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Toward an Understanding of Construction Workers' Decision to Stop Work When Experiencing Symptoms of Heat Strain: A Pilot Investigation

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This pilot study aims to understand the behavioral and cultural factors influencing construction workers' decisions to continue working despite experiencing symptoms of heat strain. A survey was developed based on a literature review and expert feedback to capture critical themes, such as awareness of heat-related health risks, experiences with heat-related illness, and behaviors when experiencing symptoms of heat strain. Initial analysis of item responses to a question on safety behavior when experiencing heat-related symptoms demonstrated high internal consistency, with Cronbach's Alpha of 0.90. Exploratory factor analysis revealed two distinct factors, cognitive and physical discomfort, showing progress toward obtaining construct validity. Preliminary data from the pilot revealed that while most respondents are aware of the risks of working in extreme heat, many still experience symptoms, with some choosing to continue working despite discomfort. Insight was also provided into why respondents choose not to stop working when experiencing symptoms of heat strain. This pilot investigation provides an initial understanding of the decision-making factors influencing workers' reluctance to stop working when experiencing heat strain and progress toward developing an instrument to understand this phenomenon more.

Key Words: Construction, Heat Safety, Pilot Study, Stop Work

Introduction

As global temperatures continue to climb, heat stress has become a significant health and safety concern for outdoor workers, particularly those in physically demanding jobs like construction (NOAA, 2023; Cissé et al., 2022). Construction professionals face unique challenges due to their exposure to high temperatures and the physical demands of their work, making it hard to maintain safe body temperatures in intense conditions (Song & Zhang, 2022). Despite safety regulations, accidents and fatalities continue to occur, with unsafe behavior among construction workers identified as a key issue (Guo et al., 2021).

Heat stress can lead to various symptoms tied to heat strain (HS) (initial response to heat), such as sweating, cramps, etc., and heat-related illnesses (HRI) (prolonged heat strain) such as heat exhaustion to more severe issues like heat stroke (OSHA, 2023). Key factors contributing to heat stress include temperature, humidity, radiant heat, and airflow, which determine the risk level on any given day (Fang et al., 2021). Dong et al. (2019) revealed that construction workers, comprising only 6% of the total workforce, accounted for 36% of all occupational heat-related deaths from 1992 to 2016 in the United States. The research also found a significant association between increasing summer temperatures and higher heat-related death rates among construction workers (Dong et al., 2019). Despite these alarming statistics, many construction workers continue to work even when experiencing symptoms of heat strain. This behavior can be attributed to various factors, including economic pressures, lack of awareness about the severity of heat-related illnesses, and organizational culture (Jia et al., 2016). Additionally, some workers may underestimate the risks of heat exposure or feel pressure to maintain productivity levels (Rowlinson et al., 2014).

This pilot study examines which HS symptoms construction workers are more likely to overlook when deciding whether to stop work and the broad factors influencing their choice to continue working despite experiencing these symptoms. The study also discusses refining a survey instrument (Bowden et al., 2002) that assesses this data while benchmarking findings before larger protocol administration. By analyzing "stop-work authority" (Southern Safety Trilateral, 2025), the authority of workers to stop work when an unsafe work condition is perceived, and the motivations behind risk-prone behaviors, the study seeks to inform targeted interventions, safety policies, and educational efforts that promote heat safety while acknowledging the common cultural attitudes.

Literature Review

In the construction industry, working in high temperatures presents serious health hazards, mainly because workers are exposed to intense heat while performing physically demanding tasks with few opportunities for relief. This combination of physical exertion and environmental exposure significantly raises the risk of heat-related illnesses (HRIs), such as heat exhaustion and heat stroke, which have immediate and long-term impacts on health (Fang et al., 2021; OSHA, 2023). Heat-related illnesses present a range of symptoms that can vary in severity. According to the Centers for Disease Control and Prevention (CDC, 2024), common symptoms include heavy sweating, muscle cramps, weakness, dizziness, headache, nausea, and fainting. In more severe cases, such as heat exhaustion, individuals may experience cool, pale, and clammy skin, a fast but weak pulse, and possible vomiting. Heat stroke, the most severe heat-related illness, can manifest with symptoms like high body temperature (103°F or higher), hot and red skin, rapid and strong pulse, confusion, and potential loss of consciousness. The Mayo Clinic (2023) adds that heat exhaustion may also involve low blood pressure upon standing and goosebumps when in the heat.

