new-hire training for better health outcomes overall.

7. Strengths and Limitations

This study provides a comprehensive overview of the workload of California Janitors. The data was collected over two years, starting toward the end of the COVID-19 pandemic. This study had a variety of strengths and limitations, as outlined below.

Study Strengths

- The cohort is specific to California and representative of California janitors who differ demographically from those in other state reports such as Washington and Minnesota.
- The mixed methods approach included surveys, interviews, and direct workload and work pace measurements.
- The workload was estimated via self-report, and various approaches to summarizing job-level exposures (peak intensity, typical intensity, and workload index) were presented.
- Time allocation approaches were compared to the time taken to perform different tasks.
- A detailed risk assessment of each task by venue was presented using direct measurement methods and validated risk assessment tools.

Study Limitations

- This study had a larger representation of unionized janitors since it was hard to find and recruit non-unionized janitors other than those with a relationship with MCTF.
- The respondents to the survey, interviews, and time study were a sample of convenience based on whom we had access to and could recruit. The sample was drawn from janitors who had a relationship with MCTF or the SEIU; therefore, the results are generalizable to that population and may not reflect the experience of janitors not engaged with either organization.
- Recruiting janitors to participate in this study's time study and risk assessment portion was highly challenging since many janitors did not want to be videotaped or wear any measurement devices. This led to a smaller sample of workers contributing information to the findings presented.
- The timing of the survey relative to each janitor’s experience at their workplace relative to COVID-19 may have varied based on the type of venue they worked in. Further, since the survey was sent as COVID-19 restrictions were being removed, these findings may not reflect the experience of Janitors during the height of the pandemic.
- Given this study's exploratory aim, numerous statistical analyses were performed; some positive associations could be spurious due to chance alone.

8. Conclusions and Recommendations

Overall, this study of California Janitors provides an overview of the workload, psychosocial stress, and work climate that contributes to a high prevalence of adverse health outcomes among a sample of California Janitors. The survey identified that most janitors experience severe pain in multiple body regions. All measures of workload (peak, typical, and workload index) showed positive associations with the prevalence of severe pain, as well as multiple measures of the negative impact of pain, such as taking medication, missing days of work, and being unable to perform activities outside of work due to pain. These results indicate that janitorial workload had a negative impact on the health and function of Janitors who participated in this study.

This study also evaluated the likely presence of anxiety or depression among janitors. Although the prevalence of anxiety or depression was much lower than the prevalence of severe pain, many aspects of janitorial work were statistically significantly associated with being likely to have anxiety or depression. High job strain, a measure of high psychological demand and low decision latitude, was strongly associated with a higher prevalence of anxiety or depression. Providing janitors with more autonomy on how they perform their work and engaging them in conversations on how to organize the demands of their work may be important strategies in reducing the overall job strain reported.

Importantly, more than half of the janitors reported that their income did not meet the needs of their expenses, that it would not be easy to find another job and that they would not report their pain or injury to their supervisor for fear of retaliation. These responses indicate that there is a much larger problem than revealed in workers compensation data for this population. The scope of this study never included the analysis of workers compensation data, and we purposefully did not collect personal information (name, date of birth, etc) that would discourage this population from participating in the study. However, any analyses of OSHA 300 logs or workers compensation data on this population should acknowledge the massive underreporting of pain and injuries as a limitation.

The occurrence of wage theft and experience of harassment were also associated with an increase in the prevalence of anxiety or depression. Both wage theft and harassment were far too common among the workers in this study. These aspects of work should be addressed by providing safe and anonymous methods for reporting such behaviors and then having a state-mandated response to addressing such reports. Janitors' training in reporting such actions may help reduce such occurrences. Mandatory training of managers on how to facilitate a fair and safe work environment and penalties for employers who are reported for wage theft and harassment may also help prevent future occurrences of both wage theft and harassment. Additionally, providing additional safety nets to janitors, such as sick leave, may help reduce anxiety around pay or job loss when a worker is in pain and needs time to recover.

