Arabian Gulf Journal of Humanities and Social Studies

ISSN: 3080-4086

Vol 7 - Issue 20 || Issued Date: 20-11-2026

Physical Workload and Musculoskeletal Injuries Among Paramedics: Occupational Risk Factors and Preventive Strategies – A Systematic Review

عبء العمل البدني وإصابات الجهاز العضلي الهيكلي بين المسعفين: عوامل الخطر المهنية واستراتيجيات الوقاية – مراجعة منهجية

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DOI: https://doi.org/10.64355/agjhss72068

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Abstract

Background: Emergency medical services (EMS) clinicians perform repetitive patient transfers, stretcher loading, lifting, carrying, stair negotiation, and clinical procedures in constrained and unpredictable environments. These tasks expose paramedics to high biomechanical loads and work-related musculoskeletal disorders (WMSDs).

Objective: To synthesize the available evidence on the burden and anatomical distribution of WMSDs among paramedics, identify occupational and organizational risk factors, and assess feasible preventive strategies for prehospital services.

Methods: This evidence-informed manuscript was developed using a targeted search of PubMed-indexed publications and accessible journal/occupational-health sources, verified to 20 November 2026. Observational studies, exposure assessments, before-and-after evaluations, and relevant prior systematic reviews were mapped by study design and outcome. Because a comprehensive multi-database search, independent screening, formal quality assessment, and numerical study-flow accounting have not yet been completed, this draft is a preliminary structured synthesis rather than a finished PRISMA-compliant systematic review.

Results: An earlier meta-analysis of 27 studies estimated an overall MSD prevalence of 56.52% (95% CI 35.00–78.04; I^2=99.8%), indicating extreme between-study heterogeneity. Individual reports identified frequent lumbar, cervical, and shoulder symptoms: lower-back complaints were reported by 60.3% of a Riyadh EMS sample and 70.8% of a Jordanian EMS sample, while a Hong Kong survey found a 38.4% overall symptom prevalence. Heavy patient handling, awkward or sustained postures, stretcher operations, cumulative workload, fatigue, and psychosocial factors recurred across studies. Before-and-after evaluations associated powered stretcher systems with reductions in stretcher- or patient-handling injuries, although nonrandomized design limits causal certainty.

Conclusion: Work-related musculoskeletal symptoms are a substantial occupational safety problem in paramedic practice. Prioritizing mechanical load reduction, equipment and vehicle ergonomics, staffing and operational planning, participatory risk assessment, and injury surveillance is more defensible than relying on lifting instruction alone. Further controlled evaluations are needed, especially in Middle Eastern EMS systems.

Keywords: paramedics; emergency medical services; physical workload; musculoskeletal disorders; occupational injuries; ergonomic risk; patient handling; injury prevention.

الملخص:

الخلفية :يؤدي ممارسو خدمات الطوارئ الطبية (EMS) مهام متكررة تشمل نقل المرضى، وتحميل النقالات، والرفع، والحمل، وصعود السلالم، وتنفيذ الإجراءات السريرية في بيئات عمل محدودة المساحة وغير قابلة للتنبؤ. وتعرّض هذه المهام المسعفين لأحمال ميكانيكية حيوية مرتفعة، وتزيد من احتمالية الإصابة بالاضطرابات العضلية الهيكلية المرتبطة بالعمل.(WMSDs)

الهدف :توليف الأدلة المتاحة حول مدى انتشار الاضطرابات العضلية الهيكلية لدى المسعفين وتوزيعها التشريحي، وتحديد عوامل الخطر المهنية والتنظيمية المرتبطة بها، وتقييم استراتيجيات الوقاية الممكنة والقابلة للتطبيق في خدمات الطوارئ ما قبل المستشفى.

المنهجية :أُعدت هذه المخطوطة المستندة إلى الأدلة من خلال بحث موجّه في المنشورات المفهرسة ضمن قاعدة بيانات PubMed والمصادر المتاحة للمجلات والصحة المهنية، مع التحقق من المعلومات حتى 20 نوفمبر 2026. وقد جرى تصنيف الدراسات الرصدية، وتقييمات التعرض للمخاطر، والتقييمات التي اعتمدت المقارنة بين ما قبل التدخل وما بعده، والمراجعات المنهجية السابقة ذات الصلة، وفقاً لتصميم الدراسة والنتائج. ونظراً إلى عدم استكمال البحث الشامل في قواعد البيانات المتعددة، والفرز المستقل للدراسات، والتقييم الرسمي لجودتها، والتوثيق العددي لمراحل اختيار الدراسات، فإن هذه المسودة تمثل توليفاً أولياً منظماً للأدلة، وليست مراجعة منهجية مكتملة ومتوافقة مع إرشادات.PRISMA

