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OCCUPATIONAL HEALTH (K APPLEBAUM AND M FRIESEN, SECTION EDITORS)

Sex and Gender Differences in Occupational Hazard Exposures: a Scoping Review of the Recent Literature

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Abstract

Purpose of Review Comparative research on sex and/or gender differences in occupational hazard exposures is necessary for effective work injury and illness prevention strategies. This scoping review summarizes the peer-reviewed literature from 2009 to 2019 on exposure differences to occupational hazards between men and women, across occupations, and within the same occupation.

Recent Findings Fifty-eight studies retrieved from eight databases met our inclusion criteria. Of these, 30 studies were found on physical hazards, 38 studies on psychological/psychosocial hazards, 5 studies on biological hazards, and 17 studies on chemical hazards. The majority of studies reported that men were exposed to noise, vibration, medical radiation, physically demanding work, solar radiation, falls, biomechanical risks, chemical hazards, and blood contamination; while women were exposed to wet work, bullying and discrimination, work stress, and biological agents. Within the same occupations, men were more likely to be exposed to physical hazards, with the exception of women in health care occupations and exposure to prolonged standing. Women compared to men in the same occupations were more likely to experience harassment, while men compared to women in the same occupations reported higher work stress. Men reported more exposure to hazardous chemicals in the same occupations as women.

Summary The review suggests that men and women have different exposures to occupational hazards and that these differences are not solely due to a gendered distribution of the labor force by occupation. Findings may inform prevention efforts seeking to reduce gender inequalities in occupational health. Future research is needed to explain the reasons for sex/gender inequality differences in exposures within the same occupation.

Keywords Gender-based analysis · Sex differences · Occupational health · Safety · Scoping review · Workers

Introduction

Differences between men and women that are socially constructed (gender) or biological (sex) can affect their occupational health and safety in different ways. Socially constructed gender roles and expectations include differences in the types of occupations and industries in which men and women work, their duties and responsibilities within these occupations and industries, and their engagement in the labor force in general. Biological differences include the average size and strength of men and women that result in ill-fitting personal protective equipment and inadequate protection from occupational hazards and differential immune responses that impact susceptibility to communicable diseases [1–4]. Understanding how sex and gender can influence the risk of exposure to occupational

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hazards is a key aspect of developing effective injury prevention and illness prevention strategies that integrate individual and social context in their design [1, 5], especially as women make up over half of the labor force in high-income countries [6].

There is a broad and sizeable body of empirical literature on the differences between men and women (for ease of communication, hereinafter gender/sex differences also will be referred to as "men and women," unless otherwise specified) in occupational hazard exposures, highlighted in a systematic review covering 1999 to 2010 that focused on differences among men and women in broad exposures to working and employment conditions [7]. The review found that compared to men, women are more likely to report high job insecurity, experience worse working conditions including a demanding psychosocial work environment, and report poorer self-perceived physical and mental health. Conversely, men compared to women were more likely to be exposed to longer work hours, more physically demanding work and noise, and to experience greater effort-reward imbalance [7]. As new work patterns continue to emerge through technological progress—automation, artificial intelligence, and other emerging technologies—and the gendered distribution of the labor force, an updated review of studies from the last 10 years can identify new or previously underreported occupational hazard differences between men and women across occupations. Furthermore, previous reviews had not focused on comparing exposure differences in men and women within the same occupations, which is important from a primary prevention standpoint as it can identify the role that sex and the gendered nature of employment plays in observed differences between men and women in occupational hazard exposures.

The objectives of this scoping review were to (1) synthesize existing evidence from the last decade regarding differences between men and women in exposures to occupational hazards across occupations and (2) identify and synthesize data from studies reporting occupational hazard exposures in men and women within the same occupations.

Methods

This scoping review used a process developed by Arksey and O'Malley (2005) and Levac (2010) and was adapted to include the IWH stakeholder engagement model [8–11]. The review was conducted using the following steps: (1) identify the research question(s); (2) identify relevant studies; (3) select studies; and (4) chart data and collate summarize and report results. The review was registered on PROSPERO on August 8, 2019 (registration number: CRD42019137010).

Identifying the Research Question

A series of meetings were held with a stakeholder advisory committee of four individuals with diverse perspectives on occupational health and safety and sex/gender-based health research (the Director of health and safety at a national union, the President of an industry association, and the Assistant Director of a sex and gender research institute), along with representation from the funder, to refine the research questions to ensure they were relevant and answerable within the project timeframe.

