REVIEWS

Work-related and individual factors in biological exposure incidents: A scoping review

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ABSTRACT

Background and objective: Biological exposure incidents are frequent in the workplace and have serious repercussions on the health of professionals, with millions of cases annually and thousands of infections by blood-borne viruses. The objective of this study was to map and analyze aspects related to work and individual factors associated with biological exposure incidents involving healthcare professionals in the hospital environment.

Methods: This is a scoping review following the JBI methodology. The guiding question was: "What are the aspects related to work and individual factors associated with biological exposure incidents in the hospital environment?" Searches were conducted in electronic databases including LILACS, BVS, MEDLINE/Pubmed, CINAHL, Embase, Scopus, and Web of Science. Studies from primary care professionals, those without clear methodology, case reports, expert opinions, review studies, and grey literature were excluded. Screening and inclusion were conducted by two reviewers with disagreements resolved by a third reviewer.

Results: A total of 10,365 articles were found; applying a temporal limit of the last 5 years yielded 4,542 articles. After removing duplicates, 1,965 studies remained. Following title and abstract screening, 140 articles were selected. After full-text review, 46 studies were included, of which 10 comprised the final sample. Work-related aspects such as high workload, long hours, and rotating shifts increase healthcare professionals' risk of incidents. Similarly, there is an association between individual factors such as fatigue, stress, and drowsiness and such accidents.

Conclusions: Studies underscore the link between biological exposure incidents and inadequate work conditions and organization, exacerbated by physical and mental factors like fatigue, drowsiness, sleep deprivation, and stress.

Key Words: Health personnel, Hospitals, Job stress, Needlestick injuries, Occupational accidents, Psychological stress

1. INTRODUCTION

Biological exposure incidents are defined as accidental contact with blood and bodily fluids in the workplace. Three different types of exposure can occur. The first is percutaneous exposure, which happens when the body is injured by sharp objects. The second type is mucous membrane exposure, which occurs when the body comes into direct contact with blood or bodily fluids on the ocular, nasal, or oral mucous membranes. The third type is non-intact skin exposure, which occurs when contact is made with areas of the skin affected by dermatitis or open wounds.[1]

These accidents are frequent and have serious implications for worker health. Global data indicate that among 35 million healthcare professionals, approximately three million experience biological exposure incidents annually, resulting in 16,000 Hepatitis C Virus (HCV) infections, 66,000 Hepatitis B Virus (HBV) infections, and 1,000 cases of Human

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Immunodeficiency Virus (HIV).[2] In Brazil, the numbers are significant, as reported by the National Institute of Social Security (INSS), which recorded 40,972 accidents between 2015 and 2017, indicating an annual increase in incidents.[3]

Previous research has focused on understanding the causes, circumstances, and characteristics of these accidents, their biological effects, economic and social impacts, transmission pathogens, high-risk occupational groups, instruments involved, the importance of protective equipment usage, and underreporting occurrences.[4,5] However, despite the topic's relevance and international interest, there is a scarcity of studies investigating the causal link between biological exposure incidents and work-related factors experienced by these professionals,[6] such as unit overcrowding, insufficient human and material resources, inadequate physical facilities, multiple shifts, workload overload, night shifts, sleep deprivation, and the need to perform multiple tasks within limited timeframes.

Even with healthcare professionals experiencing high levels of occupational burnout, studies investigating individual factors among injured professionals, such as drowsiness, fatigue, lack of concentration, stress, and emotional exhaustion due to daily contact with pain, suffering, and death, remain scarce.[7]

Given the risks healthcare professionals face, it is essential to conduct studies evaluating the work-related aspects and individual factors that may contribute to the risk of accidents involving biological materials. The occupational environment directly influences individuals' thoughts, behaviors, and physical reactions, leading workers to apply both conscious and unconscious behaviors to meet work demands. Consequently, these behaviors can cause harm not only to patients but also to themselves through accidental exposure to biological materials.[8]

Thus, this study serves as a relevant tool for investigating measures to control health risks to workers, guiding safety measures and preventive actions for these professionals. Accordingly, this review aims to map and analyze work-related aspects and associated individual factors leading healthcare professionals to experience accidents involving biological materials in hospital settings.

The research question is: "What are the aspects related to work and individual factors associated with biological exposure incidents in the hospital environment?"

2. METHODS

This is a scoping review conducted following the methodological guidelines of the Joanna Briggs Institute (JBI), as outlined in the "Updated methodological guidance for the conduct of scoping reviews" published in 2020,[9] and adhering to the recommendations of the Scoping Review extension of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA).[10] The protocol was registered on the Open Science Framework (OSF) under DOI: https://doi.org/10.17605/OSF.IO/WQ68K.