النتائج :قدّر تحليل تلوي سابق شمل 27 دراسة معدل الانتشار الإجمالي للاضطرابات العضلية الهيكلية بنسبة 56.52) %فاصل الثقة 95%: 35.00–78.04؛ ومؤشر عدم التجانس(I^2 = 99.8% ، مما يشير إلى وجود تباين شديد بين الدراسات. وأظهرت تقارير فردية شيوع الأعراض في مناطق أسفل الظهر والرقبة والكتفين؛ إذ أُبلغ عن شكاوى أسفل الظهر لدى 60.3% من عينة العاملين في خدمات الطوارئ الطبية بمدينة الرياض، و70.8% من عينة مماثلة في الأردن، في حين أظهر مسح أُجري في هونغ كونغ أن معدل الانتشار الإجمالي للأعراض بلغ 38.4%. وتكررت عدة عوامل مرتبطة بالمخاطر عبر الدراسات، من أبرزها التعامل اليدوي مع المرضى ذوي الأوزان الثقيلة، واتخاذ وضعيات جسمانية غير ملائمة أو ثابتة لفترات طويلة، وتشغيل النقالات، وتراكم أعباء العمل، والإرهاق،

والعوامل النفسية والاجتماعية. كما ارتبطت التقييمات التي قارنت ما قبل التدخل وما بعده بانخفاض إصابات العمل المرتبطة بالنقالات أو بمناولة المرضى عند استخدام أنظمة النقالات الكهربائية، إلا أن اعتماد هذه الدراسات على تصاميم غير عشوائية يحد من إمكانية الجزم بالعلاقة السببية.

الخاتمة :تمثل الأعراض والاضطرابات العضلية الهيكلية المرتبطة بالعمل مشكلة جوهرية في مجال السلامة المهنية لدى المسعفين. ويُعد إعطاء الأولوية للحد من الأحمال الميكانيكية، وتحسين المعدات والتصميم الهندسي لمركبات الإسعاف، وتخطيط القوى العاملة والعمليات التشغيلية، وإجراء تقييم تشاركي للمخاطر، ومراقبة الإصابات المهنية، نهجاً أكثر استناداً إلى الأدلة من الاعتماد على تعليمات الرفع السليم وحدها. وهناك حاجة إلى مزيد من التقييمات المنضبطة للتدخلات الوقائية، ولا سيما في أنظمة خدمات الطوارئ الطبية في منطقة الشرق الأوسط.

الكلمات المفتاحية :المسعفون؛ خدمات الطوارئ الطبية؛ عبء العمل البدني؛ الاضطرابات العضلية الهيكلية؛ الإصابات المهنية؛ المخاطر المريحة (الإرجونومية)؛ مناولة المرضى؛ الوقاية من الإصابات.

1. Introduction

Paramedics deliver time-critical care in locations that cannot be redesigned for safe patient handling. A response may require movement through a narrow hallway, extraction from an unstable scene, transfer of a dependent patient from floor level, transport over stairs, and loading of a stretcher into a vehicle. Unlike many hospital tasks, the working posture, number of available staff, environmental conditions, patient cooperation, and equipment access may be difficult to control. This creates a distinctive combination of acute peak force and cumulative physical exposure [4, 9, 15, 16].

Work-related musculoskeletal disorders (WMSDs) include pain, impairment, or injuries affecting muscles, tendons, joints, nerves, or supporting tissues when workplace exposures contribute to their development or aggravation. The burden of these conditions extends beyond pain to restricted practice, medical attendance, sickness absence, compensation expenditure, and potential attrition from the EMS workforce. In a systematic review of occupational injury among paramedics, injury incidence varied widely across the underlying studies, in part because outcome definitions, surveillance sources, and denominators differed [3].

Several lines of evidence have now converged. Observational surveys document high symptom levels at the lower back, neck, and shoulders [5–8]. Injury surveillance highlights physical handling as an important mechanism [9, 10]. Biomechanical experiments quantify the load imposed by handling equipment [14], and service-level evaluations suggest that powered stretchers may reduce specific injuries [11–13]. Yet prevalence measures must not be conflated with medically verified injuries, and intervention effects in uncontrolled studies should not be interpreted as proof of causation.

Earlier reviews emphasized injury burden or pooled symptom prevalence [2–4]. The present manuscript addresses a complementary operational question: which physical and organizational demands are implicated in musculoskeletal injury, what preventive controls have been tested, and how could EMS leaders combine these controls into a practical risk-management program? The following theoretical framework makes the proposed injury pathways, modifiers, and prevention logic explicit before the review methods and mapped evidence are presented.

2. Theoretical Framework and Conceptual Foundations

A multilevel theoretical perspective is necessary to interpret musculoskeletal injuries in paramedic practice because clinical work involves variable patient characteristics, high physical loads, limited environmental control, and organizational pressures that act together rather than in isolation. The framework adopted here integrates (i) the biomechanical exposure–tissue response model, (ii) cumulative loading and recovery principles, (iii) a work-systems and job demands–resources perspective, and (iv) the hierarchy of occupational risk controls. These concepts organize the available evidence; they are not treated as independently validated causal models for every EMS setting [20–22, 27].

2.1 Defining physical workload and work-related musculoskeletal injury

Physical workload denotes the mechanical and physiological demands imposed by a task on the body. In prehospital practice, it includes both external task demands—patient mass, stretcher resistance,

equipment weight, transfer height, travel distance, and the geometry of a scene—and the internal response needed to meet those demands, such as muscle activation, joint moments, spinal loading, metabolic expenditure, and perceived exertion. Consequently, a heavy transfer is not defined by load mass alone: a moderate load handled at arm's length, on stairs, or from a flexed and rotated trunk may produce considerable internal mechanical stress. Work exposure can be characterized by intensity, frequency, duration, variability, and the available opportunities for recovery [20, 21, 23, 26].

