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Musculoskeletal Injuries and United States Army Readiness. Part II: Management Challenges and Risk Mitigation Initiatives

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ABSTRACT

Introduction

Noncombat injuries ("injuries") threaten soldier health and United States (U.S.) Army medical readiness, accounting for more than twice as many outpatient medical encounters among active component (AC) soldiers as behavioral health conditions (the second leading cause of outpatient visits). Noncombat musculoskeletal injuries (MSKIs) account for more than 80% of soldiers' injuries and 65% of medically nondeployable AC soldiers. This review focuses on MSKI risk reduction initiatives, management, and reporting challenges within the Army. The authors will summarize MSKI risk reduction efforts and challenges affecting MSKI management and reporting within the U.S. Army.

Materials/Methods

This review focuses on (1) initiatives to reduce the impact of MSKIs and risk for chronic injury/pain or long-term disability and (2) MSKI reporting challenges. This review excludes combat or battle injuries.

Results

Primary risk reduction

Adherence to standardized exercise programming has reduced injury risk among trainees. Preaccession physical fitness screening may identify individuals at risk for injury or attrition during initial entry training. Forward-based strength and conditioning coaching (provided in the unit footprint) and nutritional supplementation initiatives are promising, but results are currently inconclusive concerning injury risk reduction.

Secondary risk reduction

Forward-based access to MSKI care provided by embedded athletic trainers and physical therapists within military units or primary care clinics holds promise for reducing MSKI-related limited duty days and nondeployability among AC soldiers. Early point-of-care screening for psychosocial risk factors affecting responsiveness to MSKI intervention may reduce risk for progression to chronic pain or long-term disability.

Tertiary risk reduction

Operational MSKI metrics enable commanders and clinicians to readily identify soldiers with nonresolving MSKIs. Monthly injury reports to Army leadership increase command focus on soldiers with nonresolving MSKIs.

Conclusions

Standardized exercise programming has reduced trainee MSKI rates. Secondary risk reduction initiatives show promise for reducing MSKI-related duty limitations and nondeployability among AC soldiers; timely identification/evaluation and appropriate, early management of MSKIs are essential. Tertiary risk reduction initiatives show promise for identifying soldiers whose chronic musculoskeletal conditions may render them unfit for continued military service. Clinicians must document MSKI care with sufficient specificity (including diagnosis and external cause coding) to enable large-scale systematic MSKI surveillance and analysis informing focused MSKI risk reduction efforts. Historical changes in surveillance methods and injury definitions make it difficult to compare injury rates and trends over time. However, the U.S. Army's standardized injury taxonomy will enable consistent classification of current and future injuries by mechanism of energy transfer and diagnosis. The Army's electronic physical profiling system further enables

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standardized documentation of MSKI-related duty/work restrictions and mechanisms of injury. These evolving surveillance tools ideally ensure continual advancement of military injury surveillance and serve as models for other military and civilian health care organizations.

OVERVIEW

Noncombat injuries ("injuries") threaten soldier health and U.S. Army medical readiness, accounting for more than twice as many outpatient medical encounters among active component (AC) soldiers as behavioral health conditions (the second leading cause of outpatient visits) or 2.2 versus 1 million encounters in 2017.[1] Noncombat musculoskeletal injuries (MSKIs) account for more than 80% of soldiers' injuries[2,3] and 65% of medically nondeployable AC soldiers.[4] MSKIs accounted for 59% of soldiers' limited duty days during the first 6 months of 2019;[5] pregnancy/postpartum and behavioral health (the second and third leading conditions) each accounted for only 10% of limited duty days.[5]

The U.S. Army incorporates primary, secondary, and tertiary risk reduction initiatives to mitigate the impact of MSKIs. MSKIs are defined as musculoskeletal disorders resulting from mechanical energy transfer,[2] including traumatic and overuse injuries, which may cause pain and/or limit function. Mitigation efforts focus on preaccession populations, trainees, and healthy but injured soldiers in operational units. Supplementary Table S1 addresses pertinent MSKI risk reduction initiatives.

Successful risk reduction strategies require understanding of the relative incidence of overuse versus traumatic MSKI, common injury sites, leading causes of injury, and long-term trends in MSKI rates. Overuse MSKIs (comprising at least 70% of AC soldiers' injuries)[2,3] are a more relevant target for risk reduction strategies than traumatic injuries, given their (1) higher incidence across the Army and (2) greater potential for mitigation by physical training-related adaptations.