These symptoms are expected to prompt someone to cease activity until their physiological state returns to normal. However, numerous social and structural factors in the construction industry encourage workers to push through these symptoms, resulting in acute heat-related health issues. The deeply ingrained cultural norms of the industry, especially the "masculine culture," contribute significantly to this trend. This culture fosters a mentality in which workers often underestimate heat-related risks and overestimate their ability to withstand them, further reinforced by peer pressure, stereotypical attitudes, and a reluctance to appear vulnerable among colleagues (Rameezdeen & Elmualim, 2017; Jia et al., 2016).

In addition to cultural influences, construction workers face intense pressure to prioritize productivity over personal safety, often leading them to disregard safe practices. Studies indicate that safety guidelines are frequently overshadowed by the drive to meet productivity goals (Fatima et al., 2023). Workers have noted that "productivity is usually seen as more important than health and safety by management" and admit that "sometimes it is necessary to take the risks to get the job done"

(Choudhry et al., 2009). Alongside job-related pressures, personal financial incentives also impact worker behavior in high-heat conditions (Jia et al., 2016). Furthermore, conformity behaviors in team settings can amplify unsafe practices. When workers prioritize internal team norms over official safety rules, the likelihood of unsafe group behaviors increases, leading to a heightened risk for individual workers (Li et al., 2021). Additional factors exacerbating heat strain include working on elevated surfaces, heavy workloads, limited heat relief accommodations, exposure to constant sunlight, clothing choices, and machinery and power tools (Kakamu et al., 2021).

The dangers of working in extreme heat are documented, and physiological and cultural factors associated with working in the heat have been explored. However, there is limited research on construction workers' decision to continue working despite experiencing heat strain and which symptoms are ignored more than others.

Methodology

This study employed a pilot survey approach to explore workers' experience, awareness, and decision-making when experiencing symptoms of heat strain. Quantitative data was collected and analyzed using JASP (JASP Team, 2024) for Cronbach's alpha and exploratory factor analysis (EFA), with MS Excel being used for descriptive statistics. The Institutional Review Board (IRB) approved this work under the exempt category (IRB Exempt Protocol #24-952).

Survey Development

The survey instrument was designed based on a literature review on workplace heat safety and related behavioral factors. There were 57 papers obtained from academic journals such as the American Journal of Industrial Medicine, Safety Science, and the Journal of Construction Engineering and Management (ASCE), in addition to others. Two papers were review articles; 19 focused on safety culture, 17 focused on safety climate, five on perceptions, seven on interventions, and seven were case-based papers. The original survey instrument asked questions that were categorized into demographics (D), personal experiences (E), behavioral and situational responses (B), and awareness (A) with each alphanumeric value being an individual question (see Table 1).

Table 1. Survey items

Item(s)	**Item Description**	**Question Type**
D1-D7	Age, ethnicity, job role, experience, gender, hours working in heat, self-reported description of health	Multiple choice and open-ended for job role
A1	Awareness of impacts	Dichotomous
A2	Awareness of heat-related illness of coworker	Dichotomous
B1	Stop work response when symptoms are experienced	Multiple choice
B2	Stop work response under varying symptoms	5- point Likert
B3	Barriers to stopping work	Multiple answers
E1	Experience of HS symptoms	Select all that apply
E2	Medical attention was required due to working in the heat	Dichotomous
E3	Missed work due to heat-related illness	Dichotomous

Pilot Sample

For this pilot investigation, convenience sampling was used based on participant availability (Etikan et al., 2016), and responses came from two groups: (1) construction workers employed by a structural contractor on an active job site and (2) those attending a safety conference with professional experience working in hot environments. All who were invited completed the survey, which amounted to 40 participants. This sample size aligns with the recommendations that suggest that pilot studies generally include 10–40 participants to meet a variety of possible aims, such as detecting primary issues with survey design and establishing initial reliability (Hertzog, 2008).

