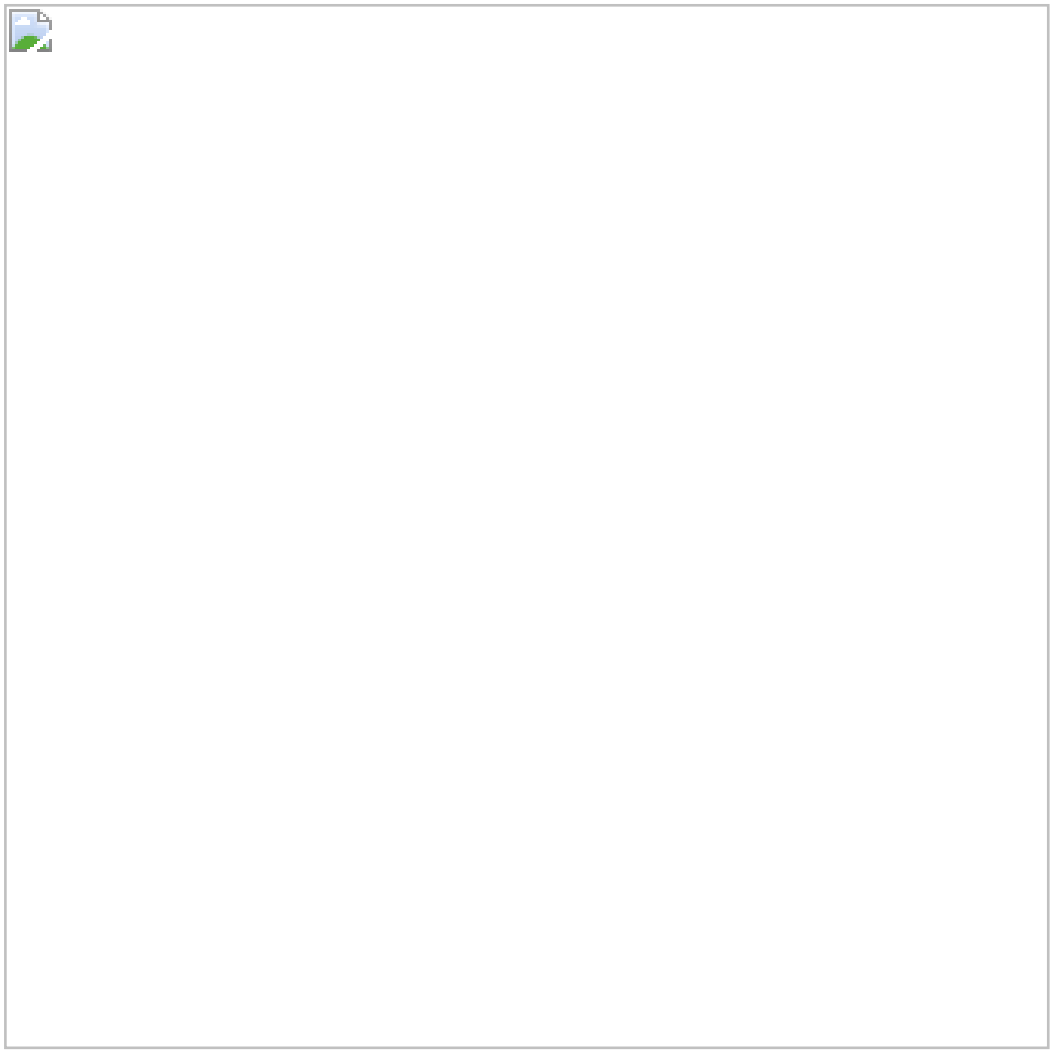

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Physical and Psychosocial Correlates of Occupational Physical Injury in the Global Construction Industry: A Scoping Review

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ABSTRACT

PURPOSE: The construction industry is a diverse sector with exposure to multiple psychosocial and environmental workplace hazards that increase the risk of injury. This scoping review aims to consolidate the existing literature on the physical and psychosocial determinants influencing the risk of occupational physical injuries among construction workers globally.

METHODS: A scoping review was conducted using the PRISMA extension checklist guided. Literature searches were performed between June and October 2023 in electronic academic databases.

RESULTS: A total of 77 studies were identified, encompassing various geographical regions, including North America (n = 29), Africa (n = 18), Europe (n = 12), Asia (n = 9), the Middle East (n = 5), and Oceania (n = 4). The review identified physical and psychosocial factors in 3 domains influencing occupational physical injuries: workplace physical environment (eg, exposure to physical hazards, availability and utilization of personal protective equipment, company size, and job type), workplace culture (eg, psychosocial stressors, gender-related barriers, migrant and ethnic disparities, educational background), and physical wellbeing, health and aging (eg, age, obesity, sleep quality, marital stats, and physical health status). Notably, workers from social minority groups (eg, women, ethnic and migrant workers) of young (<25 years old) or older ages (45-55 years old) employed in smaller construction companies are vulnerable to increased injury risk and exposure to physical and psychosocial hazards in the workplace.

CONCLUSION: The review emphasizes a global paucity of research examining the implications of physical and psychosocial factors on injury risk within the construction industry. Future research should prioritize investigating the impact of psychosocial hazards on younger and older workers to detect age-related differences in injury rate, treatment access, and work-related health outcomes.

KEYWORDS: Construction, occupational injury, psychosocial stress, public health, workplace environment

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Introduction

The construction industry is one of the largest segments of the labor market in many countries, accounting for 7% of the global workforce.[1] Economically, it impacts 5% to 15% of the total gross domestic product in most industrialized and developing countries.[2-4] In the United States alone, the construction industry accounts for one-third of all reported occupational injuries.[5,6] Similarly, studies from African[7-16] and Middle Eastern countries[17-19] have reported prevalence rate of construction-related injuries ranging from 30% to 84%. Globally, there is an increasing trend in non-fatal and fatal injuries, with and estimated 8000 work-related deaths daily, among which 855 are attributed to occupational injuries.[20] This increase in occupational injury and mortality burdens within the global construction industry may be attributed to several factors, including stagnant safety climates, lack of improvements in safety attitudes particularly in developing countries, exposures to hazardous substances and materials, limited access to health promotion initiatives and healthcare services, and a one-dimensional approach to understanding injury risk factors.[1,20,21]

Construction workers are vulnerable to multiple occupational safety risks (eg, poor safety climates, lack of access to occupational health services), hazardous workplace environments (eg, exposure to harmful construction materials, dangerous tools/machinery, working at heights or in confined

spaces), physically demanding job activities, and complex psychosocial pressures (eg, high workplace demands with low support, racial and minority inequity, and gender-based discrimination) that may confer risk for occupational injury.[22-25] Intersectional groups may be at an even greater risk as prior studies have shown that the proportion and severity of injury is greater in ethnic minorities (eg, African Americans, Hispanics),[26] individuals with low socioeconomic status,[27,28] women,[29-30] and younger, inexperienced construction workers.[31,32] Construction companies may also outsource migrant workers via the global supply chain, which makes it easier to underpay and exploit them.[33,34] These non-standard work agreements open the door to low wages, lack of safety nets, and poor working conditions, which may implicate occupational injury risk and challenges with workplace culture.[35] The interplay of work-related factors, environmental factors, and an individual's perception of that environment greatly influence their experience of occupational health and physical injury.[36] Therefore, more considerations must be given to this topic as there is a lack of urgency in not only addressing physical and psychosocial issues but also providing support for construction workers.