PURPOSE

To summarize MSKI risk reduction efforts and challenges affecting MSKI management and reporting within the U.S. Army.

METHODS

This review focuses on (1) initiatives to reduce the impact of MSKIs and risk for chronic injury/pain or long-term disability and (2) MSKI reporting challenges. This review excludes combat or battle injuries.

PRIMARY RISK REDUCTION

Primary risk reduction initiatives focus on decreasing risk for MSKI occurrence.[6] Standardized exercise programming for trainees has proven effective; other initiatives (eg, preaccession physical fitness screening and nutritional supplementation during basic training) show promise for reducing injury rates.

TABLE I. Occupational Physical Assessment Test (OPAT) Overview

Measures
Upper body power (seated power throw)
Lower body power (standing long jump)
Total body strength (deadlift)
Aerobic capacity (interval aerobic run or beep test)
Standards
Sex/age-neutral
Physical demand category qualifications
Black (specialties with heavy physical demands)
Gray (specialties with significant physical demands)
Gold (specialties with moderate physical demands)
White (not ready for any specialty)

PREACCESSION PHYSICAL FITNESS SCREENING

The U.S. Army Recruiting Command currently performs preaccession physical fitness screening through the Occupational Physical Assessment Test (OPAT). There are minimum OPAT standards for each military occupational specialty, based on that specialty's physical demand category. Career soldiers seeking to reclassify to more physically demanding specialties must also meet OPAT standards for their desired new specialty before beginning training.[7] Table I highlights OPAT measures, standards, and physical demand category qualifications.

The OPAT serves to predict an individual's capacity to perform the physically demanding tasks of their desired military occupational specialty.[8] Although not designed to predict or screen for injury risk, the OPAT may provide a secondary effect in reducing injuries and attrition by (1) establishing minimum fitness standards to enter the Army and (2) pairing individuals with an occupational specialty based on their OPAT performance and physical demand category of the occupational specialty.[9,10]

Preliminary reports indicate that male trainees with gray (significant) or gold (moderate) overall OPAT scores had a 1.2 times greater injury risk (and were 1.4 or 1.6 times more likely, respectively, to attrit during Basic Combat Training [BCT]) versus men meeting the highest standard-black (heavy)-for overall OPAT scores.[10] Female trainees with gold overall OPAT scores had a 1.1 times greater injury risk versus women with black overall OPAT scores.[10] OPAT scores among female trainees were not associated with attrition during BCT;[10] lack of an association might be because of the relatively small numbers of women in the study. Regardless of overall scores, injury risk was also greater among male and female trainees who failed to meet the black standard for each of the four individual events.[10]

The Army strives to incorporate risk reduction initiatives based on the best current and actionable evidence. Low aerobic capacity is the fitness component most strongly and consistently associated with higher injury risk among trainees.[11] Low muscular endurance is also associated with increased risk, but not as strongly or consistently as low aerobic capacity.[11] Relatively few reports have evaluated the association of muscular strength with injury risk in military populations.[11] The Army's increasing emphasis on training and testing muscular strength and power (eg, OPAT, Army Combat Fitness Test [ACFT]) will enable assessment of potential associations of muscular strength and power with injury risk.

STANDARDIZED EXERCISE PROGRAMMING

U.S. Army trainees have performed standardized exercise programming, known as Army Physical Readiness Training (PRT) since 2004. The intent of PRT is to provide a standardized, safe, and effective approach to fitness training. PRT incorporates at least two strength/mobility sessions and two endurance/mobility sessions weekly. This ideally ensures equal emphasis on strength, endurance, and mobility development while providing sufficient recovery between training sessions. PRT's exercise drills incorporate greater exercise variety than traditional Army physical training programs for optimal physical fitness development.[12] PRT's emphasis on interval runs, shuttle runs, and hill repeat runs enables aerobic and anaerobic fitness development with less running distance and frequency compared to traditional Army fitness programs that emphasized steady state runs.[12] PRT ideally ensures a gradual progression in training volume while providing standardized (1) strength, endurance, and mobility activities and (2) standardized preparation and recovery exercises.[12]

PRT is recognized as a major contributor to the decline in trainee injury rates over the past decade.[13] Three field studies evaluating PRT found that it reduced injury risk among trainees by 33 to 45% (while trainees maintained or improved overall fitness) when compared to traditional physical training programs.[14,15] PRT's effectiveness in reducing trainee injury risk is likely due in part to consistent command emphasis on and enforcement of correct PRT performance across BCT and One Station Unit Training (OSUT).

