

MEETING THE CHALLENGES OF TREATING MUSCULOSKELETAL INJURIES IN THE DoD AND VA



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Copy-editing by Eden Jackson Landow.

Art and production by CranCentral Graphics.

Front page image: Soldiers of the First Army practice lifting techniques and proper lifting posture at Foundation in East Moline, IL. The workshop is being instructed to give soldiers a better understanding of common mistakes people make during the Army Combat Fitness Test, how to correct those mistakes and how to train more efficiently for the upcoming physical test. The ACFT becomes the official Army physical test in October 2020. —Army photo

Image above: Brandon Bartz, co-owner of Foundation in East Moline, IL, observes soldiers of the First Army practicing their technique that will be used during the standing power throw of the Army Combat Fitness test. The standing power throw is the second event of the ACFT. —Army photo

MILITARY MUSCULOSKELETAL INJURIES COMPROMISE READINESS, DRIVE DISABILITY CLAIMS

Most Aren't Related to Combat

BETHESDA, MD—Three-quarters of medically nondeployable servicemembers are out of commission as a result of musculoskeletal injuries, and the vast majority of those injuries come from training and sports activities, according to a recent study.

While combat-related musculoskeletal injuries are typically more severe, non-combat-related musculoskeletal injuries occur six times more often and put 68,000 servicemembers in nondeployable status every year, according to researchers at the Uniformed Services University of Health Sciences and Walter Reed National Military Medical Center in Bethesda, MD.¹

In their report published in *Sports Medicine and Arthroscopic Review*, the researchers determined that, in all, noncombat MSKIs cause 25 million days of limited duty and drive more than two million clinic visits per year. Total costs for these injuries exceed \$3.7 billion annually.

The high cost related to these injuries in recent years is not an anomaly but part of a consistent pattern going back many years. “The primary health threat to troops for more than two decades has been common muscle, joint, tendon/ligament and bone injuries like knee or back pain that are caused by

running, sports and exercise-related activities such as basketball and weightlifting,” explained Veronique Hauschild, MPH, of the Injury Prevention Program, Army Public Health Center, Aberdeen Proving Ground, MD.

No matter how you slice the data, musculoskeletal injuries have huge immediate impact and significant long-term sequelae. “There are, in the realm of orthopedics, two areas you can divide injuries into: orthopedic trauma and casualty care and military-related musculoskeletal conditions,” said Marvin Helgeson, MD, chief of orthopedics at Walter Reed. “Both types primarily affect the lower extremities and spine.”

Acute traumatic musculoskeletal injuries such as those resulting

from accidents, falls, improper lifts or explosions account for 14% of injuries in the Army. Traumatic musculoskeletal injuries include fractures, dislocations, sprains and strains. Cumulative microtrauma from military-related training and overuse leads to nearly 70% of musculoskeletal injuries, such as stress fractures, shin splints, patellofemoral syndrome, tendinitis, bursitis, plantar fasciitis and back pain.²

These nonbattle injuries require medical evacuation more often than any other condition, with lower extremity injuries alone responsible for 40% of medevacs from combat theaters. “Spine pain is a very large reason for having to medically evacuate patients,” as well, Helgeson told *U.S. Medicine*.

While combat-related musculoskeletal injuries are typically more severe, non-combat-related musculoskeletal injuries occur six times more often and put 68,000 servicemembers in nondeployable status every year.

MSKIs dominate as the primary reason for medical visits and hospitalizations in the nondeployed environment, too. They also are the leading cause of disability discharges.

LINGERING IMPACT

Many patients continue to experience the consequences of musculoskeletal injuries for years. A variety of factors can cause MSKIs to recur, become chronic or even disabling. Osteoarthritis is a common long-term effect of these injuries which can “continue to degrade the physical and mental health status of Army soldiers and contribute to some of the highest military medical costs,” according to the APHC. Osteoarthritis develops in about one-third of servicemembers and veterans, compared to about 20% of the civilian population, the *Sports Medicine and Arthroscopic Review* authors found.

For many servicemembers, musculoskeletal injuries while on active duty translate into ongoing issues as veterans. While VA data “does not allow us to separate trauma and other injuries from degenerative conditions resulting in musculoskeletal pain,” said Friedhelm Sandbrink, MD, neurologist at the Washington, DC, VAMC, “the most common pain conditions in veterans are musculoskeletal conditions.”