The JBI scoping review process maps literature in a specific area to address knowledge gaps and guide future research. It begins with defining the research question and objectives, followed by developing a detailed protocol outlining inclusion/exclusion criteria, search strategies, and data analysis methods. Comprehensive searches across multiple databases ensure all relevant evidence is identified.[9]

After data collection, the process involves screening studies based on predefined criteria, describing relevant evidence, and presenting the results. Finally, a discussion of the main findings and their implications for practice and future research is provided. Unlike systematic reviews, scoping reviews do not critically assess the quality of included studies but aim to provide a comprehensive overview of the topic.[9]

In developing this research, various frameworks can be employed, such as PICO (Population, Intervention, Comparison, Outcome), SPICE (Setting, Perspective, Intervention, Comparison, Evaluation), or PCC (Population, Concept, Context).[10] For the present study, the PCC approach was applied, which included: POPULATION: Healthcare professionals; CONCEPT: Accidents involving biological materials; and CONTEXT: Hospital environment.

2.1 Eligibility criteria

For the POPULATION, studies were included that involved healthcare professionals who experienced accidents involving biological materials. These professionals are defined as individuals engaged in activities aimed at improving and providing health care to a specific population. The term also includes support staff such as cleaning teams, waste collectors, laundry workers, and other occupational groups involved in health-related activities.[11] Studies involving primary care professionals were excluded.

The CONCEPT of the research was broad, aiming to map in the literature the work-related aspects and individual factors preceding accidental exposure to biological materials.

Work-related aspects encompassed working conditions (location, lighting, temperature, equipment, physical and mental exertion, rest time, among others) and work organization (division of labor, task content, hierarchy, number of hours worked).[12] Regarding individual work factors, the search considered physical aspects such as fatigue, exhaus-

tion, sleep, and musculoskeletal pain, among others. Mental aspects such as stress, distress, anxiety, fear, depression, and others were also mapped.

For the CONTEXT, studies of accidents occurring in hospital settings were included. An accident was defined as an unexpected and unplanned occurrence resulting in personal injury, illness, or death of one or more workers.[13]

2.2 Search strategy

This stage was conducted between December 2023 and February 2024 in two phases. A preliminary search was conducted in databases including MEDLINE®/PubMed, OSF, JBI Synthesis, Prospero, and Cochrane Library to identify studies for inclusion, determine the presence of scoping reviews, systematic reviews, and primary studies for mapping, and to establish relevant search terms for the search strategy. The second phase involved a definitive search strategy for application and adaptation in selected databases: MEDLINE/PubMed; EMBASE and SCOPUS/Elsevier; CINAHL, ASP, Academic Source/EBSCO; LILACS, BDENF/Virtual Health Library; PsycINFO/American Psychological Association, Scientific Electronic Library Online, and Web of Science Core Collection/Clarivate Analytics.

2.3 Sources of information

Experimental studies, including randomized controlled trials, non-randomized controlled trials, and before-and-after studies, were included in the analysis. Additionally, observational analytic studies including prospective and retrospective cohort studies, cross-sectional studies, and qualitative studies using phenomenology, grounded theory, ethnography, qualitative description, action research, and other similar designs were considered for inclusion. Reviews of any kind, conference abstracts, letters and editorials, case reports, expert opinions, grey literature, and studies lacking clear methodology were excluded.

2.4 Selection of evidence sources

The results were entered into EndNote v.X9 (Clarivate Analytics, PA, USA), and duplicates were removed. Initially, selection was based on reading titles and abstracts according to the described eligibility criteria, using the online platform for systematic reviews Rayyan QCRI20. Rayyan was specifically designed to streamline the initial screening of abstracts and titles, followed by the evaluation of full texts.[14]

Selection was conducted independently by two reviewers in a blinded manner, with disagreements resolved by a third reviewer. In this phase, the first reviewer selected 92.8% of documents for exclusion and 7.4% for inclusion. The second reviewer selected 97.3% of documents for exclusion and 2.7% for inclusion. There was a 5.3% discrepancy between reviewers, necessitating assessment by a third reviewer to resolve conflicts.

2.5 Data extraction

The documents selected from the Rayyan platform were exported to a Microsoft Excel spreadsheet. For descriptive mapping, an instrument was developed in accordance with the scoping review extraction tool by JBI.[9]

A pilot test was conducted as recommended by Pollock et al. (2023)[15] to evaluate the comprehensiveness of the data extraction form using five primary research articles. Each reviewer was assigned to independently extract the data. After the pilot, a group discussion with all authors was held to review the findings and clarify any doubts, where the researchers found that the data collection instrument was clear and required no additional adjustments. The results of the test promoted a better alignment of the concepts and ensured that all items were clearly and consistently mapped.