NUTRITIONAL SUPPLEMENTATION

Nutritional deficiencies are potential risk factors for MSKI, and can negatively impact postinjury recovery.[16] The combined effects of increased nutritional energy demands and physical requirements may further increase injury risk during BCT or OSUT.

The Army is evaluating the impact of providing a calcium and vitamin D-enhanced Performance Readiness Bar daily to trainees. This bone health initiative is based on reports that calcium and vitamin D supplementation reduced stress fracture incidence by 20% among female U.S. Navy recruits[17] and improved tibial cortical bone mineral density, content, and thickness among male and female trainees.[18] It is currently unknown whether Performance Readiness Bar supplementation has affected Army trainees' stress fracture risk; the U.S. Army Research Institute of Environmental Medicine has an ongoing longitudinal study addressing modifiable and nonmodifiable factors (including self-reported Performance Readiness Bar consumption) that may affect trainees' MSKI risk.[19]

The Army is also evaluating the effects of voluntary multivitamin with iron (MVI) supplementation on injury risk among female trainees. Iron deficiency prevalence has been reported as nearly 20% among women beginning Basic Combat Training (BCT); the prevalence may exceed 50% upon completing BCT.[20] Iron status decrements across BCT have been associated with decreased 2-mile run performance.[21] Overall injury incidence among female BCT trainees decreased by 3% across the first year of voluntary MVI supplementation when compared with the prior year.[10] However, MVI intake, trainee age, body composition, and physical fitness were not controlled across the year-long observation period. It is currently unclear whether voluntary MVI supplementation has affected female trainees' injury incidence.

COMPREHENSIVE MSKI PREDICTION MODELING

MSKI risk and prognosis for recovery depend on multiple factors (eg, physical, psychosocial). Comprehensive injury prediction models account for multiple risk factors (eg, smoking status, lower aerobic capacity or muscular endurance, pain during Functional Movement Screen clearing tests),[22,23] unlike risk prediction efforts based on a single functional movement or physical performance test.[24,25] A comprehensive model's predictive accuracy is based on the number of risk factors/predictors present; probability of injury increases as more predictors are present. Comprehensive predictive modeling tools are potentially effective, time and resource-efficient, low-cost injury risk screens that direct soldier-specific risk reduction interventions. Supplementary Table S2 highlights pertinent injury predictive model reports.

HOLISTIC HEALTH AND FITNESS SYSTEM (H2F)

H2F is a "system of training and testing that optimizes and validates performance readiness across a Soldier's career."[26] As described by the Commanding General, U.S. Army Center for Initial Military Training, H2F includes "mental, spiritual, nutrition and sleep readiness taught in military education and in the unit by unit-owned performance experts" and incorporates "much broader physical training options and modalities."[26] Prospective data are needed to validate H2F's effectiveness for reducing MSKI risk and improving military readiness.

H2F's emerging physical training and testing doctrine includes a transition to the Army Combat Fitness Test (ACFT). The ACFT is a six-event test intended to (1) demonstrate a soldier's 'strength, power, agility, coordination, balance, anaerobic capacity, and aerobic capacity'[27] and (2) "better predict a soldier's readiness for the demands of the modern battlefield."[26]

RUNNING FOOTWEAR

The Army transitioned from wearing combat boots to running shoes during physical training in 1982 to reduce risk for running-related injuries.[28] However, a recent historical comparison found similar overall and lower body injury incidences among trainees wearing boots versus running shoes during physical training in BCT.[28]

Army trainees in BCT and OSUT have been directed to running shoe types (eg, cushioned, stability, motion control) based on their static plantar foot shape for many years. However, running shoe prescription based on static foot shape is not proven to reduce trainees' or recruits' injury risk.[15,29] Based on the evidence to date, soldiers' footwear selection should emphasize comfortable fit, proper sizing (length and width), and timely replacement (before obvious midsole wear/breakdown or decreased comfort occur).[15,29]