To recognize the multidimensionality of factors affecting construction workers' occupational health and injury risk, this review adopts the worker wellbeing framework outlined by Chari et al.[36] This framework emphasizes wellbeing as an integrative concept encompassing an individual's perception or beliefs about their work, and work-related, organizational, environmental, and psychosocial factors. It considers the influence of work and nonwork factors that impact worker physical health, mental health, and quality of life, with the goal of promoting positive working conditions. The worker well-being framework is categorized into 5 domains: (1) workplace physical environment and safety climate, (2) workplace policies and culture (policies, programs, and practices), (3) health status, (4) work evaluation and experience (experiences and evaluations of quality of work life), and (5) home, community, and society (life contexts situated outside of work). These domains may capture the evolving nature of the construction workplace through changes in technology and materials, updates in safety procedures, participation rates of historically underrepresented persons in the construction sector (eg, women), and the overlapping demands of work and personal commitments. By embracing this framework, the study aims to offer a comprehensive understanding of the complex interplay between various physical and psychosocial factors, and their implications for workers' wellbeing and safety in the construction industry.

Objective

The primary objective of this scoping review was to examine the impact of physical and psychosocial factors on occupational health, injury risk, and worker wellbeing within the global construction industry. Notably, this study excludes examination of mental health or mental wellbeing, as comprehensive reviews on these topics have been previously published.[37-39] This scoping review focused on 3 domains of worker wellbeing developed by Chari et al[36] including (1) Workplace Physical Environment: This includes aspects such as exposure to physical hazards, company size, job type, and the availability and utilization of personal protective equipment. (2) Workplace Culture: This domain encompasses gender-related barriers, migrant and ethnic disparities, educational influences, and various psychosocial stressors prevalent in construction settings. (3) Health, Aging, and Wellbeing: Here, we explore factors such as overall health status, obesity, sleep quality, age, and marital status as they relate to occupational physical health outcomes among construction workers. As there was limited literature available that explored the 2 domains of work evaluation and experience, and home, community, and society, we did not analyze these aspects of the worker wellbeing framework in this scoping review. Furthermore, many of concepts within these 2 domains overlap greatly with mental health studies in construction that have been previously reviewed and are out of the scope of this review.

Scoping review questions (SRQ)

SRQ #1: What prominent physical and psychosocial factors influence occupational health and injury risk in workers engaged in the global construction industry?

SRQ #2: How do these identified factors function and interact to affect occupational injury in the workplace?

SRQ #3: Is there an occupational risk profile of construction workers who are particularly vulnerable or at greater risk of occupational injury in their workplace?

Methods

A comprehensive scoping review methodological framework was employed based on standardized protocols published by Arksey and O'Malley[40] and the Joanne Briggs Institute[41,42] and review reporting guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews checklist (PRISMA-ScR).[43] A scoping review was undertaken to identify research knowledge gaps, identify key factors, and determine the overall state of research within the global construction industry without a focus on study design. This scoping review was pre-registered on Open Science (Registration ID: 6K8P5).

Eligibility criteria

Eligibility criteria, including the inclusion and exclusion criteria, were developed using the Participants, Concept, and Context (PCC) framework.[42] The framework was based purposefully on the research objective and questions and gaps identified in the literature relating to occupational health and

Table 1. Population, Concept, Context (PCC): Key search terms, inclusion and exclusion criteria.

	KEY SEARCH TERMS	INCLUSION CRITERIA	EXCLUSION CRITERIA
Population	Construction worker Worker Apprentice Building trades worker Manual laborer	- Construction industry workers including apprentices, journeypersons, skilled and unskilled workers, union and non-unionized workers found working on residential or commercial construction sites or any area where clearly defined construction activities were being performed. - Working population: aged 15 to 75 years old.	- Construction managers, supervisors, or human resources, and administrative staff. - High school students or students not participating in apprenticeship training.
Concept	Occupational health Injury risk prevention Worker wellbeing Physical health Psychosocial factors Physical factors Physical workload	- Studies reporting any reference to a musculoskeletal and/or physical injury - Studies must focus on injury prevalence and deterministic factors influencing injury risk in the construction environment.	- Studies specifically focused on evaluating safety climate, developing safety programming, and/or assessing the effectiveness of safety interventions. - Studies exclusively focused on traumatic brain injury, mental health or illicit drug usage.
Context	Construction industry Laborer industry	- Occupational research focused on the construction and construction laborer industries globally in developing and developed countries.	- Office workers or off-site employees not exposed to construction or laborer environments. - Industrial workers from manufacturing, commercial, manufacturing, and mining settings.

injury risk in the global construction industry. A summary of the PCC framework employed in this study is presented in Table 1. Studies were required to be reported in English and from peer-reviewed academic sources. Studies that reported large-scale data on multiple occupations were included, but only the construction worker samples' findings were retrieved. Studies with an exclusive focus on traumatic brain injury were not included. Systematic reviews, meta-analyses, knowledge syntheses, letters to the editor, and commentary papers were not included as this scoping review focused on studies reporting primary data. For relevance, studies included were published between January 1, 2000 and October 15, 2023. Studies that exclusively analyzed retrospective participant data collected prior to January 1, 2000 were excluded for relevance to current global construction research.

Population

Construction workers were identified as the population of interest. Construction workers were defined using broad criteria, including those identified as skilled trades workers, builders, and laborers working or involved in the construction, repair, or maintenance of buildings, machinery, infrastructure, and engaged on construction sites. Workers that were not identified as engaging in work on construction sites or performing construction-related duties were excluded, in line with prior reviews on construction workers.[37-39]

Concept

The conceptual focus of this review was on occupational health and injury within the global construction industry. Specifically, an examination of physical and psychosocial factors that influence occupational health, worker wellbeing, and risk of injury were explored. Physical health factors were conceptualized as modifiable individual and/or operational factors, including manual material handling, awkward posture, and repetitive posture, that implicate occupational health and risk of injury. Psychosocial factors were conceptualized as organizational or system-based factors based on workplace culture and/or ethnic, economic, cultural or professional membership of a social group that influences one's perception and experience of their workplace. Social minority groups (eg, migrant and foreign workers) were defined as those groups historically subordinated in the construction sector due to cultural differences and differences in workplace experiences. Lastly, we applied an underlying theoretical framework of worker wellbeing to organize our findings.[36] In focusing on the construction workplace context, we targeted 3 of the 5 domains from a physical and psychosocial perspective, including (1) workplace physical environment, (2) workplace culture, and (3) health, aging, and wellbeing.

Context

The main context of this scoping review was the global construction industry. Construction workers' settings were considered broadly to include residential and commercial or any area where clearly defined construction activities were being performed. Intensive physical labor activities similar to construction were also included, such as maintenance, renovation, reconstruction, repairs, demolition, and excavation. Public or government-led construction settings, such as roads, bridges, sewers, etc., were also included.

Search strategy

To investigate the research question(s), a well-defined set of key search terms were collaboratively established from our previous research experience within this population and the existing literature. The reviewers independently conducted an exploratory search to evaluate the viability of a scoping review protocol and examine the parameters of the established PCC criteria. The search strategy underwent refinement through constructive team discussions to ensure consistency and agreement upon the authors. The search strategy included a combination of the following relevant keywords: "psychosocial factors" "occupational injury" OR "work injury" OR "traumatic injuries" OR "health hazards" OR "injury prevention" OR "occupational health" OR "occupational safety" OR "accident prevention" OR "occupational hazard" OR "physical hazard" OR "chemical hazard" AND "construction workers" OR "apprentice" OR "building trades worker" OR "manual workers" OR "skilled workers" OR "skilled labour" OR "manufacturing" OR "industrial workers" OR "trades workers" OR "trades" OR "construction" "skilled trades." Any studies relevant to the topic and fitting the PCC framework were considered for inclusion and pre-screening. The final search strategies and the electronic databases used in the study are presented in Supplemental Table S1.