Full-text reading of the studies was also conducted by two reviewers, with discrepancies resolved by a third reviewer. Extracted data included specific details about participants, concept, context, study method, and key findings relevant to the review question.

2.6 Data synthesis

The data are presented in a narrative summary and tables, organized according to categories listed in the extraction tool. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) is used for presentation, transparency of the review process, and communication of results.

3. RESULTS

Considering the objective of mapping and analyzing work-related aspects and individual factors associated with accidents involving biological material among healthcare professionals in hospital settings. A thematic analysis was conducted to categorize the results, following the recommendations of Jowsey et al. 2020.[16] Initially, grouping and checking of data were performed. Next, identifying and synthesizing took place. Finally, a third member check was carried out by other authors. Consequently, this section presents the results synthesized into five categories: 1) Work Conditions; 2) Work Organization; 3) Physical Health Factors; 4) Mental Health Factors; and 5) Worker Behavioral Responses.

Initially, 10,365 articles were identified on the topic. Applying a temporal limit of the last 5 years narrowed this to

4,542 articles. After removing duplicates, 1,965 studies remained. Following title and abstract analysis, 1,825 studies were excluded. Full-text assessment resulted in 46 studies included, with 10 forming the final sample of this scoping review. Fig. 1 illustrates the flowchart of the literature search and selection process.

Analysis of the included studies revealed that the majority were published in 2019 (30%),[17–19] followed by 2020 (20%),[20,21] 2021 (30%),[22–24] 2022 (10%),[25] and 2023 (10%).[26] All studies employed cross-sectional designs, with 20% conducted nationally[17,24] and 80% internationally, encompassing countries such as Iran,[18,21,26] Poland,[25] Pakistan,[23] Ghana,[22] China,[19] and Ethiopia.[13]

The sample sizes of the included studies ranged from 55 to 1956 participants, totaling 5,557 individuals. Half of these studies focused exclusively on nursing,[17,18,20,23,25] while the remaining studies included a multiprofessional team comprising physicians, nurses, nursing technicians, laboratory professionals, and cleaning staff.[19,21,22,24,26] Among the affected individuals, females were more frequently involved in accidents than males.[18,20,24] However, among studies involving multiprofessional teams, nurses were the category most affected by accidents.[19,26] Nevertheless, other studies highlighted categories such as nursing technicians,[17] physicians,[24] laboratory technicians,[22] and cleaning staff,[23] but one study did not specify this categorization.[21]