SECONDARY RISK REDUCTION

Secondary risk reduction initiatives focus on decreasing the impact of existing MSKIs.[6] Reducing MSKI-related physical profiling (limited duty days), nondeployability, and risk for chronic pain or long-term disability postinjury likely improves readiness and reduces injury-related financial costs. A small percentage of soldiers is responsible for a disproportionately large number of limited duty days and MSKI costs. Four percent of AC soldiers were on chronic MSKI profiles (exceeding 90 days across the previous six months) in 2016; they accounted for 51% of all MSKI-related limited duty days (approximately 5 million days annually) that year.[30]

FORWARD-BASED/EMBEDDED MSKI CARE WITHIN THE OPERATIONAL UNIT FOOTPRINT

Soldiers with unresolved injuries are an ideal focus for timely, forward-based MSKI care; prior injury is one of the strongest predictors of future (recurrent and new-site) injuries.[15,22,31–37] The effect of prior injury is likely due partly to incomplete healing or rehabilitation, failure to return to full physical function before returning to full military duties, unresolved biomechanical or structural issues, postinjury deficits in proprioception or strength, postinjury compensatory gait patterns and/or altered pain perception.[15,31,33,34,36–40] Supplementary Table S3 highlights pertinent MSKI risk factor reports.

Forward-based/embedded MSKI care initiatives emphasizing timely identification of injuries and expert management of care and rehabilitation can potentially expedite return to duty while reducing risk of chronic pain or long-term disability postinjury. The Army is bolstering early and appropriate access to MSKI care within the operational unit footprint. Expanding access by embedding additional MSKI care clinicians and fitness experts in operational units was a key component of the U.S. Army Forces Command's (FORSCOM) multi-interventional Soldier Readiness Test and Training Program (SRT2P). This program will continue its forward-based care emphasis as it transitions into the H2F. Long-term outcome data are needed to validate forward-based MSKI care's role in decreasing the impact of existing MSKIs.

H2F FIELD TEST

The SRT2P included forward medical care provided by multidisciplinary teams outside of the traditional military treatment facility (MTF). The SRT2P team, embedded in the operational units, also included strength and conditioning (SC) coaches and athletic trainers (ATs). SRT2P transitioned to the H2F field test, which will continue through September 2020. The H2F field test shares many capabilities with the Army's Ranger Athlete Warrior (RAW) and U.S. Army Special Operations Command's Tactical Human Optimization, Rapid Rehabilitation and Reconditioning (THOR3) programs.

The H2F field test currently assigns an AT, registered dietitian (RD), physical therapist (PT), and two SC coaches to each of 30 operational battalions (typically containing 400–1000 soldiers).[41] The H2F field test also assigns occupational therapists (OT) or cognitive enhancement specialists to multiple operational battalions. The H2F field test is a bridging program to the H2F system.

The H2F system is currently envisioned to provide multifunctional, forward-based/embedded health care and fitness teams of varying staff sizes to all brigade combat teams (typically containing 4,400–4,700 soldiers)[41,42] or other brigade equivalent-sized units (typically containing 3,000–5,000 soldiers).[41] Each brigade combat team currently has an embedded PT team (one PT and PT technician). Special operations units are currently the only units with embedded teams incorporating ATs, RDs, OTs, and SC coaches. More robust, forward-based/embedded health care and fitness teams will ideally (1) facilitate access to clinical and fitness resources for improved medical readiness and soldier performance and (2) reduce disruptions to time-sensitive unit training schedules.

H2F's embedding of forward-based SC coaches in operational units is a promising primary and secondary risk reduction initiative. SC coaches can impact primary risk reduction through "safe exercise technique, appropriate programming and facility design."[43] SC coaches' collaboration with unit leadership and embedded health care providers can optimize (1) soldiers' timely injury reporting (secondary risk reduction), (2) transitions from clinical-based to occupational task-specific injury rehabilitation (secondary risk reduction), and (3) balancing of physical training and occupational duty stressors to maximize potential for adequate postactivity recovery (primary risk reduction).[43]

MSKI SUPPORT TO SUSTAINMENT BRIGADES

U.S. Army sustainment brigades provide logistical, transportation, maintenance, and personnel services support to brigade combat teams and other units operating in their assigned support areas.[44] Pending full implementation of H2F System and assignment of multi-functional health care teams to sustainment brigades, the U.S. Army Medical Command (MEDCOM) is collaborating with sustainment brigade leadership across the Army to provide early, convenient MSKI care through morning MSKI sick call conducted by PTs at the nearest MTF or within the brigade living and training area.