The time study and risk assessment analyses indicate that some tasks have higher workload demands and inadequate time allocations to meet those demands. High-demand tasks should be allocated more time to perform and recover from such tasks. More work is needed to explore the best way to organize tasks, allocate the appropriate time for each task, and evaluate any changes in how tasks and time on task are allocated using a participatory approach to include janitors, management, union representatives, and other stakeholders. Addressing labor shortages by providing more staffing buffers should be considered. The analyses of time allocated to performing various tasks and the MSD risks associated with each task indicate that work reorganization and interventions should be prioritized. The inclusion of venue occupancy, volume, and ergonomic hazard should be considered in future models of time allocations for janitorial tasks. Further research is warranted to develop better time allocation approaches that reduce the risk of MSDs.

In conclusion, this report shows that higher workloads are associated with a higher prevalence of severe pain and a higher prevalence of negative functional impacts from pain. Janitors also have high job strain and experience wage theft and harassment that increase the prevalence of likely anxiety or depression. A time study and risk assessment of specific tasks show that there is sometimes a mismatch of time allocated to tasks that have higher MSD risk. Developing a task allocation approach that provides more recovery time when performing demanding tasks is warranted. Further, interventions and policies to improve the work climate to reduce job strain, wage theft, and harassment are critically needed.

Based on the findings of this report, we urge stakeholders to consider a series of coordinated recommendations aimed at improving the health and safety of janitorial workers. A central recommendation is the adoption of a multi-stakeholder participatory approach that includes janitors, supervisors, management, company owners, labor representatives, and scientists. This collaboration should guide intervention strategies that address ergonomic hazards through four key actions: (i) conducting detailed job analyses to quantify task-specific exposures by venue and space; (ii) evaluating and redesigning tools that contribute to increased workload and musculoskeletal strain; (iii) implementing smart scheduling practices that optimize task time based on space characteristics, tool use, and ergonomic hazard scores—factoring in occupancy and space volume; and (iv) collaborating with Washington State scientists to adapt their Janitor Workload Calculator for use in California. This user-friendly, web-based tool can be developed to support hazard mitigation through proactive workload planning.

Given the widespread and severe health impacts faced by janitorial workers, California should also consider the development of a regulatory standard similar to the existing Hotel Housekeeping Musculoskeletal Injury Prevention Program. Such a standard could formalize and standardize job analyses to enable integration into a statewide database, which in turn would support tools like the Janitor Workload Calculator and the ISSA Standard Handbook. Enhanced surveillance and medical management programs should be implemented to ensure effective pain monitoring and eliminate retaliation for reporting injuries or discomfort. Janitors must also receive training on their rights, including how to report symptoms early and respond to retaliation. Comprehensive management training should be required to foster a supportive work climate, promote early reporting and effective symptom response, and implement ergonomic interventions—such as tool selection and task allocation—that reduce MSD risks. Additional focus should be placed on reducing job strain, wage theft, and workplace harassment to create safer, healthier, and more respectful work environments for all janitors.

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Appendix

A.1. Survey (Partial in English)

UCSF Janitor Workload Study Survey

Block 1: Introduction/Consent

Q1.1
As a currently employed Janitor, we ask that you participate in a research study led by Dr. Carisa Harris at UCSF/Berkeley in collaboration with the Labor Occupational Health Program and SEIU Local Chapters.
Participation is optional. The survey will take about 15 minutes and is anonymous. You can skip questions or stop anytime. Your data will be stored securely.
We will not ask for personal information such as your name or the name of your company. Responses will help determine safe and effective workloads for California Janitors.
Questions?

- Contact Dr. Carisa Harris: ucergonomics@gmail.edu
- UCSF Institutional Review Board: 415-476-1814

Block 2: Work History

Q2.1 How many years have you worked as a Janitor?

- Total Years: ________________
- Years at Current Employer: ________________

Q2.2 Approximately how many companies have you worked for as a Janitor?

- 1–3
- 4–5
- 6–10
- More than 10

Q2.3 In what kind of building(s) do you currently work? (Select all that apply)

- Office Building
- Schools/Universities
- Airports
- Public Venues
- Shopping Centers
- Manufacturing Buildings
- Other: ________________

Q2.4 What job titles have you held as a Janitor in the past 3 years? (Select all that apply)

- Cleaner
- Supervisor
- Trainer
- Lead
- Utility
- Floor Crew/Waxer
- Bathroom Cleaner
- Day Porter
- Other: ________________

Q2.5 What best describes your current work shift?

