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The effect of ambulance clinicians' well-being on occupational and patient safety in prehospital emergency medical services: a scoping review

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Abstract

Working in prehospital emergency medical services (EMS) can be unpredictable and emotionally demanding for ambulance clinicians (ACs). Burnout, stress, poor sleep quality, fatigue, and psychological health issues increase the risk of accidents and adverse events related to occupational and patient safety. This scoping review aimed to identify and map the existing literature on the current state of the effect of ACs' well-being on occupational or patient safety risks in prehospital emergency medical services settings. The methodologies of the Joanna Briggs Institute and Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews guidelines were used. The databases searched included CINAHL Plus, PubMed, Scopus, Web of Science, and MedNar on March 8, 2024. Peer-reviewed and nonpeer-reviewed scientific and nonscientific sources were searched. The reference lists of the selected sources were screened for further papers. Participants who were ACs working in prehospital EMS and reported their physical, psychological, and social well-being related to adverse events in occupational or patient safety were eligible for inclusion. Quantitative, qualitative, and mixed-method studies; reviews; text, opinion, and discussion papers; and gray literature were included. Two reviewers independently reviewed the titles, abstracts, and full texts and assessed the quality of the sources. Data were extracted from the 2 reviewers by using an extraction tool. Data were analyzed using numerical and thematic methods. In total, 35 sources were included. Four themes were identified from the heterogeneous data: Deficiencies in psychological well-being, Deficiencies in physical well-being, Deficiencies in psychophysical well-being, and Deficiencies in social well-being. Fatigue and stress experienced by ACs are the most important factors that negatively affect patient and occupational safety. Deficiencies in psychophysical well-being have a clear effect on both patient and occupational safety. There is limited evidence on the effect of ACs' well-being on patient and occupational safety in prehospital EMS.

Keywords: Ambulance clinician, Emergency medical services, Nurse, Paramedic, Patient safety, Prehospital, Occupational safety, Well-being

Introduction

The modern prehospital emergency medical service (EMS) is characterized by highly technological solutions[1,2] and advanced and complex interventions that well-educated personnel can perform on-scene.[2] Thus, prolonged on-scene time in prehospital EMS might have negative consequences for both patients and effective healthcare systems.[3–5] The changed role of the prehospital EMS includes helping not only high-risk patients needing critical care but also nonurgent patients. An increasing number of prehospital EMS missions have been identified in many countries.[6–10] Care for nonurgent patients is an important part of increased EMS missions.[11] The high workload of nonurgent patients, as well as the long time spent on patient assessment and on-scene treatment without conveyance,[12] can be experienced as burdensome and engaging among ambulance clinicians (ACs),[13] which in turn can lead to deficiencies in ACs' well-being.

The increasing demand for services, limited personnel resources, aging infrastructure, technological advancements, and regulatory compliance are the main challenges faced by prehospital EMS.[14] Organizations worldwide are experiencing increasing difficulties in recruiting and retaining qualified ACs, likely because of low salaries, poor working conditions, and limited opportunities for professional development.[14,15] The prehospital EMS work environment involves unpredictability and high emotional demands on ACs.[16] Work can be fast-paced, intensive, and varied, and may be performed in demanding and risky environments.[1,17]

Well-being is the positive state experienced by a person and is a resource in people's daily lives and is related to economic, social, and environmental aspects.[18] Several areas of well-being have been identified. Physical well-being reflects an individual's ability to perform physical activities and social roles without hindering their overall physical condition.[19] Psychological well-being includes individuals' sense of self-determination,[20] happiness,[21] control and capacity to develop themselves, the ability to maintain pleasant social relations, and experiencing a purpose[20] and fulfillment[21] in life. Two marked threats to psychological well-being are stress[22–24] and mental disorders.[25,26] Long-term fatigue[27] and sleep disorders[28] are common factors that can lead to challenges in psychophysical well-being,[27] which can be understood as a state of

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psychological processes and somatic physiology in which the "mind and body" are inseparable.[29] Social well-being refers to an individual's social integration, contributions, and functioning in society.[30]

ACs' well-being may be affected by the occupational environment and nature of work in prehospital EMS, which is a significant contributor to stress and negatively affects the psychological and physical health of ACs.[31,32] Stress risk is higher among ACs than general population.[33] Work intensification, burnout, lack of trust in management,[34] high levels of stress,[35] poor sleep quality,[16,36] and various psychological health issues decrease ACs' well-being.[16,37,38] Sleep disturbance and fatigue not only affect the health of ACs but also potentially increase the risk of accidents, injuries, and adverse events.[36] Patient care in prehospital EMS is potentially hazardous and can include harmful events.[39] Patient safety risks (PSRs) in the prehospital EMS healthcare context can be related to deficient education of ACs, incorrect clinical judgment and decision making by ACs,[39] and nonconveyance of patients.[40,41]

Understanding the factors that affect ACs' job performance when under pressure has led to the development of strategies to reduce the risk of human error and improve patient safety. The use of cognitive aids, checklists, and technological and telemedical support in prehospital EMS has shown significant benefits in ACs' job performance under pressure and in demanding situations.[1] However, methods for measuring and monitoring patient safety in prehospital EMS are not comprehensive.[42] Diverse safety dimensions related to working in prehospital EMS are essential and must be taken seriously. For example, driving an ambulance, safely handling equipment, securing patient safety, and ensuring safety during missions are considered important.[43] Unsafe care can have several negative effects on the lives of individuals, healthcare systems, and societies. Most negative events associated with possible patient harm in prehospital EMS can be avoided.[44]

Common negative occupational safety outcomes in the prehospital EMS include work-related musculoskeletal disorders[45–47] and transportation-related events.[48] Occupational safety risks (OSRs) in prehospital EMS are characterized by the complexity and multitude of contributing factors.[46] Sleep deprivation is one of the most important contributors to OSR in prehospital EMS.[48] However, there is limited evidence on the effect of ACs' well-being on OSR and PSR. This review identifies what has been studied and highlights the research gaps in this area.

Aim

This scoping review aimed to identify and map the existing literature on the effect of ACs' well-being on OSR or PSR in prehospital EMS settings. The review question was as follows: How does ACs' well-being affect OSR or PSR in prehospital EMS missions, based on the existing literature?

Methods

Study design

This scoping review was conducted using the methodology of the Joanna Briggs Institute (JBI)[49] and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR).[50] The protocol has been registered in the Open Science Framework (https://doi.org/10.17605/OSF.IO/5KDVF).

Inclusion and exclusion criteria

The sources were selected using predefined inclusion and exclusion criteria created by the PCC mnemonic (Population, Concept, Context).[49,51]

Population. Sources discussing ACs working in prehospital EMS were included. ACs included ambulance personnel who work within clinical ambulance care facilities near patients. Job titles included emergency nurse, paramedic, ambulance nurse, emergency medical technician, and prehospital nurse. Education in prehospital EMS was a mandatory requirement. There were no requirements regarding the level or duration of education or work experience. Physicians working in prehospital EMS and students in prehospital EMS professions were excluded from this review. Physicians were excluded because they have more extensive training and play a different role in prehospital EMS than ACs. Physicians may also have different individual or organizational opportunities than ACs to care for their well-being. There were no restrictions on sex, age, ethnicity, or other population characteristics of the ACs.

Concept. Sources containing evidence of ACs' physical, psychological, and/or social well-being with an effect on adverse events in occupational and/or patient safety were included. ACs' experiences of short-term transient deficiencies in well-being were excluded (e.g., acute stress and acute fatigue reactions that disappeared in the short term). Adverse events were defined as confirmed harm or the risk of harm. Articles must have discussed adverse events concerning occupational safety (e.g., for healthcare employees, materials used, and vehicles involved in prehospital EMS missions) or adverse events concerning patient safety. Patients with all types of diseases or injuries were included. There were no restrictions on the patient population characteristics.

Context. This review focused on the prehospital EMS context, including ground vehicle ambulances for civilian purposes and excluding aircraft and water prehospital units, as well as the military EMS context. Only ground vehicle ambulance units were included because of the different types of education and the characteristics of EMS missions in special units. Only double-crewed ambulance units (2 ACs) were included; single-crewed units were excluded because of the training and competence differences. ACs working in single-crewed units have been trained to work alone and they focus on the first response and patient assessment. Single-crewed units usually do not transport patients (1 AC).

Types of sources. To scope all published evidence from primary and secondary sources concerning this unique topic, studies with qualitative, quantitative, and mixed methods, as well as different types of reviews, texts, opinion and discussion papers, and gray literature, were eligible for inclusion. Sources written in English, Swedish, and Finnish were included in this study. No timeline was used.

Search strategy

The search strategy was aimed at discovering both peer-reviewed and nonpeer-reviewed literature. First, an initial search of the CINAHL Plus and Scopus databases was conducted in January 2024 by the first author to identify the articles and key terms used on the topic. Predefined inclusion and exclusion criteria according to the PCC mnemonic (Participants, Concept, Context)[49,51] were used. No current or ongoing systematic or scoping reviews were identified on this topic. An information specialist analyzed the words contained in the titles and abstracts as well as the keywords of the retrieved papers. In the second step, a search using all identified keywords was undertaken across all included databases (PubMed, CINAHL Plus, Web of Science, Scopus, and MedNar, which provide gray literature sources). There were no differences in the search strings or limitations between the databases.

Keywords were *ambulance clinician, paramedic, emergency nurse, emergency medical technician, ambulance personnel, prehospital, emergency medical services, ambulance care, ambulance settings, emergency nursing, well-being, well-being, job satisfaction, burnout, stress, exhaustion, compassion fatigue, quality of life, psychological fatigue, safety, patient harm, adverse event, hazard, accident, equipment safety,* and *psychological safety*. Finally, articles were searched for additional sources by examining the reference lists of the reports included in the review.[49,51] An example of a search string used in PubMed is presented in Table 1.