Physical profiles address soldiers' physical abilities to perform required tasks, and document specific task/duty limitations based on each soldier's injury. PTs assigned to installation MTFs now participate regularly in sustainment brigade-led physical profile review boards (where unit leaders and clinicians collaborate to track the medical and functional status of soldiers on limited duty, provide active MSKI surveillance and share MSKI readiness metrics with sustainment brigade leadership). Collaboration between MEDCOM and sustainment brigade leadership stems from leading practices implemented in 2016 by the First Armored Division and William Beaumont Army Medical Center leadership at Fort Bliss, Texas.[30,45]

FORWARD-BASED MSKI CARE WITHIN THE INITIAL ENTRY TRAINING FOOTPRINT

MEDCOM and the U.S. Army Training and Doctrine Command (TRADOC) have collaborated since 2010 to embed ATs in BCT and OSUT battalions. The ATs evaluate and treat trainees' MSKIs during early morning sick call within the trainees' living and training areas. ATs refer high-risk, complex and nonresponding patients for consultation by PTs, primary care providers, or orthopedic specialists at the nearest MTF. Per TRADOC leadership's estimate, forward-based ATs can evaluate injured trainees, establish treatment plans, provide initial treatment, and return trainees to the training unit before the start of their training day in approximately 85% of cases.

EMBEDDED PTS IN ARMY MEDICAL HOMES

MEDCOM also embeds PTs in primary care clinics within Army Medical Homes (multidisciplinary health care delivery sites).[46] Although not technically forward-based care, medical homes are located closer to the soldiers' living and training areas. The Army Medical Homes provide closer collaboration between primary care clinicians and their embedded PTs, thus optimizing early, convenient access to expert MSKI care.[46]

EARLY POINT-OF-CARE SCREENING FOR PSYCHOSOCIAL RISK FACTORS AFFECTING RESPONSIVENESS TO MSKI INTERVENTION

The Military Orthopedic Tracking Injuries Outcomes Network Musculoskeletal Data Portal (MOTION-MDP) is a Defense Health Agency program of record that collects patient-reported data within the Military Health System (MHS). MOTION-MDP is becoming a standard clinical practice for MSKI surgical and nonsurgical patient management. MOTION-MDP focuses on psychosocial and related risk factors that may identify patients who would benefit from a holistic interventional approach to MSKI care.[47–56] Table II highlights MOTION-MDP's capabilities, individual components, and overall focus.

TABLE II. Military Orthopedic Tracking Injuries Outcomes Network Musculoskeletal Data Portal (MOTION-MDP) Overview

Capabilities
Captures temporal changes in MSKI-related pain, function, and disability
Enables point-of-care risk factor screening during initial patient encounters
Facilitates clinical outcomes assessment after treatment for MSKIs and orthopedic surgical procedures
Components
National Institute of Health's Patient-Reported Outcomes Measurement Information System (PROMIS) outcome tool
Validated screening and outcomes measures
Surveys completed by patient and clinician at specified intervals across episodes of MSKI care
Focus
Resiliency, psychosocial risk factors, recovery perceptions, health care-seeking behaviors and therapeutic alliance measures that are relevant to MSKI-related outcomes

Soldiers with injuries or complex conditions that are not responding to medical care and rehabilitation as expected may respond to holistic interventional approaches. Allocating appropriate holistic health care resources early in episodes of care and collaboratively intervening with comprehensive, integrated pain management team members (including nonmedical leadership) can minimize risk for chronic pain, long-term disability and excessive health care resource consumption.[47–56] Supplementary Table S4 highlights psychosocial risk factors affecting responsiveness to MSKI intervention.