Work-related musculoskeletal disorders (WMSDs) encompass symptoms and clinically recognized conditions affecting muscles, tendons, ligaments, joints, peripheral nerves, and the spine when work contributes to their onset or aggravation. This broad definition should not obscure important differences among outcomes. A 12-month report of low-back pain, a physician-confirmed strain, an incident logged by an employer, and a compensated lost-time injury are related but non-equivalent endpoints. A symptom may be recurrent without causing absence; conversely, one acute handling incident may result in a recorded injury without a preceding history of chronic pain. Theoretical interpretation and evidence synthesis therefore require explicit outcome definitions, recall windows, anatomical sites, and severity measures [2–4, 20].

2.2 The biomechanical exposure–tissue response pathway

The biomechanical model proposes that external forces generated during work are transmitted through body segments and produce internal tissue loads. Tissue responses depend on load magnitude, direction, duration, rate, repetition, and individual tolerance. An isolated peak load may be sufficient to cause an acute strain, whereas repeated submaximal loading may contribute to fatigue and cumulative irritation. The National Research Council and Institute of Medicine describe work-related musculoskeletal outcomes as arising through the interaction of mechanical exposure, physiological characteristics, psychosocial conditions, and work organization [20]. This formulation is particularly relevant to EMS because the same lifting technique may entail substantially different loading across patients, locations, and equipment configurations.

In the paramedic setting, an important mechanical pathway begins with reaching, trunk flexion or rotation, and forceful gripping during floor-to-stretcher transfers, lateral repositioning, loading, and equipment handling. As the horizontal distance between the load and the body increases, the external moment about the lower back generally rises, requiring greater muscular force for stabilization. Uneven terrain and confined spaces can increase asymmetrical loading and make planned body positioning difficult. Laboratory comparisons of manual and powered stretchers provide task-level support for the premise that equipment design can alter peak spinal loading, although their measurements should not be interpreted as direct clinical injury rates [14–16].

The anatomical distribution of reported complaints is consistent with several plausible pathways: lumbar pain with bending and lifting; shoulder symptoms with elevated-arm force, pushing, pulling, and awkward transfers; and neck symptoms with sustained flexion, scene assessment, or procedures conducted at unsuitable working heights. Nevertheless, anatomical plausibility does not establish that an individual worker's symptoms were caused by a specific task. Pre-existing disorders, nonoccupational exposures, previous injury, and selection or reporting bias must be considered when interpreting cross-sectional associations [5–8, 20, 21].

2.3 Cumulative workload, fatigue, and insufficient recovery

An exposure that is tolerable once may become problematic when repeated without adequate recovery. The cumulative-load perspective considers the interaction of mechanical dose and tissue recovery over time. Operationally, musculoskeletal dose may be influenced by the number of patient-handling events per shift, the proportion involving high patient dependence, task duration, force peaks, awkward-posture exposure, and the interval between demanding calls. This concept helps distinguish workload intensity from total exposure: two crews with similar numbers of calls may experience different physical demands when their patient mix, building access, and use of transfer aids differ [16, 20, 21].

Fatigue is also a potential mediator or effect modifier of risk. After repeated demanding transfers, muscle endurance, postural control, and movement precision may deteriorate, particularly in the presence of restricted breaks or insufficient sleep. Rotating shifts, nighttime responses, prolonged duty periods, and emotionally stressful incidents could reduce recovery opportunities or influence perceived exertion.

These relationships are plausible mechanisms, but the existing evidence does not justify treating all shift-related associations as causal or assuming a uniform dose–response threshold for paramedics. Prospective research should measure task exposure and recovery jointly rather than infer cumulative dose from years of service alone [9, 10, 20, 22].

2.4 Work environment and sociotechnical constraints

Paramedic tasks occur in a sociotechnical system consisting of workers, patients, vehicles, devices, dispatch decisions, team arrangements, and the physical environment. Clinical urgency and patient instability can constrain the range of feasible ergonomic choices. Stairs, inaccessible elevators, narrow doors, low ceilings, slippery surfaces, roadside hazards, confined bedrooms, and non-cooperative or bariatric patients may transform an otherwise routine transfer into a high-demand event. Equipment design and placement matter as well: stretcher height, loading geometry, device weight, handle position, and the distance between the patient and vehicle affect the load and posture required [15, 16, 25].

This systems view discourages explanations that place primary responsibility on individual lifting behavior. For example, a worker may know the recommended handling technique but be unable to apply it when a patient must be moved urgently from a cramped space. A theoretically coherent prevention strategy therefore addresses the compatibility of equipment with the environment, the availability of adequate personnel, escalation procedures for difficult transfers, and realistic operational protocols. Standards developed for manual handling in healthcare, including ISO/TR 12296:2012, provide a structured starting point for risk identification and ergonomic redesign; the degree of direct transferability to roadside and out-of-hospital practice requires contextual appraisal [25].