Source selection

Following the search, all identified records were uploaded to the Covidence software.[52] Duplicates were then removed. The titles and abstracts of the search results were screened by 2 independent reviewers based on the predefined inclusion criteria. Potentially relevant data were retrieved from the full texts and assessed in detail by 2 independent reviewers against the inclusion criteria. The search of the reference lists yielded 8 additional sources. Data were excluded and the reasons for exclusion were recorded and reported. Conflicts between reviewers at each stage of the selection process were resolved through discussion or with the aid of a third reviewer.

Quality appraisal

First, all sources included were required to answer the aim/research question using an appropriate method. The quality of the included sources was independently assessed using Joanna Briggs Institute's critical appraisal tools[53] independently by 2 authors. To achieve high quality, ≥80% of the criteria had to be met; 70%–79% of the criteria indicated medium high quality, 60%–69% medium quality, and ≤59% low quality. The reviews were assessed using a checklist of systematic reviews and research syntheses.[54] Cross-sectional surveys were conducted using a checklist for analytical cross-sectional studies.[55] Two surveys and 1 Delphi study were conducted using a checklist of prevalence studies.[56] Two qualitative surveys, a single case study with embedded units and a study with focus groups, were conducted using a checklist for qualitative research.[57] One interim report, a letter to the editor, 2 magazine articles, 1 original contribution, a commentary, and a conference paper were assessed using a checklist for textual evidence: narrative.[58] One study, with a 2-group comparison design, was assessed using a checklist for quasi-experimental studies.[59] One high-quality observational study (n = 1) was assessed using a checklist for case-control studies.[55] All checklists assessed the aims and methodology of the sources. The response options were *yes*, *no*, *unclear*, and *not applicable*. The answers were as follows: *yes* = 1 point, *no* = 0 points, *unclear* = 0.5 point. If the question was *not applicable*, it was excluded from the quality appraisal. Finally, the percentage of positive answers was calculated and interpreted to indicate source quality.

Data extraction

Data were extracted by 2 independent reviewers. A tool that identified the content relevant to the review question was used for data extraction. The information that was used in the tool is available in Table 2 and Table 3. There were no disagreements between the reviewers.

Data analysis

A modification of the methodological framework Arksey and O'Malley[94] (6 steps) was used. Numerical and thematic analyses were conducted using a deductive-inductive approach. Eleven of the sources included in this scoping review were different types of reviews that included the same primary sources as those in this study. For this reason, the content of the reviews was not analyzed using thematic analysis. The deductive form was based on the components of well-being (psychological, physical, and social) and their effect on PSR or OSR. The following 5 framework steps were used: identifying the research question, identifying relevant sources, selecting sources, charting the data, and summarizing and reporting the results.[94] Thematic analysis was conducted based on the six-step method described by Braun and Clarke.[95] First, the data were read and reread several times, and the initial ideas were written in a separate document. Subsequently, the initial codes were systematically generated. Next, a search for themes and review themes was conducted. Then, the themes were defined and named, and selected extracts were analyzed in relation to the review questions and literature. Finally, a report on the analysis was produced.[95] In addition to the 3 predefined components of well-being, a fourth theme connecting psychological and physical well-being emerged inductively.

Table 1

Example of the Second Phase Search Strategy in PubMed

Search String	Database	Limitations Used in the Search	Results
((("ambulance clinician*"[Title/Abstract] OR paramedic*[Title/Abstract] OR "emergency nurs*"[Title/Abstract] OR "emergency medical technician*"[Title/Abstract] OR "ambulance personnel"[Title/Abstract] OR prehospital[Title/Abstract] OR "emergency medical services"[Title/Abstract] OR "ambulance care"[Title/Abstract] OR "ambulance settings"[Title/Abstract]) OR ((((("Emergency Medical Services"[Mesh]) OR "Emergency Medical Technicians"[Mesh]) OR "Paramedics"[Mesh]) OR "Emergency Nursing"[Mesh])) AND ((well-being[Title/Abstract] OR wellbeing[Title/Abstract] OR "job satisfaction"[Title/Abstract] OR burnout[Title/Abstract] OR stress*[Title/Abstract] OR exhaust*[Title/Abstract] OR "compassion fatigue"[Title/Abstract] OR "quality of life"[Title/Abstract] OR "mental fatigue"[Title/Abstract]) OR ((((("Quality of Life"[Mesh]) OR "Job Satisfaction"[Mesh]) OR "Stress, Psychological"[Mesh]) OR "Mental Fatigue"[Mesh]))) AND ((safe*[Title/Abstract] OR "patient harm"[Title/Abstract] OR "adverse event*"[Title/Abstract] OR hazard*[Title/Abstract] OR accident*[Title/Abstract]) OR ((("Safety"[Mesh]) OR "Equipment Safety"[Mesh]) OR "Psychological Safety"[Mesh]))	PubMed	Covering area: title and abstract Timeline: no starting point—to 8th March 2024 Languages: English, Finnish and Swedish	1371 sources

The second search, which generated 1371 sources in PubMed, was conducted on March 8, 2024. The search strategy in PubMed combined both, terms arised from the first search, and Medical Subject Headings (MeSH terms). Titles and abstracts in English, Finnish and Swedish were searched without a starting year ending to the day when the searches were finished.

Table 2

Literature Included in Analysis (N = 35)

Source	Authors (Year) Country Peer Reviewed or Not	Title	Aim	Design	Results
S1	Aasa et al. (2005)[60] Sweden Peer reviewed	Relationships between work-related factors and disorders in the neck-shoulder and low-back region among female and male ambulance personnel	To investigate the relationships between work-related physical and psychosocial factors and disorders in the neck-shoulder and low-back region among female and male ambulance personnel. An additional aim was to investigate the influence of worry about work conditions on these relationships.	Cross-sectional survey	Among the female personnel, physical demands were significantly associated with activity limitation in the neck-shoulder and low-back region, and psychological demands with neck-shoulder and low-back complaints. Among the male personnel, physical demands were significantly associated with low-back complaints and activity limitation. Psychological demands and lack of social support were significantly associated with neck-shoulder complaints and activity limitation as well as activity limitation due to low-back complaints. Worrying about work conditions was independently associated with activity limitation due to low-back complaints among the female, and to both neck-shoulder and low-back complaints and activity limitation among the male personnel.
S2	Allison et al. (2022)[61] USA Peer reviewed	Working hours, sleep, and fatigue in the public safety sector: a scoping review of the research	To report on the findings from a scoping literature review that sought to identify research gaps related to working hours, sleep, and fatigue, including contextual and co-occurring factors, linked with the occupational safety, health, and performance of workers in the public safety sector.	Scoping review	In 202 articles that met the inclusion criteria, 6 common outcomes related to working hours, sleep, and fatigue emerged: sleep, fatigue, work performance, injury, psychosocial stress, and chronic disease.
S3	Almeida et al. (2023)[62] Portugal Peer reviewed	Emotional management strategies in prehospital nurses: a scoping review	To map the emotional management strategies used by prehospital nurses.	Scoping review	From the initial 511 studies identified, 4 studies were deemed eligible after rigorous screening. The strategies used are individual (pre- and postevent) and collective, varying from formal to informal, with or without institutional support. Notable experiences included a lack of technical/scientific preparation, personal life association, treating acquaintances, pediatric-age patients, childbirth, cardiopulmonary arrests in young individuals, traffic accidents, and suicides.
S4	Baier et al. (2018)[63] Germany Peer reviewed	Burnout and safety outcomes - a cross-sectional nationwide survey of EMS-workers in Germany	To descriptively analyze the overall degree of burnout among EMS workers, and potential adverse events that might harm patients as well as the relationship between burnout and perceived safety outcomes for EMS workers in Germany.	Cross-sectional survey	A total of n = 1101 questionnaires were considered for data analysis. The vast majority of participants were male, younger than 40 years old, and full-time employees with an EMS-experience of 12 years on average. Between 19.9 and 40% of the participants showed a high degree of burnout in one of the burnout dimensions. Safety compromising behavior was the outcome measure with the highest percentage of participants reporting a negative outcome measure. The dimensions of emotional exhaustion and depersonalization were positively associated with the safety outcomes of injury and safety compromising behavior. Additionally, experiences, job satisfaction, and the intention to leave the current job were significantly associated with the outcome measures.

