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Expanding the injury definition: evidence for the need to include musculoskeletal conditions



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ABSTRACT

Objectives: The objectives of the study are to quantify the proportion of cumulative microtraumatic overuse injuries in a physically active population, evaluate their impact in terms of lost work time, and link them to precipitating activities to inform prevention initiatives.

Study design: The study design is retrospective cohort study.

Methods: For a population of U.S. Army Soldiers, diagnoses from medical records (International Classification of Diseases [ICD]-9 800–999 and selected ICD-9 710–739) were matched with self-reported injury information. Common diagnoses, limited duty days, and activities and mechanisms associated with the injuries were summarized.

Results: Most self-reported injuries (65%) were classified by providers with diagnoses that described cumulative microtraumatic tissue damage, and these injuries led to a higher incidence of limited duty (85%) than acute traumatic injury diagnoses. Reported mechanisms and activities often indicated repetitive physical training-related onset.

Conclusions: Because many diagnoses for cumulative microtraumatic musculoskeletal tissue damage are categorized as diseases to the musculoskeletal system in the International Classification of Diseases, they are often not included in definitions of injury. However, reported injury activities and mechanisms in this population provide evidence that cumulative microtraumatic injuries often arise from identifiable and preventable events. This finding confirms that these diagnoses should be classified as injuries in epidemiologic evaluations and surveillance to accurately represent injury burden.

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Introduction

An injury is defined as tissue damage due to a transfer of external energy to the body.^{1–5} It is widely accepted in military and athletic communities that overuse injuries such as stress fractures, tendinitis, and joint pain result from cumulative microtrauma from regular participation in exercise and physical training^{6–11} and should be included in injury surveillance and research.^{4,7,12,13} Unfortunately, the International Classification of Diseases (ICD) considers diagnoses for cumulative microtraumatic tissue damage as Diseases of the Musculoskeletal System and Connective Tissue (Chapter 13, ICD-9 710–739 series codes and ICD-10 M codes). As a result, this categorization groups overuse and pain-related conditions together with other disorders and diseases that do not have a specific external cause or mechanism (e.g. infectious arthropathies, rheumatoid arthritis, systemic connective tissue conditions, and age-related degenerative conditions). Therefore, there is often a failure to recognize these conditions as injuries.

Prior military studies have indicated that 30%–70% of military injuries are musculoskeletal overuse injuries (selected 710–739 codes in the ICD, 9th Revision, Clinical Modification (ICD-9-CM) code series; selected M codes in the ICD, 10th Revision, Clinical Modification (ICD-10-CM) code series).^{7,14} But, in accordance with the ICD classifications, many epidemiologic studies and national medical surveillance systems only include diagnoses for acute traumatic injuries that appear in the Injury and Poisoning chapter of the ICD (Chapter 17, ICD-9-CM 800–999;¹⁵ Chapter 19, ICD-10-CM S and T codes).^{16,17} Because this ICD classification fails to recognize numerous musculoskeletal injury diagnoses resulting from cumulative microtraumatic mechanisms as injuries, the burden of injuries on our medical systems, communities, and workplaces is underestimated.

This is especially problematic for physically active populations, such as athletes and military members. Cumulative microtraumatic injuries (often referred to as ‘overuse injuries’) have been widely accepted in injury definitions among the sports medicine community.^{11,18} The exclusion of these diagnoses in injury surveillance and epidemiological studies leads to missed injury prevention opportunities in physically active populations. Assignment of external cause codes was not recommended for diagnoses of diseases to the musculoskeletal system (i.e. ICD-9-CM 710–739 codes¹⁹), so associated activities and mechanisms for many cumulative microtraumatic injuries are not reliably captured.

To address this gap, the purpose of this investigation was to quantify the proportion of self-reported injuries that received clinical diagnoses from the Diseases of the Musculoskeletal System and Connective Tissue ICD chapter, but which meet the definition of injury. External causes and limited duty days resulting from these cumulative microtraumatic injuries are evaluated.