2.5 Psychosocial demands, resources, and organizational safety climate

The job demands–resources (JD–R) model distinguishes aspects of work that require sustained effort from those that help employees achieve goals, reduce demands, or support recovery. The model was formulated principally to explain burnout and work-related well-being, not as a paramedic-specific model of tissue injury [22]. Applied cautiously here, it provides a useful way to organize potential indirect pathways between time pressure, workload, emotional strain, understaffing, fatigue, help-seeking, and musculoskeletal outcomes. Perceived support from colleagues, competent supervision, job control, and access to functioning equipment may buffer demanding work; these propositions should be tested rather than assumed.

Psychosocial conditions may operate through several mechanisms. High work pace can encourage rushed handling or limit opportunities to request an additional crew. Low staffing can increase the number of demanding tasks completed per person. Fear of negative judgment or a weak reporting culture may delay disclosure of symptoms, while a supportive safety climate may improve early reporting and facilitate temporary task modification. Perceived pain can also influence stress and work satisfaction, creating possible reverse causation in cross-sectional studies. Therefore, organizational associations should be interpreted alongside measured physical exposure and potential confounding rather than substituted for it [5, 7, 9, 20, 22].

2.6 Individual capacity, adaptation, and susceptibility

The exposure–capacity relationship assumes that injury susceptibility is shaped partly by the interaction between task demand and individual functional capacity. Relevant characteristics include previous musculoskeletal symptoms, strength, endurance, joint mobility, conditioning, age, general health, and recovery status. Greater strength or task-specific fitness may improve the ability to complete demanding work, but there is no evidence that fitness eliminates the hazards of heavy manual patient handling. Thus, conditioning programs should complement—rather than replace—changes to equipment and task design [15, 16, 20].

Interpretation also requires attention to selection effects. Workers with severe symptoms may transfer to less physically demanding duties or leave the profession, so a cross-sectional sample of active paramedics can underrepresent workers most affected by occupational injury. Years of service may serve as a rough proxy for cumulative exposure but is also related to age, seniority, role allocation, and survival in the occupation. Studies should distinguish previous injury, baseline functional status, ongoing task exposure, and relevant demographics when assessing individual vulnerability; these factors should never be used to shift the preventive burden away from employers [20, 21].

Arabian Gulf Journal
Humanities and Social Studies

2.7 Measurement and operationalization of the main constructs

The conceptual framework benefits from distinguishing self-reported, observational, objective, and administrative measurements. Self-reported questionnaires can estimate pain prevalence, body region, perceived exertion, and functional interference, but are vulnerable to recall and common-method bias. Observational ergonomic techniques such as Rapid Entire Body Assessment (REBA) characterize the postural risk of sampled tasks; a REBA score is a screening indicator and does not diagnose an injury or predict an individual worker's future injury with certainty [23, 24]. Direct measurement using video-based posture analysis, inertial sensors, force measurement, or laboratory biomechanics may provide a closer approximation of exposure but may be limited by feasibility and representativeness in field settings [14, 23].

Administrative records, including occupational injury reports, sick leave, compensation claims, and return-to-work data, offer more consequential injury endpoints but often miss unreported symptoms. A robust EMS study should therefore triangulate methods: document stretcher and patient-handling frequency per transport; describe patient dependency and scene accessibility; record manual versus powered equipment use; assess posture and physical effort; and measure region-specific symptoms and lost-time injury using consistent definitions. Where possible, injury rates should be expressed with an appropriate exposure denominator, such as per 1,000 transports or worker-hours, rather than raw counts alone [9–13, 23].

2.8 An integrated conceptual model for this review

The proposed model comprises four linked levels. Level 1, exposure context, includes patient factors, scene constraints, call characteristics, transport equipment, crew composition, and work scheduling. Level 2, proximal physical exposure, comprises forceful exertion, awkward posture, repetition, duration, and the number and intensity of handling tasks. Level 3, intermediate responses, includes tissue loading, muscular fatigue, perceived exertion, and recovery. Level 4, outcomes, includes regional musculoskeletal symptoms, diagnosed injury, restricted duty, lost work time, and longer-term functional limitation. Organizational resources and individual capacity may modify the relationships among these levels, while previous injury may influence both exposure allocation and reporting [20–23].

Exposure context → mechanical and postural demands → tissue loading and fatigue → symptoms, injury, and work disability.

Modifiers: equipment and work design; staffing and safety climate; individual capacity and prior injury.

Feedback: existing symptoms may alter subsequent work assignments, performance, and reporting.

Within this model, several review expectations can be stated without representing them as empirically established hypotheses: more frequent or forceful manual patient handling may correspond to a greater symptom or injury burden; powered handling devices may reduce selected mechanical exposures and occupational injury rates; and supportive organizational conditions may facilitate the uptake and sustained use of preventive practices. The current review examines how far published evidence is consistent with these expectations, while separating observational associations, biomechanical proxies, and intervention-level outcomes [5–16].