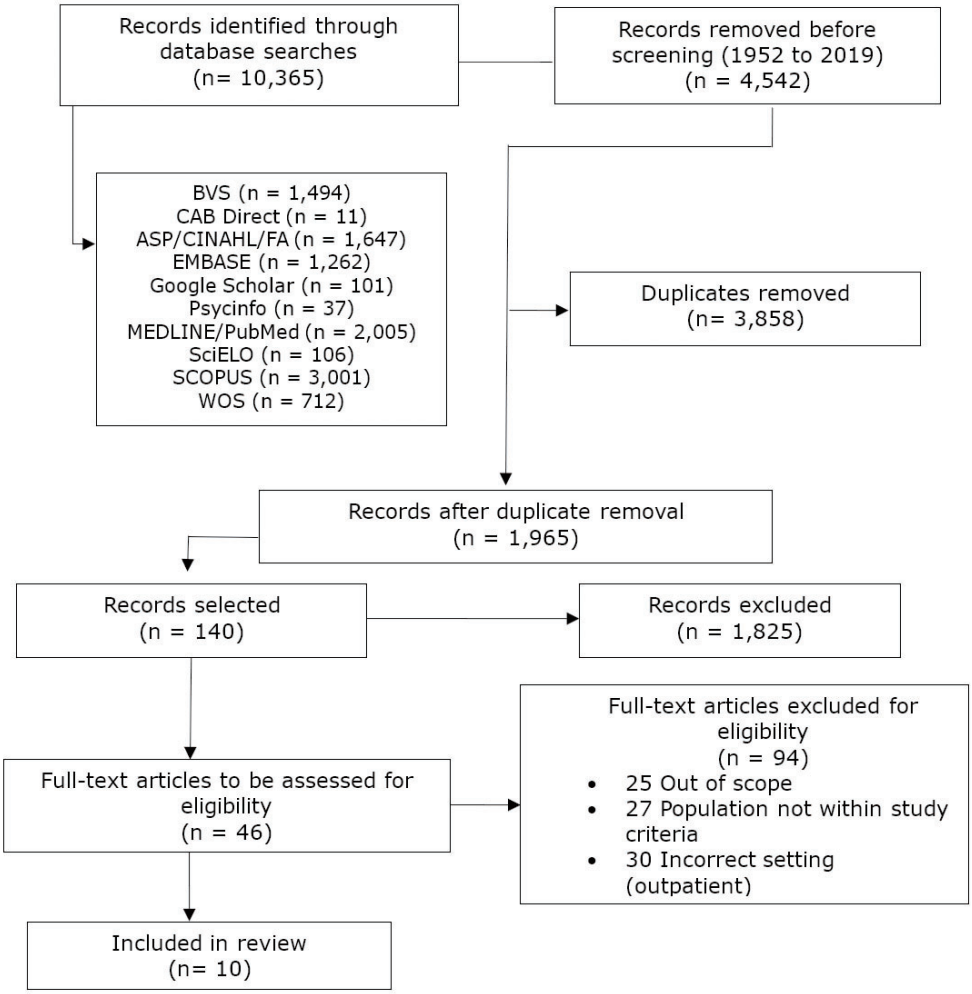

Figure 1. PRISMA flowchart of study selection

Regarding the type of accident, percutaneous exposure was found in all studies. In 30% of cases, there was also direct contact with fluids on the skin due to splashes.[17,18,23] Only 10% of studies evaluated mucosal exposure (ocular, nasal, or oral).[24] Blood was the biological material most commonly involved in accidents.[17,21,22,24,26] Other fluids mentioned included: cerebrospinal fluid (10%),[17] pleural fluid (20%),[17,24] ascitic fluid (10%),[17] unspecified fluids (40%).[18–20,25]

Needles were responsible for nearly all accidents involv-

ing sharps.[20,21,23,24,26] Other instruments mentioned included: arterial cannula,[25] scalpel/blade (40%),[17,20,21,26] scissors (10%),[17] intravenous catheter (30%),[21,24,26] glass (20%),[22,26] and unspecified instruments (20%).[18,19] The hands and fingers were the most affected body parts in the accidents.[20,24,26] Other body parts mentioned included: eyes (10%),[18] arms (10%),[20] legs (20%),[20,26] and not reported (50%).[17,19,21–23,25]

The main sectors where professionals experienced the most accidents were: emergency department,[17,20] ICU,[20] operating room,[25] surgical ward,[24] and others unspecified.[18,19,22,23] Table 1 presents the characteristics of the included studies.

3.1 Work conditions

The findings related to work-related aspects encompass the conditions and organization that professionals experience daily, including workplace protection provisions such as comfort, lighting, ventilation, hygiene, and safety, with evidenced reasons highlighting inadequate physical space,[17] poor access to PPE,[20,25] low-quality equipment,[26] and presence of contaminated sharps in the work area.[20] Units with agitated patients and/or sudden movements recurrently contributed to accident occurrences in most studies.[17,20,22,25,26]

3.2 Work organization

Work organization describes the planning and distribution of tasks, human resources, activity execution processes, and time management. In this regard, shift work was identified as one of the main reasons for accidents,[17,18,21,22,24,26] along with high workload.[19,20,22,26] Other reasons found in the studies include the nature of healthcare work,[17,18,21,25] requiring rapid action such as in the Emergency Department,[18,20] Operating Room,[21,24] and ICU,[20] long work shifts,[22,23] overtime work,[26] and lack of training on sharps safety.[25]

The findings of individual factors encompass physical and mental health. This review also identified behavioral factors adopted by professionals in their work practices that contributed to incidents.

3.3 Factors related to worker's physical health

These factors pertain to the proper functioning of the body. Fatigue was highlighted as a contributing factor to accidents in most studies,[17,23,24,26] along with tiredness[18,20,21] and exhaustion.[25] Other reasons mentioned include musculoskeletal stressors (such as prolonged standing or lifting heavy objects like patients),[22] age factors, such as being under 30 years old,[19] between 30-39 years old,[18] or older age.[25,26] Being female showed a higher association with being victims of these accidents compared to males.[18,20,24]

3.4 Factors related to worker's mental health

This section refers to the mental well-being experienced by individuals that enables them to develop skills and respond to challenges in a healthy manner. Lack of attention/concentration was associated with accidents in most studies.[17,20,24–26] Other reasons mentioned include stress[19,22,23,26] and helplessness in the face of job demands.[19]

3.5 Worker's risky behaviors and practices

Improper disposal of biological material was frequent in most studies,[17,22,24] followed by needle recapping[20,26] or intentional needle disconnection.[20] Other behaviors identified among those involved in accidents include: failure to use PPE,[17] lack of skill in handling biological material,[20,25] rushing through tasks,[26] and another professional's imprudence.[26] Table 2 presents the work-related aspects and individual factors associated with accidents involving exposure to biological material.

