Chronic physical health conditions and associated factors among people with serious orthopaedic injuries: A systematic review

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Abstract
Introduction: A clear understanding of the development of chronic physical health conditions following orthopaedic injury is essential to fully recognise the magnitude and burden of injury, improve treatment and predict certain outcomes. This review aimed at systematically identifying and evaluating current evidence of the incidence and prevalence of chronic physical health conditions and factors associated with chronic physical health conditions following serious orthopaedic injury.

Materials and method: Systematic literature search was performed using Ovid MEDLINE, Scopus, and Embase via Ovid, Cochrane Library and Ovid Emcare up to 30 December 2018. Observational studies relating to the incidence or prevalence of chronic physical health conditions and associated factors in people with serious orthopaedic injuries were included. Data extraction and methodological quality assessment were carried out independently by 2 reviewers.

Result: Of the 4835 references identified in the initial search, only five studies with sample sizes ranging from 83 to 3846 met the criteria for inclusion. The most prevalent conditions reported in people with serious orthopaedic injury included coronary artery disease, arrhythmias, myocardial infarction, hypertension, diabetes mellitus and chronic heart failure. Bronchial, rectal, prostate and breast cancers were also causes of late death in orthopaedic injury survivors. Most of the studies included in this review were unable to determine whether these conditions were related to injuries.

Conclusions: Chronic physical health conditions are prevalent among people with serious orthopaedic injury. Little is known about factors associated with chronic physical health conditions following serious orthopaedic injury or whether physical health conditions are associated with injury. Further work needs to be done to identify causal pathways and the longer-term effects of orthopaedic injury on the risk of developing chronic physical health conditions.

Keywords
Chronic conditions, chronic disease, comorbidities, orthopaedic injury, major trauma, systematic review

Introduction
Injury is among the leading causes of mortality, morbidity and disability, and affects all age groups with varying degrees of severity.1,2 Injury-related deaths are now declining in high income countries and the probability of long-term survival after injury is increasing due to advances in emergency treatment.3,4 With greater chances of surviving severe injury, there is the potential for greater injury-related disability and its long-term complications, which may also result in decreased quality of survival and a reduction in healthy life expectancy.5,6 The long-term sequelae of injury also

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create financial burden for injured people, their families, healthcare systems and society.\textsuperscript{7,8} This is evident in people with orthopaedic trauma; the most common cause of hospitalisation for injury.\textsuperscript{7,9}

For people with orthopaedic injuries, the development of chronic physical health conditions such as hypertension, cancer, diabetes mellitus, chronic respiratory disease and cardiovascular conditions is a growing concern.\textsuperscript{7,8,10,11} A clear understanding of the prevalence of these conditions following orthopaedic injury is necessary to fully recognise the magnitude and burden of injury and to improve treatment. Comprehensive knowledge of the development of chronic physical health conditions and associated factors in people with orthopaedic injuries will also help physicians and people with orthopaedic injuries establish a prognosis for certain outcomes.\textsuperscript{12}

The aetiological link between orthopaedic injuries and chronic physical health conditions is thought to be multifactorial. For example, psychological reactions to trauma (such as stress, fear, anxiety and depression) may contribute to decreased motivation to follow a healthy lifestyle and give rise to health-related risk-taking behaviours that can lead to chronic physical health conditions.\textsuperscript{13,14} In particular, health-related behaviours such as smoking or alcohol consumption rates, use of prescription medications, physical inactivity and illicit drug use, have been implicated as possible risk factors of chronic physical health conditions after orthopaedic injury.\textsuperscript{11,15} People with adverse psychological responses to injury can also experience dysregulation of physiological mechanisms (such as changes in their nervous system and hormonal balance), which can increase the risk of chronic physical health conditions. Physical trauma responses, such as chronic inflammation, are also considered to precipitate the development of chronic physical conditions following injury.\textsuperscript{16,17} The development of chronic conditions post-injury is further complicated by the presence of pre-injury conditions.\textsuperscript{7,8}

Prior research in the field has focused on describing the mechanisms associated with the development of chronic physical health conditions after injury.\textsuperscript{18,19} However, the potential impact of serious orthopaedic injury on the development of chronic physical health conditions is not well understood, and there has been no prior systematic summary of the literature in the field. The purpose of this review was to systematically identify and appraise current evidence on the incidence and prevalence of chronic physical health conditions and the factors associated with chronic physical health conditions among people who have experienced serious orthopaedic injuries.