- Daytime
- Evening
- Night
- Rotating
- Split
- Variable
- Other: _______________

Q2.6 How many hours per week did you work:

- **Before COVID-19: _______________**
- **During Shelter-in-Place: _______________**
- **Now: _______________**

Q2.7 Do you work more than one job?

- No
- Yes, another janitorial job
- Yes, cleaning houses
- Yes, a different type of job

Q2.8 *If yes to Q2.7:* How many hours per week do you work at your second job?
Q2.9 How are you paid for your work? (Select all that apply)

- Fixed monthly pay
- Hourly
- Cash
- Not paid

Q2.10 How often have you worked hours that were unpaid?

- Weekly
- 1–2 times per month
- Every other month
- 3–4 times per year
- Rarely/Never

Block 3: COVID-19 Experience

Q3.1 Does your employer have a written plan to protect you from COVID-19?

- Yes
- No
- Don't Know

Q3.2 Rate your agreement with these statements about work during COVID-19:

- **Strongly Agree / Somewhat Agree / Somewhat Disagree / Strongly Disagree**

1. I can stay home if I have symptoms without fear of job loss.
2. My work increases my risk of getting sick.
3. My employer follows state/local orders.
4. I'm notified if a coworker gets COVID-19.
5. My employer provides supplies to protect me.
6. I have time to implement protective measures.

Q3.3 How many COVID-19 vaccine doses have you received?

- One
- Two
- Three
- None

Q3.4 *If you answered "None" to Q3.3:* What would help you get vaccinated? (Select all that apply)

- Nothing, I won't get vaccinated
- Medical reasons
- Paid time to get vaccinated
- Paid time off for side effects
- Trusted information about vaccine safety
- More time to observe vaccine safety
- Belief that COVID-19 is serious to my health
- Other: _______________

Block 4: Workload

Q4.1 Rate the intensity of your work on a scale of 0 (minimal effort) to 10 (maximum effort):

- **Before COVID-19: _______________**
- **During Shelter-in-Place: _______________**
- **Now: _______________**

Q4.2 How much time do you currently spend on the following tasks?

- **Never / Less than 2 hrs/day / 2–4 hrs/day / More than 4 hrs/day**

1. Dusting
2. Cleaning windows
3. Polishing metal surfaces
4. Cleaning furniture
5. Moving furniture
6. Sweeping/mopping
7. Buffing floors
8. Shampooing carpets
9. Vacuuming
10. Stripping/waxing floors
11. Collecting/sorting trash/recyclables
12. Cleaning bathrooms
13. Disinfecting surfaces (COVID-19 specific)
14. Other: _______________

Q4.3 How physically fatiguing are these tasks? (Rate 0–10)

1. Dusting
2. Cleaning windows
3. Polishing metal surfaces
4. Cleaning furniture
5. Moving furniture
6. Sweeping/mopping
7. Buffing floors
8. Shampooing carpets
9. Vacuuming

10. Stripping/waxing floors
11. Collecting/sorting trash/recyclables
12. Cleaning bathrooms
13. Disinfecting surfaces
14. Other: _______________

Block 5: Demographics

Q5.1 What is your age group?

- 14–29
- 30–49
- 50–65
- 65+

Q5.2 What sex were you assigned at birth?

- Male
- Female
- Other
- Decline to answer

Q5.3 What is your race/ethnicity? (Select all that apply)

- White
- Hispanic
- Black/African American
- American Indian/Alaska Native
- Asian
- Native Hawaiian/Pacific Islander
- Other: _______________