4. DISCUSSION

This scoping review synthesizes recent evidence on the influence of work-related conditions and organizational factors on accidents involving exposure to biological materials. The findings align with existing literature, reinforcing the well-established association between heavy workloads, long work hours, and rotating shifts with an increased risk of occupational exposure among healthcare professionals.[27,28] Besides, the findings are consistent with prior studies highlighting how excessive work demands contribute to fatigue, stress, and impaired cognitive function, all of which compromise safety and increase accident susceptibility.

Despite adherence to safety protocols and training, occupational exposures to biological materials remain frequent, indicating that workplace conditions and individual risk factors are deeply intertwined. Female nurses emerge as particularly vulnerable,[17,18,21,25] a pattern also observed in a cross-sectional study in Turkey, where women accounted for 67.94% of exposures, with nearly half (45%) being nurses.[29] This aligns with previous research on the predominance of women in nursing, a profession historically responsible for handling potentially infectious biological materials such as blood,[17,21–24,26] cerebrospinal fluid,[17] pleural fluid,[17,24] ascitic fluid,[17] and unspecified fluids.[18–20,25] Percutaneous injuries—primarily caused by needlestick accidents—were the most frequent type of exposure, corroborating data from a retrospective study of 967 incidents, where 84% involved needles.[5] Similarly, a cross-sectional study of 400 cases found that 70.5% of needlestick injuries affected the fingers,[30] further supporting the high risk associated with needle use.

Table 1. Studies on work-related and individual factors in biological exposure incidents