**Methods**

**Design and protocol registration**

This systematic review was conducted and reported in compliance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.\textsuperscript{20} In accordance with these guidelines, the systematic review protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) on 20 July 2018 (Registration number: CRD42018094997).

**Search strategy**

The following databases were searched up to December 30, 2018: Ovid MEDLINE, Scopus, and Embase via Ovid, Cochrane Library and Ovid Emcare. The search strategy was designed and conducted with the help of a librarian, using a comprehensive set of possible search and MeSH terms relating to the study criteria. The complete search strategy used in Ovid MEDLINE is presented in online supplementary material 1. No restrictions were placed on the date of publication. Additional articles were identified by manually searching the reference lists of included articles and conducting forward citation searches in Google Scholar.

**Eligibility criteria**

Observational studies conducted to determine the incidence and/or prevalence of chronic physical health conditions or their associated factors among people with serious injury were included. Randomised and non-randomised trials, qualitative studies, editorials, commentaries, reviews, and conference abstracts were excluded. Peer-reviewed and full text articles, written only in English were eligible for inclusion.

Studies on adults (18+ years) with serious orthopaedic injuries were included. Studies including serious neurotrauma (i.e. spinal cord injury and traumatic brain injury) and burn injury were excluded. Studies on musculoskeletal conditions such as osteoarthritis, osteoporosis and rheumatoid arthritis following orthopaedic injury were excluded because musculoskeletal conditions after injury are triggered by local body reactions to injury instead of the systemic response to injury. For example, osteoarthritis occurs due to biomechanical loading and subsequent physiological responses at the injured body part.\textsuperscript{31} Serious orthopaedic injury was defined as any traumatic injury to the musculoskeletal system requiring emergency hospital admission, non-elective surgical intervention, or both. Chronic physical health conditions were operationalised as non-musculoskeletal chronic conditions with
long-lasting or persistent effects diagnosed after the orthopaedic injury event.

The primary outcome of this review was the prevalence or incidence of chronic physical health conditions among people with orthopaedic injury. In addition, factors associated with the development of chronic physical health conditions following orthopaedic injury were evaluated.

**Study selection**

Literature search results were imported to Covidence online software (Covidence, Melbourne, Australia), a primary screening and data extraction tool that facilitated collaboration during the study selection process. Pairs of reviewers (AYG + CLE/BJG/SMM/SB) independently reviewed the titles, abstracts and full-texts of identified studies, based on the pre-specified eligibility criteria. Any discrepancies were settled by consensus.

**Risk of bias assessment**

Papers selected for inclusion were assessed for risk of bias using a modified version of the Quality in Prognosis studies (QUIPS) tool. The tool includes six domains: study participation, study attrition, prognostic factor measurement, outcome measurement, study confounding, and statistical analysis and reporting. The tool was modified in accordance with a previous systematic review of chronic disease risk for people with musculoskeletal conditions, where serious orthopaedic injury was considered as an exposure that raises the risk of chronic health conditions rather than as a prognostic factor. A study was considered as having low risk of bias when the risk of bias was rated low on at least four of the six domains, and was rated low for exposure measurement, study confounding and statistical analysis. Two authors (AYG + CLE) reviewed each included study independently, deciding on the final rating by consensus if there was any discordance.

**Data extraction**

One review author (AYG) used NVivo 12 (QSR International Pty Ltd, Doncaster, Australia) to extract the following information: author, year of publication, country, sample size, study design, demographic characteristics (age, sex) of the participants, exposure definition (including mechanism of injury, severity of injury, type of orthopaedic injury), follow-up duration, outcome measurement (type, prevalence, associated factors and risk factors for chronic physical health conditions). In one study, the prevalence of chronic physical conditions was calculated manually based on the number of people with orthopaedic injuries who reported chronic physical conditions after injury and the number of injured people in the cohort. The senior author (CLE) verified the extracted data with the original data. Disagreements were resolved by discussion between the two authors.

**Results**

**Study selection**

The search identified a total of 4,835 published articles. Following title screening, 4489 articles were excluded. Of the remaining 191 articles, 123 articles were excluded based on abstract reviews as these papers clearly did not meet the inclusion criteria. In the last step, a full text review of 68 articles led to the final inclusion of five articles. Figure 1 shows a PRISMA flow diagram illustrating the results of the literature search.