A.2. Methods

A.2.1. MVTA examples for Space and Task

Figure A.2.1.A. Example of video analyzed in MVTA by type of space

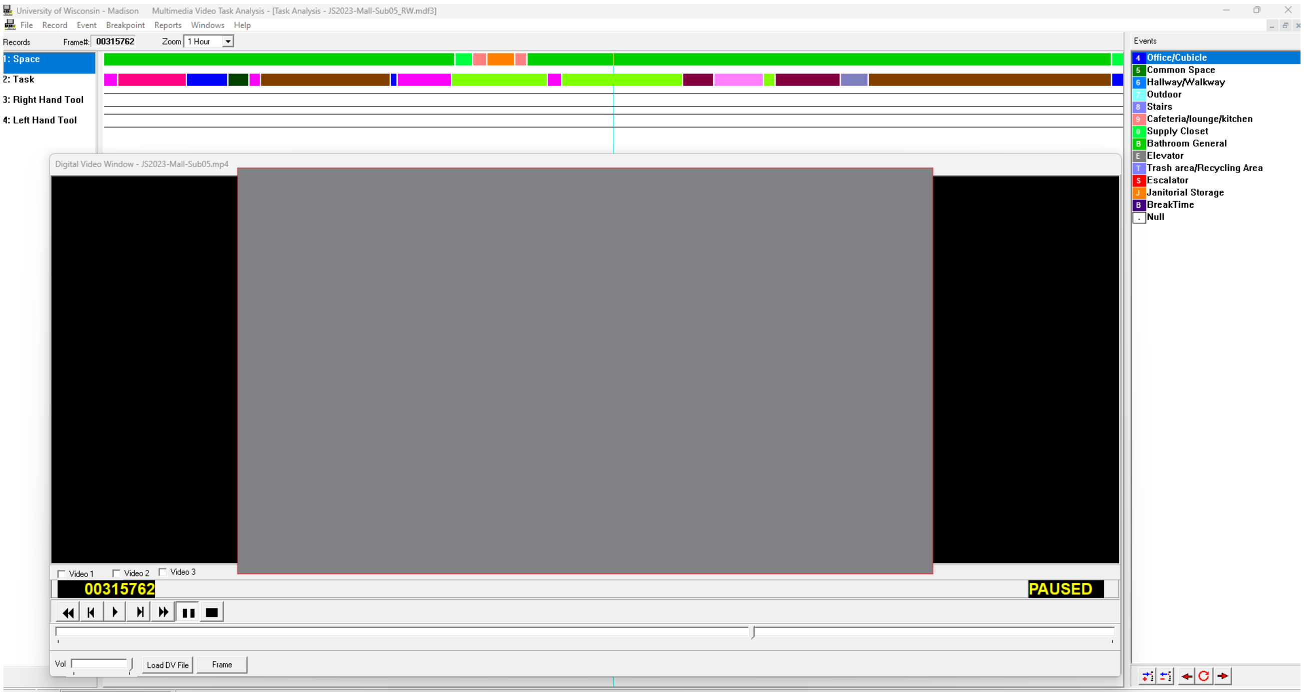
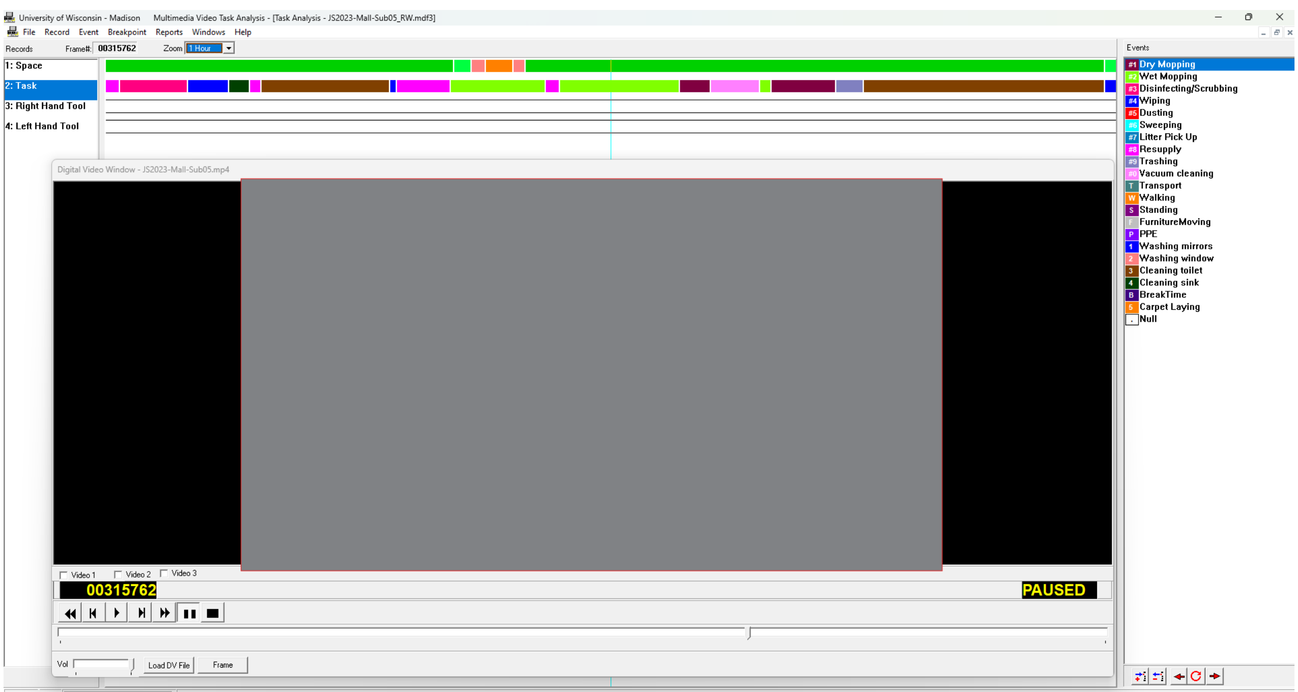