Author, year and journal	Objective	Design and population	Professional category	Type of exposition	Instrument involved	Biological material involved	Region of the body affected	Sector/Ward
Sepandi et al., 2023 Nursing Open[26]	Assess the prevalence of accidents involving biological material among Iranian health professionals in military hospitals.	Cross-sectional study.	802 professionals including nurses, physicians, operating room technicians, anesthesia, laboratory and obstetrics technicians	Percutaneous (100%)	Catheter (14.3%) Suture needle (15.8%) Blade (1.5%) Ampoule (1.5%) Other (22.6%)	Blood	Hands (16.3%) Fingers (69.5%) Leg (25.3%) Abdomen (6.9%) Other members (5.9%)	Emergency (37.4%) Cardiology ward (1.5%) Wards (4.4%) Surgical Center (31%) ICU (3.4%) Surgical ward (2.4%) Gynecology (14.3%)
Garus-Pakowska et al., 2022 International Journal of Environmental Research and Public Health[25]	Examine the frequency of sharps injuries among nurses using devices with and without safety features.	Cross-sectional study.	280 nurses	Sharps (100%)	Needle (46.42%) Safety intravenous cannula (58.92%) Safety arterial cannula (69.28%); Central safety cannula (59.64%); Vial syringes (56.07%); Needleless valves (63.57%)	Unspecified	Unspecified	Surgical Unit (58.27%) Non-surgical unit (36.09%) Emergency (5.64%)
Quixabeiro and Hennington, 2021 Rev Bras Med Trab[24]	Evaluate and describe the frequency of occupational exposure to sharp materials.	Cross-sectional, exploratory and descriptive study	87 professionals Nurse 16.2%), Nursing technician (19.5%) Medical staff (35.7%)	Percutaneous and mucocutaneous	Needle (21.8%) Sulturas (2.3%) Intravenous catheter (2.3%); Blood collection devices (2.3%) Unspecified (88.5%)	Blood (69%) Bloody fluid (1%) Pleural fluid Peritoneal (1%) Fabric (1.1%) Unspecified (27.7%)	Finger (20.7%) Hand (1.1%) Unspecified (78.2%)	Surgical Center (40.2%) ICU (3.5%) Emergency (5.8%) Endoscopy (6.9%) Nuclear Medicine (3.5%) Chemotherapy (1.1%) Radiology (3.5) Others (14,9%)
Appiagyei et al., 2021 Pan Afr Med J (Ghana)[22]	Determine the prevalence of occupational injuries among health professionals.	Cross-sectional study	246 professionals including nurses, physicians, laboratory staff and non-clinical staff	Sharps (27.4%) Glass (5%) Collision with objects (19.5%) Violence at work (18.9%) Falls (7.5)	Unspecified	Blood	Unspecified	Unspecified
Hameed et al., 2021 Pakistan Journal of Medical Sciences[23]	Investigate the perception of safety culture and the potential challenges faced by healthcare professionals.	Cross-sectional study	500 participants nurses (17%), physicians (22%) support staff (40%), and technicians (12%)	Percutaneous (45.5%) Splashes (36%) Direct contact (28.8%)	Unspecified needles (100%)	Blood and Organic fluids (unspecified)	Unspecified	Unspecified
Liyew et al., 2020) Biomed Research International[20]	Assess the magnitude and determinants of sharps accidents among nurses.	Cross-sectional study	268 nurses	Sharps (100%)	Needles (87.6%), Blades (9.3%) Lancets (5.2%)	Unspecified	Hand (15.5%), Arm (7.2%), thigh (7.2%) palm (6.2%).	ICU (46.2%) surgical (44.4%), medical (39.9%), emergency (36%), Other (35.6%) pediatric (20%).
Moghadam et al., 2020 Infectious Disorders - Drug Targets[21]	Explore the prevalence and distribution of determinants of such injuries in a university hospital.	Cross-sectional descriptive study	55 professionals, including nurses (34.6%), nursing assistants (14.5%) and physicians (12.7%),	Sharps (100%)	Suture needle (15.8%) Blade (1.5%) Catheter (14.3%) Other (22.6%)	Blood and organic fluids	Unspecified	Unspecified
Hosseinabadi et al., 2019 Journal of Clinical Nursing[18]	Determine the prevalence and types of occupational injuries in nurses and their association with workload, work shifts, and individual and organizational factors.	Cross-sectional study	616 nurses	Sharps and splashes	Unspecified	Blood and unspecified body fluids	Eyes (breathing) Skin (unspecified)	Emergency; ICU; Surgical and medical wards
Wang et al., 2019 BMC Public Health (China)[19]	Identify the association between psychosocial working conditions, global perception of stress, and needlestick injuries among Chinese health professionals.	Cross-sectional study	1956 professionals Nurses (43.05%) Nursing technicians (25.36%) physicians (31.60%)	Sharps (100%)	Unspecified	Unspecified	Unspecified	Unspecified
Aragão et al., 2019 Nursing Focus (Brazil)[17]	Determine the occurrence of occupational exposure to biological fluids in sharps accidents among hospital nursing staff.	Cross-sectional study	747 professionals Nursing assistants (42%) nursing technicians (45.8%) nurses (12.2%)	Direct contact of blood on the skin (88.3%) Percutaneous Mucocutaneous (6.7%) Unspecified (2.8%)	Needles (71%) Scissors (1%), Scalpel blade/lancet (6.9%) Ignored (14.4%).	Blood (72%) Fluid (2.5%), pleural fluid (1.7%), Liquid Ascitic (2.2%), Unspecified (21.6%).	Unspecified	Surgical ward (23.6%) Medical (27.3%) Sterilization Center (4.7%) Emergency room (27.3%) ICU (7.9%) Pediatrics (7.2%)

Table 2. Work-related aspects and individual factors associated with accidents involving exposure to biological material