Methods

Soldiers in two U.S. Army Infantry Brigade Combat Teams completed surveys as part of initial baseline data collection for

injury prevention program evaluations. These projects were reviewed and approved by the Army Public Health Center Public Health Review Board as public health practice. Surveys were administered in 2010 and 2011 in coordination with unit leadership. Injury risks for these populations have been previously reported.^{20–22}

The survey collected detailed information about respondents’ most recent injury. Injury was defined as any accidental or intentional force applied to the body. For their most recent injury, collected details included the following: injury date, injured body part, injury type, activity during which the injury occurred, mechanism of injury, and how many days of limited days resulted (if applicable). Survey respondents were asked to describe their injured body region and injury type.²³ The following options were provided for respondents to report the mechanism of their most recent injury: fall, jump, trip, or slip; struck against or struck by an object or person; cut by a sharp instrument, tool, or object; overexertion, strenuous or repetitive movements; fire, hot substance or object, or steam; environmental factors such as heat or cold; breathing or swallowing dust, particles, liquid vapors, or fumes; and other (further specification requested). Likewise, respondents could choose from the following options when asked about the activity associated with their injury: riding or driving in a motorized vehicle; exercising (further specification requested); sports (further specification requested); walking, hiking, or road marching; stepping or climbing; lifting or moving heavy objects; repairing or maintaining equipment or vehicles; and other (further specification requested).

For the same surveyed brigades, electronic medical record data for all soldiers on the rosters were obtained from the Defense Medical Surveillance System with visit dates extending back six months from the survey date. Injury diagnoses were identified using an index of ICD-9-CM medical diagnoses codes²⁵ that included the ICD-9-CM Injury and Poisonings code group (800–999), and diagnoses for selected overuse and pain-related musculoskeletal conditions in the Musculoskeletal Conditions chapter (predominantly selected 710–739 codes, based on a previously defined Overuse Injury Index²⁵ and other definitions of common injury-related musculoskeletal conditions in the military^{7,26}). Codes for poisonings, toxins, and complications related to medical procedures were not included, consistent with recommendations for military injury surveillance and prior military field investigations.^{25–27}

Self-reported injuries were previously matched with medical records based on a report date within three months and an identical (primary) or proximate (secondary) matching body part.²³ Descriptive statistics were calculated for the leading ICD-9-CM diagnoses associated with the matched injuries using the Statistical Package for the Social Sciences (SPSS®), version 19.0. For the five self-reported injuries most frequently matched with a medical diagnosis, the following information was reported: leading diagnoses from the medical record, number of injuries resulting in lost duty time, the average number of self-reported limited duty days resulting from the diagnosis, leading mechanisms of injury, and leading activities associated with injury. OpenEpi (www.openepi.com) was used to calculate the risk ratio of experiencing limited duty from an injury coded as a musculoskeletal condition

compared with experiencing limited duty from an injury coded as an acute traumatic injury. This site was also used to conduct an independent sample t-test to compare the average number of limited duty days experienced for each group of diagnosis codes.

Results

Over 5000 soldiers from two Army Infantry Brigades ($n = 5492$) were surveyed. Most respondents were enlisted ranks (91%), men (92%), and the mean age was 31 ± 6 years. Many of the survey respondents ($n = 2332$, 42%) had at least one medical encounter with an acute traumatic injury diagnosis code (ICD-9-CM 800–999) or cumulative microtraumatic overuse and pain-related musculoskeletal injury diagnoses (selected ICD-9-CM 710–739). Among the soldiers with injury medical records, a majority ($n = 3185$, 62%) had diagnoses for overuse injuries (selected ICD-9-CM 710–739).

A total of 1336 soldiers both reported an injury on the survey and had a medical record diagnosis for injury within 6 months of survey administration. Among them, 996 (75%) of the self-reported injuries matched a medical record by date (± 3 months) and had an identical or proximate injured body region.²³ As shown in Table 1, the top five self-reported injuries that matched a medical diagnosis were ankle sprain/strains (10%), knee sprain/strains (9%), lower back sprain/strain (4%), shoulder sprain/strains (3%), and lower back pain (3%). Self-reported limited duty days were associated with 83% of these injuries ($n = 823$ of 996), for an average of 58 reported days of limited duty per injury.