Data Collection Procedures

The survey was conducted on-site with construction workers and at a health and safety conference. For the on-site data collection, efforts were made to minimize interruptions to their work schedules. For data collected at the health and safety conference, attendees were asked to complete the survey during a presentation session. The survey was distributed electronically via Qualtrics® (Qualtrics, 2024) and took an average of 9.33 minutes, in line with findings by Galesic and Bosnjak (2009), who highlighted that shorter questionnaires promote higher response and completion rates, the survey duration is expected to enhance participation when administered in the future.

Initial Instrument Quality Review

The initial responses from the data collected provided insight into improving instrumentation quality, with investigators understanding that the process is iterative. Initial insight into content validity was achieved through an analysis of existing literature to aid in developing the survey items (A1, A2, E1, E2, E3). Two professionals with construction industry experience reviewed the survey. These professionals provided technical insight, while an organizational psychologist's expert review further contributed insights into survey design and cultural adaptation for all items. This piloting also revealed issues of clarity and potentially missing information on demographic details, with 'other' being used to complete the demographic item.

For item B2 specifically, a 5-point Likert scale (e.g., 0 = Definitely won't stop, 5 = Definitely will stop) was used to assess the likelihood of workers stopping work when experiencing symptoms (variables) of dizziness, nausea, headache, extreme thirst, rapid pulse, confusion, slurred speech, and faintness. For this item, Cronbach's Alpha ($\alpha = .90$) was calculated to assess the internal consistency of the items related to the likelihood of stopping work in response to heat-related symptoms. The analysis indicates high internal consistency among the items. Further, the exploratory factor analysis (EFA) of these items shows that the survey captures two factors ($\lambda > 1$). These factors are closely related to cognitive factors (faintness, dizziness, and confusion) and physical discomfort (headaches, extreme thirst, nausea, and rapid heart rate). At the same time, slurred speech moderately loads on both but inherently is more associated with cognitive impairment. This structure supports a step toward the construct validity of the survey item, measuring how people are affected by heat, which aligns with what the research team intended to assess. By identifying these two areas, the research team can be more confident in the direction of instrument validation.

Analysis of Pilot Data

The feedback gathered from participants, heat safety specialists, and expert reviewers allowed adjustments to improve question clarity, cultural relevance, and survey length. The responses provided benchmark data for future findings in the more extensive study. The research team wanted to understand various workers' awareness, experience, and self-reported expected behaviors.

Participant Demographics

Of the 40 respondents, 58% of responses were provided in Spanish, and the remainder were in English. Regarding ethnicity, most respondents identified as Hispanic (58%), with 33% of participants identifying as White and 8% identifying as Black, with the remainder not choosing to provide this information. Regarding gender, 90% were male, 5% were female, and the other 5% preferred not to say. Most participants (68%) report working over 8 hours daily in hot environments, while 25% spend 6-8 hours in the heat, 5% spend 4-6 hours, and 2.5% spend 2-4 hours. Other key demographic information, such as the years of experience working, is summarized in Table 2.

Table 2. Additional Participant Demographics

Age Range	***n***	**%**	**Job Role**	***n***	**%**	**Experience (years)**	**n**	**%**
18-25	11	27.5	Carpenter	12	30	0 – 5	21	52.5
26-30	8	20	Bricklayer	4	10	6 – 10	5	12.5
31-35	3	7.5	Laborer	4	10	11 – 15	6	15
36-40	5	12.5	Operator	2	5	16 – 20	2	5
41-45	3	7.5	Rigger	1	2.5	20+	6	15
46-50	2	5	Electrician	1	2.5			
51-54	1	2.5	Safety Expert	12	30			
55+	7	17.5	Unanswered	4	10			