2.9 From theory to prevention: the hierarchy of controls

The hierarchy of controls translates the model into prevention priorities. Hazard elimination or substitution, when practical, prevents a high-risk manual handling action from arising; engineering controls reduce exposure by redesigning the equipment or task; administrative controls guide staffing, procedures, training, scheduling, and inspection; and personal protective measures have a more limited role in preventing force-related musculoskeletal injury. NIOSH emphasizes controlling hazards at their source because measures that depend chiefly on individual behavior are generally less reliable than well-designed engineering approaches [27]. In EMS, this distinction supports prioritizing powered stretchers and loading systems, mechanical transfer aids, appropriate vehicle layouts, and planned assistance for unusually demanding patient movements [11–14, 28].

Training remains important for device use, teamwork, hazard recognition, and safe decision-making, yet instruction in body mechanics alone cannot reliably neutralize patient mass, restricted space, or an inadequately staffed transfer. An effective program should combine equipment selection with maintenance, task-based staff involvement, reporting systems, fatigue-aware operational planning, and

outcome evaluation. Process indicators (availability and actual use of assistive devices; high-risk call escalation; training completion) should be distinguished from clinical or occupational outcomes (symptom prevalence; medically attended strains; lost-time injuries) to determine whether an intervention changes exposure, improves uptake, and ultimately reduces harm [11–14, 25, 27, 28].

In summary, the theoretical basis of this review is deliberately integrative: biological plausibility identifies how high-demand tasks could damage tissues; exposure–recovery reasoning explains why workload patterns matter; work-systems and JD–R concepts identify organizational constraints and resources; and the hierarchy of controls identifies prevention options. These frameworks guide interpretation but do not substitute for standardized outcome definitions, transparent study appraisal, or adequately controlled empirical estimates. Their greatest value is to connect exposure assessment with practical, testable interventions in prehospital care [20–28].

3. Methods

3.1 Review design and reporting status

The intended design is a systematic review with narrative synthesis under PRISMA 2020 [1]. This draft was assembled from targeted verification of indexed research records, accessible full texts, and authoritative occupational-safety resources on 20 November 2026. No registration number is claimed; a prospective protocol should be registered (for example, in PROSPERO if eligible) before formal review screening. The study summaries below are an evidence map, not an exhaustively identified and independently adjudicated set of included studies.

3.2 Review question and eligibility framework

Population: civilian ambulance paramedics, emergency medical technicians, and EMS clinicians involved in direct prehospital care. Exposure: patient lifting and transferring; carrying and moving equipment; stretcher raising, lowering, and loading; sustained or awkward clinical postures; shift and workload factors; and occupational psychosocial demands. Outcomes: self-reported regional WMSD symptoms, clinically identified musculoskeletal injuries, incident or compensation rates, lost work time, task-level biomechanical exposure, and injury-prevention effects. Study designs: quantitative observational, laboratory/field biomechanics, quasi-experimental or controlled intervention studies, and randomized trials when available. Earlier reviews are used for context but are not double-counted as primary data.

For the eventual full review, exclude studies restricted to hospital emergency-department clinicians without identifiable prehospital data, general physical fitness papers with no relevant exposure or injury outcome, non-civilian rescue populations unless separately reported, and purely editorial material from the primary synthesis. Protocol papers may inform research gaps but cannot supply intervention-effect estimates.

3.3 Information sources and search strategy

Targeted discovery focused on PubMed-indexed records and accessible publication pages for paramedic/EMS musculoskeletal injuries, physical demands, patient handling, mechanical stretchers, and ergonomic interventions. To make the final review reproducible, database-specific searches should be executed and exported from MEDLINE/PubMed, Embase, CINAHL, Scopus, Web of Science, and SPORTDiscus, supplemented by forward/backward citation searching and selected occupational-health guidance. The proposed PubMed logic and documentation fields are provided in Appendix A. No unverified database coverage or search yield is asserted here.

3.4 Study selection, extraction, and quality assessment

The completed systematic review should use duplicate-independent title/abstract and full-text screening, with disagreements resolved by consensus or an independent reviewer. A standardized extraction form should record country, design, participant characteristics, sample size, exposure measures, symptom recall window, injury definition, effect estimates, funding, and confounder adjustment. Cross-sectional prevalence studies can be appraised with JBI analytical cross-sectional or prevalence tools, and nonrandomized intervention evidence with a design-appropriate tool such as ROBINS-I. These steps are specified as requirements, not represented as already performed.

3.5 Evidence synthesis

Because outcomes range from 12-month symptom prevalence to emergency-department-treated injury rates, biomechanical loads, and longitudinal injury trends, effect estimates are narrated separately by design and measurement scale. The prevalence estimate reported by Tahernejad et al. [2] is cited as an existing published meta-analysis, not a new pooled estimate. A new meta-analysis should be considered only where populations, measurement windows, and denominators are sufficiently comparable; otherwise, structured narrative synthesis with attention to study limitations is preferable.

4. Results: Mapped Evidence

4.1 Overview of the evidence

The verified literature spans cross-sectional surveys in Saudi Arabia, Jordan, Hong Kong, and Türkiye, injury-report analyses in Australia and the United States, task biomechanics, and service-level stretcher interventions [5–16]. Table 1 summarizes representative primary studies with verifiable study characteristics; it is not a PRISMA inclusion list and should not be used to infer a total number of eligible publications.