The reviewers (censored for peer-review) searched independently from June 19 to October 15, 2023, across 4 electronic databases: PubMed, PsychINFO, Cinahl, and Scopus. A secondary hand-search of Google Scholar was performed by 1 reviewer (censored for peer-review), to identify any secondary literature not identified in our primary search databases. References lists and consultation of any related conferences were also reviewed for studies. The initial database search identified 1892 studies after filtering for English language. The secondary Google Scholar search identified 7 additional studies for review. The identified articles were uploaded to Covidence software for initial review, screening, full-text review, and data extraction. Before subjecting these studies to screening, duplicates, non-peer reviewed sources, and studies published prior to January 1st, 2000, were removed, leaving 1732 studies for title and abstract screening. Subsequently, the reviewers (censored for peer-review) evaluated the titles and abstracts of these studies against the PCC criteria developed leading to the exclusion of 1509 studies. The review team met weekly during the title and abstract screening process to discuss any challenges and difficulties to study selection related to eligibility criteria and study objectives. Full-text PDF screening of 223 studies was divided among the reviewers (censored for peer-review) and performed individually against the pre-determined PCC criteria. Collaborative team discussions occurred where a reviewer identified a study that did not clearly meet the developed PCC criteria and required team input for inclusion or exclusion into the review. Any disagreements were resolved by consulting 2 senior research members (censored for peer-review). This comprehensive evaluation led to the exclusion of 171 studies. A final count of 77 studies were included in this review. Figure 1 illustrates the PRISMA-ScR flow diagram and study selection progress.

Data charting

Data extraction was performed using a data charting form developed by the reviewers (censored for peer-review) and in discussion with the remaining team (censored for peer-review) based on the guidance from Arksey and O'Malley,[40] Levac et al,[45] and JBI Reviewer's Manual.[42] Data was organized in a Microsoft Excel table with relevant study characteristics and variables of interest based on the PCC criteria and the worker wellbeing framework.[36] The main variables included were author, year of publication, study location, study design, study objectives, outcome measures, and main findings. Data was also collected on specific variables of interest, such as workplace environment and hazards, age, injury characteristics, injury type, sleep quality, BMI, marital status, gender, ethnicity, socioeconomic status, job type, and company size. After entering data for the first 10 studies, the team collaboratively tested the table's effectiveness and applied revisions until the data was representative of the objectives of the scoping review. Any inconsistencies in data charting or were addressed by team review of the full-text PDF and discussion to achieve group consensus.

A critical appraisal of evidence was not performed to gather all the available insights and evidence and to avoid methodological emphasis due to many of the studies being secondary data analyses.[42] There were considerations of methodological approach and rigor when examining the differences in the reported findings of retrospective and prospective research designs, however it was not the primary focus of this scoping review. Instead, data was collated, summarized, and reported using the procedures outlined in Levac et al.[45] First, an overall data analysis was performed numerically and qualitatively to explore the characteristics of the included studies. Subsequently, reporting of the main findings of the studies based on the study objective was organized and described.

Results

Overview

A total of 77 studies were included in this review. Among the 77 studies, research from the United States was most predominant (n = 26), followed by Ethiopia (n = 12), Iran (n = 5), Australia (n = 4), Canada (n = 3), Singapore (n = 3), and the United Kingdom (n = 3). Countries with less than 3 studies included: Netherlands (n = 2), Finland (n = 2), China (n = 2), Korea (n = 2), Spain (n = 2), India (n = 1), Italy (n = 1), Bangladesh (n = 1), Denmark (n = 1), Uganda (n = 1), Nigeria (n = 1), Kenya (n = 1), Egypt (n = 1), Switzerland (n = 1), Gambia (n = 1), and Ghana (n = 1). Most of the study designs employed a

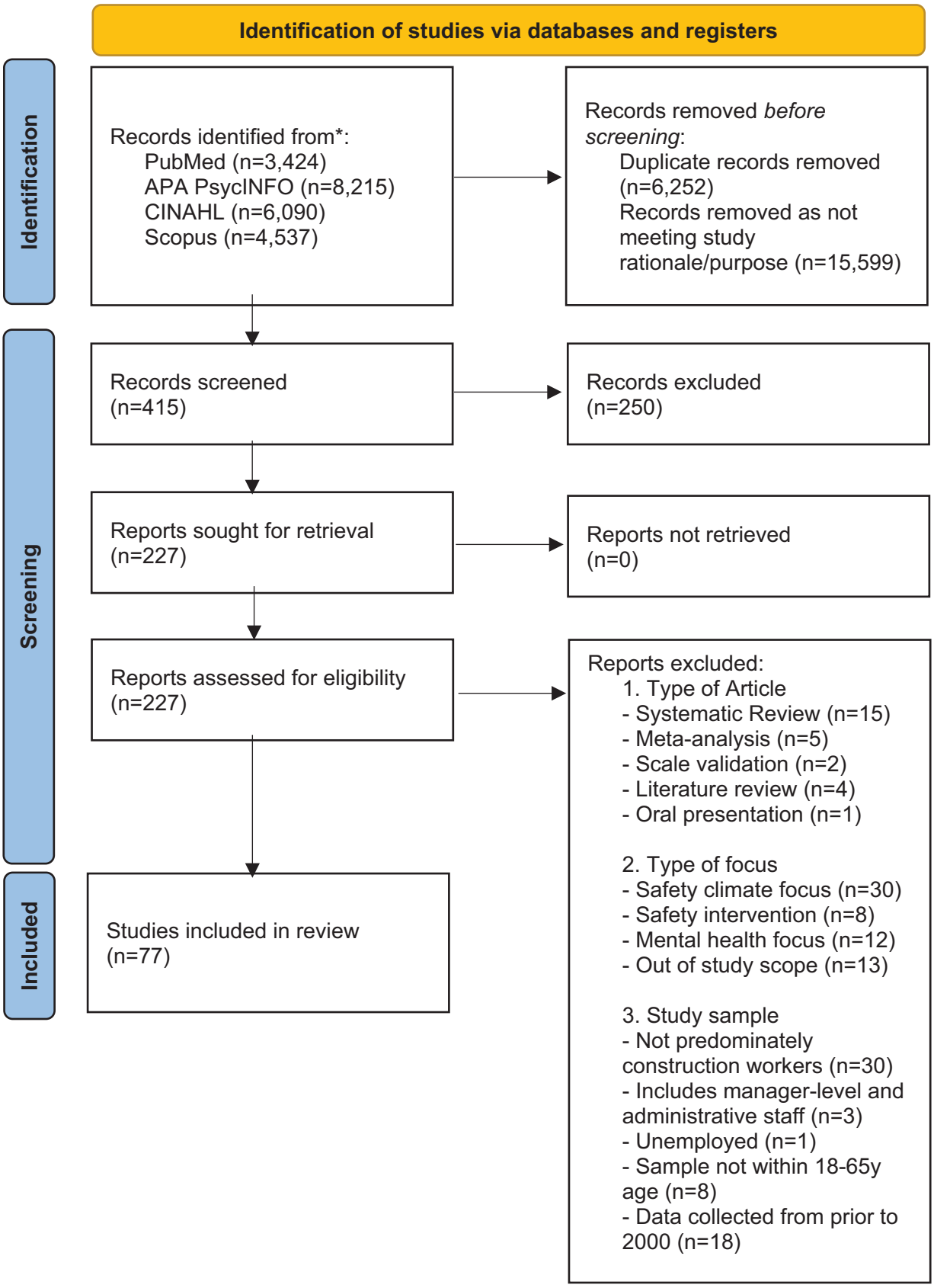

Figure 1. PRISMA chart for the search strategy.
Source: Adapted from PRISMA 2020 guidelines for new systematic reviews which included searches of databases and registers only (Page et al[44]).

quantitative research design (n = 50), followed by qualitative (n = 14), and mixed-methods (n = 13). Moreover, 47 studies used primary collection tools such as surveys, questionnaires, focus groups, interviews, or ethnographic observations, while 30 analyzed retrospective, secondary data. Most studies were cross-sectional (n = 47). Sex composition of study participants was predominately male (70%+ males sample, n = 37), followed by mixed sexes (40%-60% each sex, n = 9), exclusively male (n = 6), exclusively female (n = 4), and predominately female (70%+ female sample, n = 2). Nineteen studies did not report the sex composition of the participant data.

