Investigating Perceptions of Safety, Ergonomics, and Musculoskeletal Disorders Among Undergraduate Construction Students

Abstract
This study investigates undergraduate construction students' perceptions of safety, ergonomics, and musculoskeletal disorders (MSDs) through survey data collected during their engagement in hands-on fabrication tasks in a studio classroom. With construction activities presenting significant ergonomic risks leading to MSDs, understanding students' awareness and attitudes is vital for improving safety education. The research focused on survey responses related to students' knowledge of MSDs, confidence in recognizing symptoms, and awareness of preventive measures. The study leveraged the context of modular fabrication to provide a realistic framework for exploring these perceptions. While the larger study included a motion-capture recording element, that data is analyzed separately in another study. Here, we focus exclusively on the survey data filled out by students. Findings reveal a significant gap in students' awareness of MSDs and their confidence in implementing preventive measures, despite moderate awareness of general safety risks. These insights highlight the importance of integrating targeted education on long-term health hazards, such as ergonomic risks, into construction management curricula. By addressing these knowledge gaps, educators can better prepare students for the physical demands of construction work, promoting a safer and healthier workforce. Additionally, the study informs educators about improving safety protocols in lab-based construction courses.

Keywords
Construction Safety, Construction Education, Musculoskeletal Disorders, Vision Based Technologies, Student Perception.

1. Introduction

The construction industry is well-regarded for its critical contributions to global economies but remains one of the most hazardous professions due to the physical demands placed on workers (Anwer et al., 2021), (Antwi-Afari et al., 2023), (Rahman et al., 2023). Among the most prevalent occupational health issues in this sector are musculoskeletal disorders (MSDs), which account for a significant portion of work-related injuries. MSDs arise from activities such as repetitive motions, awkward postures, overexertion, and prolonged exposure to physical stressors (Valero et al., 2016), (X. Wang et al., 2017), (Reddy et al., 2016). These injuries not only impact workers' long-term health and productivity but also incur substantial costs to employers, project timelines, and the broader industry.

Musculoskeletal disorders (MSDs) are a leading cause of disability and lost workdays in the construction industry, highlighting the urgent need for comprehensive prevention strategies (*Simple Solutions*, 2020), (Antwi-Afari et al., 2023). These disorders, which affect muscles, joints, tendons, and other soft tissues, often result from repetitive motions, sustained awkward postures, and overexertion (Odebiyi et al., 2023), (D. Wang et al., 2015). Construction workers are particularly susceptible due to the physically demanding nature of tasks such as lifting, carrying, and handling tools.

Ergonomic interventions have proven effective in mitigating MSD risks in professional construction settings. Modifications such as tool redesign, improved work environments, and task-specific training have been shown to reduce physical strain and improve productivity (Albers, 2007), (Gatti et al., 2014), (*Biomechanical Evaluation of Passive Back-Support Exoskeletons in a Precision Manual Assembly Task: "Expected" Effects on Trunk Muscle Activity, Perceived Exertion, and Task Performance - Saman Madinei, Mohammad Mehdi Alemi, Sunwook Kim, Divya*

Srinivasan, Maury A. Nussbaum, 2020, n.d.), (Pacifico et al., 2020). Despite these advancements, ergonomic education in construction management programs remains underexplored. Early exposure to ergonomic principles could play a pivotal role in fostering a culture of safety and prevention among future construction professionals.

Although ergonomic risks are widely studied in professional construction settings (Albers, 2007), (David, 2005), (Dong et al., n.d.), limited research has focused on how these risks are perceived by students preparing to enter the workforce. Undergraduate construction education programs often provide hands-on learning environments, such as modular buildings, where students can develop practical skills. However, these experiences may expose students to the same ergonomic hazards seen in professional settings. Understanding students' awareness of MSD risks and their confidence in recognizing and mitigating these hazards is essential for shaping effective educational interventions.