Author, year and journal	Work aspects		Individual aspects		
	Working conditions	Work organization	Physical Health	Mental Health	Behavior
Sepandi et al., 2023 Nursing Open (Iran)[26]	Sudden movement of the patient (5.4%) Low-quality equipment (2.5%)	Night work (OR: 1.91; 95% CI (1.18; 3.12)), Working overtime (OR: 1.50; 95% CI: (1.07; 2.12)) Workload (17.7%)	Older age (OR: 1.02; 95% CI (1.01; 1.04)) Fatigue and drowsiness (5.4%)	Stress at work (1%) Lack of attention/distraction (15.3%)	Needle recapping (OR: 2.90; 95% CI: (1.98; 4.22)) Getting the job done in a hurry (10.3%)
Garus-Pakowska et al., 2022 International Journal of Environmental Research and Public Health[25]	Patient movement (29%); Poor access to PPE in the workplace (45%)	Nature of the work (61%) Staff had little influence on the type of sharp instrument supplied (41.07%) Lack of training in the use of safe needles (20%) Lack of control over the quality of safe medical equipment purchased (13.21%)	Exhaustion at work (OR = 1.78; 95% CI = 1.13-2.83). Male ((OR = 4.92; 95% CI = 2.19-11.29) Age (young nurse) (OR = 4.92; IC95% = 2.63-9.31)	Lack of attention (27%) Stress (16.3%)	Haste (31.4%)
Appiagyei et al., 2021 Pan Afr Med J (Ghana)[22]	Patient movement (85%)	8-hour working day (54.5%) Shift work (94.3%) Workload (48.9%)	Musculoskeletal stressors, including Standing for a long time and moving heavy objects, Including patients (85%)	Stress at work (73.2%)	Inadequate disposal (13.4%)
Hameed et al., 2021 Pakistan Journal of Medical Sciences[23]	Unspecified	(28.6%) worked 60-79 hours/week and (24%) worked more than 100 hours/week.	Fatigue, Restlessness Effort.	Stress Cognitive impairment	Unspecified
Quixabeiro and Hennington, 2021 Rev Bras Med Trab (Brazil)[24]	Working in the surgical department (40.2%);	Working the morning shift (84%)	Fatigue (7.2%) Being female (57.5%)	Lack of attention when disposing of sharps	Inadequate disposal of sharps.
Liyew et al., 2020 BioMed Research International[20]	Presence of contaminated needles and/or sharps in the work area (AOR = 2.052 (95% CI 1.110; 3.791)), Abrupt movement of patients (52.3%) Working in the ICU (46%) Lack of proper disposal of materials (35.1%) Lack of gloves (29.6%), Lack of sharps collection bins (13.3%)	Workload (61.9%). Too many patients (35.7%), Emergency situations (5.1%),	Being female AOR = 0.461 (95% CI 0.252; 0.845)) Tiredness (7.2%)	Lack of attention (9.3%))	Needle refill after use (AOR = 1.780 (95% CI 1.025; 3.091)) Removal of used needles (12.2%). Unsafe collection of sharps (26.4%)).
Moghadam et al., 2020 Infectious Disorders - Drug Targets[21]	Working in the emergency room (38.1%) and operating room (18.2%).	Working as a nurse (34%) The majority worked in shifts during the morning (50.9%).	Fatigue as the most common reason for needlestick injuries (67.4%).	Unspecified	Unspecified
Hosseinabadi et al., 2019 Journal of Clinical Nursing (Iran)[18]	Working in the emergency sector (31.6);	Nature of nursing work (85%) Nurses working rotating shifts had between 15% and 53% more accidents than those working fixed shifts.	Fatigue/back pain (35%) Be female (68.0%) Age (30-39) (44.5%)	Increased mental workload, needlestick injuries increase (35%)	Unspecified
Wang et al., 2019 BMC Public Health (China)[19]	Unspecified	Work demand ($p < .05$) Effort at work ($p < .05$) Low self-efficacy ($p < .05$)	Age (30 years or younger) average frequency of needlestick injuries was 1.19 ± 1.75 (ranges from 0 to 9 times)	Total perception of stress ($p < .05$) Feeling of helplessness ($p < .05$)	Unspecified
Aragão et al., 2019 Nursing Focus (Brazil)[17]	Inadequate physical space (15.4%) Use of inappropriate material (13.9%) Agitated patient (1.5%)	Being a nursing technician ((OR=3.88; 95%CI=2.27-6.64); I work the morning shift (89.3%), Lack of training (1%)	Fatigue (14.4%)	Lack of attention/concentration (30.3%)	Non-use of PPE (6.7%) Inadequate disposal of sharps (12.4%)

The highest exposure rates were reported in high-risk hospital sectors such as emergency rooms, ICUs, and surgical units, where the handling of sharp instruments and invasive procedures increases susceptibility to accidents.[17,20,24–26] This trend aligns with a study of 366 healthcare professionals, which found that those working in emergency or ICU settings had nearly six times the odds (OR: 5.9; 95% CI: 2.69–12.97) of experiencing an occupational exposure compared to colleagues in lower-risk units.[31]

Beyond work settings, deficient working conditions further exacerbate risks. Factors such as inadequate physical space, poor equipment quality, insufficient access to safety materials, and lack of proper training contribute significantly to occupational exposures.[17,20,25,26] This aligns with findings from an epidemiological study of 133 healthcare professionals, where inadequate working conditions and lack of training were identified as major causes of percutaneous injuries.[28] Additionally, unsafe patient behaviors, such as agitation and sudden movements during procedures, have been linked to accidental exposure, a risk confirmed by a cross-sectional study of 400 healthcare professionals, where 70.6% of reported accidents occurred while treating non-cooperative patients.[30]

Work organization also plays a critical role, with shift work and night shifts consistently associated with higher accident rates.[17,18,21,22,24,26] Interestingly, a study of 1,525 healthcare professionals found that 70% of percutaneous injuries occurred during morning shifts, likely due to increased workload pressures related to patient admissions, bureaucratic tasks, and surgical preparations.[32]