Table 1. Selected original studies and their principal findings

Study / setting	Design / sample	Relevant findings and caution
Aljerian et al., 2018 [6] / Riyadh, Saudi Arabia	Cross-sectional; 360 EMS workers	Lower-back symptoms 60.3%; knee 41.4%; neck 40.3%. Self-report, region-specific sample.
Nazzal et al., 2024 [5] / Jordan	Cross-sectional; 435 EMS personnel	In this sampled group, all reported pain at ≥1 site in the preceding year; low back 70.8%, neck 57.9%. This distinctive sampling result must not be generalized as a population prevalence.
So et al., 2025 [7] / Hong Kong	Cross-sectional; 404 EMS workers	Overall reported WMSD symptoms 38.4%; several lifting and postural tasks were associated with symptoms.
Altintaş & Babaoğlu, 2026 [8] / Türkiye	Cross-sectional; 246; REBA in 30	MSD prevalence 59.76%; highest reported task REBA risk score for stretcher lifting (8.62).
Reichard et al., 2017 [9] / United States	National ED injury follow-back; 572 interviewed	Of body-motion injury events, an estimated 90% involved lifting, carrying or transferring patients/equipment; weighted national estimates.
Kearney et al., 2024 [10] / Victoria, Australia	Retrospective service injury reports; 7,591 events	2,124 (28%) produced lost work time; manual handling was the leading injury mechanism by incidence.
Studnek et al., 2012 [11] / United States	Pre–post EMS injury surveillance	Stretcher-related injury rate ratio 0.30 (95% CI 0.17–0.52) following powered stretcher rollout; nonrandomized.
Armstrong et al., 2017 [12] / Ontario, Canada	Controlled service-level before–after	Stretcher-related MSD incidence fell from a pre-period mean of 20.0 to 4.3 per 100 FTE at the intervention service (78% reduction).
Pryce et al., 2024 [13] / Canada	Interrupted time-series, 2009–2019	Ambulance patient-handling injury rates decreased after adoption by 50.4% per 1,000 calls and 46.6% per 100 FTE in ITS estimates.
Lad et al., 2018 [14] / Canada	Biomechanical comparison; 8 paramedics	Powered devices reduced peak lumbar compression by 13–62% across tested tasks; small experimental sample.
Fischer et al., 2017 [15] / Canada	Observed >90 calls during 20 shifts	Identified critical physically demanding duties; observational task analysis, not injury-causation testing.

4.2 Burden and anatomical distribution

A published systematic review and meta-analysis covering 27 studies estimated a pooled MSD prevalence of 56.52% (95% CI 35.00–78.04%) and the highest body-region estimate for the lower back (47.38%) [2]. Crucially, I^2 was 99.8%, meaning that the pooled proportion reflects highly heterogeneous studies rather than a stable rate to be applied to any particular EMS service. An earlier occupational injury systematic review reported wide incidence variation, reinforcing the importance of defining the outcome and denominator [3].

The regional studies illustrate this variability. The 2018 Riyadh study (n=360) reported lower-back complaints in 60.3% of participating EMS personnel [6]. Jordanian EMS data (n=435) showed 70.8% lower-back pain and 57.9% neck pain in the preceding 12 months; the report stated that all respondents experienced symptoms in at least one body region, emphasizing that the sampling context is essential [5]. By contrast, a Hong Kong survey (n=404) found a 38.4% overall prevalence of self-reported WMSD symptoms [7]. In Türkiye, a study of 246 ambulance staff reported 59.76% MSD prevalence [8]. These outcomes cannot be pooled directly without harmonizing recall periods, symptom case definitions, response patterns, and worker categories.

Surveillance outcomes describe a different construct from questionnaires. In a US national follow-back investigation of ED-treated occupational events, sprains and strains accounted for more than 40% of events among interviewed EMS workers; among estimated body-motion injury events, 90% were related to patient/equipment lifting, carrying, or transfer [9]. Australian paramedic injury-report data identified 7,591 reported injuries over the study period, including 2,124 resulting in lost work time; these are incident-report counts rather than symptom prevalence estimates [10].

4.3 Occupational risk factors

Heavy manual handling and transferring. Repositioning patients, initial floor lifts, lateral transfers, stretcher movement, and ambulance loading can generate high lumbar compressive and shear loads. Exposure is aggravated by large or nonambulatory patients, constrained rooms, stairs, uneven ground, and limited assistance. Patient handling is repeatedly prominent in injury surveillance and task analyses [9, 14–16].

Awkward and static postures. Paramedics may perform resuscitation, airway procedures, equipment manipulation, and patient assessment while stooping, twisting, kneeling, or reaching, sometimes while the ambulance moves. In the Turkish REBA investigation, stretcher lifting had a substantially higher ergonomic risk score than vascular-access tasks [8]. The Hong Kong study associated multiple postural or manual tasks with reported symptoms, but its cross-sectional design cannot establish temporal causality [7].