Construction management education commonly incorporates experiential learning approaches such as project-based learning (PBL) and applied learning to provide students with hands-on training (Garshasby et al., 2024; Guo et al., 2020). PBL emphasizes real-world engagement by allowing students to actively participate in problem-solving and skill development. In the context of construction education, students engage in hands-on fabrication tasks, which mirror the physical demands of actual construction work. While this method enhances technical competency, it may also expose students to ergonomic risks that professionals face in the field. Research indicates that hands-on construction training environments, such as modular fabrication projects that was utilized in the current study settings, offer valuable opportunities for students to develop practical skills while learning about workplace hazards (Garshasby & Rokooei, 2023), (Garshasby et al., 2024). However, these environments can also replicate the physical demands and risks present in the professional workforce, including MSD-related hazards. Surveys and observational studies have demonstrated that students often underestimate long-term health risks, such as MSDs, focusing instead on immediate safety concerns like fall hazards and electrocutions (David, 2005), (Karhu et al., 1977).

While existing studies provide a foundation for understanding ergonomic risks and MSD prevention in professional construction contexts, there is a lack of research examining these issues within construction education. Limited attention has been given to students' perceptions of MSDs and their preparedness to implement preventive measures. Addressing this gap is critical for designing curricula that equip students with the knowledge and skills necessary to navigate ergonomic challenges in their future careers.

This study investigates the perceptions of safety and MSD-related risks among undergraduate construction students engaged in fabrication tasks. Using survey data, the research explores students' self-reported awareness of MSDs, confidence in identifying symptoms, and familiarity with preventive measures. By addressing gaps in knowledge and perceptions, this study aims to contribute to the development of educational strategies that prepare students to prioritize long-term health and safety in their professional careers. Additionally, this study provides insights for educators to improve safety training protocols in lab-based construction courses. The findings may inform curriculum development, emphasizing both immediate safety risks and long-term health hazards.

This study seeks to bridge this gap by analyzing survey data on students' awareness of MSDs and their confidence in recognizing and mitigating ergonomic risks. By focusing on educational settings, this research contributes to the broader goal of integrating comprehensive safety and health training into construction management programs.

2. Methods

This study employed a quantitative approach using a survey instrument to investigate undergraduate construction students' perceptions of safety, ergonomics, and musculoskeletal disorders (MSDs). The survey was designed to collect data on students' awareness of MSD-related risks, confidence in recognizing symptoms, and familiarity with preventive measures, all within the context of their hands-on fabrication tasks. The survey consisted of 20 questions and took approximately 10–15 minutes to complete. Additional questions explored their understanding of physical safety risks, health hazards, and heat-related risks associated with construction activities.

The survey instrument consisted of multiple sections. Demographic questions gathered information about students' academic levels, prior construction experience, and the types of construction work they had undertaken. Subsequent sections assessed students' self-reported awareness of physical and health hazards on construction sites, their understanding of MSDs, their confidence in implementing preventive measures, and their awareness of heat exposure risks and related symptoms. A five-point Likert scale was used for most items to quantify students' perceptions and levels of confidence across these areas.

In addition to survey responses, a motion capture software solution was utilized to analyze students' tasks and ergonomic risk factors in hands-on fabrication activities. The software allowed for detailed motion analysis, highlighting risk levels associated with various body movements and postures. Figures 1 and 2 included in this section illustrate examples of key outputs from the software, such as risk categorization for common tasks (e.g., welding, framing, and finishing) and posture-specific ergonomic evaluations. These visuals provide a comprehensive understanding of the risks assessed and support the broader interpretation of survey findings.