**Study characteristics**

All five studies selected for the review were retrospective observational studies. Most were conducted in the USA (n = 4). All studies used data from registries/electronic databases. The included studies involved 5107 participants, and sample sizes varied widely from 83 to 3846 participants. Three of the five studies included males and females, of which the large majority of study participants were male. One study included only males, and another included only females. Participants’ age (both mean and median reported) was between 22.8 (25) and 35.6 (15) years. The mean/median age of participants was not stated for one study. The mean duration of follow-up ranged from four years to 17.1 years. In all studies, the primary outcome was the prevalence or frequency of chronic physical health conditions measured after serious injury. Only one study reported possible risk factors associated with the prevalence of chronic physical health conditions. The characteristics of included articles are presented in Table 1.

**Risk of bias of included studies**

Of the five included studies, three had a high risk of bias. Two studies had a moderate risk of bias. Risk of bias was highest in the study confounding domain, with four studies at high risk and one study at moderate risk. Key characteristics of the study participants such as injury severity were not adequately described in most of the studies. None of the selected studies included a matched non-injured comparison group to determine the relative risk of chronic
physical health conditions in injured versus non-injured population. Four studies did not consider potential confounders which could obscure the real effect of injury on the development of chronic physical health conditions. Only one study adjusted for age, race, mean arterial pressure, heart rate, and presence of comorbidities. Four studies failed to exclude people with pre-injury conditions of interest. The criteria and the results of the risk of bias assessment of included studies are presented in supplementary material 2.

Chronic physical health conditions

Table 2 shows the results of all included studies. Six major types of chronic physical health conditions (different types of cancers, cardiovascular diseases, “chest conditions”, metabolic/endocrine conditions, diabetes mellitus and chronic kidney disease) were identified. Hypertension was reported by two studies. Stewart et al. reported a hypertension prevalence of 14.3% in USA service members who sustained combat injuries, whereas Melcer et al. reported a prevalence of 9%, 14% and 15% in participants with limb salvage, late amputation and early amputation, respectively.

The prevalence of cardiovascular disorders after serious orthopaedic injury were reported by two studies. Stewart et al. estimated that 1.4% of injured USA service members had coronary artery disease during the follow-up period. Probst et al. estimated that 22.6% of late deaths after injury were caused by cardiovascular conditions (such as arrhythmias, myocardial infarction and chronic heart failure).

The prevalence of other health conditions, such as cancer, metabolic disease, diabetes mellitus and chronic kidney disease, were also reported amongst injury survivors. A study on long-term mortality and causes of death after serious orthopaedic injury reported that 5.9% of people with serious orthopaedic injury died due to bronchial, rectal, prostate or breast cancer. Probst et al. reported that 1.2% of study participants had metabolic/endocrine conditions following serious orthopaedic injury. Stewart et al. found that the prevalence of diabetes mellitus and chronic kidney disease among injured USA service members was 2.1% and 1.4% respectively. The prevalence of “chest conditions” was reported to be 1.0% among injured female service members and 2.0% among injured male and female service members.

Factors associated with chronic physical health conditions following orthopaedic injury

One study reported risk factors associated with the incidence of chronic physical health conditions
| Source (Country) | Population description | Sample size | Age, yrs mean (SD) | Men % | Definition of injury | Mean follow-up time | Adjustment variables |
|------------------|------------------------|-------------|-------------------|-------|---------------------|-------------------|---------------------|
| Probst et al. (Germany) | All poly-traumatised patients treated at Hannover Medical School hospital between 1973 and 1990 | 103 | 35.6 (17.2) | 83.1 | Multiple injuries registered at Hannover Medical School hospital database 
ISS ≥16 | Mean 17.1 yrs | N/A |
| Cross et al. (USA) | Combat wounded service members in Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) entered into a military causality database | 450 | 26.3 | 96 | Battlefield orthopaedic injuries confirmed by patient history and physical examination by medical care provider | NR | N/A |
| Rivera et al. (USA) | Female service members who were injured while deployed in support of OIF between 2002 and 2011 | 83 | NR | 0 | At least 1 orthopaedic injury requiring midlevel treatment registered by the Military Orthopaedic Trauma Registry | NR | N/A |
| Stewart et al. (USA) | Critically injured US military service members in support of military operations in Iraq and Afghanistan registered in the Department of Defence Trauma Registry (DoDTR) | 3846 | 26.0 (6.1) | 98.3 | Severe combat injury admitted to intensive care unit | Median follow-up = 1.1–4.3 yrs | Age, sex, race, MAP, heart rate and injury location |
| Melcer et al. (USA) | Combat injured patients with amputation and limb salvage registered in the DoDTR | 625 | Median age 
EA group = 24.2 
LA group = 24.3 
LS group = 22.8 | 100 | Records of ICD-9-CM injury coding used to identify unilateral lower limb amputation and well-established criteria used to select limb salvage cases | 4 yrs | NR for selected outcome |