ARMY MEDICAL LEADERSHIP POLICY GUIDANCE ON BONE STRESS INJURIES (BSIS)

MEDCOM has issued policy guidance concerning clinical and administrative management of soldiers sustaining BSIs. The objective is to optimize clinical and functional outcomes by minimizing variance in BSI identification and management. The policy guidance incorporates leading practices in clinical BSI management, including imaging procedures, standardized grading criteria for advanced imaging techniques, recommended notifications, early intervention, and diagnostic coding procedures. Outcome data are necessary to determine this policy's effectiveness in mitigating the impact of BSIs across the Army.

TABLE III. Operational MSKI Metrics for Corps, Division and Brigade-Sized Units[30]

Percentages of soldiers on MSKI-related limited duty in prior 180 days
1–30 days (short-term)
31–90 days (long-term)
Beyond 90 days (chronic)

TERTIARY RISK REDUCTION

Tertiary risk reduction emphasizes mitigating long-term effects of chronic MSKIs on Army readiness and the individual soldier. Operational MSKI metrics enable unit commanders and clinicians to readily identify soldiers with nonresolving MSKIs. Monthly injury reports to the Army's leadership have increased command focus on soldiers with nonresolving MSKIs.

These soldiers should be considered for (1) reassignment to occupational specialties they can perform within the constraints of their MSKI-related duty limitations or (2) medical separation from the Army. Reassignment to more appropriate occupational specialties or medical separation may benefit soldiers by minimizing exposures to activities that aggravate their chronic conditions.

OPERATIONAL MSKI METRICS

MEDCOM has developed MSKI-based measures of effectiveness targeting soldiers' limited duty days, as documented electronically in physical profiles. Clinicians write MSKI-associated profiles in the Army's electronic physical profiling (eProfile) system to limit soldiers' physical activities and duty requirements during postinjury recovery periods. eProfile enables standardized documentation of MSKI-related duty/work restrictions and mechanisms of injury.

Operational metrics communicate the extent of MSKI burden on military units, accounting for noncontinuous, repetitive short-term profiling in the past 180 days. Table III highlights operational MSKI metrics for corps, division, and brigade-sized units. Monthly metrics reported to Army leadership facilitate installation-level MSKI monitoring. The U.S. Army Public Health Center (APHC) publishes Army and installation injury metrics,[30,57] develops tools for monitoring high risk populations,[58] and coordinates with public health assets[59] to support MSKI risk reduction at the military installation level.[60]

Army leadership emphasis and the above initiatives are contributing to a reduced MSKI burden. AC soldiers had nearly 17% or 1.6 million fewer days on limited duty because of MSKI in 2018, despite the Army AC changing minimally in size when compared with 2017.[61]

IMPROVING MILITARY MSKI REPORTING

Timely, accurate MSKI reporting and consistent/mandatory external cause coding are critical for (1) assessing the extent of the Army's MSKI problem, (2) identifying underlying causes of MSKIs, (3) identifying MSKI trends across units and time, and (4) determining the relative effectiveness of MSKI risk reduction interventions. Clinicians must document MSKI care with sufficient specificity (including diagnosis and external cause coding) to enable large-scale systematic MSKI surveillance and analysis informing focused MSKI risk reduction efforts.

Varying MSKI definitions, inadequate medical coding in the electronic health records and the October 2015 transition in coding systems have hindered MSKI reporting and surveillance efforts. Standardized injury definitions and consistent coding are essential for addressing the MSKI problem through effective reporting and surveillance.

The MHS transitioned to the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) medical coding system in October 2015, making it difficult to compare injury rates with earlier reports.[62,63] The ICD-10 system provides a much greater selection of detailed injury diagnostic codes than prior coding systems.[64] Numbers of reported injuries may increase with ICD-10 coding, given (1) variance among clinicians when choosing MSKI diagnostic codes and (2) repeated documentation of the same injury by multiple clinicians across multiple clinical encounters.[2] However, the ICD-10 transition should not impact other injury incidence reports (eg, numbers of individuals sustaining at least one injury across a set time).