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Table 2 *(Continued)*

Source	Authors (Year) Country Peer Reviewed or Not	Title	Aim	Design	Results
S5	Barger et al. (2018)[64] USA Peer reviewed	Effect of fatigue training on safety, fatigue, and sleep in emergency medical services personnel and other shift workers: a systematic review and meta-analysis	To critically review and synthesize existing literature on the impact of fatigue training on fatigue-related outcomes for EMS personnel and similar shift worker groups.	Systematic review	Of the 3817 records initially identified for review, 18 studies were relevant and examined fatigue training in shift workers using an experimental or quasi-experimental design. Fatigue training improved patient safety, personal safety, and ratings of acute fatigue and reduced stress and burnout. A meta-analysis of 5 studies showed improvement in sleep quality (fixed effects SMD: −0.87; 95% confidence interval [CI]: −1.05 to −0.69; $P < 0.00001$; random effects SMD: −0.80; 95% CI: −1.72 to 0.12; $P < 0.00001$).
S6	Booker et al. (2024)[65] Australia Peer reviewed	Sleep and fatigue management strategies: How nurses, midwives and paramedics cope with their shift work schedules—a qualitative study	To understand the benefits and challenges of shift work, and the coping strategies used by nurses, midwives and paramedics to manage the impact of shift work on sleep and fatigue from shift work.	A single case study with embedded units	Participants enjoyed the lifestyle, flexibility, and financial rewards offered by working shift work. However, fatigue and sleep deprivation undermined these benefits, as it impacted their ability to enjoy social and family events. There were also concerns of long-term health consequences of shift work and delivery of care. Changes to rostering practices and sleep and shift work education were common recommendations.
S7	Boorman (2009)[66] England Nonpeer reviewed	NHS Health and Well-being Review	To use Interim reports contents as a basis for discussion at workshops throughout the country, seeking further feedback from NHS workers and other stakeholders during summer and early autumn.	Interim report	We have made a number of recommendations to improve staff health and well-being and have highlighted the next steps that need to be taken to achieve this. We recognize that these will require some investment in improving services. We believe that adopting innovative approaches to supporting staff health and well-being, as we recommend in the report, will free up resources that can be reinvested in better and more appropriate services. More importantly, we are confident that any costs will be outweighed by the benefits which will flow to NHS organizations. As well as financial benefits—from reduced costs of sickness absence, increased productivity and lower spending on staff turnover, agency spending and ill-health retirement—there will be benefits to patient care and patient satisfaction from being treated by happy, healthy staff working in teams with familiar colleagues, rather than by tired, unwell and unhappy staff.
S8	Broniecki et al. (2010)[67] Australia Peer reviewed	Musculoskeletal disorder prevalence and risk factors in ambulance officers	To explore the prevalence and determinants of musculoskeletal disorders in ambulance officers, and the limitations of the current epidemiological evidence to inform the development of interventions.	Literature review	Existing research shows a high annual prevalence of back, neck and shoulder musculoskeletal disorders in ambulance officers and emergency medical technicians, while limited research has demonstrated significant associations between individual, physical, and psychosocial demands, and musculoskeletal disorders of the low-back and neck-shoulder area.
S9	Chirico et al. (2023)[68] Italy Peer reviewed	Occupational health services have a relevant role in protecting the health and safety of paramedics	To point out occupational health and safety risks for paramedics, and highlight the relevant role carried out by multidisciplinary occupational health services in the prevention of occupational risks and the promotion of physical and psychological well-being of these workers.	Letter to editor	-
S10	Cotter (2011)[69] USA Non peer reviewed	Seeking shift work solutions	-	Journal article	-

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Table 2 *(Continued)*

Source	Authors (Year) Country Peer Reviewed or Not	Title	Aim	Design	Results
S11	Cottrell et al. (2014)[70] USA Peer reviewed	Understanding safety in prehospital emergency medical services for children	To building upon and further refine our understanding of the landscape of factors leading to safety events in the prehospital emergency care of children.	Focus groups	Key factors and themes identified in the analysis were grouped into categories using an ecological approach that distinguishes between systems, team, child and family, and individual provider-level contributors. At the systems level, focus group participants cited challenges such as a lack of appropriately sized equipment or standardized pediatric medication dosages, insufficient human resources, limited pediatric training and experience, and aspects of emergency medical services culture. EMS team-level factors centered on communication with other EMS providers (both prehospital and hospital). Family and child factors included communication barriers and challenging clinical situations or scene characteristics. Finally, focus group participants highlighted a range of provider-level factors, including heightened levels of anxiety, insufficient experience and training with children, and errors in assessment and decision making.
S12	Donnelly & Siebert (2009)[71] USA Peer reviewed	Occupational risk factors in the emergency medical services	To systematically examine gaps in the extant literature and to present a theoretically driven conceptual model to serve as a basis for future intervention and research efforts.	Systematic review of literature	Exposure to traumatic events was reported to be between 80% and 100% among EMTs, and rates of PTSD are >20%. High-risk alcohol and drug use rates among other emergency response professionals were reported to be as high as 40%. The proposed model suggests direct linkages between occupationally related stress exposure, including chronic and critical incident stress, PTSD, and high-risk alcohol and other drug use. Social support and personal resources (e.g., coping, locus of control) are proposed to have mediating and moderating influences on the 3 main constructs, and cohesion is introduced as an important, idiosyncratic influence in this population. The moderating influences of gender, age, ethnicity, marital status, and socioeconomic status, level of training, and years of service are included in the proposed model.
S13	Donnelly et al. (2019)[72] Canada Peer reviewed	Fatigue and safety in paramedicine	To determine if fatigue and shiftwork variables were related to safety outcomes in Canadian paramedics.	Cross-sectional survey	In this sample, 55% of paramedics reported being fatigued at work. Fatigued paramedics were over twice as likely to report injuries, 3 times as likely to report safety compromising behaviors, and 1.5 times more likely to report errors/ adverse outcomes. When controlling for fatigue, shift length variables did not consistently influence safety outcomes.
S14	Donnelly et al. (2020)[73] Canada Peer reviewed	What influences safety in paramedicine? Understanding the impact of stress and fatigue on safety outcomes	To build on extant research linking fatigue to safety outcomes in paramedicine by assessing the influence of a multiplicity of workplace stressors, including chronic and critical incident stresses on safety outcomes.	Cross-sectional survey	80% of paramedics reported an injury or exposure to pathogen, 95% reported safety compromising behaviors, and 76% reported medical errors. In the GEE analyses, paramedic injury was significantly related to fatigue (0.13, SE = 0.06, $P = 0.020$), critical incident stress (0.03, SE = 0.01, $P < 0.01$), and PTSS (0.03, SE = 0.01, $P < 0.01$). Safety compromising behaviors were significantly associated with fatigue (0.37, SE = 0.06, $P < 0.01$), organizational stress (0.06, SE = 0.01, $P < 0.01$), and critical incident stress (0.01. SE = 0.01, $P = 0.017$). Medication errors were significantly related to fatigue (0.12, SE = 0.05, $P < 0.01$). Finally, the bivariate analysis showed that increased stress factors and fatigue was associated with increased safety outcomes.

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Table 2 *(Continued)*

Source	Authors (Year) Country Peer Reviewed or Not	Title	Aim	Design	Results
S15	Hines Duncliffe & Batt (2019)[74] Canada Nonpeer reviewed	When ambulances crash	-	Magazine article	-
S16	Franche et al. (2010)[75] Canada Peer reviewed	Work disability prevention in rural areas: a focus on healthcare workers	To identify rural–urban differences in work disability outcomes (defined as the incidence of occupational injury and the duration of associated work absence), as well as risk factors for poor work disability outcomes in rural healthcare workers.	Literature review	Of 860 references identified, 5 discussed work disability outcomes and 25 discussed known risk factors. Known risk factors were defined as factors firmly established to be associated with poor work disability outcomes in the general worker population based on systematic reviews, well-established conceptual models of work disability prevention, and public health literature. Although somewhat conflicting, the evidence suggests that rural healthcare workers experience higher rates of occupational injury compared with urban healthcare workers, within occupational categories. Rural workers also appear to be more vulnerable to prolonged work absence although the data are limited. No studies directly compared risk factors for work disability prevention outcomes between rural and urban healthcare workers. However, potential risk factors were identified at the level of the environment, worker, job, organization, worker compensation system, and healthcare access. Important methodological limitations were noted, including unclear definitions of rurality, inadequate methods of urban-rural comparisons such as comparing samples from different countries, and a paucity of studies applying longitudinal or multivariate designs.
S17	Friedenberg et al. (2020)[76] Israel Peer-reviewed	Work-related musculoskeletal disorders and injuries among emergency medical technicians and paramedics: a comprehensive narrative review	To review the current knowledge relating to work-related musculoskeletal disorders and nonfatal injuries in emergency medical technicians and paramedics.	Narrative review	Falls, slips, trips, and overexertion while lifting or carrying patients or instruments ranged from 10% to 56%, with overexertion being the most common injury. Risk factors were predominantly lifting, working in awkward postures, loading patients into the ambulance, and cardiopulmonary resuscitation procedures. Lack of job satisfaction and social support was associated with WRMDs and injuries. EMTs-Ps had the highest rate of worker compensation claim rates compared to other healthcare professionals. Positive ergonomic intervention results included electrically powered stretchers, backboard wheeler, descent control system, and the transfer sling.
S18	Hammer et al. (1986)[77] USA Peer-reviewed	Occupational stress within the paramedic profession: an initial report of stress levels compared to hospital employees	To extend the 4-component model of occupational stress to paramedics and to relate these stress measures to measures of job performance.	Survey	Results indicate that this profession experiences a high degree of job-related stress relative to other medical personnel. In a component analysis of this stress the results show that job stress manifests itself as job dissatisfaction, organizational stress, and negative patient attitudes, but not as frequently as somatic distress.