Diagnoses for injury-related musculoskeletal conditions (selected ICD-9-CM 710–739 codes) accounted for 65% of the matched injuries ($n = 646$ of 996). Of these, 85% ($n = 546$ of 646) were associated with self-reported limited duty for an average of 68 days per injury. In comparison, 80% of acute traumatic matched injuries (ICD-9-CM 800–899 codes) resulted in limited duty ($n = 274$ of 345), with an average of 39 days per injury. Therefore, the relative risk of experiencing limited duty for an overuse injury was significantly higher (1.06, $P = 0.04$) than the risk of experiencing limited duty for an injury that was diagnosed as an acute traumatic injury. Analysis with a two-sample independent t-test indicated that the number of limited duty days associated with overuse injuries was also significantly higher than those associated with acute traumatic injuries ($P < 0.001$).

The existence of an associated causal mechanism and/or activity identifies incidents as preventable injuries, rather than underlying disease conditions, especially for those injury encounters diagnosed as musculoskeletal conditions (selected ICD-9-CM 710–739; selected ICD-10-CM M codes). Nearly all respondents with a self-reported injury and matching diagnosis in this population reported an associated activity (96%) and mechanism (94%). The top activities associated with the matched self-reported injuries were running (29%), other exercise (13%), and lifting or moving heavy objects (11%). Activities commonly reported as ‘other exercise’ were weight training, martial arts, and unspecified military physical training. The mechanisms most frequently reported for

matched injuries were overexertion (39%), falls/trips/slips (29%), and struck by or against an object or person (12%).

Discussion

The contribution of cumulative microtraumatic tissue damage diagnoses to athletic injuries

The matched diagnoses from electronic medical records were predominantly (65%) selected ICD-9-CM 710–739 codes which reflect overuse and overexertion-related injuries. These injuries have a significant impact on military readiness²⁸ and have been consistently identified as common injuries in physically active populations.^{7,11,29–31} For example, one previous investigation found that the most common outpatient injury diagnoses among military members were lower extremity overuse injuries, accounting for 43% of injuries and 15% of limited duty days.³⁰

Among soldiers self-reporting an injury in this study, the most common injuries matching a medical record were ankle sprains, knee sprains, lower back sprains, shoulder sprains, and lower back pain. These musculoskeletal injuries are consistent with the types of injuries to the lower extremities and lower back that are most commonly associated with physical activities.^{6,7,9–11,18,32–35} As shown by this study, many of these injuries are diagnosed by medical providers with ICD codes that are not formally classified as injuries (selected ICD-9-CM 710–739; selected ICD-10-CM M codes).

Sports and physical training have often been cited as activities associated with military injuries,^{6–8,30,31} even during deployments.³⁶ Knowledge of the specific activities and mechanisms associated with injuries are actionable details that can inform injury prevention planning,¹⁸ but this information cannot reliably be obtained directly from medical records because cause-coding of outpatient military injuries is not required and is, therefore, only captured in one-tenth of outpatient records.³⁷ Acknowledging this limitation, a past analysis of Army soldier medical records showed that 72% of injury diagnoses with an external cause code for overexertion (ICD-9-CM E927) were sprains or strains.³² Most of those sprains or strains were to the lower extremities (59%), and 32% also had an activity code associated with running (ICD-9-CM E001.1).

Because clinical documentation of the mechanisms and activities leading to injuries is lacking,³² especially for cumulative microtraumatic injuries, the use of self-reported survey data is integral to identifying injury causes. In one survey of over 10,000 military service members, 52% of all self-reported injuries were associated with sports or exercise.⁶ In fact, running is often the most frequently cited activity leading to injury in military populations.³⁰

Identifying associated activities and mechanisms of injury is an integral aspect of the public health process to injury prevention.⁷ This study provides further verification and evidence of the relationship between common military injuries and their precipitating activities and mechanisms. For example, it was observed from these survey responses that many injuries to the ankle and knee were commonly associated with falls/slips/trips during running, whereas back and

Table 1 – Leading self-reported injuries (n = 996 soldiers with injuries matched to medical records).