EA: early amputation; ISS: Injury severity score; LA: late amputation; LS: limb salvage; SD: standard deviation; ICD-9-CM : International Classification of Diseases; Ninth Revision; Clinical Modification; N/A: not applicable; NR: not reported; yrs: years; MAP: mean arterial pressure.
Table 2. Results of included studies.

| Source (Country) | Outcomes | Outcome definition and measurement | Prevalence | Measurement of association (if any) |
|------------------|----------|------------------------------------|------------|------------------------------------|
| Probst et al.\textsuperscript{15} (Germany) | 1. CVD (arrhythmias, MI, CHF)  
2. Malignancies (bronchial, rectal, prostate, breast)  
Metabolic/endocrine conditions | Diagnoses obtained from official death certificate | 1. CVD conditions = 22.6%  
2. Malignancy = 5.9%  
3. Metabolic/endocrine conditions = 1.21% | NR |
| Cross et al.\textsuperscript{24} (USA) | Chest conditions, not further specified | Medical diagnoses (patient history and physical examination completed, coded and recorded by medical care provider of US army PEB) | 2% | NR |
| Rivera et al.\textsuperscript{26} (USA) | Chest conditions, not further specified | Physical evaluation completed by medical specialists and documented in the army PEB Administrative Database | 1% | NR |
| Stewart et al.\textsuperscript{8} (USA) | 1. HTN  
2. CAD  
3. DM  
4. CKD | Critically injured US military service Medical diagnoses by AFMES and records of ICD-9-CM codes obtained from administrative databases. Procedures for determining ICD-9-CM codes reviewed by an epidemiologist. HTN defined as mean arterial pressure greater than 106 mmHg. | 1. HTN = 14.3%  
2. CAD = 1.43%  
3. DM = 2.1%  
4. CKD = 1.2% | • Every 5-point increase in ISS associated with a 6%, 13%, 13% and 15% increased prevalence HTN, CAD, DM and CKD.  
• Higher age associated with prevalence HTN, CAD and DM.  
• Black service members had 69% higher prevalence HTN compared with white participants.  
• Higher MAP associated with increased prevalence HTN and DM.  
• Higher heart rate associated with an increased prevalence CKD. |
| Melcer et al.\textsuperscript{25} (USA) | HTN | Diagnosed by clinicians and records of ICD-9-CM codes obtained from Expeditionary Medical Encounter Database | 15%, 14% and 9% for EA, LA and LS respectively | NR |

CVD: cardiovascular disease; CAD: coronary artery disease; CKD: chronic kidney disease; CHF: chronic heart failure; EA: early amputation; LA: late amputation; LS: limb salvage; MI: myocardial infarction; ICD-9-CM: International Classification of Diseases; Ninth Revision; Clinical Modification; HTN: hypertension; DM: diabetes mellitus; NR: not reported; ISS: Injury Severity Score; MAP: mean arterial pressure; PEB: Physical Evaluation Board; AFMES: Armed Forces Medical Examiner System.
following serious orthopaedic injury.\textsuperscript{8} Stewart et al. found that every 5-point increase in the injury severity score (ISS) was associated with a 6\%, 13\% and 15\% increase in the prevalence of hypertension, diabetes mellitus and chronic kidney disease, respectively.\textsuperscript{8} Stewart et al. also indicated that age was associated with an increased prevalence of hypertension, coronary artery disease, and diabetes mellitus.\textsuperscript{8} It was reported that black USA military service members had a 69\% higher rate of hypertension compared with white service members. A significant association was also reported between high mean arterial pressure measured at the time of injury and incidence of hypertension and diabetes mellitus.\textsuperscript{8} A higher heart rate was associated with an increased prevalence of chronic kidney disease.\textsuperscript{8}

Discussion

This systematic review aimed to synthesise the evidence on the incidence/prevalence of chronic physical health conditions and associated factors following serious orthopaedic injury. Five studies evaluated the prevalence of non-musculoskeletal conditions following serious orthopaedic injury. The most prevalent cardiovascular and metabolic conditions reported in people with serious orthopaedic injury included coronary artery disease, arrhythmias, myocardial infarction, hypertension, diabetes mellitus and chronic heart failure. Bronchial, rectal, prostate and breast cancers were also causes of late death in orthopaedic injury survivors. Most studies included in this review reported only the prevalence of chronic physical health conditions after serious orthopaedic injury and were not able to determine if these conditions were linked to their injuries.