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Table 2 *(Continued)*

Source	Authors (Year) Country Peer Reviewed or Not	Title	Aim	Design	Results
S19	Hansen et al. (2015)[78] USA Peer-reviewed	Children's safety initiative: a national assessment of pediatric educational needs among emergency medical services providers.	To identify educational needs of EMS providers related to pediatric care in various domains in order to inform development of curricula.	Delphi study	The top educational priorities identified in the final round of the survey include pediatric airway management, responder anxiety when working with children, and general pediatric skills among providers. The top 3 needs in decision making include knowing when to alter plans midcourse, knowing when to perform an advanced airway, and assessing pain in children. The top 3 technical or procedural skills needs were pediatric advanced airway, neonatal resuscitation, and intravenous/intraosseous access. For neonates, specific educational needs identified included knowing appropriate vital signs and preventing hypothermia.
S20	Hunt et al. (2023)[34] Wales Peer-reviewed	Contemporary portrait of the working lives of ambulance services staff in Wales	To understand the well-being and working environment of ambulance services staff in Wales.	Survey with mixed-method analysis	Key factors impacting well-being include work intensification, burnout, and a lack of trust in management, which were increasing intentions to leave the profession.
S21	Lipman et al. (2021)[79] England Peer-reviewed	Staff well-being: a matter for quality indicators or a concern in its own right?	To answer the study questions: is staff well-being and its impact on patient care of such a concern that indicators should be included in the AQI framework, and should staff well-being be prioritized in its own right, not just because of its impact on patient care?	Systematized review	A total of 1143 unique articles were screened by title and abstract, and an additional 93 records were identified by hand search. Of 491 eligible returns, 478 were excluded after full assessment. This left 13 peer-reviewed articles for inclusion. The results overwhelmingly evidence that poor retention and high staff sickness rates in the UK's NHS ambulance service are intrinsically linked with staff well-being.
S22	Nortje et al. (2004)[80] South Africa Peer-reviewed	Judgment of risk in traumatized and nontraumatized emergency medical service personnel	To investigate the hypothesis that posttraumatic stress is associated with a judgment of risk bias.	Two-group comparison	Emergency medical service personnel with high PTSD symptomatology (n = 27) and without PTSD symptoms (n = 74) completed the PTSD Symptom Scale: self-report version, the Work Experiences Questionnaire, the Beck Depression Inventory, and an Event Probability Questionnaire. Analysis showed that individuals with high PTSD symptomatology exhibited significantly more judgment of risk bias, that this cognitive bias was toward a wider range of threats than those involving only the threat of external harm, and that intrusion was its best predictor.
S23	Page (2016) USA[81] -	When exhaustion equals errors	-	Original contribution	-
S24	Patterson et al. (2012)[82] USA Peer-reviewed	Association between poor sleep, fatigue, and safety outcomes in emergency medical services providers	To determine the association between poor sleep quality, fatigue, and self-reported safety outcomes among emergency medical services (EMS) workers.	Cross-sectional survey	We received 547 surveys from 30 EMS agencies (a 35.6% mean agency response rate). The mean Pittsburgh Sleep Quality Index (PSQI) score exceeded the benchmark for poor sleep (6.9, 95% CI: 6.6–7.2). More than half of the respondents were classified as fatigued (55%, 95% CI: 50.7–59.3). Eighteen percent of the respondents reported an injury (17.8%, 95% CI: 13.5–22.1), 41% reported a medical error or AE (41.1%, 95% CI: 36.8–45.4), and 90% reported a safety-compromising behavior (89.6%, 95% CI: 87–92). After controlling for confounding, we identified 1.9 greater odds of injury (95% CI: 1.1–3.3), 2.2 greater odds of medical error or AE (95% CI: 1.4–3.3), and 3.6 greater odds of safety-compromising behavior (95% CI: 1.5–8.3) among fatigued respondents versus nonfatigued respondents

Continued next page

Table 2 *(Continued)*

Source	Authors (Year) Country Peer Reviewed or Not	Title	Aim	Design	Results
S25	Patterson et al. (2020)[83] USA Peer-reviewed	Should public safety shift workers be allowed to nap while on duty?	To define intrashift napping, summarize arguments for and against it, and to outline potential applications of this important fatigue mitigation strategy supported by evidence.	Commentary	The personnel who work in EMS stand to benefit from intrashift napping due to frequent use of extended duration shifts, a high prevalence of personnel working multiple jobs, and evidence showing that greater than half of EMS personnel report severe fatigue, poor sleep quality, inadequate intershift recovery, and excessive daytime sleepiness. The benefits of intrashift napping include decreased sleepiness and fatigue, improved recovery between shifts, decreased anxiety, and reduced feelings of burnout. Intrashift napping also mitigates alterations in clinician blood pressure associated with disturbed sleep and shift work. The negative consequences of napping include negative public perception, acute performance deficits stemming from sleep inertia, and the potential costs associated with reduced performance.
S26	Pirrallo et al. (2012)[84] USA -	The prevalence of sleep problems in emergency medical technicians	To investigate the prevalence, demographic, and work associations of self-reported sleep complaints in US EMTs.	Survey	Sleep problems in working EMTs were more prevalent than in a comparison group. Seventy percent of working EMTs had at least 1 sleep problem. The most common sleep problem was a risk of long sleep onset disorder (50%). EMTs with tiredness-related work difficulties were more than 50% as likely to report this problem. The prevalence of excessive daytime sleepiness (ESS > 10) was 36%; 6% of the EMTs had an ESS > 16. EMTs reporting tiredness-related work difficulties were more than twice as likely to have ESS scores >10 and more than 3 times as likely to ESS scores>16. Symptom-defined risk of sleep apnea was present in 5%. Risks of sleep onset and maintenance disorder problems were more prevalent among those who worked longer shifts and had longer work weeks and were associated with poorer job satisfaction and poorer health.
S27	Poranen et al. (2022)[85] Finland Peer-reviewed	Perceived human factors from the perspective of paramedics—a qualitative interview study	To investigate the human factors in the prehospital emergency medical care setting. The following research question was formulated: from the perspective of paramedics, what are the human factors, and how are they linked to prehospital emergency medical care?	Qualitative interview study	Three main categories of human factors were identified. The first main category consisted of factors related to work which were divided into 2 generic categories: "Challenging organizational work environment" and "Changing external work environment." The second main category comprised factors related to paramedics themselves and were divided into 3 generic categories: "issues linked to personality," "personal experiences", and "factors resulting from personal features." The third main category described that paramedics have difficulties in understanding and describing human factors.
S28	Ramey et al. (2019)[86] Canada -	Drowsy and dangerous? Fatigue in paramedics: an overview	To provide an overview of fatigue in paramedics and its potential effects on various areas of practice and provider health, and to outline potential solutions to assess and manage the risk of fatigue in paramedics as suggested by the literature.	Literature review	We conducted unstructured, nonsystematic searches of the literature in order to inform an overview of the literature. An overview is a summary of the literature that attempts to survey the literature and describe its characteristics. We thematically structured the review under the following headings: defining occupational activity and health status; clinical performance and patient safety; shift length and time at work; effects on paramedic health; effects on driving abilities; fatigue risk management; and fatigue proofing.

Continued next page

Table 2 *(Continued)*

Source	Authors (Year) Country Peer Reviewed or Not	Title	Aim	Design	Results
S29	Schwartz et al. (1993)[87] USA Peer-reviewed	The prevalence of occupational injuries in EMTs in New England	To characterize the prevalence and morbidity of injuries to emergency medical technicians (EMTs) in New England [United States].	Cross-sectional survey	A total of 439 of the 786 (56%) surveys were returned representing 13,875 hours of duty time in the 6-month period. 71% of the EMTs were male with a mean age of 35 years. 66% were basic-EMTs. Injury attack rates (number of injuries/100 EMTs/6 months) were: stress, 11.2; back, 10.5; extremity, 9.8; assault, 8.4; ambulance collision, 4.1; hearing loss, 2.5; and eye injury, 1.4. 12% of the EMTs were injured more than once in the 6-month period. The paramedics more frequently were involved in ambulance collisions, suffered from stress, and were less likely to injure their back. There were minor interstate differences. Disability due to back injury affected 2.5% of those surveyed, 4 EMTs lost duty time secondary to an assault, and 0.5% of the EMTs were out of work due to stress.
S30	Sedlár (2022)[88] Slovakia Peer-reviewed	Work-related factors, cognitive skills, unsafe behavior and safety incident involvement among emergency medical services crew members: relationships and indirect effects	To examine relationships between work-related factors—stress and fatigue, cognitive skills—situation awareness and cognitive flexibility, unsafe behavior and safety incident involvement among EMS crew members, and whether cognitive skills and unsafe behavior together indirectly affect the relationship between work-related factors and safety incident involvement.	Cross-sectional survey	The correlation analysis showed significant positive interrelationships between work-related factors, unsafe behavior and safety incident involvement, and that cognitive skills were significantly negatively related to these variables. The multiple indirect effects analysis revealed significant indirect effects of both work-related factors on safety incident involvement through situation awareness and unsafe behavior, but not through cognitive flexibility.
S31	Senkamalavalli et al. (2023)[89] India -	Smart personal protective equipment in ambulance Services with IoT Integration for Safety	-	Conference paper	Several significant outcomes and widespread debate in the healthcare industry have resulted from introducing the Smart PPE system with IoT connectivity. One of the most notable results is an increase in the security of first responders in the medical field. The technology has helped make workplaces safer by real-time monitoring of environmental factors and vital signs, decreasing the potential of heat-related diseases, exhaustion, and exposure to dangerous situations.
S32	Sofianopoulos et al. (2012)[90] Australia Peer-reviewed	Paramedics and the effects of shift work on sleep: a literature review	To identify the literature available on prehospital providers regarding the effects of shift work on sleep.	Literature review	The electronic databases cited 226 articles, of which 9 met the inclusion criteria with another 3 articles sourced from references in the retrieved papers. There is a lack of literature describing the effect of shift work on sleep in the prehospital arena, with only 1 paper exploring paramedics in the Australian setting. These findings suggest that further work is required to examine shift hours and workforce health and safety in the prehospital setting.
S33	Weaver et al. (2012)[91] USA Peer-reviewed	The association between EMS workplace safety culture and safety outcomes	To determine the association between EMS workplace safety culture scores and patient or provider safety outcomes.	Cross-sectional survey	Sixteen percent of all respondents reported experiencing an injury in the past 3 months, 4 of every 10 respondents reported an error or AE, and 89% reported safety-compromising behaviors. Respondents reporting injury scored lower on 5 of the 6 domains of safety culture. Respondents reporting an error or AE scored lower for 4 of the 6 domains, while respondents reporting safety-compromising behavior had lower safety culture scores for 5 of the 6 domains.