Top five injury type/ body part responses on survey ^a	Soldiers with matched diagnosis n (%)	Top three medical diagnoses from ICD records		Soldiers with resulting limited duty days ^a n (%)	Average number of limited duty days per soldier ^a	Top injury activities ^a		Top injury mechanisms ^a		
		Diagnoses	n (%)			Activity	n (%)	Mechanism	n (%)	
Ankle sprain/strain	98 (10)	845.00	Sprain of ankle	42 (43)	83 (85)	41 ^b	Running	47 (48)	Fall/trip/slip	73 (74)
		719.47	Joint pain, ankle	28 (29)			Walking/hiking	12 (12)	Overexertion	15 (15)
		719.46	Joint pain, lower leg	8 (8)			Sports	11 (11)	Struck by	2 (2)
Knee sprain/strain	89 (9)	719.46	Joint pain, lower leg	55 (62)	77 (87)	62 ^b	Running	33 (37)	Fall/trip/slip	40 (45)
		844.90	Sprain or strain, knee	8 (9)			Sports	13 (22)	Overexertion	34 (38)
		726.64	Patellar tendinitis	6 (7)			Other exercise	13 (22)	Struck by	7 (8)
Lower back sprain/strain	44 (4)	724.20	Lumbago	24 (59)	33 (75)	46 ^b	Lifting	16 (36)	Overexertion	29 (66)
		847.20	Sprain lumbar region	4 (10)			Running	6 (14)	Fall/trip/slip	4 (8)
		724.50	Backache	3 (7)			Road marching	5 (11)	Struck by	3 (5)
Shoulder sprain/strain	34 (3)	719.41	Joint pain, shoulder	15 (41)	29 (85)	54 ^b	Other exercise	14 (41)	Overexertion	18 (53)
		840.40	Rotator cuff sprain	4 (12)			Lifting	8 (23)	Fall/trip/jump	8 (24)
		840.80	Sprain of shoulder	4 (12)			Running	2 (6)	Struck by	4 (12)
Lower back pain	32 (3)	724.20	Lumbago	23 (72)	28 (88)	63 ^b	Lifting	8 (25)	Overexertion	15 (47)
		724.10	Pain in thoracic spine	2 (6)			Running	7 (21)	Fall/trip/slip	5 (16)
		724.50	Backache	2 (6)			Road marching	3 (9)	Struck by	3 (9)

^a Self-reported survey response for most recent reported injury.

^b 78 of 83 who said they had an ankle sprain/strain injury with limited duty reported the number of days; 69 of 77 (knee sprain/strains); 23 of 33 (lower back sprain/strains); 27 of 29 (shoulder sprain/strains); 24 of 28 (lower back pain).

shoulder injuries were likely to be attributed to overexertion while exercising or lifting heavy objects. Even though medical providers used codes from the Diseases of the Musculoskeletal System and Connective Tissues ICD chapter (selected ICD-9-CM 710–739; selected ICD-10-CM M codes) to diagnose 65% of these injuries, they can all be attributed to a transfer of energy because specific activities and mechanisms were identified.

Findings from this investigation provide evidence that reporting only acute traumatic injuries identified by the ICD Injury and Poisonings chapter (ICD-9-CM 800–999; ICD-10-CM S and T codes) may fail to capture up to two-thirds of all injuries, especially in physically active populations. Furthermore, the impact of these missed injuries may often be greater than that of the acute traumatic injuries. Specifically, musculoskeletal overuse and overexertion injuries in the current population led to a higher incidence of reported limited duty days compared to acute traumatic injuries (85% compared to 80%, $P = 0.03$), and the limited duty lasted longer on average (68 days vs 39 days, $P < 0.001$).

Information relevant to the prevention of musculoskeletal conditions

While aerobic and muscular endurance are protective against injuries during sports and physical training,^{8,38,39} the cumulative effects of repetitive microtrauma experienced during physical activities have been shown to lead to overuse injuries.^{9–11,20,40,41} Program-induced cumulative overload, or overtraining that increases injury risk, has been identified as a concern for Army soldiers.⁴² Other studies have also shown that an increased volume of physical training among soldiers can lead to increased injury risk,²⁸ especially higher running mileage,^{20,41} or more intense road marching training.⁴³ Strategies that have previously been suggested to minimize the risk of injury from overtraining include balanced physical training which incorporates a variety of activities and exercise types,^{44,45} reducing weight-bearing activities,⁴⁶ reducing running mileage,^{20,41} gradually increasing road marching training intensity,^{43,47} and leading strategic initiatives to reduce injuries in smaller, targeted populations to address differences in mission and physical training needs.²⁸