This scoping review proposed 3 review questions to assess occupational health, injury risk, and worker wellbeing in the global construction industry. Occupational injury and its associated factors can influence construction workers' workplace health and safety. Physical and psychosocial factors were specifically focused in the context of worker wellbeing in this scoping review. Physical factors examined risk factors of occupational injuries that occur when an individual performs job-related duties. Based on the available evidence from the global construction industry, we focused on 4 primary physical factors within the workplace environment, including exposure to physical hazards, access and availability of personal protective equipment, company size, and job type. Psychosocial determinants of occupational injury can influence injury risk and rehabilitation outcomes related to reporting and care access. Therefore, we examined the following psychosocial factors defined by workplace culture, including psychosocial stressors (eg, include time pressure, discrimination, bullying, overcompensation, work-life balance, social support/supervisory support, job satisfaction, harassment, job stress, and job demands/strain), gender-related barriers, migrant and ethnic disparities, and education. Lastly, identified factors relating to health, aging, and physical wellbeing were discussed, including obesity, sleep quality, age, physical health status, and marital status. A summary of our findings are presented in Tables 2 and 3.

Workplace physical environment

Exposure to physical hazards. Construction workers are exposed to multiple physical hazards in their workplace that influence their occupational injury risk. They are exposed to chemical agents and hazardous building materials, climate change (eg, heat stress), falling objects, electrical shock, vibrational and mechanical forces from machinery and tools, sharp objects, unsafe or dangerous work environments, poor air quality, and noisy environments.[25,30,46-48] The most common causes of workplace injury for construction workers include slip and falls at ground level, falling from heights, and being struck by tools or building objects.[48-55] Construction activities are performed on ladders, scaffolds, stairs, roofs, and other building structures that produce risks of traumatic fall-related injuries.[12,50,56-58] When working on ladders or at heights, falls were demonstrated to be the most frequent cause of occupational injury.[55-57] The movement or height of ladders and scaffolders were found to be associated with fall-related injuries and fractures. Workers may also be exposed to electrical injury from the operation of tools or lack of safety equipment when working with electrical current.[32,57,58] Workers who frequently worked with electrical tools reported exposure to unprotected high voltage accidents, resulting in electrical burns and other types of electrical-related injuries (eg, traumatic shock, multiple injuries, and concussion with internal injuries).[32,58-61] Other causes of physical injury include or carrying objects, physical overexertion, repetitive postures and motion, assisting co-workers, and operation of construction machinery/devices.[7,9,62,63] Dutta[33] and Dutta et al[3] stated that a lack of accommodation or facilities in the workplace for resting, quality food, and heat-related measures may also increase physical injury risk. Ekpenyong and Inyang[10] found that body positions, including kneeling, vibration exposure, working in awkward postures, stooping or twisted posture, showed a strong association with musculoskeletal symptoms. Given the physical nature of the work and workload, ergonomic hazards can pose additional injury risks as they are prevalent and inherent within a construction work site.[64-66]

Availability and use of PPE. Many studies reported that lack of adequate personal protective equipment (PPE) and poor safety supervision contribute to workplace injury.[18,22,56,67] The most common reason for the lack of PPE was companies not providing PPE for their workers.[68,69] Hours worked (>8 hours per day or >45 hours/week), physically demanding jobs, lack of injury surveillance/ reporting procedures, and complex construction activities were also identified as mediating factors that contributed to lack of PPE usage, increased hazard exposure and occupational injury risk.[19,25,31,70] Other reasons include PPE usage interfering with the ability to perform their work, lack of safety training or supervision, concerns about employment insecurity when asking for PPE, and lack of awareness of hazards requiring PPE use.[11,22,71] PPE usage in studies of construction workers in African countries was variable and ranged from 3% to 70%.[9,11,14-16,18,49,72] PPE usage in North American and European countries were also variable at 50% to 70%.[51,53] PPE usage in construction reduced risk of injury by almost 2-5x in some studies.[13,15,49,72] Those without general safety training were also less likely to use PPE.[71] Studies on women in the construction industry have reported inaccessibility to properly fitting PPE and inadequate sanitary facilities.[64] Construction workers in countries with hot and dry climates such as India developed heat-related symptoms during work, including heavy sweating, intense thirst, dehydration, and neurological symptoms such as headaches, blurred visions, and fainting due to an absence of accessible PPE.[3]

Safety training in the workplace and pre-employment preparation were rarely reported upon review of the included studies.[71] Studies that did report access and availability to safety training noted that training and safety supervision were not

Table 2. Summary of physical correlates.

PHYSICAL CORRELATE	DESCRIPTION	NUMBER OF PAPERS	SOURCES
Workplace physical environment characteristics			
Workplace physical hazards	Injuries in the construction industry may be identified at the individual, organizational, environmental, and equipment-related levels. These may include attentional capabilities, specific tool usage, and workplace environmental factors such as electricity, vibration, and noise. Specific activities, such as scaffolding, floor tiling, painting, and masonry are also identified. Occupational injury associated factors include exposure to activities necessary for working in an occupation, such as working at heights, operating heavy machinery, and exposure to hazardous/chemical materials. This factor categorizes and highlights the various risks associated with such tasks and their role in occupational health and safety.	41	3, 7, 9, 10, 12, 15, 17, 19, 22, 25, 30, 32, 33, 47-67, 73, 77, 80, 81, 86, 87, 94
Personal protective equipment (PPE)	Inadequate use of personal protective equipment (PPE) can be attributed to various factors, including the absence or shortage of properly fitted PPE provided by the workplace. A lack of safety measures within the construction industry may contribute to the infrequent provision of PPE in the workplace. Some construction workers may perceive the use of PPE as hindering their ability to work.	23	3, 9, 11, 13-16, 18, 19, 22, 25, 32, 47, 50, 51, 53, 65, 68, 71, 74, 75, 77
Company size and occupation type	Company size and employment practices have a crucial role in construction industry injury risk, with larger companies typically have more resources for safety measures, while smaller ones may lack sufficient safety infrastructure. Subcontracting and temporary employment (gigs) can pose challenges to maintaining consistent safety standards within the industry. Each occupation within exposure has repetitive exposure risk based on the primary activity. For example, roofers, carpenters, and drywall installers may suffer increased prevalence of lower back pain. While unskilled workers and bricklayers may experience increased risk of non-fatal and fatal injuries due to repetitive labor intensive tasks.	22	8, 10, 13, 14, 18, 23, 32, 33, 50, 52, 57, 58, 67, 69, 70, 71, 74, 75, 77, 79, 80, 81
Falls	Falls are the most frequent cause of occupational injury and fatality in the construction industry. The movement or height of ladders and scaffolders were found to be associated with fall-related injuries and fractures in construction workers.	18	9, 12, 17, 19, 22, 48-50, 53-56, 58, 61, 63, 77, 80, 90
Health, aging, and wellbeing			
Types and severity of injury	Fractures, lacerations, sprains, and strains most commonly affect the upper and lower limbs, followed by the head, thorax, or spine. Other injuries include fall-related injuries, electrical trauma, occupational dermatoses, musculoskeletal disorders, and eye injuries.	36	3, 7, 8, 12-15, 17-19, 25, 33, 47, 48, 50-54, 58, 59, 62, 63, 67, 68, 72, 73, 80, 85, 86, 89, 92-96
Age	Age significantly affects occupational injury risk in the construction industry. Younger workers may be more susceptible to acute accidents because of risk-taking behaviors, lack of training and experience, and safety non-compliance. Older workers may face chronic injuries due to age-related physical declines and conditions like musculoskeletal issues.	37	7-10, 12-14, 18, 22, 25, 33, 48, 49, 51, 52, 55, 56-59, 61, 63, 64, 67, 70, 73, 75, 77, 79, 80, 82, 85, 89, 92-94, 98
Fatigue	States of physical or mental exhaustion, often resulting from prolonged or irregular work hours, physically demanding tasks, and inadequate rest periods, may increase injury risk by reducing a worker's ability to perform tasks safely and effectively.	6	34, 51, 70, 71, 86, 98
Sleep Quality	Sleep duration, disturbances, efficiency, and overall satisfaction may influence workers' capabilities to manage their demanding and potentially irregular work schedules, physical exertion, and environmental factors. The potential risks associated with poor sleep quality can have negative implications for safety, productivity, and well-being.	7	12, 13, 48, 50, 54, 94, 97
Obesity	Construction workers often exhibit higher BMI scores, which can contribute to increased injury risk and a higher likelihood of developing lower back pain. While some of these elevated scores may be attributed to lean body mass, many workers in this physically demanding profession tend to have higher body fat percentages, suggesting that their high BMI is often not associated with increased muscle mass.	7	10, 32, 77, 82, 86, 93, 94

Table 3. Summary of psychosocial correlates.