Identifying Relevant Studies

Eight electronic databases (MEDLINE [Ovid], Embase + Embase Classic [Ovid], PsycINFO [Ovid], Business Source Premier [EBSCO], EconLit [EBSCO], ABI Inform [Proquest], Social Services Abstracts [Proquest], Sociological Abstracts [Proquest]) were searched for peer-reviewed studies published from January 1, 2009 to May 1, 2019. The inclusion of studies was not limited by language or study design. The search strategies were created by a research librarian and used a P.I.C.O. structure (population, intervention, comparison, and outcome). A set of search terms to describe each of the categories was developed in consultation with a research librarian. After the initial search strategy was developed, the reviewers consulted with the four members of the stakeholder advisory committee to discuss the relevance of the terms and identify any missing terms. As controlled vocabularies differ significantly in the electronic databases, search terms were customized as needed. Terms within each category were combined with a Boolean OR operator, and the main categories were then combined using a Boolean AND operator. In this way, the searches captured only studies that mentioned at least one term within each of the categories. The search terms used for the MEDLINE database are provided in Supplementary Table 1**.** Due to the extensive occupational health literature, the search strategy included broad categories by incorporating variations of the search terms "sex," "gender," and "occupational hazards" but did not include specific names of chemical, physical, and job-specific hazards (e.g., names of specific chemicals). To supplement the searches, the reviewers and stakeholders were asked to recommend studies that were in-press (accepted by a journal but not yet published) or articles that could be important for the review but were not captured by the formal search strategy. Reference lists of included studies

and relevant review articles were also scanned for references not previously captured. EndNote® was used to store references from all literature searches. Duplicates were removed and references loaded into DistillerSR®, an online systematic review management software designed specifically for the screening, quality appraisal, and data extraction phases of a systematic review.

Study Selection

Table 1 summarizes the inclusion criteria used to select relevant peer-reviewed studies.

Reviewers were not blinded to the authors of the studies, but they did not screen or extract data from any of their own studies. Standardized relevance screening forms were created in DistillerSR® software to ensure the reviewers uniformly applied the inclusion/exclusion criteria. The selection of relevant studies took place in two stages. In the first stage, the titles and abstracts of identified references were reviewed based on the inclusion/exclusion criteria. Full texts were retrieved in the second stage for those studies that (i) were assessed by two reviewers as meeting the inclusion criteria or (ii) there was insufficient information on the basis of the title and abstract to determine relevance.

Due to the large number of studies retrieved by the search, the artificial intelligence (AI) feature of the DistillerSR® software was used, pairing a human reviewer with the AI feature to double-review each reference at the title/abstract and full-text stages of relevance screening. This required "training" the AI on a portion of studies reviewed by two humans at both stages so that the AI "learned" which types of studies were relevant to the review before "running" the AI as a second reviewer to the single human reviewer. Disagreements between the human and AI features were reviewed by a third (human) reviewer until consensus was achieved. Non-English language studies were examined by the reviewers and their contacts who were fluent in the language. Regular meetings were held with all reviewers to monitor the reviewing process, address questions, and troubleshoot difficulties in assessing the studies.

Charting Data and Collating, Summarizing, and Reporting Results

A data charting form was created in the DistillerSR® software based on input from review members and the project funder. Once consensus was reached on the data charting form, 10% of included studies were independently reviewed by pairs of reviewers as per AMSTAR guidelines [12]; conflicts were resolved by discussion. The remaining studies were allocated to each reviewer for data charting. Studies were characterized according to the first author, year of publication, the country where the study was conducted, sample size and proportion/percentage of women participants, occupational hazard exposures, type of occupation or industry associated with the hazards, and the main findings. For studies where exposure to an occupational hazard was unclear (e.g., work precarity), reviewers read the full text to infer the occupational hazard category. If it was not possible to infer exposure to a relevant occupational hazard, the study was excluded from the review (15 studies). Occupational hazard exposures were grouped on the basis of the major categories of the CSA Z1000-14 standard: psychological/psychosocial, physical (includes ergonomic), biological, and chemical [13]. Supplementary Table 2 provides examples of occupational hazards included within the four broad hazard categories.

Table 1 Summary of inclusion and exclusion criteria

Category	Inclusion	Exclusion
Population	Is the population (18 and up to retirement) tied to a current or previous workplace setting?	Exclude sex workers, housewives, and occupations that are generally not regulated under workers' compensation systems.
Intervention/exposure	Does the article examine exposure to hazards related to working conditions (occupational hazards)?	Nonoccupational hazards exposure
Comparison	No comparison groups	
outcomes	Does the article examine work-related health problems as outcomes? These work-related health problems should be related to occupational hazard exposures.	Outcomes linked indirectly to health, health behaviors, and dimensions of wellbeing. For example, physical inactivity, presenteeism, return on investment, diet quality, job satisfaction, happiness, and indicators of education/social status, etc. Reproductive health outcomes specific to a sex e.g., ovarian and testicular cancers
Sex/gender	Have the effects for men and women been reported separately? Have studies made assertions about differences between men and women or stratified their analyses for men and women?	Results presented for an overall sample of men and women together Results presented only for men or only for women

Identifying Differences Between Men and Women Within Studies

Studies were required to provide a quantified comparison of the men and women exposed to an occupational hazard (e.g., percentages, proportions, odds ratios) within the main manuscript (data only included as supplemental information were not screened), otherwise they were excluded at the full-text review stage. If findings were reported on the basis of regression models, only exposure estimates unadjusted for occupation were recorded to compare differences between men and women across occupations. The analysis of occupational hazard exposure differences within the same occupations was based on whether studies stratified or matched their results by occupation for men and women, or explicit mention was made in the article text.