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Table 2 *(Continued)*

Source	Authors (Year) Country Peer Reviewed or Not	Title	Aim	Design	Results
S34	Weaver et al. (2015)[92] USA Peer-reviewed	An observational study of shift length, crew familiarity, and occupational injury and illness in emergency medical services workers	To examine the relationship between shift length and occupational injury while controlling for relevant shift work and teamwork factors.	Observational study	The cohort contained 966,082 shifts, 4382 employees and 950 outcome reports. Risk of occupational injury and illness was lower for shifts ≤8 h in duration (RR: 0.70; 95% CI: 0.51–0.96) compared with shifts >8 and ≤12 h. Relative to shifts >8 and ≤12 h, risk of injury was 60% greater (RR 1.60; 95% CI: 1.22–2.10) for employees that worked shifts >16 and ≤24 h.
S35	Yung et al. (2021)[93] Canada Peer-reviewed	Developing a Canadian fatigue risk management standard for first responders: defining the scope	To report on a scoping review that broadly identifies relevant research pertaining to fatigue in first responder literature, including a cursory analysis for each occupational group, and possible linkages between risk factors, fatigue, and outcomes.	Scoping review	We found that the distribution of papers based on the type of fatigue, risk factors, and outcomes differed between occupations. There were stronger similarities in the distribution of outcome types between police and firefighting; physical outcomes were the main focus in all 3 occupations. Of the papers that describe the link between risk factor, fatigue, and outcome, we found that burnout, cognitive fatigue, and physical fatigue were associated with adverse health and performance outcomes.

Literature included in analysis (n = 35) summarized, including the information of the authors, publication year, country, if the article was peer reviewed, the aim, design, and the main results.

AE, adverse event; AQI, ambulance quality indicator; CI, confidence interval; EMS, emergency medical services; EMTs-Ps, emergency medical technicians and paramedics; EMT, emergency medical technician; GEE, generalized estimating equations; NHS, national health service; PPE, Personal Protective Equipment; PTSD, posttraumatic stress disorder; PTSS, posttraumatic stress symptomatology; SMD, standardized mean difference; SE, standard deviation; WRMD, work-related musculoskeletal disorders.

Results

A structured search in databases generated 5002 sources which were imported into the Web-based review tool Covidence.[52] After the removal of duplicates (n = 1444), 3566 sources were screened for titles and abstracts. Sources that could not answer the review questions were excluded (n = 3424). In total, 142 articles were read in full text, of which 107 were excluded (wrong context [n = 8], wrong setting [n = 39], wrong outcomes [n = 33], wrong indication [n = 2], wrong participants [n = 13], full text not available [n = 9], and full text not available in English, Finnish, or Swedish [n = 3]). Finally, 35 sources were included.[34,60–93] Eleven sources were secondary (reviews) and 24 were primary (empirical). A flowchart of the search and selection processes is presented in the PRISMA-ScR flow diagram (Fig. 1).[50]

All the included sources were written in English. The sources are listed in detail in Table 2. Quality appraisal showed that the reviews were of high quality (n = 3), medium-high quality (n = 2), medium quality (n = 3), and low quality (n = 3). The cross-sectional surveys were of high quality (n = 6), medium-high quality (n = 1), and medium quality (n = 1). The other types of quantitative surveys and 1 Delphi study were of high quality (n = 3). Studies using a qualitative method had a high quality (n = 4). According to the assessment of the gray literature (an interim report, a letter to the editor, 2 magazine articles, 1 original contribution, commentary, and a conference paper), these sources were of high quality (n = 7). One 2-group comparison study (n = 1) and 1 observational study (n = 1) were of high quality.

Characteristics of included sources

The characteristics and quality of the sources are presented in Table 3. A more detailed information of population and contexts of the sources is provided in Table 4. Whether the sources were peer-reviewed was controlled using the web-based tool Ulrichsweb.[96]

Populations and contexts. Sources were from 14 different countries. A clear majority of the sources were from the United States (n = 14).[61,64,69,71,77,78,81–84,87,91,92] Most of the sources focused on paramedics as a profession group.[61–63,65–67,69,70,72,76,79,80,83–86,90] A wide variation of the names of the ACs was used, and even other professions than ACs were included. Prehospital EMS was the main context. Some sources did not provide detailed information about nor population neither context.

Review findings

The following 4 themes emerged: *Deficiencies in physical well-being*, *Deficiencies in psychophysical well-being*, *Deficiencies in psychological well-being*, and *Deficiencies in social well-being*. A summary of these findings is presented in Table 5. Secondary sources (reviews) are included in the overall results but are not analyzed in the text because duplicates of the primary studies pose a risk for the distortion of research results.

The effects of deficiencies in physical well-being were identified only on OSR (n = 3).[67,75,76] Paradoxically, Hammer et al.[77] linked a lower level of ACs' somatic distress to PSR. Physical fitness, back problems, and being overweight were equally important deficiencies in physical well-being. Effects of deficiencies in psychophysical well-being were identified on PSR (n = 1),[66] OSR (n = 4),[67,68,75,84] and both PSR and OSR (n = 16).[62–65,69,72,73,81–83,85,86,90,92,93,97] Fatigue was the most significant deficiency in psychophysical well-being. Effects of deficiencies in psychological well-being were identified on PSR (n = 4),[34,70,78,87] OSR (n = 7),[60,67,71,74,76,80,89] and both PSR and OSR (n = 5).[64,73,79,91,97] Stress was the most important factor

Table 3

Characteristics and Quality of Included Sources (n = 35)

Year of Publication (n = 18)	Country (n = 14)	Method (n = 5)	Profession (n = 19)	Quality (n = 4)
1986 (n = 1)	Australia (n = 3)	Qualitative (n = 3)	Ambulance officers (n = 1)	1 Low (n = 3)
1993 (n = 1)	Canada (n = 6)	Quantitative (n = 13)	Ambulance personnel (n = 1)	2 Medium (n = 4)
2005 (n = 1)	England (n = 2)	Mixed method (n = 1)	Ambulance services staff (n = 1)	3 Medium high (n = 3)
2009 (n = 2)	Finland (n = 1)	Review (n = 11)	Ambulance staff (n = 1)	4 High (n = 25)
2010 (n = 2)	Germany (n = 1)	Other (n = 7)	EMS crew members (n = 1)	Min 1 Low
2011 (n = 1)	India (n = 1)		EMS personnel (n = 1)	Max 4 High
2012 (n = 4)	Israel (n = 1)		EMS personnel and other shift workers (n = 1)	Mean 3, 4
2014 (n = 1)	Italy (n = 1)		EMS providers (n = 3)	Median 4
2015 (n = 2)	Portugal (n = 1)		EMS workers (n = 3)	
2016 (n = 1)	Slovakia (n = 1)		EMTs (n = 3)	
2018 (n = 2)	South Africa (n = 1)		First responders (n = 1)	
2019 (n = 3)	Sweden (n = 1)		Healthcare workers (n = 1)	
2020 (n = 2)	USA (n = 14)		NHS staff (n = 1)	
2021 (n = 3)	Wales (n = 1)		Nurses, midwives, and paramedics (n = 1)	
2022 (n = 3)			Paramedics (n = 8)	
2023 (n = 4)			Paramedics and EMTs (n = 4)	
2024 (n = 1)			Prehospital nurses (n = 1)	
Min 1986			Public safety sector (n = 1)	
Max 2024			Public safety shift workers (n = 1)	
Mean 2018				
Median 2015				

Sources included (n = 35) were published between 1986 and 2024, the majority (n = 4) being from 2023. Sources were conducted in 14 different countries within 5 continents. Most of the sources were conducted in USA (n = 14). There were 5 study design categories, whereas different kinds of quantitative methods (n = 13) was the most common. Several terms (n = 19) were used to describe the prehospital EMS population in the sources included. The majority of the sources were peer-reviewed (n = 30). The majority of the sources (n = 25) had a high quality between 80% and 100%. Three of the sources had a medium-high quality, 4 a medium, and 3 a low quality.

EMS, emergency medical services; EMT, emergency medical technician; NHS, National Health Service.

affecting psychological well-being. Paradoxically, Hammer et al.[77] indicated that ACs experiencing higher job satisfaction and less stress had a greater effect on PSR than ACs with deficiencies in psychological well-being. Effects of deficiencies in social well-being were identified on OSR (n = 1)[91] and on both PSR and OSR (n = 3).[60,67,76] Lack of social support was the most important deficiency in social well-being among ACs.

Deficiencies in physical well-being

Deficiencies in physical well-being were identified in 3 sources.[67,75,76] These reviews identified that ACs' poor physical fitness, back problems, and injuries or illnesses that occurred during prehospital EMS missions could affect OSR.