SOCIAL CORRELATE	DESCRIPTION	NUMBER OF PAPERS	SOURCES
Workplace culture			
Gender-related challenges	Women in construction may face challenges due to their minority status in this male-dominated industry. Psychosocial stressors can distract from their work, while ill-fitting personal protective equipment (PPE) designed primarily for men can compromise safety. Inclusive workplace cultures, targeted support, and properly fitting PPE may improve their safety and well-being in this traditionally male-oriented field. Traditional masculinity and gender norms are deeply rooted in the field, where workers may feel the need to conform to the ideals of physical toughness and risk-taking behavior. Adherence to such can lead to an increased willingness to engage in risky tasks and a reluctance for aid-seeking behaviors and injury reporting.	27	3, 7, 8, 11, 14, 16, 17, 22, 28, 30, 49, 53, 54, 58-61, 64, 65, 75, 78, 83, 85-88
Psychosocial stressors	These stressors may influence worker risk perception, hazard awareness, and predispose workers to increased physical injury risk. Some examples of psychosocial stressors in the construction workplace may include time pressure, discrimination, bullying, overcompensation, work-life balance, social support/supervisory support, job satisfaction, harassment, job stress, and job demands/strain.	21	7, 10, 13, 14, 16, 17, 23, 25, 30, 45, 50, 61, 69, 70, 72, 81-85, 97
Ethnic and migrant disparities	Minority and migrant workers face unique challenges such as language barriers, cultural differences, and unfamiliarity with safety protocols. Without the knowledge to effectively navigate the safety landscape, they are more likely to take on laborious or hazardous jobs due to limited employment opportunities, worsened due to discrimination and resource inequity. Workers of underrepresented racial or ethnic groups may encounter unique obstacles that increase their vulnerability and safety non-compliance. Such factors may include restricted access to resources, communication barriers, unequal access to safety training and personal protective equipment, or a disproportionate assignment to dangerous tasks. At a glance, minority workers may have fewer advocates and voices for their safety concerns because of the industry's historical exploitation and lack of representation and inclusivity.	15	10, 13, 22, 28, 31, 33, 55, 58, 63, 66, 68, 73, 89-91
Marital Status	There is no consensus on whether marital status has a defined relationship with occupational injury risk. Some theorize that having social roles and responsibilities associated with having a family (eg, "second shifts") may implicate the potential for fatigue accumulation.	6	9, 12, 16, 18, 30, 75
Education	Construction workers report lower levels of educational attainment with most completing high school education or less. Participation in vocational training is protective against physical injury through increased safety adherence and adequate risk perception. Risk for physical injuries increase for those with lower levels of educational attainment and/or without vocational training.	7	10, 12, 18, 22, 49, 74, 75

regularly conducted.[9,13,15,49,73] Those without injury prevention awareness, safety training, or knowledge of physical hazard mitigation generally had lower risk perceptions in the construction environment.[74,75] Perceptions of a safe work environment was also associated with lower physical injury prevalence.[13] Workplace safety supervision was also found to be protective against workplace injury in most studies,[10,17,49] but not associated with injury reduction in one study.[13] When compared to no safety supervision, injury rates were 2-3x lower.[72] Effective safety training, adherence to safety procedures, supervision and safety personnel, and access to PPE were reported as critical to prevent occupational injury.[15,46,52,76]

Company size and job type. The studies reviewed generally found that companies with fewer employees are exposed to greater risks for physical injury in the workplace. Fall-related injuries and fatal and non-fatal accidents were reported more often in smaller companies with less than 25 employees.[56,57,68,77,78] Workers in smaller companies have greater risk for physical injury for multiple reasons including less resources to invest in occupational health and safety reporting and rehabilitation,[31,69,77] less knowledge of workplace hazards, and poorer management of safety training and resource implementation as compared to larger companies.[18,69,70,73,78] Smaller companies are also more likely to recruit ethnic and unskilled laborers that have low-risk perception, language and or cultural communication barriers, and a lack of safety knowledge that may increase risk for physical injury.[31,77]

The characteristics of the job performed within a construction company is also an important risk factor for physical

injury. Commercial construction workers are at a higher risk of injury and more likely to report musculoskeletal pain in their hands, neck, lower back, and knees compared to residential workers.[69,74] Temporary or seasonal workers and unskilled laborers are at higher risk for workplace accidents and physical injury in construction settings.[8,10,13,18,51,76,79] A study of Ethiopian construction workers found a higher prevalence rate of lower back pain in daily laborers than other building construction workers.[49] Electricians, carpenters, painters, roofs, substructure workers, and plumbers also have higher work-related musculoskeletal disorders, and fatal and non-fatal accident rates.[10,32,51,56,80] Electricians, bricklayers, and building laborers were found to be exposed to more electrical accidents than other trades workers.[32] Bricklayers also have a high rate of musculoskeletal symptoms in the neck, as well as back and upper limb disorders.[10,23] Crane operators, insulators, and painters had higher odds of neck disorders, while roofers and floorers had higher odds of lower back and lower extremity injuries.[66] No studies reported consistent data on construction jobs that have lower risk for physical injury, however 2 studies found that plumbers, welders, and ironworkers reported less injuries than their construction counterparts.[14,79]

Workplace culture

Psychosocial stressors. Several psychosocial stressors exist in the construction workplace. Workers experience work pressures that result in long and demanding working schedules, high work demands, disruptions of work-life balance, limited work task variability, and low work autonomy.[10,14,25] They interact with diverse groups of people in changing environments, which may expose them to unique stressors as they enter the job site.[81] Physical injury, poor physical health, and musculoskeletal symptoms have been associated with high work demands, time pressure, overtime and long working hours, and skill underutilization.[13,17,50,53,70,78,81-83] Lack of supervisory and co-worker support for safety and wellbeing was associated with decreased work ability, absenteeism, higher job strain, and musculoskeletal symptoms.[69,70,81-84] Similarly, Kiconco et al[13] reported that competent supervision did not reduce or prevent physical injury. Job dissatisfaction was associated with an increased risk for occupational injury globally due to multiple factors, including negative attitudes toward the work environment, job uncertainty, financial stress, repetitive work, and/or low worker morale in the workplace.[7,13,16,25,30,72] Conversely, job satisfaction and co-worker support has been reported to reduce the risk for lower back pain and work-related injury.[85] Also, studies reported experiences of workplace violence, physical and sexual harassment, age and gender-based discrimination, and bullying for construction workers with a more prominent impact on a female workers' wellbeing and physical health.[30,61,86]