A narrative synthesis was used to summarize and describe trends in the findings. Although a formal comparison of small, medium, or large effect size differences between men and women was planned; it was precluded due to too much heterogeneity between studies in study samples, occupational hazard exposures, statistical approaches, and the reported findings. Differences in occupational hazard exposures between men and women were primarily based on a study's reporting of confidence intervals, while inspecting *p*-values only was deemed to be not sufficiently informative. For studies where no direct statistical tests were conducted, a visual trend of patterns across effect estimates or summaries from article text was used to determine differences of association. Studies that did not reach statistically significant differences, but that reported meaningful practical differences (i.e., Cohen's $d = \geq 0.2$ or $\geq 60\%$ higher or lower odds) [14], were identified as having no comparative difference between men and women but were described by the trend of the findings.

Results

Relevance Screen

The search identified 9474 references, of which 1983 studies made it to full-text relevance screening (Fig. 1). An additional 28 studies from other sources and from a manual search of the reference lists of 9 systematic reviews were also added for a detailed review. Studies in Romanian, Hungarian, and Icelandic (4 studies) were not reviewed as these languages could not be translated.

Charting the Data

Data was charted for 58 unique studies identified as relevant to the study questions, and there were 90 unique findings as some of these included studies which described multiple occupational hazard exposures. Fig. 2 describes the number of studies included from each country. Most studies examining physical occupational hazard exposures were from Canada (5 studies) and South Korea (4 studies); studies examining psychological/psychosocial occupational hazards were mostly from Italy (5 studies) and Canada (7 studies); most studies examining biological occupational hazards were from South and Central America (2 studies); and most studies examining chemical occupational hazards were from Italy (3 studies) and South and Central America (3 studies). Fig. 3 shows an overview of the study designs by each occupational hazard category. Cross-sectional study designs were most frequently used (45 studies), while the remaining studies used prospective cohort designs (11 studies) and a case-control design (1 study). The largest study had 26,188,006 participants [15], and the smallest study had 41 participants [16]. The composition of women among all study participants (27,625,244 participants) was 47%. The percentage of studies with ≥50% representation of women was 33% of physical occupational hazard studies, 59% of psychological/psychosocial occupational hazard studies, 40% of biological occupational hazard studies, and 35% of chemical occupational hazard studies.

Occupational Hazard Exposure Differences Between Men and Women

This section describes different or equivalent occupational hazard exposures for men and women in the reviewed studies. Table 2 reports on the differences or similarities in exposures to occupational hazards for men and women overall across occupations. Detailed study characteristics are available in Supplementary Table 3, including the identification of studies reporting occupational hazard exposures of men and women within the same occupations.

Physical Occupational Hazards

Exposure Differences Between Men and Women Across Occupations

Eight out of sixteen studies reported a higher prevalence among men of exposure to ergonomic and biomechanical risks including repetitive tasks, uncomfortable postures, prolonged sitting or standing at work, and working at high speed [16–23]; four studies reported that women were more exposed to these hazards [2, 18, 22, 24] while four studies found no differences in these exposures between men and women [25–28]. Ten out of thirteen studies reported a