Figure A.2.1.B. Example of video analyzed in MVTA by type of task



A.2.2. Definitions of Space and Task used in MVTA

Space Type	Space Type Description
Bathroom General	
Common Space	Shared area accessible to both employees and customers
Outdoor	
Cafeteria/Lounge/Kitchen	
Office/Cubicle	
Supply Closet	
Janitorial Storage	Storing cleaning supplies, equipment, and tools
Trash/Recycling Area	
Elevator	
Escalator	
Hallway	Corridors connecting different areas of a building, intended for operational needs for employers
Meeting/Conference Room	
Breaktime	When janitor is on their break

Task	Task Description
Wet Mopping	
Dry Mopping	Using a duster mop
Sweeping	
Litter Pick Up	Using the picker-upper/tongs
Dusting	
Disinfecting/Scrubbing	Using different tools to clean different surfaces. Surfaces include toilets, sinks, and bathroom walls or doors
Wiping	Cleaning with a rag or towel, without the use of a spray bottle
Trashing	
Resupply	Supply activities from the cart or supply closet, typically occurring during task switch (e.g. restocking paper products, refilling mop water)
Transport	Tasks involving push and pull forces
Walking	Without any tools in hand
Standing	
Furniture Moving	Smaller furniture is often moved by hand; larger or heavier furniture are moved with a rider
PPE	Janitor changing PPE, such as gloves
Vacuum Cleaning	
Cleaning Toilet	
Cleaning Sink	
Cleaning Elevator Wall	
Cleaning Mirrors	
Washing Windows	
Street Washing	
Cleaning Escalator	

Repair and Maintenance	
Miscellaneous	
Breaktime	When janitor is on their break

A.2.3 ISSA Reference Sections and Descriptions

Space Type	Task	Tool	Page	Section #	Rate	Unit	What to Measure	Note
Bathroom			43	RCL-5	1.64	min./fixture	Number of plumbable units (toilet, urinal, sink)	light clean GENERAL AREA (incl: trash, resupply, scrub, sweep)
Bathroom			43	RCL-7	3.00	min./fixture	Number of plumbable units (toilet, urinal, sink)	deep clean GENERAL AREA (incl: trash, scrub, mop, mirror, walls, wet mopping, vaccum)
	Trashing	Tongs	51	TBC-2	2.00	min./fixture	Number of trash cans	empty 32-gal trash can, spot wipe inside and out, and replace liner
Cafe/Lounge/Kitchen	Disinfecting /Scrubbing	Rag/Towel	39	UHF-2	13.44	sq.ft./min.	Surface area of the items being cleaned (tables, chairs countertops, sofa, etc)	disinfect with spray bottle and cloth
	Transport		73	Walking	264	lin. ft./min.	Distance travelled in lin.ft.	slow walking pace
	Furniture Moving	Hands						no ISSA match, this is part of other related tasks
	Litter Pick up	Tongs	45	LDT-1	276.24	sq.ft./min.	Floor area cleaned	spot clean (incl: trash, wipe/scrub, duster)
	Wiping	Rag/Towel	40	KFS-2	40	sq.ft./min.	Surface area of the items being cleaned (tables, chairs countertops, sofa, etc)	damp wipe hard-surface chairs with cloth and disinfectant
	Walking	No tool	73	Walking	264	lin. ft./min.	Distance travelled in lin.ft.	slow walking pace
	Dry Mopping	Dust Mop	28	DMP-7	375	sq.ft./min.	Surface area of the items being cleaned (tables, chairs countertops, sofa, etc)	48" dust mop, dust pan and broom
	Trashing		51	TBC-5	2.75	min./fixture	Number of trash cans	empty 55 gal trash can, spot wipe inside and out, and replace liner
	Standing							no ISSA match, this is part of other related tasks
Outside	Wiping		40	KFS-2	40	sq.ft./min.	Surface area of the items being cleaned (tables, chairs countertops, sofa, etc)	damp wipe hard-surface chairs with cloth and disinfectant
	Trashing		51	TBC-2	2.00	min./fixture	Number of trash cans	empty 32 gal trash can, spot wipe inside and out, and replace liner
Common Space	Walking		73	Walking	264	lin. ft./min.	Distance travelled in lin.ft.	slow walking pace
	Transport		73	Walking	264	lin. ft./min.	Distance travelled in lin.ft.	slow walking pace
	PPE							no ISSA match, this is part of other related tasks
	Trashing		51	TBC-2	2.00	min./fixture	Number of trash cans	empty 32 gal trash can, spot wipe inside and out, and replace liner
	Litter Pick up	Tongs	45	LDT-1	276.24	sq.ft./min.	Floor area cleaned	spot clean (incl: trash, wipe/scrub, duster) (1000 sq ft/3.62 min)