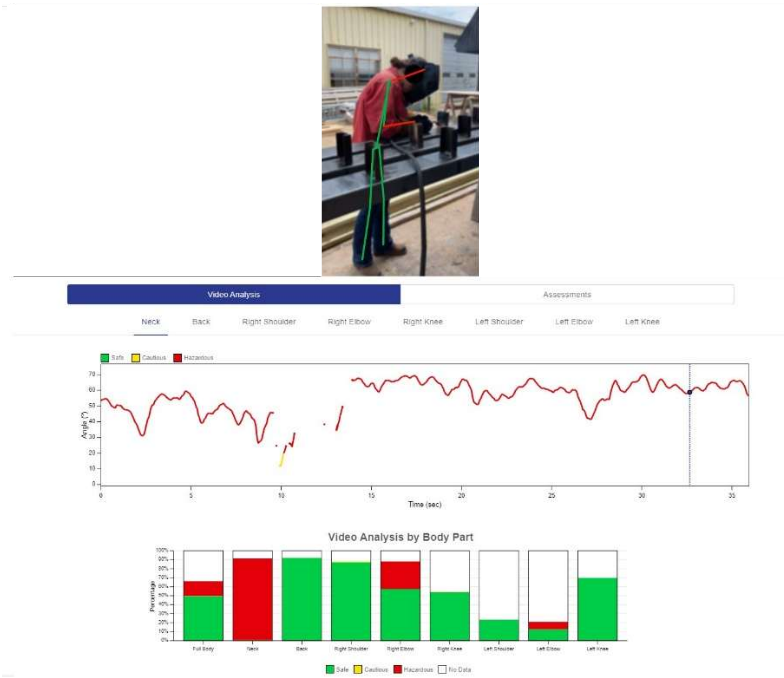

Figure 1. Analysis output for a welding activity

Figure 2. Analysis output for a finishing (painting) activity

Institutional Review Board (IRB) approval was obtained through the Office of Research Compliance and Security at Mississippi State University (IRB-24-323) in the summer of 2024. Participation was voluntary, and electronic consent was obtained from all participants after informing them about the study's objectives. Responses were anonymized to ensure confidentiality.

The study population comprised 63 undergraduate construction students participating in a building studio working towards building a modular structure in Fall 2024. The survey was distributed at the end of the semester, capturing students' perceptions upon the completion of the tasks. Data were reviewed to remove duplicates and incomplete responses, ensuring the integrity of the dataset. Statistical analyses were conducted using SPSS software, including descriptive statistics to summarize students' perceptions and comparative analyses to explore potential differences based on demographic factors such as academic level and prior construction experience.

3. Results

In the first phase of the study, 63 students participated in Fall 2024, including 67% at freshman level, 25% at sophomore level, and the rest were junior level students. The first section of the survey explores some demographics information as well as the general status of students. Students were asked to specify their construction experience. Various intervals were provided to students to quantify their experience. As shown in Figure 3, the majority of students had at least 6 months or more of construction experience.

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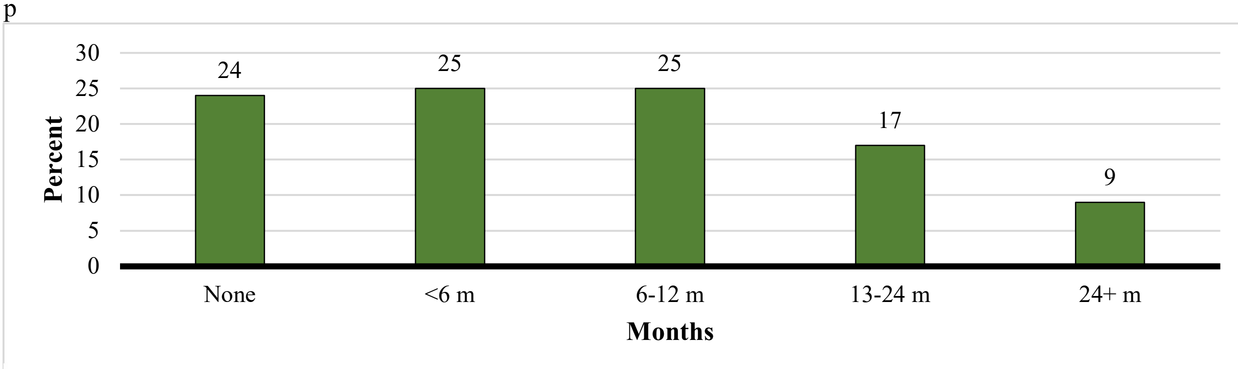

Figure 3. Construction experience

In the next question, students were asked to specify the types of construction experiences they had before their current semester. A list of common types of experiences was provided to students which included Informal or occasional assistance in construction projects (e.g., helping family or friends), Part-time or summer job in the construction industry, Educational projects or internships focused on construction management, Work experience in construction (e.g., laborer, technician) for more than 3 months, Formal apprenticeship or vocational training in construction, Leadership or management experience in construction projects. Various types of work experiences could potentially indicate the different environments that might affect students' perceptions on health issues. The percentage of each type is shown in Figure 4.