Exposure accumulation, staffing, and shift patterns. Multiple calls, repeat transfers, unpredictable dispatch, heavy equipment, and insufficient recovery can produce sustained workload. In the Victoria injury-report study, injury severity varied by shift- and event-related characteristics [10]. Work schedules and fatigue are plausible interacting contributors; however, the magnitude of a direct independent effect on WMSDs remains less certain than the observed biomechanical burden.

Individual and psychosocial factors. Studies have reported associations with age, years of service, body mass, exercise habits, stress, and organizational demands [5, 7, 8]. These findings may reflect confounding, selection, or accumulated exposure, and do not justify attributing responsibility to workers. Workplace design and exposure reduction should remain the first-line prevention objectives.

4.4 Effectiveness of preventive interventions

Powered stretchers and automated loading have the clearest service-specific intervention evidence. Studnek et al. found a stretcher-related injury rate ratio of 0.30 after electrically powered stretcher implementation in a US EMS system [11]. In Ontario, Armstrong et al. reported a 78% reduction in stretcher-related MSD incidence after introducing powered stretchers and loading systems compared with preimplementation data; a neighboring service served as a comparison [12]. More recent Canadian interrupted time-series analysis found substantial estimated decreases in patient-handling injuries among ambulance-deployed providers after power-stretcher adoption [13].

A small biomechanical trial comparing manual and powered stretchers found 13–62% lower peak lumbar compression and 58–93% lower peak shear under the tested conditions, although longer handling times

produced mixed cumulative-force findings [14]. The consistency across biomechanical and service-level outcomes strengthens plausibility, but none of the before-and-after service evaluations is equivalent to a randomized equipment trial.

Training, fitness, and organization are reasonable adjuncts, not substitutes for engineering controls. The Jordanian survey reported no statistically evident association between having received lifting training and absence of WMSDs [5]. This does not prove that all training is ineffective; it does show that a training-only strategy is unlikely to address uncontrolled loads, equipment constraints, and workload design. An Australian participatory ergonomics cluster trial protocol described a wider program targeting both physical and psychosocial hazards; a protocol alone does not establish effectiveness [17].

5. Discussion

5.1 Principal interpretation

Across the mapped evidence, WMSDs are consistently important, but the magnitude depends strongly on how symptoms or injuries are measured. Self-reported annual pain is not the same as an incident musculoskeletal injury, a compensation claim, or lost-time injury. Studies with very high symptom frequencies are not necessarily inconsistent with surveillance datasets that count fewer but more serious events. The high heterogeneity reported by Tahernejad et al. [2] reinforces the need for outcome-specific reporting rather than a single generalized prevalence statement.

The recurring pattern of lumbar, neck, and shoulder complaints is mechanically consistent with lifting, handling, twisting, and working in constrained postures. This relation is supported by task-level biomechanical measurements and by event descriptions from injury surveillance. Nonetheless, observational associations between workload, demographics, and symptoms remain vulnerable to residual confounding, reverse causation, and healthy-worker effects. Future work should distinguish acute overload events from cumulative exposure and from persistent pain without a recognized injury event.

5.2 Practical hierarchy of preventive strategies

A combined intervention package should start with changes that lower hazardous mechanical exposure at its source. Table 2 links prevention levels to practical EMS actions and suggested evaluation measures. It is intended as an evidence-informed implementation framework, not a claim that each component has been evaluated in randomized paramedic trials.

Table 2. Recommended EMS prevention package and measurable indicators

Prevention level	Recommended service action	Process and outcome measures
Engineering / equipment	Introduce powered stretcher and ambulance loading systems; sliding or transfer aids; stair-descent aids; task-appropriate equipment and load limits.	Proportion of vehicles equipped; device use per eligible transfer; stretcher-related injuries/1,000 transports; near misses.
Task design / staffing	Require scene-level lift planning, extra crew or rescue assistance for high-demand transfers, and a defined route of patient extraction.	High-risk transfers supported; unplanned single-crew lifts; manual-handling incident rate.
Work organization	Review call allocation, shift length, recovery opportunity, equipment maintenance, and workload peaks; address psychosocial strain.	Overtime hours; high-load dispatches; missed breaks; fatigue reports; work absence.
Training / team skills	Provide practical competency training for powered devices, team communication, and context-sensitive handling, with refreshers and direct observation.	Training competency completion; correct device use; observed high-risk workarounds.

Prevention level	Recommended service action	Process and outcome measures
Monitoring / participation	Create confidential injury and near-miss reporting, task-based ergonomic assessments, frontline worker participation, and feedback loops.	Reporting timeliness; quality of investigation; corrective-action closure; regional WMSD symptom trend.

5.3 Implications for Saudi prehospital services

Saudi EMS services, including the Saudi Red Crescent Authority, operate across urban, intercity, and remote environments with variable access, geography, and response requirements. A prevention program should therefore be adapted by duty pattern rather than simply imported from an urban Canadian or Australian ambulance service. The existing Riyadh survey provides regional relevance but does not alone establish current nationwide rates [6]. Future Saudi research could use stratified sampling across regions and operational roles, separating ambulance clinicians from dispatch-only staff, documenting vehicle and device types, and measuring workload per transport rather than relying solely on job title.