Gender-related barriers. Construction work has traditionally been viewed as a physically challenging male-dominated career.[30,87] Hegemonic masculinity with strong personal identification with the worker role, stigmatization of injury disclosure, physical overcompensation, and displays of competitiveness and aggressiveness may often be seen in the construction workplace.[59,87] Occupational research has focused primarily on male workers on the job site since they represent more than 80% to 90% of the global construction workforce.[65,86] Accordingly, gendered exposures to hazard in the construction workplace result in different risk profiles for men and women.[3,83] Curtis et al[30] found that differences in physical capabilities resulted in gender-specific task exposures with women more likely to be exposed to tasks involving chemicals, while men were predominantly engaged in tasks related to dust and welding fumes. Due to gendered distributions of work tasks, studies have reported that males experience more traumatic injuries through exposure to dangerous, physically challenging, and risky work environments.[30,59] Studies suggest that the development of brotherhood cultures, which enforces masculine behavioral norms may lead to gender segregation, discrimination, social isolation, workplace bullying, and pressures to perform in the workplace resulting in increased perceived stress and physical injury, more so in women compared to their male counterparts.[3,28,30,59] Women may experience withholding of training or job information due to the competitive masculine environment which may lead to a higher rate of injuries, reduced willingness to report injuries, and poor safety knowledge.[28,65] When faced with this institutionalized belief, women were found to need to prove themselves, leading to the fear of reporting injuries and a greater disregard for work-life balance.[30,61] Women also experience reduced protection from physical hazards and higher risk of musculoskeletal symptoms due to differences in body anthropometry resulting in challenges to procure properly fitting PPE and inadequate sanitary facilities.[28,55,61,64] These gender differences in hazard exposures require women to develop personal resilience and reframe negative experiences to withstand the challenges of working in a male-dominated career.[1]

There is a gendered experience of physical injuries while working in construction with different hazard exposure, injury risk profiles, and rehabilitation patterns.[53] Men experience more fall-related fatal and non-fatal injuries while women experience more injury due to inanimate objects.[59] Males are more likely to experience traumatic work-related injuries and electrical accidents compared to female workers.[22,54,59,60] Studies have shown that males have a lower risk perception and are vulnerable to injury due to undereducation, higher risk-taking behaviors, and neglect of safety procedures.[75] Studies estimate that males experience between 2 and 6 times greater risk of injury in the workplace.[7,8,11,12,14,16,17] This increased risk estimate is to be interpreted with caution, as women have been underrepresented in occupational research.[87] Women are at greater risk for physical injury when they experience high job strain, increased body anthropometry or age-related declines in physical performance and muscle mass due to differences in

aerobic capacity.[54,75,87] Both genders report high rates of carpel tunnel syndrome while working in the construction trades.[88] Liu et al[75] found that women had higher levels of occupational health risk perception, more help-seeking behavior, and faster recovery times from work-related injuries than male workers.

Migrant and ethnic disparities. Ethnic visible minorities and migrant workers experience high rates of physical injuries in the global construction industry.[68,89] Hispanic American and non-American workers in the US faced disproportionately higher fatality rates than their non-Hispanic American counterparts.[22,31,73,89,90] Similar findings were reported among foreign workers in China and Switzerland.[55,91] Other studies have reported that native and White Caucasian workers report a higher rate of work-related musculoskeletal disorders than Hispanic workers, however they acknowledge this may be due to underreporting in construction settings.[22,58,66,90] Hispanic workers are also more likely to occupy construction jobs with higher risks of injury including laborers, painters, drywall installers, and electricians.[90] Studies have suggested that ethnic and migrant workers are more vulnerable to work-related injuries as they tend to work with smaller construction companies that may not have injury reporting procedures or reliable occupational health and safety programming, making the risk of physical injury higher.[22,31,68] Job insecurity, financial stress, education level, and inability to utilize health and safety compensation systems may also prevent injury reporting rates among this vulnerable group of workers.[10,28,63] Ethnic and migrant low-income workers may also experience difficulties in accessibility of PPE and vocational training to prepare them for the hazards of construction work.[13]

Language and cultural factors may predispose migrant workers to experience physical injury or accept dangerous construction work.[55,68] Dutta[33] found that migrant workers often do not understand English-based instructions and therefore experience job stress and hardship due to reprimands from their supervisors. Dutta[33] stated that due to the mistreatment workers experience because of communication and language barriers, they develop different beliefs, values, and perceptions of risks and anxieties. This lack of effective communication also impacted their ability to concentrate and identify hazards in the workplace leading to increased injuries and errors made during work.[73,89] The difficulties understanding health and safety regulations may also prevent adequate safety risk assessment resulting in accepting high risk, transient work in dangerous conditions.[89] Gabriel Ibarra-Meja et al[63] reported that risk perception for Hispanic-Latino construction workers was associated years of residence in the working country. This acknowledges the impact of cultural influences on injury reporting as a sign of weakness and fears of job loss and retaliation among these workers. These linguistic barriers may reduce adaptability and resiliency to stress in the hazardous construction work environment.[68]

Education. Globally, studies have found that educational attainment in construction workers are relatively low with less than 10% to 20% of workers having completed post-secondary education.[12,74,75] Fewer years of educational attainment was associated with increased risk for work-related musculoskeletal disorders and dangerous exposures in the workplace.[10,22,74] Workers who completed a high school education or less had a 3-4x greater risk of work-related injury and musculoskeletal disorders than those who completed post-secondary education (eg, college or university).[12,18] Lette et al[49] suggested that workers who did not participate in vocational training have a 3x higher risk of physical injury than those who did. Greater years of educational attainment were associated with injury reduction. Del Puerto and Gilkey[74] reported that with each additional year of formal education, there was a reduction in the risk of physical injury. Education level was also found to effect risk perception and coping behavior in construction workers with those having more education being more apt to mitigate hazard exposure and reduce injury risk.[75]

Health, aging, and physical wellbeing

Physical health. Construction workers experience poor long-term health outcomes and one of the highest occupational injury rates among industrial, health, and office workers.[3,46,85,92,93] Hanson et al[93] found that construction workers reported being pain-free significantly less than the general US population. The experience of chronic pain contributed to reduced participation in normal social activities, medical co-morbidities (eg, coronary heart disease, high cholesterol, obesity, hypertension), and sleep disorders. Jenkins et al[88] reported that construction trades workers experience higher rates of carpal tunnel syndrome compared to the general US population. Work stress and access to occupational health and safety services may contribute to poor health outcomes in construction workers.[14] Studies suggest poor health and injury surveillance post-injury that may influence the development of chronic pain, absenteeism, leaving occupation due to health-related reasons, and disability.[7,66,76,84] Dale et al[69] found that residential carpenters frequently reported missing days of work due to work-related pain or injury or missing days due to any pain or injury. Regular access to clinical pain management and injury treatment was important for symptom management, presenteeism, and prevention of diminished physical health.[25,84,94] Good health status was associated with less risk for lower back pain.[85] Welch et al[84] reported that factors for disability retirement include older age, presence of a musculoskeletal disorder, severity of injury, pain and functional disability, low work ability, lack of accommodation, lack of work support, and low expectations of recovery.

Physical injuries commonly reported in the construction industry were fractures, lacerations, contusions, abrasions, burns, sprains and strains, carpal tunnel syndrome, fall-related injuries, electrical trauma, head and eye injuries, and musculoskeletal

disorders.[8,13-17,19,47,49,50,53,63,67,71,72] Body parts that were often injured include the hands, upper and lower limbs, knees, lower back, and bilateral shoulders.[12,23,47,51,57,79,95] Traumatic or severe injuries were often sustained in the upper half of the body (eg, head, thorax, abdomen) and pelvic regions.[32,48,52,58,62] Construction workers who worked in carpentry and floor laying often reported lower back pain or musculoskeletal pain in the hands, knees, back, and wrists.[69,85] Construction workers also experience skin irritations and disorders.[18,49,61] Workers are exposed to various building and construction chemicals (eg, cement and concrete, etc.) that may cause skin irritations and chronic skin disorders. These chemical exposures may also put workers at-risk of respiratory conditions including asthma, rhinitis, and pneumonia.[61] Eye injuries were the least commonly reported injury in this scoping review and were largely due to irritation or foreign objects in the eyes.[18,49,62]

Obesity. Obesity was evaluated in 7 (~9%) of the studies in this review. The overall findings suggest that construction workers may have higher BMI scores in the range of overweight or obese, implicating postural-related risk for injury, work ability, and increased mechanical strain on muscles and joints.[10,81,93] Obesity has also been linked to poor health outcomes (eg, high blood pressure, sleep disorder, osteoarthritis), absenteeism, short-term absence of disability, and illness.[76] Ekpenyong and Inyang[10] identified that high BMI scores were associated with a 2x increased prevalence of work-related musculoskeletal disorders, especially when performing heavy construction tasks. Dong et al[31] reported that obesity was associated with a workplace injury, Gu et al[92] found no association between BMI scores and work-related injuries for workers in the construction industry. Gilkey et al[85] reported that body anthropometry was a risk factor for work-related injury in female construction workers only. Gilkey et al[85] found a positive correlation between BMI and low back pain.