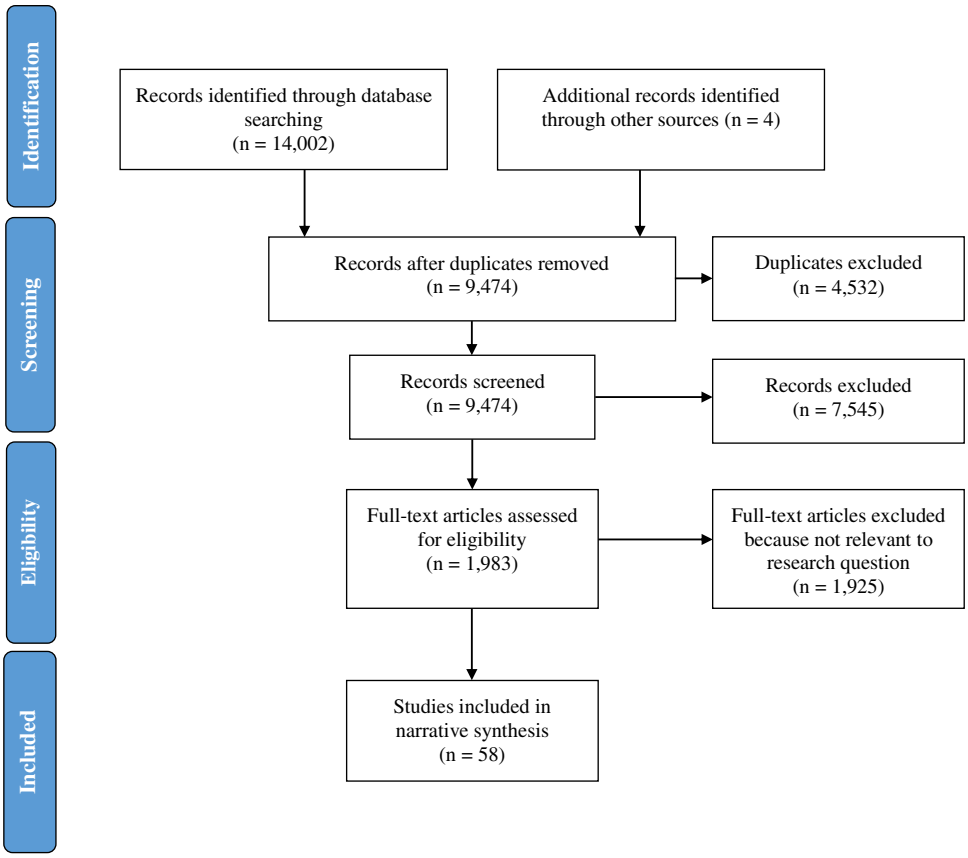

Fig. 1 PRISMA flow chart of document selection

higher proportion of men exposed to physically demanding work including lifting and manual material handling [15, 16, 19, 21, 24, 27, 29–32], and three studies reported a higher prevalence of these hazards in women [18, 19, 33]. A higher proportion of men were exposed to occupational noise [2, 27, 31, 34], vibration [21, 27, 29, 35], ultraviolet radiation from sun exposure [31, 36], radiation exposure from radioactive substances and diagnostic medical devices [31, 37], and work-related falls [38]; no study showed women having a higher exposure than men to these occupational hazards. One study reported a higher prevalence of work-related heat stress among men [39] while another study reported a higher prevalence for women exposed to uncomfortable working temperatures [33]. Two studies reported a higher proportion of women exposed to wet work [40, 41], while no study reported a higher proportion of men exposed to wet work. Two studies reported a higher proportion of men exposed to physical violence, threats, and assaults at work [20, 42], while one study reported a higher proportion of women exposed to physical attacks or assaults at work [43], and one study reported women more likely to experience sexual violence than men but that both men and women were equally likely to experience physical violence at work [44].

Exposure Differences Between Men and Women in the Same Occupations

Nine studies reported physical hazard exposure differences between men and women within the same occupations [2, 18, 19, 25, 26, 36, 37, 42, 43]. Matching men and women survey respondents from the same general Australian occupational groups involving outdoor work; more men than women were exposed to higher levels of solar UV radiation [36]. Among medical diagnostic technicians in South Korea, more men than women were exposed to larger radiation doses [37]. Two studies reported occupational differences in physical violence among men and women health-care workers but in different directions. Among Italian health care workers in emergency, psychiatric, midwifery, and pediatrics departments, men were more likely to experience physical violence and threats [42]. In contrast, among health care workers in Rwanda, women were more likely to report being physically attacked at work [43]. In a study comparing men and women in New Zealand in occupations with the same first five digits of their occupation codes, men were more likely to use tools that vibrate and be exposed to loud noise, while women were more likely to carry out repetitive tasks, work at very high speed, and work in awkward or tiring positions [2]. Examining men and women assigned