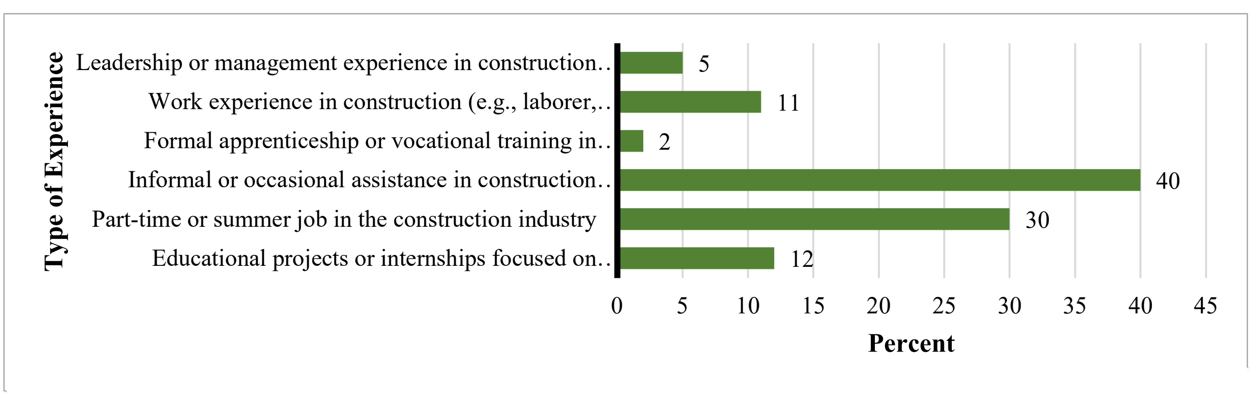

Figure 4. Work experience types

In the next section, students were asked to rate their level of awareness about to subjects:

- level of Awareness Regarding Physical Safety Risks (e.g., fall hazards, struck-by hazards, electrocutions) on Job Site
- level of Awareness Regarding Health Hazards (e.g., ergonomic risks, chemical exposures, biological hazards) on Job Sites

A five-level Likert scale was provided to students to rate their level of awareness. The percentage of each level is shown in Figure 5. As depicted in the figure, students expressed some level of awareness in both areas. Also, the level of awareness regarding health hazards was significantly lower than that of physical safety risks.