Sleep quality. Sleep quality was assessed in 7 (~9%) of the studies reviewed. Sleeping problems and poor sleep quality was associated with risk for myalgias and musculoskeletal disorders.[12,53,72,93] Wendimu et al[96] reported an association between poor sleep quality and a history of physical injury. Dutta[33] found that lack of sleep results in greater levels of fatigue and, consequently, a higher risk of workplace injury. Similarly, Hussen et al[12] stated that workers in Ethiopia doing night shifts were more injured than those during the day shifts, possibly due to circadian rhythm alterations resulting in more fatigue, sleepiness, and less vigilance. This is further evidenced by Kiconco et al,[13] who found more than a quarter (30.2%) of workers had a sleeping disorder in the building construction industry in Uganda, with 70% of the occupational injuries occurring among night shift workers. In contrast, Abbas et al[47] did not find an association between sleep quality and occupational risk of non-fatal physical injury. From the literature, it appears there is a reciprocal relationship between sleep quality and physical injury, such that poor sleep quality may predispose to injury and previous injury may implicate poor sleep quality.

Age. Age was identified as an influential factor for identifying physical injury risk and developing mitigation strategies. The reviewed studies identified 2 distinct age groups that were at increased risk for physical injury in the construction workplace. Younger workers (⩽25 years of age) were identified as an at-risk group for non-fatal and fatal physical injury and occupational accidents.[8,13,22,32,47,50,58,60,69,74,76,79] Studies suggested that younger workers may have an increased risk for physical injury due to lack of apprenticeship or job training, poor occupational safety compliance, inability to identify hazards and request for support to manage hazards, and lower job skill.[9,18,63] Younger workers may engage in longer work schedules, shift work, and overtime that can increase their exposure to workplace hazards and subsequent injury.[76] Other studies found no association of increased injury trends for younger workers, but rather higher injury prevalence in workers aged 30 to 44.[12,49,51,55,88]

Older workers (aged 45-55) were also identified as vulnerable to physical injury in the construction workplace.[60,66,74,92] Studies reported that older workers are more likely to sustain severe and consequential injuries that would put them at risk for prolonged disability, early retirement, or job change due to concerns with work ability.[55,56,66,78,81] Generally, musculoskeletal symptoms and disorders increased with age.[10,25] Older workers are more likely to be self-employed and have less access to occupational safety and health programs.[66] Work-related fatality rates have also been found to increase with age.[55,76,91] Few studies reported that older workers have a poorer general health status and accumulation of chronic stressors that may influence injury risk.[10,93] Welch et al[84] reported that for each yearly increase in age was associated with a 15% increase in the likelihood of leaving roofing. Self-perceived ability to undertake physically intensive tasks, changes in physical functioning, and ability to manage work demands also declines with aging conferring risk to workplace injury.[10,62,66,69,97] Anantharam et al[48] and Lombardi et al[57] identified an association between increasing age, pre-existing conditions, and the risk of fractures when working on ladders that could predispose older workers to increased fall risk. After injury, older workers were reported to have more days at work than their younger counterparts.[74] Interestingly, few studies reported no association between aging and increased injury or accident risk.[13,14,32,92]

Marital status. There were mixed findings on the influence of marital status on physical injury risk in the construction workplace. Generally, married workers reported more work-related physical injuries than single workers.[9,16] This increased rate of work-related injuries may be due to higher life responsibilities, financial stress, fatigue accumulation, and work-family conflict.[9,16,30] However, other studies reported that

married workers had less risk for physical injury in the workplace.[12,18] Liu et al[75] found that there was no difference in occupational risk perception between married and single workers. Overall, there is no conclusive data on the impact of marital status on risk of physical injury for construction workers.

Discussion

In this study, a wide range of physical and psychosocial factors that impact occupational physical injury and wellbeing in the global construction industry were discussed. These factors may exert individual, additive, or interactive effects on occupational injury risk and wellbeing depending on the working environment as it shapes worker's health, safety behaviors, and risk perception.[1,63,98] Through examination of SRQ1, we found that age, physical health, sleep quality, psychosocial stress, gender, migrant and ethnic worker disparities, availability and use of PPE, company size and job type, exposure to workplace physical hazards were associated with occupational health and physical injury risk. There were inconsistent findings reported and a small sample size of studies for marital status, obesity, and education, therefore no consensus could be determined on their influence on occupational health and injury.

SRQ2 sought to understand the relationships between the identified factors and how they implicate occupational health and injury. The workplace physical environment is a critical organizational factor requiring considerable research and practice attention.[20,25,99] Construction workers face variable occupational risks leading to injury related to their organization including workforce management and operations, safety policies, injury reporting procedures, and the organization's commitment to worker health in the workplace. Companies and organizations are also key players in implementing various safety regulations as they can influence workers' risk perception and safety behaviors.[100,101] Hazard exposure and mitigation strategies are largely absent in many construction settings globally as the industry is growing rapidly in many developing countries.[9,12,46] In developed countries, there continues to be equity and education barriers for minority and vulnerable persons (eg, women, race and ethnic minorities, temporary/migrant workers), exposing them to stressful, difficult, and dangerous working environments.[28,30,65,87] Therefore, the interplay between individual factors, environmental, and psychosocial factors operate on construction workers to influence their occupational health and injury risk through exposure to stressful and dangerous working environments.

Adequate PPE, safety training, and safety regulations for construction workers in developing countries is lacking.[49,76] Construction workers are not be equipped with the safety knowledge and implementation practices to effectively mitigate the hazards of their workplace leading to workplace accident and errors.[30,32] To increase the PPE utilization rate among construction workers, employers should consider safety training before commencing work, PPE training, and PPE development with necessary stakeholders.[64,102,103] Effective and available PPE, accessible, language and culturally-appropriate safety training/materials, and hazard reporting procedures may benefit construction employers.[93,103,104] Language barriers may also prevent employers' effectiveness of safety training and injury prevention strategies.[26,104,105] Language is critical in safety training and ensures migrant workers can grasp workplace safety knowledge. Hussain et al[104] and Lin et al[105] identified interventions that could reduce language barriers during safety training, such as 3-D visual training material, cross-cultural training focused on a bilingual approach (eg, use of workers' language and common language during training) and language learning tutorials (eg, common safety workplace phrases in different languages). To maximize the impact of these interventions, considerations to company size are important given limited financial resources and implementation challenges (eg, time allocation, hazard and safety knowledge, safety personnel) with smaller construction companies.[69,77]

Construction workers experience poor health outcomes and are susceptible to a wide range of physical injuries. This review found that age, obesity, and sleep quality are individual-level characteristics that can contribute to increased risk for work-related injuries.[106,107] Workers with higher body mass may be at risk for injury due to increased stress on their muscles and joints, ineffective or inaccessible PPE or health-related functional limitations affecting their ergonomics.[10,92] Obesity and poor nutrition has also been associated with increased risk for chronic diseases commonly reported by construction workers, including osteoarthritis, carpal tunnel syndrome, and cardiovascular disease.[77,107,108] Young (<25 years old) and older workers were identified to have greater risk for injury given their physical functioning, capacity to appraise hazards, familiarity with job demands, and awareness of workplace safety policies and protections. Younger workers may be more susceptible to acute work injuries related to safety knowledge and inexperience, while older workers may experience more health-related functional limitations.[10,109,110] Given their differences, work health and safety programming should be tailored to increase safety knowledge, improve risk perception, and identify health-related challenges that are influencing age-related injury risk and work ability.[111-113] Older workers should have additional training to understand their limitations, considerations of modified work adapted to changing physical risks or non-traditional employment roles rather than active construction activities, and access to ergonomic aids.[56,77]