The studies included in this review were from Germany,\textsuperscript{15} and US,\textsuperscript{8,24–26} where chronic conditions are the leading causes of mortality, morbidity and disability.\textsuperscript{27,28} In the US, roughly 50\% of the adult population has one chronic condition\textsuperscript{27} and about three in five adult Germans have chronic conditions.\textsuperscript{29} The studies included in this review from the US failed to compare the prevalence of chronic physical health conditions in the trauma population to that of the general population. However, Probst et al. found that the mortality of poly-traumatic patients due to chronic conditions up to 20 years after injury was higher than that of the general German population.\textsuperscript{15} The characteristics of poly-traumatised patients in Germany\textsuperscript{15} and combat-wounded US military service members\textsuperscript{8,24–26} are likely to differ greatly from the general population. For example, US military service members tend to be younger, fitter and healthier than the general population.\textsuperscript{8,24–26} Therefore, comparisons in the prevalence of chronic conditions between injured and non-injured populations must be made with caution, as the general population may differ in many ways from the trauma population, including in overall health and health behaviours.\textsuperscript{30–32}

The most significant limitation of all included studies was the lack of a control (non-injured) group. The failure to use an appropriate control or comparison group impeded the ability to estimate the association between serious orthopaedic injury and chronic physical health conditions that could be expressed by differences in frequency between injured and non-injured groups. Three studies attempted to mitigate this by comparing the prevalence estimates found in their cohorts with previously published prevalence estimates.\textsuperscript{8,15,26} Stewart et al. further examined the relationship between injury severity and chronic physical conditions by using less serious injury as a reference.\textsuperscript{8}

Pre-injury conditions of interest have been identified as important predictors of chronic physical health conditions following injury.\textsuperscript{8,11} However, only one study excluded injured people with pre-existing conditions of interest.\textsuperscript{8} Failure to preclude injured people with pre-existing conditions of interest at the beginning of the study meant that the incidence (new onset) of physical health conditions following serious orthopaedic injury was not addressed. In addition, failure to consider the effects of pre-existing disability and other health related factors such as smoking and alcohol abuse makes it difficult to establish a clear causal link between the severity of orthopaedic injury and chronic physical health conditions.

Notably, the inclusion and exclusion criteria of three studies were not clearly stated.\textsuperscript{24–26} For example, indicators of severity, level and duration of serious orthopaedic injury that could predict chronic physical health conditions after injury were not described or measured.\textsuperscript{24–26} Three studies included small samples and could be powered insufficiently to provide a reliable estimate of the prevalence of chronic physical health conditions.\textsuperscript{15,25,26}

Another possible issue is that outcomes such as “chest conditions” were not clearly defined and, were based exclusively on history taking and physical evaluation. Additional use of diagnostic testing (such as chest radiography) or clinical investigation could give a more reliable measure of outcomes. People with serious injuries could have difficulty recalling their conditions since reporting could be influenced by the severity of illness and current stresses. People with serious injuries may only recall more severe and complex conditions, which require extensive treatment, excluding less severe cases which do not need urgent treatment.\textsuperscript{33}

All studies in this review used data from administrative and in-hospital databases. Documentation in
administrative databases often vary in accuracy and completeness. There could be a risk of missing relevant chronic physical health conditions such as hypertension and diabetes if they were considered not relevant to the admission. Furthermore, all people with chronic physical health conditions following injury might not be hospitalised. 34 Two studies used the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes to assess outcomes. 8,25 There might be under-coding of conditions of interest and underestimation of the prevalence of chronic physical conditions as ICD-9-CM codes provide lesser specificity and reduced detail on health conditions than ICD-10-CM codes. 35

Chronic physical health conditions may not appear for many years after serious orthopaedic injury. 36 In this review, the mean follow-up time of two included studies was not reported 24,26 and the median follow-up time of one retrospective cohort study (1.1 to 2.8 years) was relatively short. 8 Hence, participants in those studies may not have been studied for long enough capture chronic physical health conditions. Long-term follow up studies are required to show noticeable changes over time.

In this review, older people with serious orthopaedic injuries were not well represented in the included studies. As such, age-related chronic physical health conditions (such as malignancies and cardiovascular conditions) may be underreported. Hence, the results of this review might not be generalisable to the entire orthopaedic injury population.