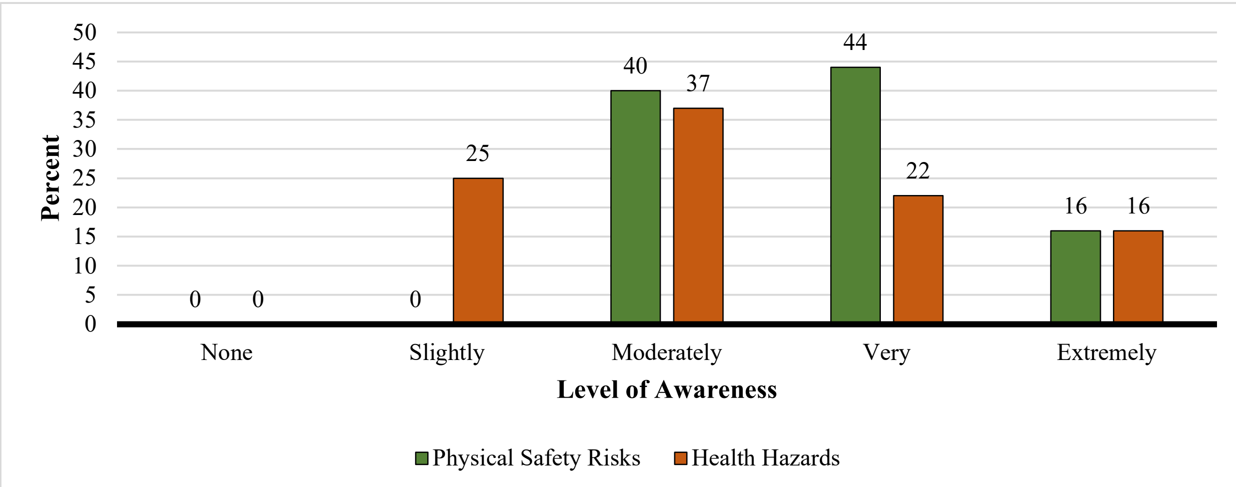

Figure 5. Level of awareness

In addition, students were asked to rate their understanding in regard to two statements:

Statement 1: The understanding of Musculoskeletal Disorders (MSDs)

Statement 2: Confidence in Recognizing MSD Symptoms and Factors Leading to MSD Severity Related to Construction Operations.

Similarly, a five-level Likert scale was provided to students to rate their perceptions. The percentage for each level is shown in Table 1.

Table 1. Perception level

	Statement 1	Statement 2
Very Low	46	46
Low	24	22
Moderate	17	25
High	10	5
Very High	3	2

As shown in the table, the vast majority of students expressed a low-level familiarity with Musculoskeletal Disorders (MSDs) and MSD symptoms and impacting factors.

In the next question, students were asked to rate their confidence in implementing preventive measures to reduce MSDs or their severity related to construction operations, using a five-level Likert scale. As shown in Figure 6, about two-thirds of students were not familiar with preventive measures and actions to reduce MSDs.

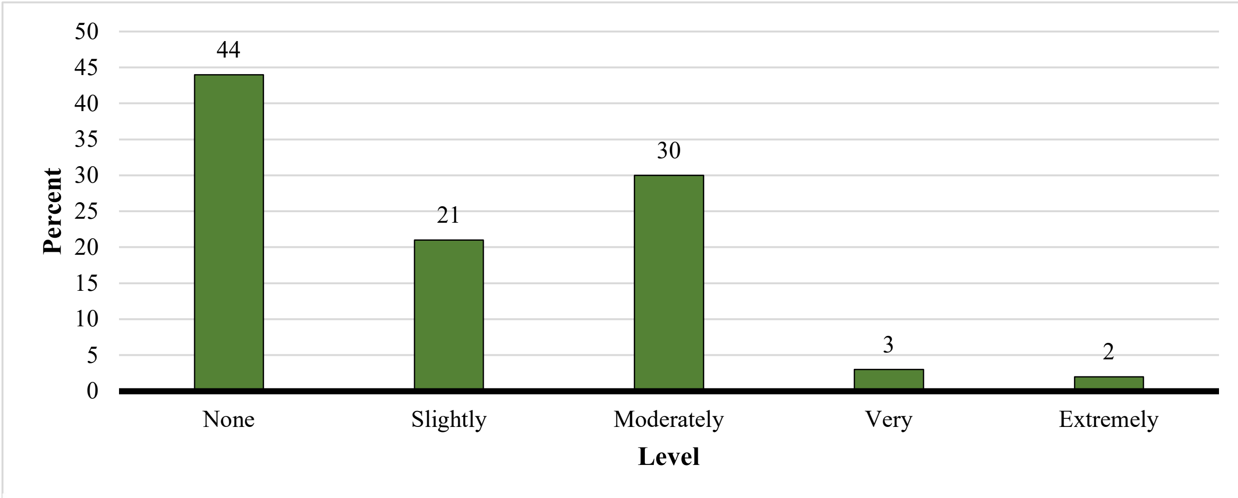

Figure 6. Familiarity with MSDs preventive measure

In the next sections, the heat-related risks and familiarity of students with them were explored and students were asked to answer two questions: 1) how aware were they of the potential risks associated with working in high temperatures? And 2) how would they rate their ability to recognize the symptoms of heat-related illnesses (e.g., heat exhaustion, heat stroke)? To quantify responses, five levels were provided to students. The percentage of each level for both questions is shown in Table 2. As indicated, students reported above-average levels of awareness and ability to recognize heat-related symptoms.