The ICD-9/10 coding system addresses traumatic injuries and injury-related musculoskeletal conditions (primarily overuse injuries) in separate diagnosis code series. Military injury surveillance efforts must account for all injuries (overuse and traumatic);[2] failing to account for overuse injuries would underestimate injury-related, outpatient encounters by more than 50%.[65]

The APHC developed a comprehensive injury taxonomy because of challenges with ICD-9/10's injury classification system.[2] The taxonomy advances injury surveillance by identifying and categorizing overuse and traumatic MSKI, differentiating between MSKI and nonmusculoskeletal injuries and differentiating among causative sources of injuries (eg, via mechanical energy or environmental exposures to thermal or radiant energy).[2]

Infrequent external cause coding in electronic health records for MSKI-related outpatient encounters limits analysis of underlying causes of MSKIs.[66] Consistent/mandatory external cause coding for MSKI-related encounters is critical for identifying and targeting underlying causes for MSKIs.

Differences in MSKI assessments can hinder comparisons among injury reports and assessments of injury trends over time. Variability in MSKI definitions related to (1) activity

TABLE IV. Survey Research Capabilities[66–68]

Determination of cause or mechanism of injury
Determination of injury severity, functional loss, and/or limited duty time
Measurement of degree of pain
Deployment injury data capture
Note: Future analysis of electronic physical profile data will enhance understanding of severity of military injuries.
Note: MOTION-MDP implementation should improve surveillance efforts to account for pain and functional loss associated with injuries.

or work restrictions and (2) injuries requiring medical intervention versus self-treatment can lead to differing MSKI estimates.[2] Table IV highlights situations requiring MSKI survey research because of current medical surveillance limitations.

Standardized definitions are essential for injury risk reduction measures. Incorporating a severity measure (eg, amount of work loss, number of recurrences, long-term costs) provides greater clarity, but results must be clearly stated. Reported injury rates can vary considerably, based on the presence or absence of a time-loss severity measure (such as requiring at least one limited duty day per injury).[67–69]

Varied definitions exist for "training-related injury." The APHC categorizes all overuse and traumatic injuries of the lower back, pelvis and lower extremities sustained by trainees as training-related injuries. This subset of MSKI includes the most common injuries sustained by trainees. In contrast, other researchers have included all injuries (MSKI and non-MSKI) in their definition of training-related injuries sustained during BCT.[70]

Comparisons among reports are also influenced by the varied populations under study. Reports have addressed the entire Army AC (BCT, OSUT and operational units combined), operational Army units, BCT and OSUT combined or BCT and OSUT separately. When comparing injury rates and trends among surveillance reports, one must consider each report's injury definition, study population, surveillance methods and surveillance period length. One must also account for variations in Army populations, such as (1) female trainees comprising a greater proportion of the BCT versus the OSUT trainee population[3] and (2) shorter BCT versus OSUT duration (10 weeks versus 13–19 weeks).

The military environment poses additional unique challenges. Frequent moves among soldiers and clinicians impact continuity of care, which can increase long-term medical costs.[71] Soldiers may return to full military duty before they are fully ready because of (1) unit training or operational requirements or (2) insufficient criteria for determining readiness to return to full duty. Efforts are ongoing to understand and establish optimal return to duty criteria after an MSKI.[72] Concerns about career advancement opportunities and avoidance of duty limitations can cause underreporting of MSKIs.[73,74] Alternatively, pursuing medical documentation (potentially for disability compensation) or justifying substandard duty performance can cause over-reporting of MSKIs.[74] Supplementary Table S5 highlights military MSKI surveillance and reporting issues.

SUMMARY

Standardized exercise programming has reduced trainee MSKI rates. Secondary risk reduction initiatives show promise for reducing MSKI-related duty limitations and nondeployability among AC soldiers; timely identification/evaluation and appropriate, early management of MSKIs are essential. Tertiary risk reduction initiatives show promise for identifying soldiers whose chronic musculoskeletal conditions may render them unfit for continued military service.

Clinicians must document MSKI care with sufficient specificity (including diagnosis and external cause coding) to enable large-scale systematic MSKI surveillance and analysis informing focused MSKI risk reduction efforts. Historical changes in surveillance methods and injury definitions make it difficult to compare injury rates and trends over time. However, the U.S. Army's standardized injury taxonomy will enable consistent classification of current and future injuries by mechanism of energy transfer and diagnosis. The Army's electronic physical profiling system further enables standardized documentation of MSKI-related duty/work restrictions and mechanisms of injury. These evolving surveillance tools ideally ensure continual advancement of military injury surveillance and serve as models for other military and civilian health care organizations.

SUPPLEMENTARY MATERIALS

Supplementary materials are available at *Military Medicine* online.

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