Joint pain affects 43.6% of veterans, Sandbrink told *U.S. Medicine*, while 32.8% are plagued by back pain, and 15.9% have neck pain.

That’s consistent with findings by

While VA data “does not allow us to separate trauma and other injuries from degenerative conditions resulting in musculoskeletal pain, the most common pain conditions in veterans are musculoskeletal conditions.”

—Friedhelm Sandbrink, MD
Neurologist, Washington, DC, VAMC

Hauschild and her colleagues that knee and lower back injuries each accounted for 16% of all injuries in active duty soldiers in 2017, with most caused by cumulative microtrauma.³ Notably, acute anterior cruciate ligament injuries occur 10 times more often in servicemembers than in the general population. As ACL injuries entail a recovery period of more than six months, the impact on readiness is significant.

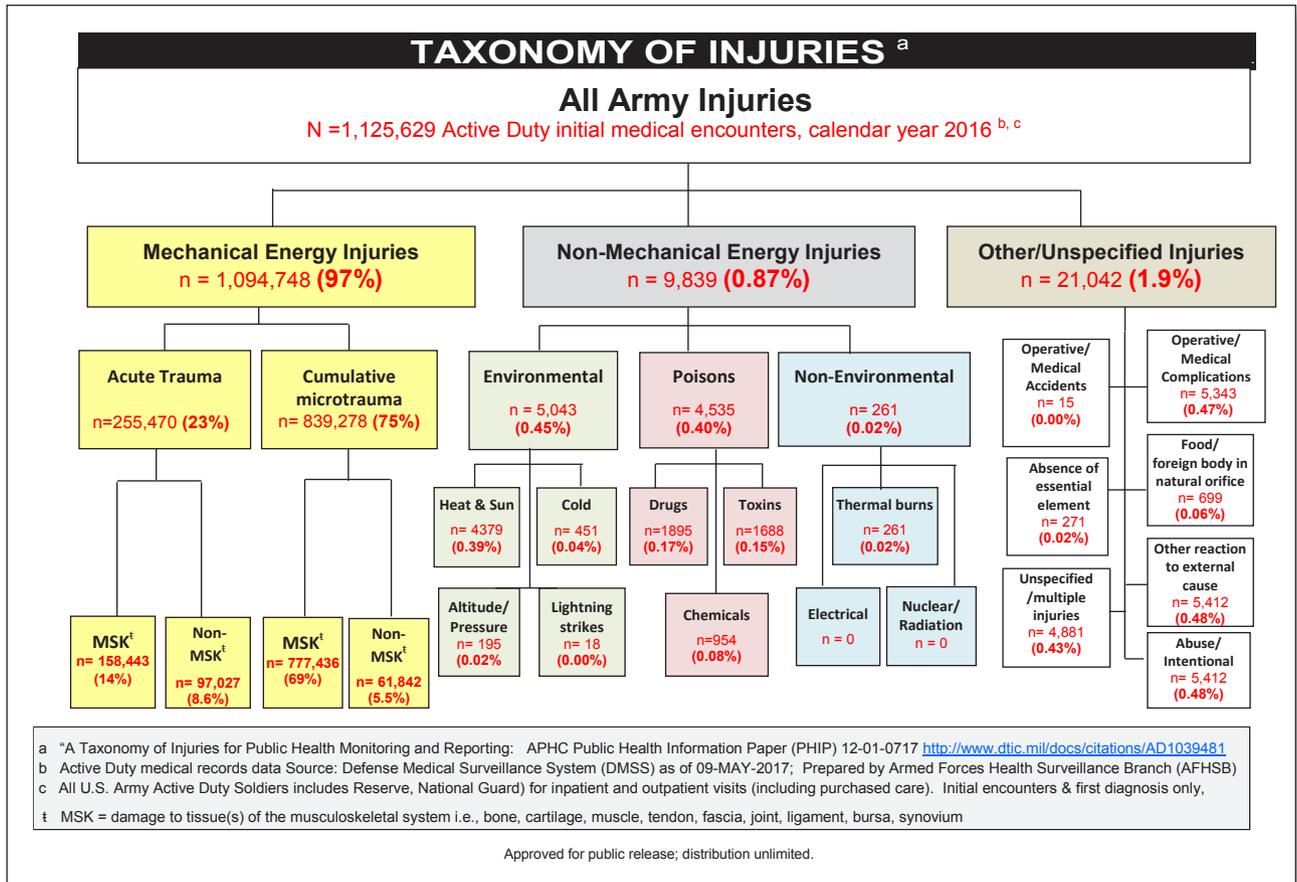
PRIMARY CAUSES

The high rate of overuse or cumulative microtrauma injuries in the lower limbs and lower back “are attributed primarily to running and foot marching long distances with heavy loads” and routinely lifting heavy objects, according to the APHC.