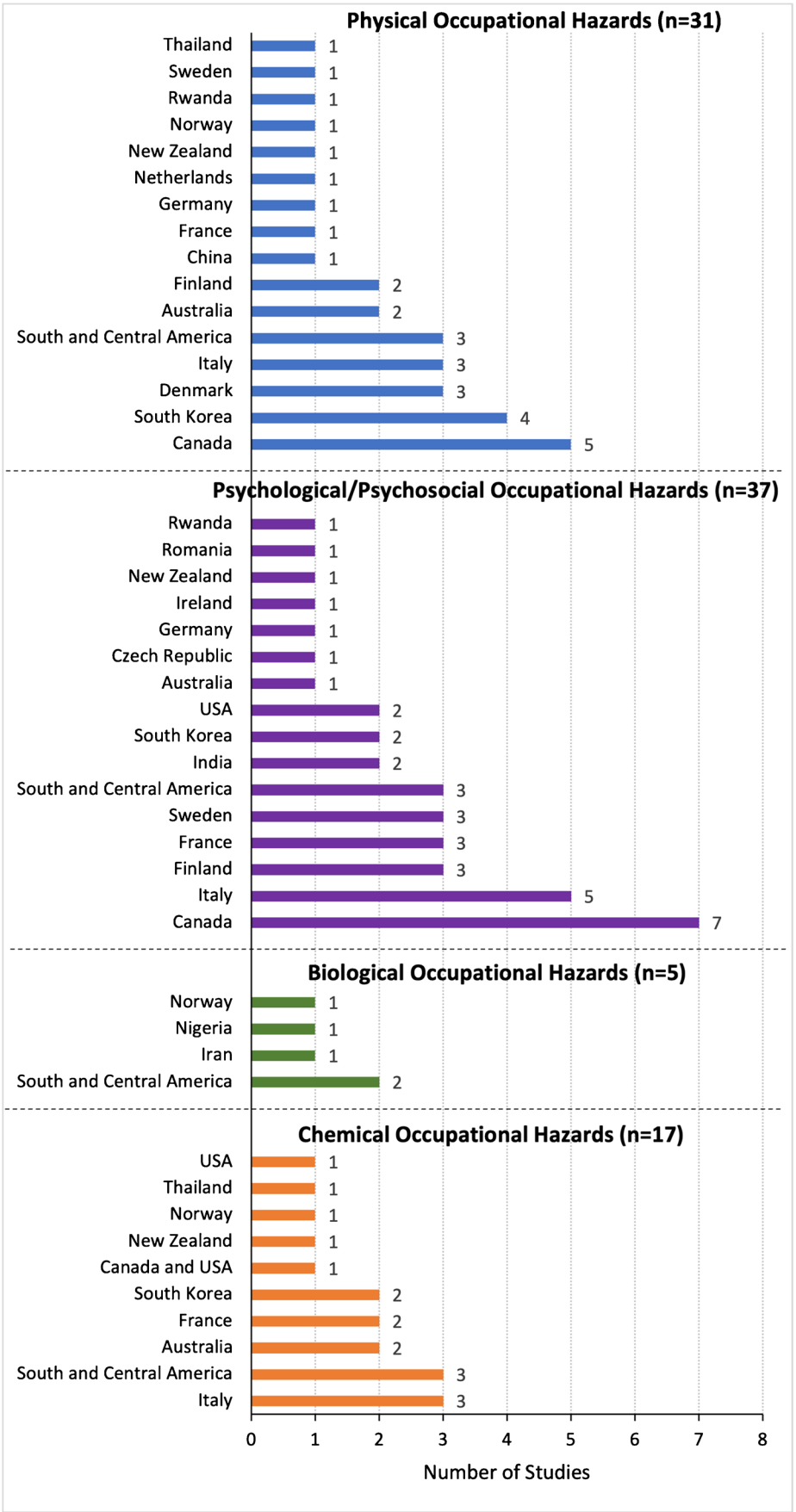

Fig. 2 The number of studies included from each country describing occupational hazard exposures