	Disinfecting /Scrubbing	Rag/Towel	39	UHF-2	13.44	sq.ft./min.		disinfect with spray bottle and cloth
	Furniture Moving	hands						no ISSA match, this is part of other related tasks
	Wet Mopping	Wet mop	29	SMP-4	80.4	sq.ft./min.	Floor area cleaned	string mop and 20 oz dual chamber bucket
	Sweeping	Broom	30	MSW-9	46	sq.ft./min.	Floor area cleaned	12" angle broom including corners and edges
	Wiping	Rag/Towel	40	KFS-2	40	sq.ft./min.	Surface area of the items being cleaned (tables, chairs countertops, sofa, etc)	damp wipe hard-surface chairs with cloth and disinfectant
	Windows	Rag/Towel	56	GLS-1	42.76	sq.ft./min.	surface area of the glass panels on the entry door	clean entry door with microfiber attachment and extension tool and chemical
	Windows	Rag/Towel	56	GLS-2	2.25	min./door	Number of glass doors	clean glass door hardware with trigger sprayer, cloth, and chemical
	Windows	Rag/Towel	56	GLS-3	8.78	sq.ft./min.	Glass surface area	clean glass panel or relight with trigger sprayer, cloth, and chemical
	Windows	Squeegee	54	WCL		sq.ft./min.	Glass surface area	use a washer, squeegee, and bucket for cleaning; refer to the tool rates based on different sizes, specified by tool width in inches.
Hallway	Walking		73	Walking	264	lin. ft./min.	Distance travelled in lin.ft.	slow walking pace
	Trashing		51	TBC-5	2.75	min./fixture	Number of trash cans	empty 32 gal trash can, spot wipe inside and out, and replace liner
	Transport		73	Walking	264	lin. ft./min.	Distance travelled in lin.ft.	slow walking pace
	PPE							no ISSA match, this is part of other related tasks
	Litter Pick up	Tongs	45	LDT-1	276.24	sq.ft./min.	Floor area cleaned	spot clean (incl: trash, wipe/scrub, duster)
Office/Cubicle								
	Vacuum	Backpack vacuum	45	VAS-2	217.4	sq.ft./min.	Floor area cleaned	Routine vacuum, backpack vacuum with 14" tool, extension cord, trash liner, and microfiber
	Dusting	Duster	39	UFH-3	179.00	sq.ft./min.	Floor area cleaned	Telescopic duster and sleeve
	Trashing		51	TBC-2	2.00	min./fixture	Floor area cleaned	empty 32 gal trash can, spot wipe inside and out, and replace liner
	Sweeping	Broom	30	MSW-9	46	sq.ft./min.	Floor area cleaned	12" angle broom including corners and edges
Elevator								
	Cleaning Elevator		24	ELC-1	10	Sq.ft/min.	The floor area of the elevator and additional surfaces(walls,	Cleaning cloths, chemical, vacuum, duster, mop, and bucket