Deficiencies in psychophysical well-being

Deficiencies in psychophysical well-being were identified in 19 sources.[61,62,64–68,70–72,81–85,92,97]

Poor sleep, tiredness, and fatigue have been identified as possible threats to both OSR and PSR in prehospital EMS.[82] The origin of these areas of psychophysical well-being was associated with longer work shifts; shifts of <24 hours were more favorable for safety aspects in prehospital EMS. Physical and emotional exhaustion affected PSR and OSR.[85] Fatigue was related to decreased evaluation skills, attention, and motivation during prehospital EMS missions. Fatigue caused ACs to function more automatically, potentially leading to errors if deviant measurements were not noticed and important questions were unanswered. Exhausted ACs may not be able to pay attention to the quality of care or follow safety protocols.[85] Fatigue and sleep deprivation could impair ACs' ability to think clearly and contribute to PSR and OSR, such as failures in medication administration and patient management.[65,82] Among the ACs who experienced fatigue, 18% reported an injury, 41% reported a medical error or an adverse event, and 90% reported a safety compromising behavior. The odds of injury were 2.3 times higher among ACs with poor sleep than the ACs with good sleep.[82]

ACs' well-being is inseparably linked to patient care outcomes, and deficiencies in overall well-being could threaten PSR.[66] Many different types of psychological and physical deficiencies in ACs' well-being could affect OSR. ACs suffer from musculoskeletal disorders due to cumulative or acute injuries and fatigue.[76] Good psychological and physical health among ACs was identified to improve job performance and quality of care, as well as reduce the number of OSR, such as ambulance crashes, infectious diseases, and falls.[68] Fatigue had an effect on PSR.[85] A connection was also found between fatigue, OSR, and PSR together.[69,97] Fatigue in ACs can result from extended work shifts and sleep disorders. Possible OSRs included traffic accidents, and PSRs could include medical errors.[69] Poor sleep quality and fatigue were linked to decreased psychological and physical health and medical problems such as cardiovascular diseases among ACs.[83] A small majority (55%) of ACs had been fatigued while working in the ambulance. During the 3 months prior to data collection, 96% of ACs had a safety compromising behavior, and 66% had contributed to a medical error or adverse event. During this time, injury reports were made for 34% of ACs. A relationship between ACs working > 40 h weekly and negative safety outcomes was also identified.[72] Fatigue was identified as a deficiency in psychophysical well-being (P = 0.017) that predicted PSR and OSR in prehospital EMS.[73] Work shifts ≥16 h in prehospital EMS, and as long as 24 h, increased the risk of injury or illness by 60% because of fatigue. Shifts ≤8 h decreased OSR by 30%.[92] Fatigue could be related to long shifts and a high number of shifts per month. ACs who worked 6–15 shifts monthly, worked 24-h shifts, and were in poor health experienced fatigue. Fatigued ACs have a potentially higher risk of being involved in OSR and PSR, including injuries, errors, and adverse events.[82]

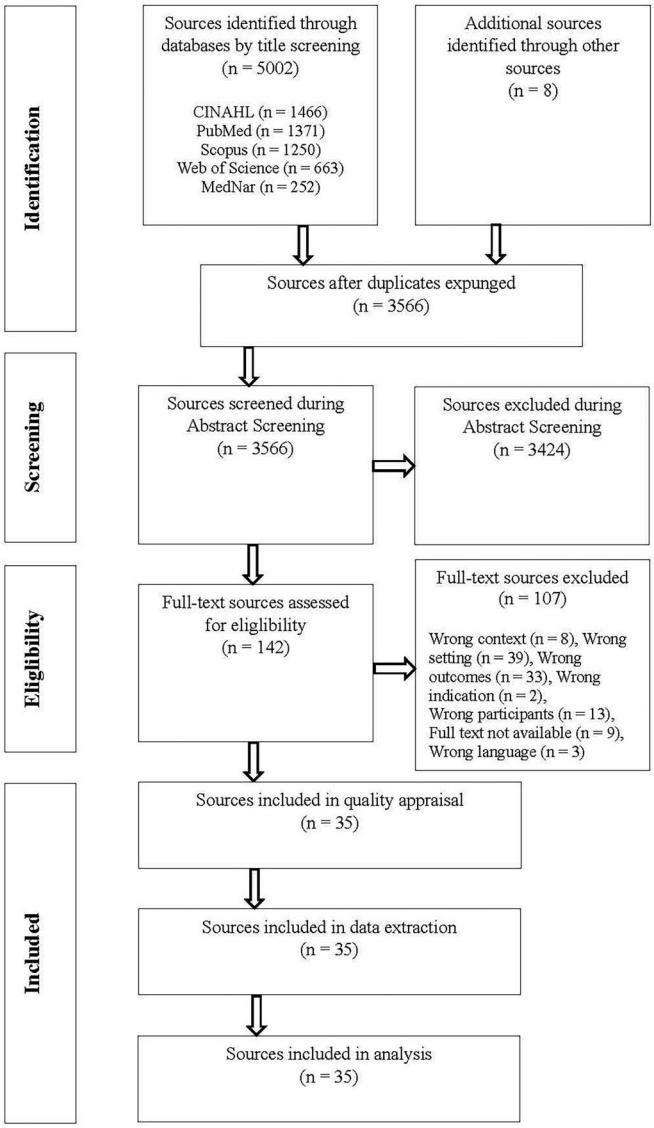

Figure 1. PRISMA-ScR flowchart over the study selection process according to Tricco et al. (2018). The flowchart shows the study selection process conducted by 2 independent reviewers. This process generated 35 sources, which were included in the final analysis. PRISMA-ScR, Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews.

Tiredness[84,85] and sleep deprivation can negatively affect both PSR and OSR.[81] Sleep deprivation is associated with problems in focus, attention, cognitive ability, and reaction time, possibly leading to vehicle accidents and harm to patients.[81] Tiredness could increase the risk of emergency ambulance driving, especially over long distances at night.[85] Overall, 4% of ACs reported tiredness-related difficulties in operating ambulance vehicles for short distances, and 10% reported for long distances. Difficulties in remembering clinical protocols owing to fatigue in the past 12 months were reported in 10% of ACs.[84]

Deficiencies in psychological well-being

Deficiencies in psychological well-being with an effect on safety risks were identified from 17 sources.[34,60,62,63,66,69,70,72,74,75,77–79,86,89,90,96] Brer et al.[77] found the opposite results: ACs with better well-being made judgments that failed in patient care and were involved in PSR more often. ACs' psychological demands regarding EMS missions and worry about work conditions[60,77] had an effect on OSR. Psychological demands are related to ACs' physical ailments and activity limitations in the neck-shoulder and low-back areas caused by working in awkward postures and handling heavy loads.[60] Using smart technology to continually monitor ACs' vital signs and work environment could reduce ACs' concerns as well as the number of OSR. Smart technology could recognize dangers and remind ACs to eat, drink, and rest.[89] Work-related stress, psychological demands, and burnout experienced by ACs could affect the prevalence of PSR.[34] Emotional exhaustion, callousness, and impersonal responses toward patients were higher among ACs who reported more injuries, errors, and adverse events. Burnout was significantly associated with PSR and OSR. ACs' behaviors related to OSR included ignoring speed limits or neglecting checks of the ambulance. PSR-related behaviors included ACs not printing and properly interpreting an electrocardiography strip, or not checking the glucose of a patient with a low consciousness level.[63]

ACs who worried about their lack of experience in caring for acute and critical pediatric patients were more likely to be involved in situations with PSR. The lack of pediatric care experience, together with stress and anxiety, posed a risk for procedural errors as well as delays and errors in assessment and decision-making.[70] High levels of stress and anxiety among ACs could cause harm to patients.[78] ACs' stress could also affect both PSR and OSR.[97] Stress is related to worse situational awareness and decreased cognitive flexibility among ACs, as well as more frequent unsafe behaviors and safety incident involvement.[97]

Cumulative exposure to emotionally difficult situations could reduce ACs´ functioning and is linked to OSR in ACs themselves. ACs with multiple trauma exposures during EMS missions can develop psychological disorders related to recurring, emotionally difficult situations as a negative occupational safety outcome. Cumulative exposure has been associated with the development of PTSD in ACs.[71] ACs with PTSD had a significantly higher risk of bias than those without posttraumatic stress disorder (PTSD). ACs' attention and memory could be biased because of PTSD symptoms and permanent activation of the fear network, which leads to experiencing constant survival mode.[80] The judgment of risk bias could lead to OSR. ACs who experienced organizational stress ($P = 0.050$), critical incident stress ($P < 0.001$), and PTSD ($P = 0.003$) were predicted to more likely have an effect on PSR and OSR.[73] ACs' stress was identified as a factor that could lead to PSR, with a prevalence rate of 27.1 events/100 full-time equivalent per year.[87] Stress could decrease ACs' overall job performance and affect OSR, for example, involving ambulance vehicle collisions.[74] Low job satisfaction was associated with safety-compromising behavior, which could lead to both PSR and OSR.[91] Low job satisfaction, psychological work demands, low decision latitude, and worrying about job-related aspects, such as making mistakes or being subjected to violence at work among ACs, were related to OSR.[60]

Deficiencies in social well-being

Deficiencies in social well-being were identified in 4 sources.[60,67,76,91] Lack of social support from supervisors or coworkers was an underlying factor in ACs' poor social well-being, with a potential factor for OSR or PSR.[60,76] A poor teamwork climate was associated with OSR.[91]

Discussion

This scoping review aimed to identify and map the existing literature on the current state of the effect of ACs' well-being on OSR or PSR