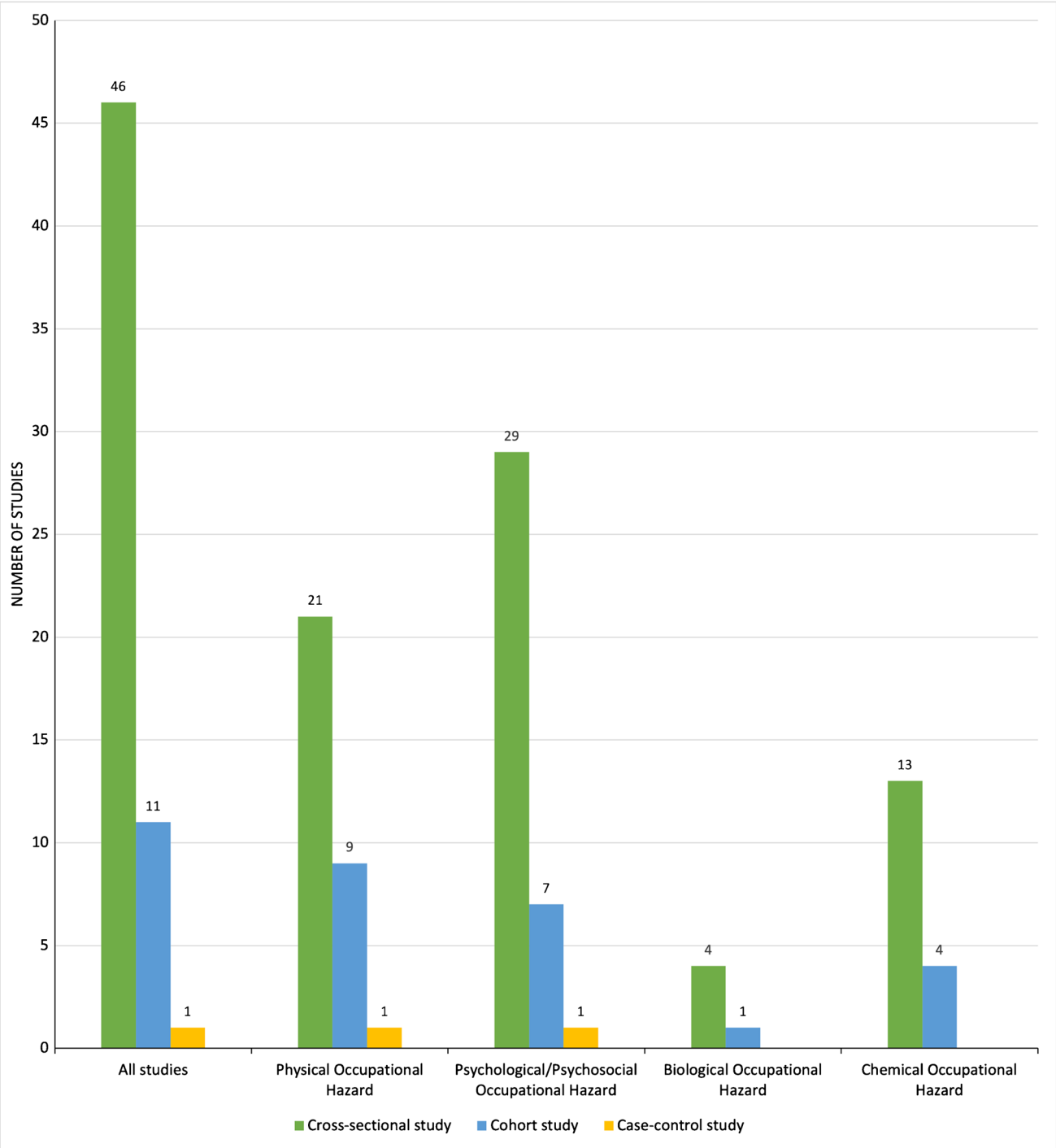

Fig. 3 Overview of the study designs by each occupational hazard category

to similar work tasks within care work, laboratory work, cooking, administrative work, and assembly line occupations in the Netherlands, men reported spending more time in sitting, pushing, and pulling tasks, while women reported spending more time in tasks involving prolonged standing, kneeling, lifting, and other material handling [18]. Matched according to similar occupations in Finland, men in manual labor occupations were more frequently exposed to high physical workloads than women, except for tasks involving repetitive movements and keyboard work. Among administrative/professional work tasks, high physical workload tasks were more common in women than men [19]. In Canadian workers with office and administrative tasks, no differences between men and women in postural risk factors were

Table 2 Frequency of study mentions comparing the prevalence of occupational hazard exposures in men and women

Occupational hazard exposures	Higher prevalence in men	Higher prevalence in women	Similar prevalence in men and women
	Number of study mentions		
Physical occupational hazards			
Solar ultraviolet radiation/sun exposure	2	-	-
Noise	4	-	-
Vibration	4	-	-
Radiation	2	-	-
Ergonomics and biomechanics[a]	8	4	4
Physically demanding work[b]	10	3	-
Physical violence/assault	2	2	1
Wet work	-	2	-
Falls	1	-	-
Heat stress/uncomfortable work temperatures	1	1	-
Psychological/psychosocial occupational hazards			
Bullying, discrimination, verbal aggression/abuse, and harassment	1	13	3
Stress/stress indicators	9	13	9
Biological occupational hazards			
Biological agents/biological dust/biological waste	-	2	1
Blood (human or animal)/animal flesh	2	-	-
Chemical occupational hazards			
Pesticides/herbicides	3	1	1
Smoke, fumes, gas, and hazardous chemical substances	10	2	1
Workplace second-hand smoke	2	0	1
Asthmagens, asbestos	2	0	0

[a]Includes repetitive tasks, uncomfortable postures, sitting/standing, and work at high speed

[b]Includes high mechanical workload/lifting, physically demanding work, and manual material handling

reported [26]. Another Canadian study found no differences between men and women in prolonged occupational standing among food servers [25].

Psychological/Psychosocial Occupational Hazards

Exposure Differences Between Men and Women Across Occupations

Nine studies found more women than men were exposed to bullying [19, 20, 35, 43, 45–49], seven studies found more women were exposed to sexual harassment and discrimination [29, 43, 49–54], four studies found more women were exposed to verbal aggression/abuse [20, 42, 43, 55], and two studies found more women experienced sexual assault [20, 43]. Three studies reported comparable levels of verbal aggression [42], bullying [47], and harassment based on ethnicity [52] for men and women. One study reported that men were more likely to experience harassment at work [33]. Several studies also reported a higher prevalence of psychological demands and workplace stress among women than men. Nine studies found more women were exposed to higher levels of stress indicators (e.g., high job strain, effort-reward imbalance) [17, 20, 29, 30, 55–59], six studies reported that women were more exposed to higher levels of perceived stress and emotional demands at work [45, 47, 53, 60–62], and three studies reported that women were more exposed to lower support from colleagues or superiors [37, 58, 60]. Five studies reported men having higher job stress and psychosocial demands [2, 21, 58, 63, 64], two studies reported men exposed to higher levels of different stress indicators [19, 20], and two studies reported more men exposed to a lack of social support from colleagues or superiors [62, 29]. No differences between men and women for various psychosocial exposures were also reported [20, 23, 26, 27, 31, 63, 65, 66].