Running, marching with heavy loads and lifting heavy objects comprise common activities during military training, but the training is not designed to injure

servicemembers but to strengthen them. Ideally, the body repairs microtears in the tissues of the lower body caused by running, foot marching, jumping and other training activities, making them stronger. When the body does not have time to heal the tears, however, an overuse injury can occur.

The APHC notes that rates of injury are highest among less fit recruits and servicemembers, with risk rising with the initiation or resumption of a new strenuous training activity. For individuals new to intense physical training, like many recruits, the sudden demands on their bodies and limited time allotted for rebuilding translates into high rates of injury. More than 45% of Army recruits sustain at least one MSKI, about half of which affect the lower extremities or back, the *Sports Medicine and Arthroscopic Review* authors found.



Completion of basic training does not eliminate the risk of injury, however. Nondeployed soldiers have musculoskeletal injury rates as high as 1.42 per infantryman, according to those authors. Female servicemembers have higher rates of musculoskeletal injury than their male counterparts, with rates twice that of male servicemembers in some cases, they noted.

A number of other factors increase the risk of MSKI, including smoking, high or very low

body mass index, extreme or limited flexibility, inadequate sleep and prior injury. Women with the female athlete triad—inadequate consumption of calories or nutrition, decreased bone mineral density (generally associated with very low body fat), and amenorrhea—face additional risk. 

¹ Grimm PD, Mauntel TC, Potter BK. Combat and Noncombat Musculoskeletal Injuries in the US Military. *Sports Med Arthrosc Rev.* 2019 Sep;27(3):84-91. doi: 10.1097/JSA.0000000000000246.

² Hauschild V, Hauret K, Richardson M, Jones BH, Lee T. A Taxonomy of Injuries for Public Health Monitoring and Reporting—Public Health Information paper (PHIP) No. 12-01-0717. 25 July 2017.

³ Hauschild VD, Schuh-Renner A, Lee T, Richardson MD, Hauret K, Jones BH. Using causal energy categories to report the distribution of injuries in an active population: An approach used by the U.S. Army. *J Sci Med Sport.* 2019 Sep;22(9):997-1003.

DoD/VA TAKE AIM AT MUSCULOSKELETAL INJURIES WITH INNOVATION, DATA

BETHESDA, MD—For traumatic musculoskeletal injuries, the Military Health System provides cutting-edge care as it continues to pioneer new techniques to preserve limbs and restore function. For more mundane, yet frequently disabling injuries, both the VA and DoD rely on data-driven therapies and innovation to repair damage and minimize pain.

“Military orthopedic surgeons have more experience dealing with traumatic injuries than any other healthcare system,” said Melvin Helgeson, MD, chief of orthopedics at Walter Reed National Military Medical Center in Bethesda, MD. “As a profession, that’s our niche.”

The DoD has focused on streamlining “the reconstructive ladder from point of injury to restoring function,” Helgeson told *U.S. Medicine*.

Efficiently delivering servicemembers from where they incurred the injury to the initial level of care is the first step. Once there, “we take a multidisciplinary approach to cleaning wounds and stabilizing fractures,” Helgeson said.

For warriors who have sustained traumatic limb loss or are at risk of amputation, minimizing the risk of infection is paramount.

“Musculoskeletal infections frequently complicate the clinical course of combat-injured patients with traumatic amputations and limb-threatening wounds,” according to a recent review of musculoskeletal injuries in the U.S. military.¹ “Infectious complications range in severity from cellulitis, requiring only antibiotic therapy, to deep infection requiring surgical debridement.”

Because physicians within the MHS see many more of these injuries, “we lead the community in research in debridement and closure techniques, as well as in reconstructing tissue to optimize function,” Helgeson noted. Orthopedic, plastic and trauma surgeons work together to help injured servicemembers achieve the best possible results, he added.

Walter Reed has developed two unique procedures to maximize use and minimize issues associated with prosthetics for amputees. Osseointegration addresses the difficulties created by the socket required for attachment of most prosthetics. For leg prosthetics, the socket transfers the force of the prosthetic foot hitting the ground to the skin, soft tissues and muscles before reaching the remaining bone.