Awareness

The data shows that most respondents are aware of the short- and long-term health impacts of working in extreme heat (question A1), with a majority saying "Yes" (*n=34*) and few saying "No" (*n=6*) to this question. Additionally, a substantial number of participants have witnessed a coworker experiencing a heat-related injury or illness resulting in a medical emergency or missed work (question A2), with most respondents saying "Yes" (*n=28*) and the remainder saying "No" (*n=12*). This suggests a relatively high level of awareness among workers regarding the health risks associated with extreme heat and a significant level of firsthand exposure to heat-related incidents in the workplace.

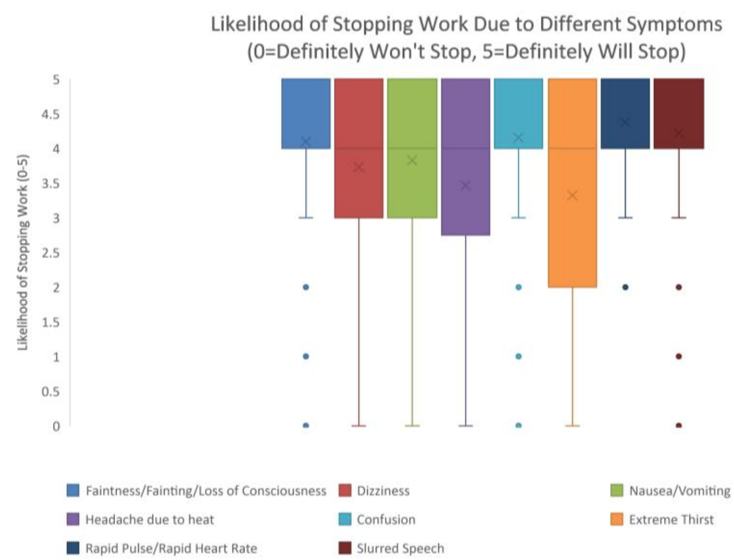
Experience with Heat-Related Symptoms

The data reveals insights into respondents' experiences with heat-related symptoms, medical attention, and work absences due to these symptoms. For question E1, "Have you experienced any of the following symptoms when working in hot environments at work?" the most common response was, "I have not experienced any of these symptoms" *(n=20)*. However, some respondents reported specific symptoms, with dizziness *(n=6)*, headache due to heat *(n=9)*, and extreme thirst *(n=5)* being among the more frequently cited symptoms. Others reported multiple symptoms, such as dizziness, nausea/vomiting, and headache due to heat *(n=3)*, and a combination of dizziness, nausea/vomiting, headache due to heat, confusion, extreme thirst, rapid pulse/rapid heart rate, and slurred speech *(n=1)*. For question E2, "Have you ever had to seek medical attention (for example: see a doctor) for any of the heat-related symptoms asked in the previous question?" most respondents indicated "No" *(n=39)*, while only one responded "Yes", suggesting that medical attention for these symptoms is relatively rare in this sample. Similarly, for question E3, "Have you ever had to miss work due to a heat-related injury or illness?" the majority again answered "No" *(n=37)*, with a few respondents answering "Yes" *(n=3)*. Overall, while many respondents report experiencing heat-related symptoms, few have sought medical attention or missed work as a result, which may indicate either mild symptom experiences or a tendency to continue working despite symptoms.

Behaviors

In response to question B1, "Upon experiencing symptoms, do you continue working or do you stop working until the symptoms subside?" a range of behaviors was observed among participants. A majority of respondents (*n=32*) indicated a preference to "stop" working upon experiencing symptoms, reflecting a proactive approach to managing well-being in potentially high-risk situations. However, a notable subset reported continuing to work until instructed to stop (*n=6*), while a few (*n=2*) expressed a willingness to "keep working" regardless of symptoms. This group of workers who persist in working despite symptoms (*20%*) highlights potential gaps in safety culture, as continuing to work under such conditions may pose significant discomfort and dangers.