Exposure Differences Between Men and Women in the Same Occupations

Two studies reported differences in verbal abuse, bullying, and harassment between men and women workers in health care occupations, with a higher prevalence in women workers in Rwanda [43], while no differences between men and

women were reported for verbal aggression among Italian health care workers [42]. More women than men in administrative work tasks in Finland experienced bullying [54], while more women police officers in an Indian study were likely to experience workplace harassment [52]. Matched by occupations with the same first five-digit codes in New Zealand, men were more likely to report work stress compared to women in the same occupations [2]. Men in manual labor occupations in Finland were more exposed to low job control than women in similar occupations [19]. Women who were registered nurses in Italy experienced higher levels of work stress and lower social support than registered nurses who were men [60]. Women who were officers of public and private banks in India reported more work stress than men in the same occupations [61]. Women who were managers in Sweden more often reported high emotional demands and lacking influence, while managers who were men reported more conflicts with superiors and a lack of support from managers [62]. No differences in work stress were found between men and women who were paramedics [56] and office workers/professionals [26] in Canada.

Biological Occupational Hazards

Exposure Differences Between Men and Women Across Occupations

Two studies reported that women were more likely to be exposed to urban waste and biological materials from garbage collection [31] and biological dust [67], while another study reported no differences between men and women in exposures to a range of biological agents [27]. One study reported that men were more likely than women to be exposed to blood contamination with livestock [68].

Exposure Differences Between Men and Women in the Same Occupations

One study reported biological occupational hazard exposure differences between men and women in the same occupations, with mortuary workers who were men (including porters and attendants but excluding pathologists) in Nigeria more likely to be exposed to blood contamination via needle-stick injuries, blood splashes, and cuts than women [69].

Chemical Occupational Hazards

Exposure Differences Between Men and Women Across Occupations

Ten out of thirteen studies reported more men exposed to hazardous chemical substances, smoke, and gas fumes [2, 21, 27, 31, 35, 67, 70–73]; two studies reported more women exposed to these hazards [74, 75]; while one study reported similar exposures between men and women [76]. Studies reported more men exposed to pesticides and herbicides from agricultural work [68, 72, 77], while one study reported more women exposed [78] and another found men and women had comparable exposures to pesticides and herbicides [76]. Two out of four studies reported a higher prevalence of workplace second-hand smoke exposure in men [59, 27], while one study reported similar exposure between men and women [79]. Two studies reported more men were exposed to asthma-causing agents and asbestos [80, 81].

Exposure Differences Between Men and Women in the Same Occupations

Two studies reported chemical occupational hazard exposure differences between men and women in the same occupations [2, 76]. Matched according to the first five-digit occupation codes in a sample of workers from New Zealand, men were more likely than women to report exposure to smoke/fume/gas, oils and solvents, herbicides, wood dust, and welding fumes [2]. Among farmworkers in Thailand, men and women had similar levels of exposure to pesticides [76].

Discussion

This scoping review identified and described studies published from 2009 to 2019 that reported occupational hazard exposures for men and women across occupations and in the same occupations. The review summarizes the existing evidence on differences in occupational hazard exposures between men and women and highlights where there is available research on this topic area. Across occupations, more men were exposed to physical hazards such as vibration, noise, falls, solar radiation, second-hand smoke, asbestos, and hazardous chemical substances, while more women were exposed to wet work. Differences between men and women in their exposure to psychological/psychosocial hazards were less clear, with some studies showing both men and women at a higher risk of work stress, lower risk of social support at work, and at a higher risk of conflicts with superiors. A distinct difference was that most studies reported a higher exposure of workplace bullying, harassment (including sexual harassment), and discrimination in women than men. A comparably smaller number of studies reported occupational hazard differences between men and women within the same occupations. Men were more likely to be exposed to physical and chemical hazards in the same occupations as women, with some exceptions. Women in the same occupations as men were more likely to be exposed to

harassment, while men in the same occupations were more likely to be exposed to higher work stress.

Previous systematic review findings on occupational hazards complement those observed in the current review. Campos-Serna et al. found that more men were exposed to physical hazards such as physically demanding work and noise, while more women were exposed to challenging psychosocial work environments [24]. Women also were reported to be at higher risk of workplace bullying than men [82]. Focusing on workplace violence against health care workers, a meta-analysis performed by Liu et al. found that men were more likely to encounter physical violence, while women were more likely to encounter sexual harassment [83]. It is possible that a greater exposure to physical and chemical hazards in men is attributable to a higher representation in primary and secondary sectors of the labor force such as manufacturing, construction, and the trades sectors [2]. The difference in psychosocial occupational hazards between men and women might be explained by a higher concentration of men in management or leadership occupations, or in occupations with more flexibility, that translates into more autonomy and control at work; and higher concentration of women in occupations with less autonomy and control (e.g., in the service sector and in lower-paid work) [3, 84, 85]. Gender differences in labor opportunities and career progression can also shape the choices of men and women in work-related activities that in turn can affect their experience of role overload and work stress [86].