While younger workers would benefit from mentorship and education from older workers concerning hazard appraisal, risk management, and promotion of safety behaviors.[91,110,113] Poor sleep quality also contributes to development of chronic diseases and risk of musculoskeletal disorders in construction workers. Long working hours, high work demands, and ongoing pain can contribute to poor sleep quality and fatigue, reducing work ability and performance.[25,77,97] Therefore, workplace interventions may be beneficial for workers who are

experiencing poor sleep quality and functional impairment related to obesity or age as they are vulnerable to physical injury.[99,112,114] However, there still remains challenges to the effectiveness of workplace interventions including limited staff resources, financial cost, low worker participation rates, lack of management support, and implementation and design issues.[34,115] Furthermore, ongoing accessibility and usage rates of occupational health and safety services is limited in many construction settings globally.[47,94,116]

The relationship between work demands, psychosocial work factors, and the lack of workplace support could diminish a construction worker's work ability.[24,76,81] In this review, high job demands, low work autonomy, and poor supervisor and colleague support was associated with reduced work ability and increased risk for physical injury.[81] On the other hand, a positive psychosocial work environment improved job satisfaction and was protective against physical injury.[47] Women experience additional hazards that result in gender discrimination in work allocation, wage distribution, work-family conflict, and workplace support.[29,65,86,117] Work-family conflict is of particular concern as women often occupy the primary child-rearing role for their family and may be more susceptible to high job strain and negative psychosocial effects of work on their home life.[117-119] Perpetuation of the historical hegemonic culture in construction needs to be adequately address to protect women and other visible minorities from psychosocial harm that may lead to job stress and increased risk for injury.[65,120] Creating engagement opportunities for women as stakeholders in policy development for safer and more supportive work environments is paramount.[29,121] Mentorship opportunities, encouragement of diverse masculine behaviors, and development of self-advocacy and resiliency skills has also been suggested to help women cope with the psychosocial challenges in the workplace.[65,86,120,121] Studies have shown that gendered segregation of work also affects men as they are overrepresented in higher risk construction activities reinforcing institutionalized hypermasculinized behaviors (eg, toughness, stoicism, fearlessness, and self-reliance) and occupational pressures to perform that may pre-dispose them to increased risk for injury.[60,121]

In this study, examination of SRQ3 has revealed that workers from social minority groups (eg, women, ethnic, and migrant workers) of young (<25 years old) or older ages (45-55 years old) employed in smaller construction companies are vulnerable to increased injury risk and exposure to physical and psychosocial hazards in the workplace. Occupational health research has found gender-specific elements of workplace culture that influence worker health.[122] Social and environment aspects of work have predicted women's wellbeing and supervision and management has predicted men's wellbeing.[29] It has been suggested that workplaces and researchers take a gender-sensitive approach to understand how social processes and the psychosocial environment influence workplace safety behavior for construction workers, specifically.[59,86] Few studies have considered the relationship between intersectional identities and workplace safety behaviors regarding physical injury risk and risk perception.[22,26] Based on our findings, there may be a "triple jeopardy" of injury risk considering membership as an ethnic minority, a gender minority, and poor income status as a vulnerable working group.[27,29] Therefore, future studies and global industry stakeholders should consider the influence of intersectional identities (eg, race, class, abilities, gender, socioeconomic status) to inform injury prevention through improvements in safety practices, regulations, and policies for the vulnerable.

Injury prevention begins with adopting healthy workplace coping behavior must be practiced at and between individual, family, workplace, and industry.[98,116,123,124] Employers should consider the impacts of work scheduling, job design, work family support, and their ability to engage in healthy behaviors.[34,116] For migrant or minority workers, access to health insurance, job insecurity, and family stress should also be considered in creating supportive and inclusive workplace environments.[89,114] Individual-level coping behaviors that should be encouraged to improve occupational risk management among construction workers include planned problem solving, emotional discharge, positive re-appraisal, and access to social support networks.[65,75] Worker family supports of to promote work-life balance from the literature, including flexible and predictable scheduling, external supports for child care, respectful workplace training, and mental health supports.[86,112] Rentscher et al[116] found that the demand hour system and working hours cap were the most effective workplace factors in reducing psychosocial stressors.

Multi-disciplinary and multi-domain interventions in the workplace targeting physical and psychological contributions to injury risk and prevention appear promising.[123-125] Peters et al[124] conducted a randomized controlled trial designed to target improving ergonomic and safety practices at work to improve musculoskeletal health with integrated health promotion (eg, diet, physical activity, injury prevention, and smoking cessation) focused on improved health and wellbeing. They found that after 1-month follow up, significant improvement were reported in improved ergonomic practices at work, a reduction of pain and injury incidence, and improved physical health and nutritional consumption of healthy foods. Further integrated workplace interventions should include emphasis on a supportive social and physical environment (eg, reduction of psychosocial hazards, anti-discrimination policies), health and wellbeing promotion programs (eg, sleep hygiene, nutritional support), ergonomic supports (eg, age-related functional supports), integrated injury screening and reporting procedures, and accessible resources to external rehabilitation and pain management treatment.[34,109,123,125] Lastly, industry and policymakers should continue to address health and safety regulations and policies for construction establishments to ensure adequate training and hazard appraisal for construction workers.

Strengths and limitations

To our knowledge, this is the first review that comprehensively examines physical and psychosocial correlates to occupational physical injury. This review identified workplace and worker risk factors that may confer vulnerability and/or interact with psychosocial hazards commonly found in the construction workplace. This scoping review also has a few limitations. Despite the review being a global survey of occupational risk of physical injury, many of the articles included were from North American and African countries, making it difficult to discern continental differences. Safety regulations, injury prevention, and occupational risk management vary greatly between countries, jurisdictions, and individual companies, therefore the findings may not be generalizable to all construction settings. Some identified factors (eg, marital status, obesity, and education) were underrepresented in the construction literature and their influence may not be fully characterized in this review. Studies included were limited to English; therefore, data from countries where the primary language was not English were excluded. Lastly, given the breadth of this review, stringent inclusion criteria was implemented to include studies that focused specifically on the study rationale.

Conclusion

This review examined workplace factors that influence occupational injury and ultimately, worker physical health, and wellbeing. These findings have implications for employers to protect workers, improve job satisfaction, reduce physical injury, and health-related reasons for leaving the construction industry. Employers should take a personalized approached with their workforce to have supervisors provide supportive initiatives and safety planning that consider individual-level (eg, age, obesity, sleep quality, gender, race, socioeconomic status, family responsibilities) and organizational-level factors (eg, company resources, job-specific hazards, availability of PPE) that may increase risk of injury and reduce worker wellbeing. For policymakers and stakeholders, continued robust awareness, education, and advocacy of inclusive and supportive workplaces to mitigate the effects of psychosocial hazards implicating physical injury the workplace is imperative. Government regulators, industry organizations, and trade associations should advocate for improvements in hazard mitigation (eg, risk perception, safety controls) education and safety training accessibility for minority workers, ethnic minorities, and smaller construction companies. They should also offer hands-on accessible cross-cultural and diversity competency training to all workers to improve colleague and supervisory support for vulnerable construction industry persons.

Future research should examine the individual and interactive impact of the identified workplace environment hazards, physical health factors, and psychosocial stressors on body mechanics while performing specific construction activities. In addition, evaluating the impact of psychosocial hazards and availability of workplace support on younger and older workers to detect age-related differences in injury rate and work-related health outcomes.

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Author Contribution

BNK conceptualized the study, supervised, and provided resources for the project. ASH, BY, JT, HS, NSC, DO, and MS performed the scoping review search and PRISMA methodology. ASH co-conceptualized the study and wrote the manuscript with support from BY, JT, HS, NSC, DO, MS, VKC, ABF and BNK. All the study authors read and approved the final draft of the paper.

Informed Consent

There is a review article and informed consent is not required.

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Supplemental Material

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