Table 2. Level of awareness and symptom recognition ability

	Level of Awareness	Symptom Recognition Ability
Very Low	0	0
Low	2	17
Moderate	24	21
High	45	56
Very High	29	6

To assess students' encounter with the heat-related approach, two questions were asked: 1) how often did they feel discomfort due to heat during construction activities? And 2) during your construction activities, how frequently did they take breaks to cool down and hydrate? Table 3 shows the percentage of each frequency level.

Table 3. Frequency of discomfort and break while working

	Discomfort Frequency	Break Frequency
Never	6	2
Rarely	37	14
Sometimes	48	57
Often	6	24
Always	3	3

Finally, students were also asked to rate the overall risk of heat exposure in their construction activities, using a five-level Likert scale. Figure 7 shows the percentage of each level, which to some extent indicates an underestimation of heat-related risks to construction professionals.

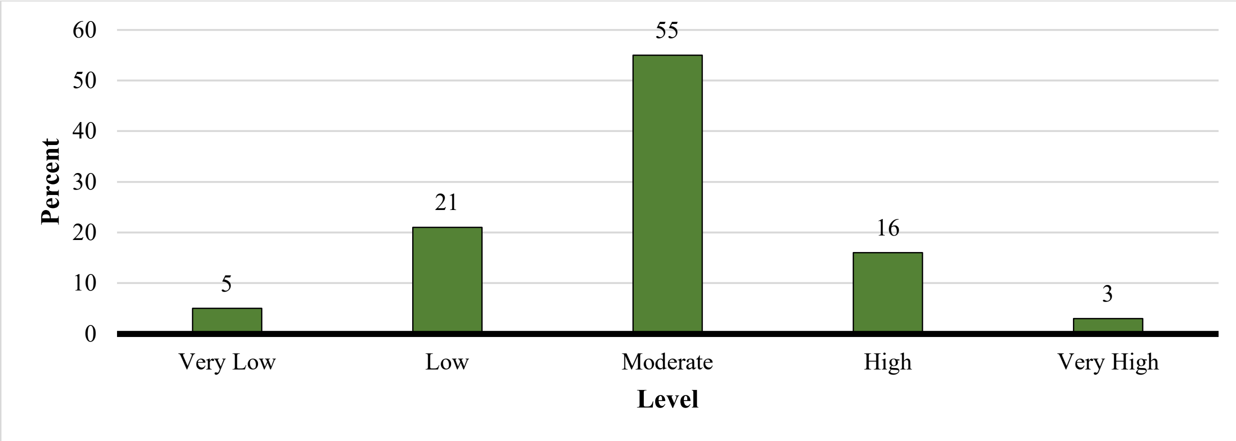

Figure 7. Heat exposure risks

4. Discussion

While this study primarily utilized descriptive statistics, no inferential tests were performed. The rationale for this decision is that the study focused on exploratory insights rather than hypothesis testing. Future research may consider using correlational analyses to investigate relationships between students' backgrounds, construction experience, and MSD awareness. The analysis of the study conducted on construction students regarding Musculoskeletal Disorders (MSDs) and related health hazards reveals several important insights and areas for concern in construction education and industry. While the term 'health hazards' in the survey included chemical and biological risks, this study focused specifically on ergonomic and heat-related risks, which were more pertinent to the students' hands-on fabrication tasks. Chemical and biological hazards were not emphasized in the analysis due to their limited relevance in the course context.

4. 1 Discussion (Construction Experience and Awareness)

Although a large portion of the respondents were traditional first-year students, the reported construction experience reflects informal or part-time work prior to enrollment, such as summer jobs, family business involvement, or vocational training during high school. The majority of students in the study had at least 6 months of construction experience, with various types of exposure to the industry. This practical experience provides a foundation for understanding the realities of construction work. However, the study highlights a significant disparity in awareness levels between physical safety risks and health hazards on job sites. Students demonstrated a higher level of awareness regarding physical safety risks compared to health hazards, indicating a potential gap in education and training related to long-term health issues in construction.