Table 4

Populations and Contexts

Authors	Population	Context
Aasa et al. (2005)[60]	Swedish ambulance technicians and registered nurses (n = 1187).	An ambulance organization in Sweden.
Allison et al. (2022)	Different occupations in the public safety sector from 25 articles.	This scoping review included peer-reviewed and gray literature written in English that were related to sleep, fatigue, and work schedules in the US public safety sector.
Almeida et al. (2023)[61]	Prehospital nurses (n = 66) in 4 articles.	This scoping review included all study types that discussed emotional management strategies in prehospital nurses in Portuguese, English, and Spanish languages.
Baier et al. (2018)[63]	German EMS workers (n = 1101).	German prehospital EMS.
Barger et al. (2018)[64]	Shift workers, EMS personnel and groups of similar workers.	This systematic review included literature describing the impact of fatigue training on fatigue and/or sleep health.
Booker et al. (2024)[65]	Nurses, midwives, and paramedics.	Shiftwork among different health care workers in Australia.
Boorman (2009)[66]	English National Health Service (NHS) workers (n = 11,000).	NHS healthcare in England.
Broniecki et al. (2010)[67]	Ambulance officers, emergency service technicians, paramedics, and other professional and nonprofessional workgroups in 2 articles.	This review included studies that discussed musculoskeletal disorders in ambulance officers.
Chirico et al. (2023)[68]	Paramedics.	Paramedics' occupational safety risks.
Cotter (2011)[69]	Paramedics.	Work shift lengths in prehospital EMS in the USA.
Cottrell et al. (2014)[70]	EMS providers at basic, intermediate, and paramedic EMT levels.	Safety issues regarding pediatric patients undergoing prehospital EMS.
Donnelly & Siebert (2009)[71]	EMTs, paramedics, paramedical personnel, and first responders.	The relationships between occupational stress exposure, posttraumatic stress disorder, and the use of alcohol and other drugs in prehospital EMS.
Donnelly et al. (2019)[72]	Canadian paramedics (n = 717).	ACs' fatigue, safety outcomes, and work patterns.
Donnelly et al. (2020)[73]	Canadian paramedics (n = 717)	Evaluation of the influence of workplace stress, posttraumatic stress, and fatigue to paramedics' safety in 10 paramedic services in Canada.
Franche et al. (2010)[75]	EMS workers.	Occupational injury-associated work absence duration, risk factors for poor work disability outcomes among rural healthcare workers, and rural/urban comparisons of outcomes and risk factors in high-income countries.
Friedenberg et al. (2020)[76]	EMTs and paramedics. Unclear how many articles.	This narrative review included studies that discussed the prevalence, risk factors, prevention, and economic aspects of work-related musculoskeletal disorders among EMTs and paramedics, regardless of the design or methodological quality.
Hammer et al. (1986)[77]	American paramedics (n = 374).	Comparison between paramedics' occupational stress and that of hospital employees in the USA.
Hansen et al. (2015)[78]	Prehospital EMS employees (n = 737), of which 89% ACs, and 11% physicians.	A nationwide assessment of the need for pediatric training in prehospital EMS in the USA
Duncliffe & Batt (2019)[74]	Paramedics.	Canadian prehospital EMS.
Hunt et al. (2023)[34]	Welsh ambulance employees (n = 594).	The working lives of ambulance service staff in Wales.
Lipman et al. (2021)[79]	Emergency operation centers and clinical NHS ambulance staff in 13 articles.	This review studied well-being among NHS ambulance staff in England.
Nortje et al. (2004)[80]	EMS personnel (n = 101) from Cape Town.	Investigated the association between the traumatization of South African EMS personnel, cognitive bias, and judgment of risk.
Page (2016)[81]	Ambulance crews, paramedics, and EMTs.	The serious consequences of sleep deprivation among ambulance crews in the USA.
Patterson et al. (2012)[82]	EMS agencies (n = 30) and EMS workers (n = 511) from the USA.	Measured sleep quality, fatigue, and safety outcomes among EMS workers.
Patterson et al. (2020)[83]	Public safety shift workers in the USA.	Arguments for and against napping during the work shifts.
Pirrallo et al. (2012)[84]	American EMTs (n = 1854).	The prevalence, demographics, and work associations of self-reported sleep complaints in EMS in the USA.
Poranen et al. (2022)[85]	Finnish paramedics (n = 15).	The human factors perceived by paramedics in prehospital EMS settings in Finland.
Ramey et al. (2019)[86]	Paramedics. Unclear how many articles.	This review studied the effects of fatigue on paramedics.
Schwartz et al. (1993)[87]	EMTs (n = 439).	The prevalence and morbidity of occupational injuries in the prehospital EMS in the USA.
Sedlár (2022)[88]	EMS crew members (n = 131), including physicians (n = 18), paramedics (n = 108), ambulance drivers (n = 4), and 1 nurse.	Work-related factors, cognitive skills, unsafe behavior, and safety incident involvement among EMS crew members in Slovakia.
Senkamalavalli et al. (2023)[89]	Paramedics and EMTs.	A smart personal protective equipment system with Internet of Things (IoT) technology integration in ambulance services and how they could improve working in prehospital EMS.

Continued next page

Table 4 *(Continued)*

Authors	Population	Context
Sofianopoulos et al. (2012)[90]	Paramedics in 12 articles.	This review focused on articles written in English about disturbances/disorders, fatigue, and work-related stress in prehospital EMS.
Weaver et al. (2012)[91]	EMT paramedics (n = 213), EMT basics (n = 142), and others (n = 61).	Association between prehospital EMS workplace safety culture and safety outcomes in the USA.
Weaver et al. (2015)[92]	EMS workers (n = 4382) in 14 EMS agencies.	Association between shift duration and the risk of occupational injury in EMS settings in the USA.
Yung et al. (2021)[93]	EMS personnel, EMT personnel, ambulance workers, ambulance drivers, and paramedic trainees in 403 articles.	This scoping review included peer-reviewed literature regarding the fatigue risk management standard.

Empirical studies provided number of populations. This information was not available in all other types of sources. Ambulance clinicians had a wide variation of names of the professions included, and many of the sources included several professions. Majority of the sources had prehospital EMS as an organizational context, but they focused on different kinds of topics.

AC, ambulance clinician; EMS, emergency medical services; EMT, emergency medical technician; NHS, National Health Service.

in prehospital EMS settings. These findings show that deficiencies in ACs' well-being have a potentially negative effect on occupational and patient safety in prehospital EMS. The main findings of this scoping review show that deficiencies in psychological and psychophysical well-being can markedly affect OSR and PSR. Stress, fatigue, and sleep problems were the most distinct symptoms. Surprisingly, deficiencies in physical and social well-being that have an effect on safety issues in prehospital EMS were mentioned in only a few sources. Articles on other populations (e.g., physicians and firefighters) were included in this scoping review because of the lack of published material concerning only ACs as a population. The scientific gaps identified included an overall lack of published literature on the topic, which indicates a great need for further research, as well as the absence of congruent terms used for well-being and safety risks and events.

In this review, the concept of well-being was understood as a permanent and long-term state, which acute and transient situations do not affect. The components of well-being were divided into psychological, physical, psychophysical, and social based on definitions in the published literature. Psychological well-being encompasses life satisfaction, overall happiness, and psychological and emotional functioning.[98] Stress, which was identified as the most significant deficiency in psychological well-being, is defined as "a state of worry or psychological tension caused by a difficult situation" and as "a natural human response that prompts us to address challenges and threats in our lives" by World Health Organization.[99]

Psychology literature presents a large variation in different kinds of stress, such as psychological and biological,[100] work-related,[101] and acute and chronic stress.[102] Many sources included in this scoping review did not provide a comprehensive explanation of the nature of the stress they discussed. Work-related stress is related to PSR,[34] PTSD to OSR,[71] organizational stress, critical incident stress, and PTSD to PSR and OSR.[73] Pathological stress can cause somatic and psychological symptoms.[103,104] In this scoping review, stress was classified as a deficiency in psychological well-being because it has been shown to increase the risk of cognitive bias, such as challenges in decision making.[103–105] Cognitive functioning is a critical component of high-quality job performance in ACs.[88]

According to the findings of this scoping review, fatigue and sleep problems were the most important deficiencies in psychophysical well-being. Psychophysical well-being can be defined as a condition in which psychological and somatic well-being are parallel, inseparable, and influence each other.[106] Fatigue is a multidimensional and complex concept that includes physical, psychological, cognitive, motivational, and emotional dimensions.[107] Fatigue is often associated with chronic somatic diseases such as cancer and multiple sclerosis (MS).[108–110] Fatigue includes extreme exhaustion that cannot be relieved with sleep or rest. This can have a marked effect on an individual's functionality and performance.[107] The concept of fatigue was insufficiently defined in the sources included in this review. Nevertheless, the findings clearly show that ACs' fatigue can lead to PSR and OSR in prehospital EMS. The reason behind fatigue is often related to shift work in prehospital EMS.[69,90,92] Similarities can be found in the study by Toyokuni et al.[111] who found that ACs' fatigue was caused by an irregular lifestyle, such as irregular mealtimes and daytime napping.