Although it has previously been suggested that injuries resulting from cumulative microtraumatic tissue damage should be included in a broader injury surveillance definition to accurately capture the burden of injuries,^{2,4,7,12,13} they are not currently included in the Injury and Poisonings chapter of the ICD and are often excluded from medical injury surveillance and epidemiological studies. The sports medicine and military health communities, however, do acknowledge musculoskeletal overuse injuries as a substantial injury problem in their physically active populations,^{4,11,18,26} and a matrix has been created to categorize, monitor, and focus prevention strategies for these cumulative microtraumatic injuries.⁷

A consistent injury definition is needed to understand the distribution of injuries among populations of interest, which can be used to inform injury prevention planning.^{4,29,48–50} This definition should include both acute traumatic injuries and cumulative microtraumatic injuries, regardless of their ICD classification code. To support this need, a recent effort has systematically defined injury, identified all ICD diagnoses

meeting the definition, and categorized them.⁴ Categories specify causal energy mechanisms (e.g. mechanical, thermal, chemical, or electrical energy), injury types, and injured body regions. This comprehensive methodology allows for all injuries, including overuse injuries, to be captured in the injury distribution for a population, which can provide data-driven motivation to focus prevention initiatives on certain sub-categories of injuries (i.e. acute mechanical musculoskeletal injuries, heat injuries, or lower extremity injuries). This taxonomic structure allows specific types of injuries to be easily monitored separately, as desired. The results of the present study support the need for organizations and surveillance systems to embrace this broader, all-inclusive definition of injury.

Limitations

Although the proposed inclusion of overuse injuries best represents a population's burden of injury, the application of a broader injury definition may result in larger injury datasets which could require additional resources to process and analyze. As with any analytical methodology transition, observations using the revised definition may not be comparable to past analyses.

This study used medical data that predated the ICD-10-CM coding system that is now required for U.S. medical practice.¹⁷ Most of the ICD-9-CM 710–739 codes for injury-related musculoskeletal conditions map to ICD-10-CM M-series codes, and ICD-9CM 800–999 codes for acute injuries map to ICD-10-CM S-series and T-series codes.¹⁶ As many more codes exist in ICD-10-CM than were in ICD-9-CM,^{17,51} additional specificity may be gained by considering ICD-10-CM coding in future studies. The ICD-10-CM update also classifies cumulative microtraumatic injuries with other non-injury-related musculoskeletal conditions, separate from acute injuries.

In addition, the data acquired for this study represent predominantly male soldiers, as only 8% of this survey population was women. While this is an approximately current representation of women in the Army,⁵² musculoskeletal conditions are typically more prevalent among women^{9,11} and female soldiers may require different prevention strategies than men.⁵³

Conclusions

Injury is often defined as the transfer of external energy to the body, and injuries resulting from cumulative microtrauma are common in physically active populations. However, because the ICD classifies overuse and cumulative microtraumatic injuries as musculoskeletal diseases and disorders, these diagnoses are grouped inappropriately with other disease-related chronic conditions and often go unrecognized as injuries, even though they have an external cause. Although injury-related musculoskeletal conditions are sometimes included in definitions of injury in certain populations of athletes and military members, this practice should be extended to injury definitions more broadly.

This investigation was the first to demonstrate that a majority of self-reported injuries are diagnosed as musculoskeletal overuse injuries in a large, physically active population. Most reported injuries (65%) were associated with

musculoskeletal overuse injury diagnoses, and these diagnoses were significantly more likely to be associated with self-reported limited duty for significantly more days. Associated activities and mechanisms were reported, suggesting that strategic injury mitigation strategies could have prevented their occurrence. These findings support the inclusion of musculoskeletal overuse injuries resulting from cumulative microtraumatic tissue damage during physical training in injury definitions. Injury prevention initiatives used to reduce overtraining in athletes should be adapted for other populations with high rates of cumulative microtraumatic injuries. The results of this study can be used to specifically emphasize the need for continued investigation into and development of interventions for the prevention of overuse injuries that occur during running, sports, and lifting activities.

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Ethical approval

This work was approved by the authors' institution Public Health Review Board as public health practice.

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Competing interests

None declared.

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