doors, or ceilings) if cleaned

A.2.4 Example of video analyzed in MVTA by type of tool and hand exertion

Figure A.2.4.A Example of video analyzed in MVTA by type of tool

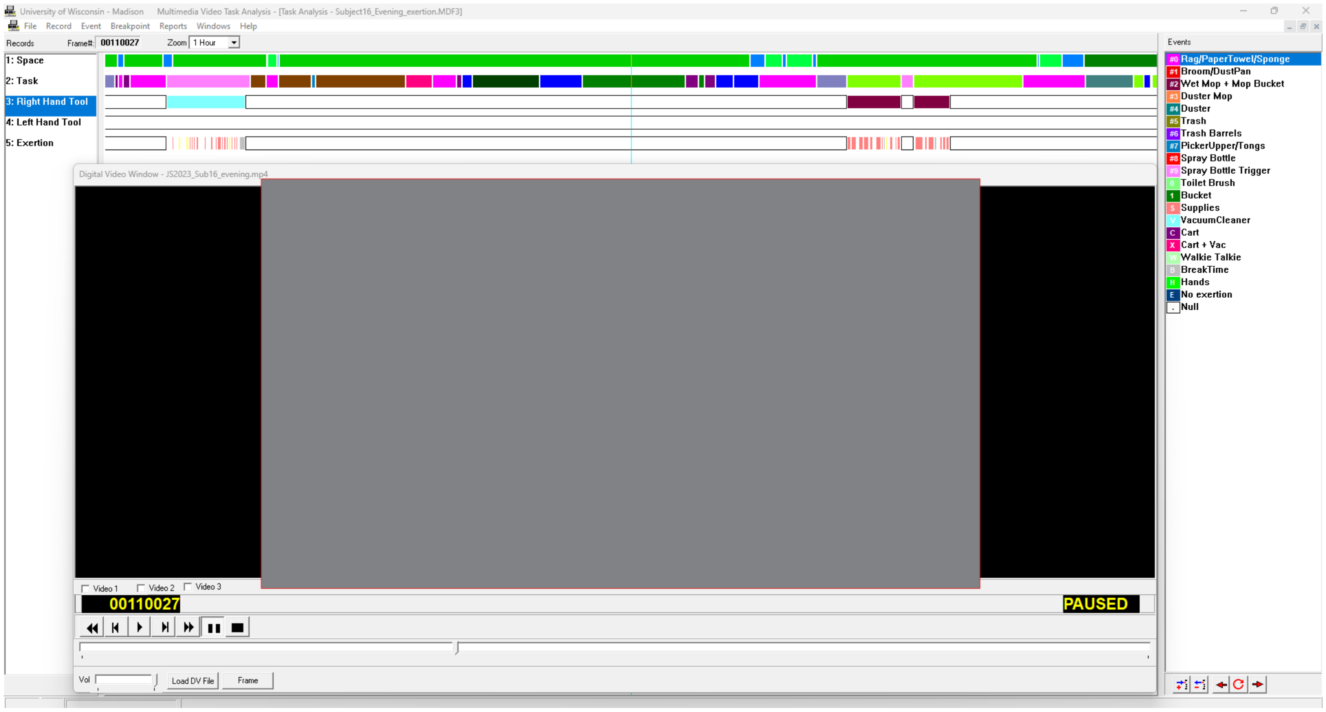
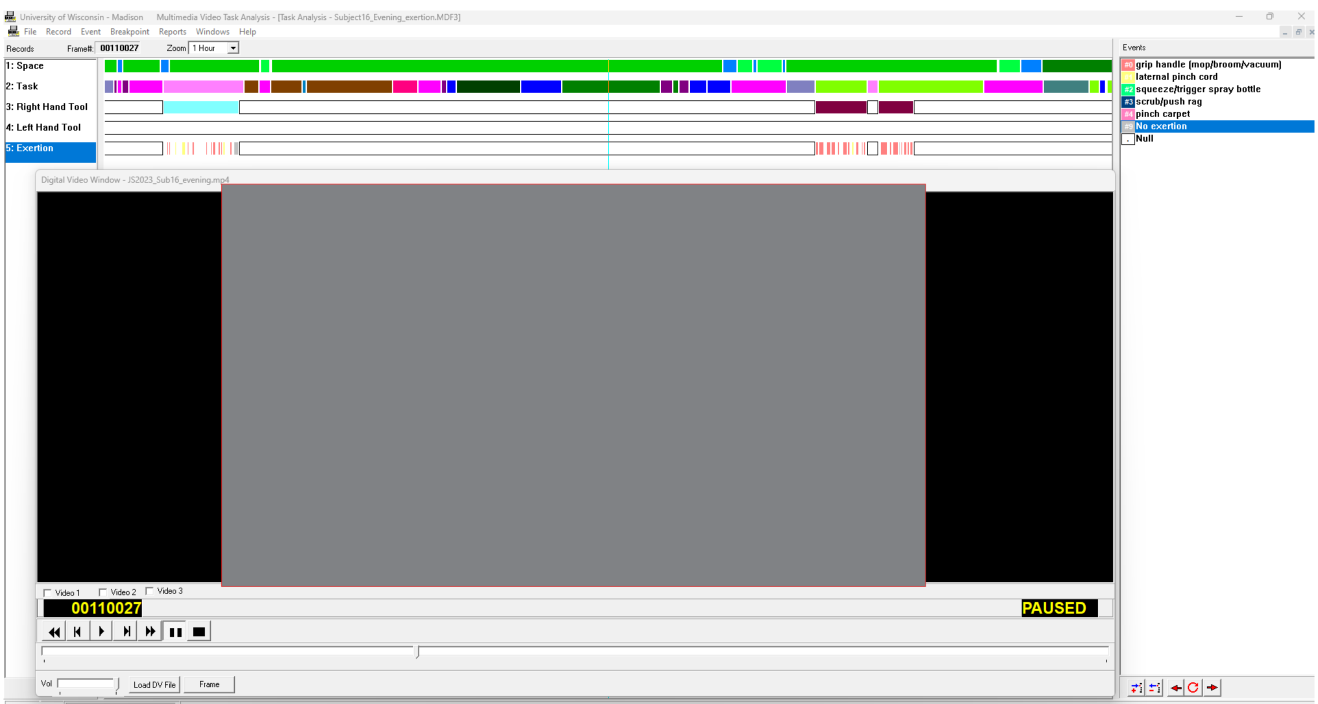