The responses to question B2 "If you were to experience the following symptoms, how likely are you to stop working?" reveal a general tendency to stop working when experiencing heat strain symptoms. This question was asked to gather more specific data about the perceived severity of symptoms and a worker's willingness to stop upon experiencing the symptom. The average likelihood to stop, rated on a scale from 0 (definitely won't stop) to 5 (definitely will stop), varies across symptoms but is generally high, especially for symptoms like *Rapid Pulse* (*x = 4.375*), *Slurred Speech* (*x = 4.22*), *Confusion (x = 4.2)*, and *Fainting* (*x = 4.1*) indicating a strong likelihood to stop in these cases. Other symptoms, such as *Nausea* (*x = 3.8*), *Dizziness (x = 3.7)*, *Headache (x = 3.5),* and *Extreme Thirst (x = 3.3)*, have slightly lower averages, suggesting some respondents may be less likely to stop when experiencing these symptoms. The boxplot (see Figure 1) displays the distribution of responses for each symptom, highlighting the range and central tendency in workers' reported likelihood of stopping work for different heat-related symptoms. This visual comparison underscores the likelihood of stopping for symptoms with potentially more immediate physical or cognitive impacts, such as faintness, confusion, rapid pulse, and slurred speech.



Note: x is the mean, and the dots represent outliers outside of 1.5 times the interquartile range (whiskers)

Figure 1. Likelihood of stopping work when experiencing various heat-related symptoms

Compared to the previous question, where most responses indicated a tendency to stop upon experiencing symptoms, these detailed symptom ratings provide further insight into the variation in stopping likelihood based on specific symptoms. The data suggests that while workers generally prioritize stopping when symptomatic, specific symptoms may prompt a stronger immediate reaction.

The responses to question B3, "What prevents you from stopping work when working in hot environments?" reveal several recurring themes. The most common concern is fear of job loss, with many *(n=17)* mentioning continuing work due to worries about losing their employment. Another prominent factor is deadlines or pressure to complete tasks on time *(n=10)*, suggesting that productivity expectations may sometimes override safety considerations. Other factors include peer pressure *(n=5)*, lack of employer support *(n=5)*, lack of awareness or training on heat stress *(n=5)*, and absence of health and safety policies related to heat stress *(n=3)*. The responses also highlighted issues including inadequate monitoring systems (n=2), insufficient rest areas (n=3), and concerns about being mocked (n=2) when breaks are taken.

Discussion

This pilot investigation explores various factors impacting workers' decisions to continue working despite experiencing symptoms of heat strain. Key aspects of this research include the design and quality of the survey instrument, along with an initial analysis of responses. The instrument has demonstrated initial quality, with content validity, construct validity, and reliability measures initially being favorable; further quality improvement is expected with future iterations.

Preliminary results from the survey highlight awareness among workers regarding the risks of working in high heat. Most workers mention stopping work when experiencing symptoms. However, when a follow-up question asked about specific symptoms and the likelihood of stopping work, variations in the responses became apparent. For example, cognitive symptoms like slurred speech or dizziness had a higher reported likelihood of prompting a stop-work decision compared to other symptoms like increased heart rate, suggesting symptom-specific perceptions of urgency among workers. That said, while there is a strong indication that most workers would stop working due to cognitive decline (e.g., slurred speech), some workers are less likely to stop working, either indicating a tendency to *might* or *might not stop working*, to be *unlikely to stop working* or answering *definitely won't stop working*. This data point is of significant concern. While it is a relatively small percentage, it implies that some workers would not stop work even in severe cognitive malfunction. This finding underscores the need to understand workers' limits further when it comes to stopping work on a micro level and what crew-level culture would need to exist to eliminate this mindset.

While most workers mention acting appropriately to their body's response to an acute heat-related issue, many have mentioned witnessing a colleague experience heat-related injury or illness resulting in a medical emergency or missed work. This data contradicts the number of surveyed participants mentioning prioritizing their health over work. While it is possible our survey was only responded to by workers who would behave according to negative physiological feedback when working in the heat, it is unlikely. This could be an instance of saying one thing but doing another.