The wear and tear on the skin and soft tissue is particularly problematic for battle-injured amputees who are more likely to have had split thickness skin grafts to preserve maximum limb length, but are more susceptible to ulceration, according to Walter Reed. Heterotopic ossification or bone formation in soft tissues of injured limbs, which occurs in up to 91% of traumatic amputations, also contributes to ulceration, pain, and nerve damage with traditional prosthetics.

The new procedure entails implanting a titanium peg into the femur or humerus to which an abutment that goes through the skin is attached. The external prosthesis then directly attaches to the abutment, eliminating the need for a socket. “We have done this procedure in 20 to 30 patients and all have been able to maintain their prostheses,” Helgeson said.

Patients also experience an improved range of motion, better ambulation, and greater sensory awareness of the limb, which leads to more natural gait.²

The second advance is targeted muscle reinnervation, which can preemptively avoid pain from neuromas and phantom limb pain by surgically transferring amputated



Air Force Col. Edward Anderson, MD, 99th Medical Group orthopedic spine surgeon, performs a lumbar microdiscectomy surgery at Nellis Air Force Base, NV. A lumbar microdiscectomy surgery is performed to remove a portion of a herniated disc in the lower back. —Air Force photo by Airman 1st Class Andrew D. Sarver

nerves to motor nerves in nearby muscles at the time of amputation.³ In addition, it “allows more function by being able to recruit muscle fiber more actively for amputees,” Helgeson added. The procedure also enables more intuitive control and an expanded range of motion for prosthetics.

BEYOND BATTLEFIELD INJURIES

Both the DoD and the VA have made significant investments in improving care and outcomes for servicemembers or veterans who have experienced more common, non-combat-related injuries that lead to low-back pain and anterior cruciate ligament ruptures.

Broadly speaking, VA/DoD

guidelines encourage patients and physicians to try a wide range of interventions before resorting to surgery for back pain. “In the low-back realm, spine surgery as a whole gets a negative rap sometimes. In the civilian sector, there is evidence that there is too much surgery” with too little benefit, Helgeson said.

“Discectomies classically do well and patients who have them tend to stay on active duty. But reherniation happens in about 5% of cases, though we have no good studies that correlate reherniation to technical aspects of the surgery,” he observed. “It may be the manner in which you remove the disc and tissue around it, but no one has been able to prove that. In the meantime,

we don’t want to miss the short-term outcomes because if something you do makes them undeployable for a year, they won’t be in the military.”

Other surgeries provide no simpler answers. “For cervical spine one- or two-level fusion or disc replacement, there are more questions about what happens 10 to 20 years down the road, whether it leads to degeneration,” he noted. “We don’t know if the best option is to fuse someone in the long-term because of problems with healing and adjacent damage. And only about half of patients stay on active duty after fusion.”

The advances seen in cervical spine options have not been paralleled in the lumbar region, Helgeson

noted. “We’ve been on the leading edge for the last 15 years with cervical disc arthroplasty and patients have done very well. In the lumbar spine, we were in leading trials, but lumbar spine arthroplasty has not been proven to preserve motion as well as cervical.”

Walter Reed has adopted minimally invasive techniques as they have been developed. Those approaches may be especially suitable for the relatively young and healthy active duty population, which has a unique profile. Most back surgery patients have pain resulting from age-related degeneration.

The VA sees more of that older cohort as well as younger veterans who sustained injuries that led to ongoing back pain. Like DoD, VA focuses on providing a range of service to address pain, including surgery.

“Patients are choosing to be proactive about seeking musculoskeletal evaluation earlier rather than simply masking the pain with opiates. By seeking care earlier, we can intervene with non-surgical methods earlier as well, which tend to help,” said Alan Dang, MD, orthopedic attending at the San Francisco VAMC.

“There are multiple new techniques and technologies that are advancing the field of spine care, including endoscopic approaches for decompression,” Sanjog Pangarkar, MD, Physical Medicine and Rehabilitation, Greater Los Angeles VAMC, told *U.S. Medicine*. “In addition, certain

lumbar surgery approaches such as OLIF [oblique lateral lumbar interbody fusion], are muscle sparing and allow faster recovery times.”

The VA also offer radiofrequency ablation for back pain, sometimes called “laser surgery,” as well as very complex multiday, staged spinal fusion surgeries, 3D printed titanium spine implants, robotic surgery, and computer navigation for complex cases, Dang said. “Any surgery that has strong evidence for use and, if applicable, is FDA cleared or approved is available at the VA,” he noted.