The finding that sleep problems are a marked deficiency in ACs' psychophysical well-being, with an effect on PSR and OSR, is in line with earlier literature. Sleep problems affect ACs' well-being and potentially increase the risk of negative safety outcomes in prehospital EMS.[36,48] Barger et al.[64] found that providing information on sleep, circadian rhythm, and sleep environment could improve sleep in ACs. Pedagogical contributions to methods that can positively affect ACs' well-being could increase awareness of the importance of well-being components and the effect of deficiencies in well-being. This could improve the well-being of ACs, which could lead to safer prehospital care. The need for a better safety management system for prehospital EMS organizations was identified. Fatigue management should be a key priority in reducing prehospital risks, preventing errors, and enhancing patient and occupational safety.[86]

The results of Hammer et al.[77] were opposite to what might be expected. ACs who experienced higher job satisfaction, less stress, and lower levels of somatic distress reported more frequent errors in patient safety, such as judgment failures. Sharing experiences of deficiencies in well-being related to PSR or OSR might have been stigmatized in the 1980s. Safety reporting cultures and systems were not as advanced as they are today. Most ACs were men, and it is possible that a more masculine culture did not provide an open atmosphere for discussions on well-being and safety issues. Psychological health issues are still a stigma.[112]

The findings showed that deficiencies in ACs' well-being were often related to work, evidence of how working circumstances in prehospital EMS can influence ACs. A life-world perspective on ACs as individuals, with their earlier experiences, knowledge, living environment, social relations, and cognitive and somatic capacities contributing to well-being, is missing. According to Seamon,[113] people often live their day-to-day lives unaware of all aspects that influence their lifeworld. Surprisingly, none of the sources discussed the effect on ACs' long-term well-being of by private life problems, such as divorce, death of a family member, or chronic diseases. These factors can also affect the well-being and safety of prehospital EMS. This scoping review mapped the heterogeneous literature

Table 5

Summary of the Findings

Source	Deficiencies in Psychological Well-being (n = 12)	Impact	Deficiencies in Physical Well-being (n = 3)	Impact	Deficiencies in Psychophysical Well-being (n = 11)	Impact	Deficiencies in Social Well-being (n = 2)	Impact
Aasa et al. (2005)[60]	▪ Psychological demands ▪ Worrying	OSR	-	-	-	-	▪ Lack of social support	PSR OSR
Allison et al. (2022)[61]	-	-	-	-	▪ Fatigue	PSR OSR	-	-
Almeida et al. (2023)[62]	-	-	-	-	▪ Fatigue ▪ Physical and emotional exhaustion ▪ Sleep deprivation ▪ Tiredness	PSR OSR	-	-
Baier et al. (2018)[63]	-	-	-	-	▪ Emotional exhaustion ▪ Depersonalization ▪ Burnout	PSR OSR	-	-
Barger et al. (2018)[64]	▪ Burnout ▪ Stress	PSR OSR	-	-	▪ Fatigue ▪ Sleep disorders	PSR OSR	-	-
Booker et al. (2024)[65]	-	-	-	-	▪ Fatigue ▪ Sleep deprivation	PSR OSR	-	-
Boorman (2009)[66]	-	-	-	-	▪ Overall well-being	PSR	-	-
Broniecki et al. (2010)[67]	▪ Low decision latitude ▪ Low job satisfaction ▪ Psychological demands ▪ Stress ▪ Worrying	OSR	▪ Physical fitness	OSR	▪ Fatigue	OSR	▪ Lack of social support	PSR OSR
Chirico et al. (2023)[68]	-	-	-	-	▪ Psychological and physical health	OSR	-	-
Cotter (2011)[69]	-	-	-	-	▪ Fatigue ▪ Sleep disorders	PSR OSR	-	-
Cottrell et al. (2014)[70]	▪ Anxiety ▪ Stress ▪ Worrying	PSR	-	-	-	-	-	-
Donnelly & Siebert (2009)[71]	▪ Cumulative exposure of critical incidents ▪ Multiple traumatic exposures	OSR	-	-	-	-	-	-
Donnelly et al. (2019)[72]	-	-	-	-	▪ Fatigue	PSR OSR	-	-
Donnelly et al. (2020)[73]	▪ Critical incident stress ▪ Organizational stress ▪ Posttraumatic stress	PSR OSR	-	-	▪ Fatigue	PSR OSR	-	-
Hines Duncliffe & Batt (2019)[74]	▪ Stress	OSR	-	-	-	-	-	-
Franche et al. (2010)[75]	-	-	▪ Back problems	OSR	▪ Sleep deprivation	OSR	-	-
Friedenberg et al. (2020)[76]	▪ Psychological demands ▪ Worrying	OSR	▪ Overweight	OSR	-	-	▪ Lack of social support	PSR OSR
Hammer et al. (1986)[77]	*Higher job satisfaction and less stress experienced by ACs*	PSR	*Lower level of somatic distress experienced by ACs*	PSR	-	-	-	-
Hansen et al. (2015)[78]	▪ Anxiety ▪ Stress	PSR	-	-	-	-	-	-
Hunt et al. (2023)[34]	▪ Burnout ▪ Psychological demands ▪ Stress	PSR	-	-	-	-	-	-
Lipman et al. (2021)[79]	▪ Stress	PSR OSR	-	-	-	-	-	-
Nortje et al. (2004)[80]	▪ Posttraumatic stress	OSR	-	-	-	-	-	-
Page (2016)[81]	-	-	-	-	▪ Sleep deprivation	OSR PSR	-	-

Continued next page

Table 5 *(Continued)*

Source	Deficiencies in Psychological Well-being (n = 12)	Impact	Deficiencies in Physical Well-being (n = 3)	Impact	Deficiencies in Psychophysical Well-being (n = 11)	Impact	Deficiencies in Social Well-being (n = 2)	Impact
Patterson et al. (2012)[82]	-	-	-	-	▪ Fatigue ▪ Sleep deprivation	OSR PSR	-	-
Patterson et al. (2020)[83]	-	-	-	-	▪ Fatigue ▪ Sleep deprivation	OSR PSR	-	-
Pirrallo et al. (2012)[84]	-	-	-	-	▪ Tiredness	OSR	-	-
Poranen et al. (2022)[85]	-	-	-	-	▪ Exhaustion ▪ Tiredness	OSR	-	-
					▪ Exhaustion ▪ Fatigue	PSR	-	-
Ramey et al. (2019)[86]	-	-	-	-	▪ Fatigue	PSR OSR	-	-
Schwartz et al. (1993)[87]	▪ Stress	PSR	-	-	-	-	-	-
Sedlár (2022)[88]	▪ Stress	PSR OSR	-	-	▪ Fatigue	PSR OSR	-	-
Senkamalavalli et al. (2023)[89]	▪ Worrying	OSR	-	-	-		-	-
Sofianopoulos et al. (2012)[90]	-	-	-	-	▪ Fatigue	PSR OSR	-	-
Weaver et al. (2012)[91]	▪ Low job satisfaction	PSR OSR	-	-	-	-	▪ Low teamwork climate	OSR
Weaver et al. (2015)[92]	-	-	-	-	▪ Fatigue	PSR OSR	-	-
Yung et al. (2021)[93]	-	-	-	-	▪ Fatigue	PSR OSR	-	-

A total of 28 different kinds of deficiencies in ACs' well-being were found. Deficiencies in psychological well-being (n = 12) had an impact on PSRs according to 5 sources, on occupational safety risks according to 7 sources and on both patient and occupational safety risks according to 7 sources. Three deficiencies in physical well-being were found all impacting occupational safety risks according to 3 sources. Deficiencies in psychophysical well-being (n = 11) had an impact on PSRs in 1 source, on occupational safety risks in 4 sources, and both PSRs and occupational safety risks according to 16 sources. Two deficiencies in physical well-being were identified, having an impact on occupational safety risks according to 1 source, and on both PSRs and occupational safety risks according to 3 sources.

PSR, patient safety risks; OSR, occupational safety risks.

from many different countries and decades, which indicates that this topic has been researched occasionally but not in depth.

Limitations

There are limitations in this study. Eleven reviews were included in this scoping review, which creates a significant risk of distortion of the results because of duplicates of the primary sources. Therefore, only primary sources (n = 24) were analyzed. The reviews are included in the overall results and provide important insights into how few scientific articles have been published on this topic. Most of the included sources did not provide a deeper definition of the key concepts or their effect on well-being. Concepts such as fatigue, as well as concepts regarding safety issues (e.g., errors and adverse events) were often discussed without a clear definition. This may have influenced the authors' interpretation of the data, and the risk of misinterpretation cannot be eliminated. Regarding quality appraisal, the quality of the sources was not comparable because the criteria for different study designs varied significantly. It was not always possible to differentiate the ACs' answers from sources with many occupations. However, the answers were presumably similar between ACs and other occupations, and this has not biased the findings. Some sources found in the first screening answered the review question but were not found in the full text (n = 9). Since only sources written in English, Swedish, or Finnish were included, relevant evidence from other languages may have been excluded. However, with the scoping review methodology and broad sample of sources included, the review question was answered with valuable findings, which strengthened the validity of the study. The screening of titles and abstracts, as well as the extraction of data, was conducted by 2 independent reviewers, which decreased subjective bias.

Conclusion

There is little evidence on how the well-being of ACs affects potential safety risks in prehospital EMS. However, it seems that deficiencies in the psychophysical well-being of ACs have a clear impact on both PSR and OSR. Stakeholders and organizations need to provide preventive methods to support the well-being of ACs in the work environment. ACs' well-being benefits sustainable ambulance personnel management, economics in prehospital EMS organizations, and patient care. Research from a phenomenological perspective is needed to increase the understanding of this phenomenon, the origin of deficiencies in different well-being areas among ACs, and the process from an individual deficiency in well-being to a negative event in patient or occupational safety.

Conflict of interest statement

The authors declare no conflict of interest.

Author contributions

Conceptualization as well as the selection of the search strategies were conducted by Tikkanen V, Kääriäinen M, and Roivainen P. Systematic search in databases was conducted by Tikkanen V. Screening of titles and abstracts was conducted by Tikkanen V, Kääriäinen M, and Roivainen P. Screening of full texts and data extraction were conducted by Tikkanen V and Kääriäinen M. Numerical and thematical analyses were conducted by Tikkanen V and critically reviewed by Kääriäinen M and Roivainen P. Tikkanen V had the main responsibility of writing the manuscript, which was critically reviewed by Kääriäinen M and Roivainen P. Administration of the research process and writing of the manuscript took place by Kääriäinen M and Roivainen P.

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