Figure A.2.4.B Example of video analyzed in MVTA by type of hand exertion



A.2.5 Definitions of tools and exertions used in MVTA

Tool	Tool Description
Brooms + Dust Pan	
Rag/Paper Towel/Sponge	
Trash Barrels	
Trash	
Picker-Upper/Tongs	
Duster	A cleaning tool for dusting, with a soft, extendable handle and fibers to attract or trap dust
Duster Mop	A cleaning tool with a wide head designed for dry mopping large floor areas to remove dust and debris
Spray Bottle	A handheld container with a nozzle that dispenses cleaning solutions or disinfectants
Wet Mop + Mop Bucket	
Supplies	
Toilet Brush	
Bucket	
Vacuum Cleaner	
Cart	Janitorial supplies cart
Vacuum + Cart	Maneuvering the cart while carrying the vacuum cleaner
Swiffer Sweeper	
Scraper	
Toilet Bucket	
Riders	
Pen/Pencil	
Hands	
Walkie Talkie	
No Exertion	
Breaktime	

Exertions	Exertion Description
Grip Handle	Gripping a handle that is part of a mop, broom, vacuum, etc. Observed in Dust Mopping, Wet Mopping, Sweeping, Vacuuming, etc.
Lateral Pinch Cord	Using a lateral pinch grip on the power cord of a vacuum Observed in Vacuuming
Squeeze/Trigger Spray Bottle	Gripping the trigger of a spray bottle or the body of a squeeze bottle containing disinfectant solution Observed in Disinfecting, Wiping
Scrub/Wipe/Push Rag	Gripping while using a rag or other cleaning cloth, using scrubbing/swiping/pushing motions Observed in Disinfecting, Wiping
Pinch Carpet	Using a pinch grip to hold/lift a rug or carpet Observed in Vacuuming, Mopping
No Exertion	No/negligible force is exerted (estimated < 10% MVC), for example when the hand is empty or just holding the towel/rag