The responses to the question on what prevents you from stopping work when working in hot environments highlight factors that prevent workers from prioritizing their health in extreme temperatures. The most frequently cited barrier, fear of job loss, underscores a significant tension between job security and safety. This finding aligns with existing research on occupational stress, where job insecurity can adversely affect decision-making regarding health and safety in the workplace. Deadlines and pressure to meet productivity goals were notable factors, pointing to a potentially systemic issue where speed and efficiency are prioritized over well-being. Additionally, peer pressure and concerns about being mocked further illustrate the culture that discourages breaks. Workers may feel compelled to keep pace with their peers or fear disapproval from peers for prioritizing their health.

Respondents identified the lack of employer support, inadequate heat stress training, and absence of policies for managing high-temperature work environments as significant barriers. These factors highlight gaps in organizational responsibility for heat-related health and safety. The findings on cultural and organizational barriers align similarly with the constructs outlined in the Model of Construction Safety Culture proposed by Choudhry et al. (2007). This model emphasizes the interactive relationship between psychological factors (e.g., perceptions and attitudes, such as fear of job loss), behavioral factors (e.g., safety practices reinforced by cultural norms), and situational factors (e.g., absence of safety policies and monitoring systems).

Although no specific OSHA regulations address heat stress, the General Duty Clause requires employers to provide a workplace "free from recognized hazards that are causing or likely to cause death or serious harm to employees," including heat-related hazards (OSHA, 2024). Without adequate training and awareness, workers may not fully understand the risks of heat stress or the employee rights under this clause. The absence of policies and monitoring systems reinforces a lack of structural support, leaving workers to rely on personal judgment when deciding to rest, often leading to inconsistent practices and heightened risks. These findings indicate a need for organizational and cultural change, including improved safety policies, regular training, and structural adjustments to ensure rest and recovery in high-heat conditions.

Implications of the Study

The pilot study reaffirms that construction safety generally has many influential factors, including the masculine culture. It also reaffirms that some workers can underestimate risks and overestimate their ability to withstand them. Based on the findings and process of conducting this study, the research team has moved toward understanding what symptoms workers would be more prone to ignore than others. This could lead to targeted interventions and adjustments to current safety programs that would highlight the importance of stopping work for every type of HS symptom experienced; however, as a pilot investigation, there is no certainty that these factors are the ones to focus on. Also, there is a need for stronger guidelines and a shift in organizational culture that allows workers at the authority to stop working when feeling any HS symptoms. This paper hopes to encourage others to engage with the instrument and protocol to provide additional quality measures and gain further insight through collaborative efforts. The authors hope that future work in this area will generally impact the heat safety behaviors of construction workers, which is the goal of this work.

Limitations

This study is limited by its small sample size and will not reflect the full spectrum of behaviors and experiences among the population. The convenience sampling approach also limits the study's representativeness, so the findings are not generalizable. The reliance on self-reported data is another limitation, as responses may be influenced by recall bias or the desire to provide socially acceptable answers. Also, participants were drawn from a limited geographic scope and therefore will not reflect the diversity across regions. Furthermore, as a pilot study, the findings are preliminary and require validation through larger-scale research to ensure broader applicability and generalizability.

Future Work

Further research is warranted to expand upon this pilot study with a larger, more diverse sample size of construction workers. Future studies should consider inferential statistics and an understanding of intended behaviors across groups with a sample size that would allow for generalizability.

Conclusion

The findings of this pilot study reveal that workers face multiple personal and organizational barriers in prioritizing their health under extreme heat conditions. Awareness of heat-related symptoms and health risks is high, yet economic pressures, cultural factors, and workplace norms often impede workers from taking necessary breaks. Having an instrument with initial quality established (and further quality tests to come), the research team can continue to move forward with this exploration. These insights provide a foundational understanding for developing more robust safety interventions, policies, and training programs to encourage construction workers to prioritize their health in high-heat environments.

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