4. 2 Discussion (Understanding of MSDs)

A particularly concerning finding is the low level of familiarity with Musculoskeletal Disorders (MSDs) among the students. The vast majority expressed a low-level understanding of MSDs and limited confidence in recognizing MSD symptoms and factors contributing to their severity. This lack of knowledge is further compounded by the students' low confidence in implementing preventive measures to reduce MSDs, with about two-thirds reporting unfamiliarity with such actions.

4. 3 Discussion (Heat-Related Risks)

In contrast to the low awareness of MSDs, students reported above-average levels of awareness and ability to recognize heat-related symptoms. This discrepancy might be attributed to the more immediate and visible nature of heat-related illnesses compared to the gradual onset of MSDs. However, the data suggests a potential underestimation of heat-related risks, as indicated by the students' ratings of overall heat exposure risks in construction activities.

4. 4 Discussion (Implications and Recommendations)

- Curriculum Enhancement: The findings underscore the need for a more comprehensive approach to health hazard education in construction programs. Integrating in-depth modules on MSDs, their causes, symptoms, and prevention strategies could significantly improve students' awareness and preparedness.

- Practical Training: Implementing hands-on training sessions focusing on ergonomic practices and MSD prevention techniques could bridge the gap between theoretical knowledge and practical application.
- Industry Collaboration: Partnering with construction companies to provide real-world exposure to health hazard management practices could enhance students' understanding of the importance of these issues in professional settings.
- Balanced Safety Focus: While maintaining emphasis on physical safety risks, educational programs should strive to elevate the importance of long-term health hazards to the same level of priority.
- Continuous Assessment: Regular surveys and assessments of students' knowledge and perceptions of health hazards could help track improvements and identify areas needing further attention.

While students showed a reasonable grasp of immediate safety concerns and heat-related risks, there was a critical need to address the knowledge gap regarding MSDs and other long-term health hazards in construction education. Addressing this gap is crucial for preparing future construction professionals to create safer and healthier work environments in the industry.

5. Conclusions

This study investigated undergraduate construction students' perceptions of safety, ergonomics, and musculoskeletal disorders (MSDs) through survey data collected at the end of a hands-on fabrication course during Fall 2024. Findings revealed significant gaps in students' awareness of MSDs and confidence in implementing preventive measures, contrasting with moderate awareness of general safety risks and heat-related hazards. These results emphasize the importance of integrating targeted training on ergonomic principles and MSD prevention into construction management curricula. Addressing these knowledge gaps can better prepare students for the physical demands of the construction industry, fostering a culture of safety and promoting long-term worker health.

6. Limitations

This study has several limitations. First, the reliance on self-reported data may introduce response bias or inaccuracies in students' self-assessment of their awareness and confidence levels. Second, the study focused on a single cohort of students in Fall 2024, limiting the generalizability of the findings to other populations or academic contexts. Third, the survey was distributed at the end of the semester, capturing students' retrospective perceptions but not accounting for potential changes in their awareness or confidence during the course. Finally, while the study leveraged survey data to explore students' perceptions, it did not incorporate objective measures such as direct task observation or motion-capture analysis, which could provide additional insights into ergonomic risks.

7. Future Work

Future research should address these limitations by including multiple cohorts across different institutions to enhance the generalizability of findings. A longitudinal design that tracks changes in students' awareness and confidence throughout the semester and after graduation could provide deeper insights into the effectiveness of educational interventions. Future studies may compare students across different academic levels (e.g., first-year vs. third-year) to examine how curriculum progression influences awareness and confidence related to MSDs and ergonomic safety. Additionally, integrating motion-capture analysis with survey findings could offer a more comprehensive understanding of ergonomic risks and students' ability to recognize and mitigate them. Research could also explore the impact of hands-on training, virtual simulations, and collaborative industry partnerships in improving students' understanding of safety and long-term health risks. Such studies would contribute to the development of innovative, evidence-based approaches for enhancing construction education and fostering safer work environments in the industry.

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