At the organizational level, prospective injury data should be linked to transport volume, exposure to manual transfers, shift scheduling, and availability of mechanical assistive devices. A pilot implementation could compare preintervention and postintervention injury trajectories, include an untreated or later-adopting comparison service, and record adoption fidelity, costs, and maintenance events. Outcome definitions should distinguish an incident injury, discomfort, compensated claim, and lost workday. This would support more credible budgeting and occupational-health decisions.

5.4 Strengths, limitations, and certainty of evidence

Strengths of the mapped literature include multiple countries, different outcome sources, direct biomechanical testing, and several real-world equipment evaluations. The present draft is also careful not to construct invented PRISMA counts, pooled effects, or quality ratings. Important limits remain: the study retrieval in this drafting exercise was targeted rather than exhaustive; independent dual screening and risk-of-bias judgments have not been completed; some reports were inspected by abstract or publisher summaries; and no final systematic-review evidence inventory exists yet. Accordingly, selective retrieval cannot be excluded, and this document must not be submitted as a completed systematic review without the work described in Appendix A.

For the underlying studies, common weaknesses include cross-sectional exposure/outcome measurement, possible recall or nonresponse bias, inconsistent definitions of WMSD, and site-specific implementation studies susceptible to secular trends. Evidence that powered systems reduce peak physical loads is comparatively direct. Evidence that a particular multicomponent program prevents long-term clinical injury across heterogeneous EMS systems remains less certain. The recommendations are therefore graded qualitatively by plausibility and study design, not by a completed formal GRADE assessment.

5.5 Research priorities

Priority research should evaluate: (1) cluster-randomized or robust interrupted time-series adoption of mechanical devices; (2) combined equipment and workload redesign compared with training alone; (3) associations between task-level biomechanical exposure and prospectively measured WMSD outcomes; (4) effects of staffing, fatigue, shift schedules, and psychosocial hazards after adjustment for confounders; (5) cost-effectiveness using standardized denominators; and (6) Saudi and wider Middle Eastern comparisons that account for geography, call type, and equipment availability. Common core outcomes could include 12-month Nordic Musculoskeletal Questionnaire responses, medically attended injuries, injuries per 1,000 transports, lost-time cases per 100 full-time equivalent staff, and days lost per case.

6. Conclusion

Physical workload and musculoskeletal injury prevention are central to safe paramedic operations. Available evidence associates high-demand patient handling, stretcher movement, awkward clinical positions, and cumulative operational demands with musculoskeletal symptoms and injury. The strongest direct prevention signal concerns powered stretcher and loading technology, supported by biomechanical

and nonrandomized service evaluations. EMS leaders should adopt a layered approach that combines engineering controls, patient-movement planning, reasonable staffing and recovery, practical competence, and injury surveillance. A final, fully reproducible systematic search and independent critical appraisal remain necessary before this working manuscript can be described as a completed PRISMA-conformant systematic review. The integrated theoretical framework indicates that sustained risk reduction requires simultaneous attention to mechanical exposure, recovery opportunities, and the organizational conditions governing safe patient handling.

Declarations

Ethics approval: Not required for analysis of publicly available published studies. Consent to participate: Not applicable. Funding: Not provided by the author group. Competing interests: Not provided; each author should verify and approve a journal-specific statement. Data availability: Data presented here derive from cited publications; an eventual search export, extraction workbook, and appraisal tables should be archived for the final submission. Authors' contributions: To be confirmed with all eight authors before submission; authorship order has been retained exactly as provided in Group S.

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Appendix A. Search and reporting actions needed for final PRISMA submission

Suggested PubMed strategy (to be adapted per database):

(("Emergency Medical Technicians"[MeSH] OR "Emergency Medical Services"[MeSH] OR paramedic[tiab] OR "ambulance personnel"[tiab] OR "emergency medical technician*"[tiab]) AND ("Musculoskeletal Diseases"[MeSH] OR "Occupational Injuries"[MeSH] OR musculoskeletal[tiab] OR back pain[tiab] OR strain*[tiab] OR sprain*[tiab] OR ergonomic*[tiab]) AND (lifting[tiab] OR*

"patient handling"[tiab] OR stretcher[tiab] OR workload[tiab] OR occupational[tiab] OR prevention[tiab] OR intervention*[tiab]))*

Search period for the final review: database inception through a declared final search date; publish all search strings, platform names, restrictions, and the exact search dates. Include non-English studies when translation is feasible to reduce language bias.

1. Register and date the review protocol, final inclusion criteria, and planned outcome hierarchy before screening.
2. Export all database records and deduplicate with a documented tool; preserve counts from each source.
3. Perform two-person independent title/abstract and full-text screening, logging each full-text exclusion reason.
4. Produce an accurate PRISMA 2020 flow diagram only from the recorded search and screening log.
5. Extract estimates in duplicate, including denominator, time window, outcome definition, and adjusted effects.
6. Complete and document study-specific risk-of-bias appraisal, certainty judgments, and sensitivity analyses.
7. Verify every bibliographic detail and complete author declarations, institutional permissions, and target-journal format.