Similarly, workload-related stress has been identified as a key predictor of biological material exposure.[19,20,22,26] Insufficient staffing and material resources force professionals to overextend their capabilities, leading to fatigue, lack of concentration, and errors. Therefore, workload stands as a primary cause of exposure among healthcare professionals.[33]

The cumulative effect of extended work hours, overtime, and excessive workload leads to chronic fatigue, exhaustion, and musculoskeletal strain, all of which elevate accident risks.[17,18,20–26] This is reinforced by a study of 847 healthcare professionals, where those working overtime had a 6.6-fold higher risk of needlestick injuries compared to those with standard workloads.[27] In addition, a qualitative study of 688 healthcare professionals found that fatigue, sleep deprivation, and cognitive overload impair hazard recognition and increase workplace injuries.[4]

Age also correlates with accidental exposure,[25] with older age[26] and younger age (<30 years)[19] both associated with increased accident rates. Older workers experience decreased muscle strength, slower reflexes, and diminished vision and hearing, making them more susceptible to accidents.[34] Conversely, younger professionals' accidents stem from lack of skill, knowledge, and experience. This pattern was further supported by a cross-sectional study in China involving 847 healthcare professionals showed that novices or those with less experience had a 3.9 times higher incidence of biological material accidents compared to more experienced counterparts.[27]

Notably, gender disparities persist in occupational exposures. Studies consistently show that women experience more biological material accidents than men, a trend supported by a Spanish study of 1,062 biological risk accidents, where 72.1% involved female healthcare professionals.[18,20,24,35] One possible explanation is the work-family conflict disproportionately affecting women, increasing stress and diminishing attention to occupational safety.[35]

Mental health factors—including stress,[19,22,23,26] inattention,[17,20,24–26] and rushing through tasks[19,21,24] frequently contribute to biological material accidents.[17,19–26] Given the strong correlation between workload, stress, and accident rates, workplace interventions should prioritize health promotion, targeted training,[22,25,26] education programs,[25] and improvements in organizational conditions.[18,19,21,23,24]

4.1 Implications for practice and future research

This research provides new evidence on the relationship between work aspects and individual factors among healthcare professionals in the occurrence of biological material accidents. This knowledge is crucial both for healthcare professionals and scientific advancement. For professionals, particularly those facing occupational risks like nurses, doctors, and others, understanding these factors enables the implementation of work practices that minimize risks. Identifying the impact of stress and sleep deprivation can guide the development of public policies aimed at reducing excessive workloads and promoting mental health, ensuring greater safety.

In the research field, this evidence allows for a broader understanding of the psychosocial and physiological factors affecting workers' health and safety. It encourages the development of future intervention studies for stress management, sleep health, and accident prevention, strengthening the foundation for more effective implementations. Longitudinal studies tracking healthcare professionals across various work contexts are recommended to examine how changes in work conditions and mental health factors over time influence the

occurrence or prevention of biological material accidents. Exploring stress management programs and improvements in work conditions, along with evaluating their impact on reducing biological material accidents, is also recommended.

4.2 Strengths and limitations

In line with the scoping review methodology, the studies included in this review were not assessed for quality. While this approach consolidates evidence, it may limit the findings. The search for recent evidence was restricted to the past five years, meaning that some relevant studies may not have been included.

A significant knowledge gap in this area is the lack of longitudinal studies exploring the causal relationship between these variables over time. Most existing research is cross-sectional, which limits the understanding of how stress, physical and mental fatigue, and sleep patterns contribute to the occurrence of accidents.

5. Conclusions

Work-related factors such as high workload, long hours, and rotating shifts place healthcare professionals at greater risk of accidents involving biological material. Similarly, the association between individual factors such as fatigue, stress, and sleep deprivation and these accidents is evident. Therefore, offering continuous education in safety and providing protective equipment alone are not sufficient to address this issue.

It is essential that hospital institutions' self-management recognize the importance of developing a framework to ensure adequate working conditions and minimize individual factors such as work-related fatigue, stress, and sleep deprivation in order to protect their most valuable resource: healthcare professionals.

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Authors contributions

Dr. Suleima Vasconcelos was responsible for the study conception, design, supervision, and manuscript revision. Tatiany Marques contributed to the study conception, design, data collection, data analysis, and manuscript revision. Dr. Suleima Pedroza Vasconcelos, Thaina Ribeiro, and Greiciane Rocha revised the manuscript. All authors contributed equally to the approval of the final version of the article.

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Conflicts of Interest Disclosure

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Sciedu Press. The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

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The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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