Sex and gender differences may not be perceived as modifiable targets for prevention practices and policies if differences are only according to male- or female-centric representation in occupations and industries. This review found most studies reported occupational hazard exposures of men and women across occupations, with comparably fewer studies examining exposure differences in the same occupations. To advance occupational exposure and health research, future studies should focus on understanding occupation-specific gender/sex segregation within occupational hazard exposures as these are likely to be perceived as modifiable targets for prevention practices and policies than if only male- or female-centric exposure differences across occupations were described. The finding that more men were exposed to physical and chemical hazards within the same occupations as women may be due to different assigned tasks in the same occupations because of perceptions of different physical capabilities based on the higher average muscular strength and stature of men [2]. Social constructions of what is suitable work for men and women also can play a role in task assignment, even though studies have shown that there was no reason why women could not perform heavy work typically assigned to men [84]. Furthermore, poor-fitting personal protective equipment may result in men and women with the same tasks not performing these tasks in the same way [87, 88]. There also can be a misconception that women's work is generally safe, which may come from the relatively few women employed in well-known hazardous occupations (e.g., construction work, welding, mining, chemical manufacturing). Alternatively, this review found that women can be exposed to less visible and less recognized occupational hazards such as bullying and harassment. Women also are predominantly in occupations traditionally viewed as safe from hazards such as in health care, but in reality, are exposed to hazardous exposures, including physical violence and biomechanical strain that result from patient handling [89]. Accordingly, the inclusion of gender analysis in work and health research can support a better understanding of the occupational safety needs of workers, particularly women. The few studies to have reported differences in occupational hazard exposures between men and women in the same occupations also suggest that this should be a focus for future research studies.

It is possible that some inconsistencies and variations in the findings are explained by the different methodologies used to collect and categorize exposure measures across studies, although this offers less of an explanation for observed differences within the same occupation in the same study. Furthermore, many research tools and methods in the field of occupational health were originally developed in relation to occupations with predominantly men and may not adequately capture women's experiences [90]. For example, job exposure matrices were used in several studies, whereby an estimate of typical exposures was assigned to occupational titles. However, average job exposure ratings may inaccurately capture how men and women experience their occupations and differences have been noted in manual lifting capability, fatigability, and lifting posture [91]. It is important that future occupational health studies recognize the possibility of measurement biases when ascertaining occupational hazard exposures in men and women; while, also moving the field forward by developing measures that accurately reflect the types, intensities, and duration of work that men and women do in their occupations.

It is estimated that over 160 million people globally suffer from activity-limiting work-related injuries and illnesses every year [85]. Accordingly, targeting gender and sex differences at work can have important public health and social implications. For example, the reporting of some psychosocial hazard exposures, such as works stress and low social support, were found to be similar for men and women in the current review. In these cases where differences are not evident, generalized gender-neutral primary prevention strategies are still warranted. Occupational hazards and occupations where there are differences between men and women will require targeted primary prevention strategies that recognize sex and gender differences. Future prevention strategies and policies should be informed by the

varied ways in which men and women can be exposed to occupational hazards based on gendered differences in labor force representation as well as differences in work tasks and assignments within the same occupations.

Limitations

The findings of this scoping review should be considered with the acknowledgment of the following limitations. First, given the breadth of the occupational health research literature, it is possible that our search strategy did not capture all studies that have been published in the field over the past decade. We incorporated variations of the search terms "sex," "gender," and "hazard" to broadly capture sex/gender differences in occupational hazards but did not include the names of specific hazards. Accordingly, this review might have been more effective at identifying more common hazards but might not have captured all possible occupational hazards such as chemical- and biological-specific exposures. We did undertake steps to mitigate the possibility of missing studies, the development of the search strategy involved a research librarian and stakeholders knowledgeable about sex and gender differences in occupational health research. We also included studies in several different languages to the best of our ability. It also is important to note that several potentially relevant studies might have been published since the literature search was conducted, including occupational hazard exposures related to the COVID-19 pandemic. Second, we cannot rule out that the unequal representation of men and women in some studies represents sampling bias that over- or underestimates the prevalence of some occupational hazards. Most studies included a large, often population-based sample of participants (10% of studies sampled fewer than 1000 participants) and included >30% of women. Nonetheless, some studies had small worker samples and a low representation of women, and these studies might have insufficient power to identify exposure differences between men and women. Third, this scoping review did not have a quality assessment stage of the studies under review. Quality appraisal of studies is difficult to conduct in scoping reviews due to heterogeneity in study designs, research approaches, and, in this case, a rapidly emerging area under study. This study, therefore, emphasizes the breadth of information provided within the available literature rather than depth in a high-quality-based document selection. Fourth, it was not possible to empirically compare exposure differences between men and women across occupational hazards and studies because of the substantial variation in study reporting.

In conclusion, this scoping review found that men were more likely to be exposed to occupations involving physical hazards and chemical substances than women, while women were more likely to be exposed to workplace bullying harassment and discrimination than men. Similar trends were reported in terms of differences between men and women in occupational hazard exposures within the same occupations. There is a need for future research to clarify the variations in the study findings in order to detect whether the differences are really sex/gender related or due to other differences between people or study methodology.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s40572-021-00330-8.

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Declarations

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