**Factors associated with chronic physical health conditions following orthopaedic injury**

Most studies in this review were descriptive in nature and failed to identify risk factors for the development of chronic physical health conditions following serious orthopaedic injury or whether these conditions were associated with injury. Only one study showed that the severity of combat injury is associated with the prevalence of hypertension, coronary artery disease, diabetes mellitus, and chronic kidney disease. 8 Stewart et al. examined linear, quadratic, dose response and threshold effects of ISS on outcomes to determine the association between injury severity and chronic physical health conditions after trauma and found that a five point increment in the ISS was associated with an increase in prevalence of hypertension, coronary artery disease, diabetes mellitus, and chronic kidney disease. 8

There has been increasing evidence to support the impact of trauma biology on the development of chronic physical health conditions following injury. 37,38 Previous research has established that adverse physiological changes such as chronic inflammatory reactions, metabolic changes and vascular impairments lead to subsequent development of many diseases such as cardiovascular conditions. 39,40 For example, according to Van Netten et al., the association between physical trauma and cancer may be caused by the release of stimulatory cytokines following injury that could accelerate the growth and modify the time of presentation of established tumours. 41

Physical inactivity and sedentary behaviours increase the risk of a range of chronic physical health conditions, such as obesity, cardiovascular disease, type 2 diabetes and cancer. 42 People with orthopaedic injuries have been shown to exhibit high levels of sedentary behaviour and low physical activity levels in the six months following injury, 6 and are at greater risk for long-term physical disability. 43 Accordingly, it is plausible that physical disability, physical inactivity and sedentary behaviours following orthopaedic injury could be implicated in the development of chronic physical health conditions. For example, previous findings indicated that physical inactivity and sedentary behaviours were associated with the development of obesity, ischemic heart disease, hypertension and diabetes mellitus in people with traumatic amputations. 44,45

There is an established link between PTSD and cardiovascular disease, 46 cancer 47 and pulmonary disease. 48 In people with combat injury, PTSD has been shown to be an independent risk factor for subsequent development of hypertension. 11 The impact of PTSD on the development of chronic physical health conditions can be mediated by biological changes, 49 engagement in poor health behaviours, 11 altered responses to physiological processes, 50 and inappropriate coping strategies. 51 In this review, three studies 24–26 reported that a large number of combat veterans had both PTSD and chronic physical health conditions. However, none of the included studies investigated the association between injury-related PTSD with the development of chronic physical health conditions.

In this review, Stewart et al. showed that black service members had a 69% higher rate of HTN compared with whites. 8 Higher prevalence of hypertension in black people is well established in the US as compared to white people. 52,53 Although the exact cause is still largely unknown, different factors, such as biological differences, socio-economic status, dietary habits, and behavioural characteristics, are likely to play a key role in creating this disparity. 54,55

**Strengths and limitations of the review**

The major strength of this review was that it used a rigorous search strategy, and screening was performed...
by four groups of two authors. However, there are some limitations to note. First, only articles published in English were included, so there is potential for studies published in other languages to have been missed. Second, the heterogeneity of included source populations, definitions of serious orthopaedic injury, statistical analysis techniques and outcomes prevented an estimation of the overall prevalence of chronic physical health conditions or meta-analysis of reported data. Third, musculoskeletal chronic conditions following serious orthopaedic injury were beyond the scope of this review due to their distinct pathophysiology. Fourth, the majority of included studies in this review had a high risk of bias. However, total exclusion of studies with high risk of bias, where there are few studies in the field, may also introduce bias.

**Conclusion**

Information on the incidence/prevalence of chronic physical health conditions following serious orthopaedic injury is scarce. The majority of the included studies were conducted on members of the military, limiting extrapolation of the findings to the civilian injury population. After serious orthopaedic injury, various forms of chronic physical health conditions exist, highlighting the need for long-term follow-up of survivors. The findings of this review did not clearly indicate the factors associated with chronic physical health conditions following serious orthopaedic injury or whether injury is associated with the development of chronic physical health conditions. This review provides the impetus for additional research to better understand causal pathways and the longer-term effects of orthopaedic injury on the risk of developing chronic physical health conditions.

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**Guarantor**

CLE and BJG.

**Contributorship**

All authors have made considerable contributions: protocol design (all), title and abstract screening (all), full-text screening (all), data extraction (AYG And CLE), interpreting the results (all), drafting the manuscript and designing tables and figures (AYG), and final approval of the version to be submitted (all).

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**Supplemental material**

Supplemental material for this article is available online.

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