More recently, the San Francisco VA has used 3D patient-specific printed models created in-house to plan surgery and communicate with the surgical team and patient, Dang added. The cost can be less than a pair of sterile gloves and production takes less than 24 hours.

VA has also developed more intensive interdisciplinary pain programs than any other system, including cognitive behavior therapy, aquatic and physical therapy, acupuncture, yoga, tai chi, and other non-pharmacological, non-surgical techniques to help veterans “restore functioning and regain a sense of purpose,” said Jennifer L. Murphy, PhD, national cognitive behavioral therapy for chronic pain master trainer at the Tampa VAMC.

ACL REPAIRS

With ACL tears 10 times more common among active duty forces than civilians, military orthopedic surgeons have had abundant op-

portunity to study the injury and techniques for repair. “DoD is very interested in musculoskeletal injuries such as ACL ruptures because it’s one of the most common reasons for individuals to be not ready for deployment,” Helgeson said.

“Our sports-related surgeons do an incredible amount of volume,” he added. That allows the DoD to “critically assess long-term outcomes and whether specific technical aspects have an impact. Does ACL surgery result in recurrence or long-term stability or increase the risk of osteoarthritis? If so, is that outcome procedure specific?”

Continual evaluation of results and refinement of procedures keep “our folks always at the leading edge,” Helgeson said. “There is a lot of variation in how to approach ACL ruptures. We use the most advanced techniques here and continually evaluate how they might be refined to improve outcomes.” 

¹ Grimm PD, Mauntel TC, Potter BK. Combat and Noncombat Musculoskeletal Injuries in the US Military. *Sports Med Arthrosc Rev*. 2019 Sep;27(3):84-91.

² Zaid MB, O’Donnell RJ, Potter BK, Forsberg JA. Orthopaedic Osseointegration: State of the Art. *J Am Acad Orthop Surg*. 2019 Nov 15;27(22):e977-e985.

³ Valerio IL, Dumanian GA, Jordan SW, Mioton LM, Bowen JB, West JM, Porter K, Ko JH, Souza JM, Potter BK. Preemptive Treatment of Phantom and Residual Limb Pain with Targeted Muscle Reinnervation at the Time of Major Limb Amputation. *J Am Coll Surg*. 2019 Mar;228(3):217-226. New and Emerging Devices Could Transform Musculoskeletal Surgeries

NEW AND EMERGING DEVICES COULD TRANSFORM MUSCULOSKELETAL SURGERIES

Several recently approved devices have the potential to improve outcomes for service members and veterans with musculoskeletal injuries. Additional promising devices and procedures are now in testing.

Some notable innovations include:

Barricaid Annular Closure Device: Approved for use following lumbar discectomy, Barricaid is designed to close annular defects of at least 6 mm in width to reduce the incidence of reherniation. Reherniation occurs in about 10% of lumbar discectomies among service members,¹ and in 25% of lumbar discectomies when only looking at the large defect patient population. The device consists of a polyester fabric which is designed to close the opening in the annulus. A titanium anchor affixes the device to the adjacent vertebral bone for secure fixation.

First annular closure technology to receive FDA PMA approval

In February 2019, the Food and Drug Administration approved the Barricaid annular closure device to reduce the chance of reherniation at the specific level (L4-S1) from occurring, adding that, after a three-year follow-up in a clinical study, patients receiving the Barricaid device had significantly fewer reherniations.

It is designed to close the hole in a patient's intervertebral disc following a limited discectomy procedure in the lower back (L4-S1) after an initial herniated disc. To do that, it rests in the disc space to reduce the number of potential reherniations.

According to the FDA, the product is indicated for patients with a numbness or weakness that extends to the buttock or legs—with or without back pain—caused by a herniation that is pinching a nerve root in the spine at one level between L4 and S1 that requires a limited discectomy procedure.

If it is determined during the surgery that the size of the hole left when the ruptured portion of the disc is removed is between 4-6 mm tall and 6-10 mm wide, the surgeon can implant the Barricaid, according to the approved labeling. If the hole is not large, then the likelihood for another herniation or operation is



Barricaid Annular Closure Device

naturally lower, and the patient does not qualify for use of this device.

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¹ Fredericks DR, Colantonio DF, Wagner S, Helgeson MD. 185. Reoperation rates after single-level lumbar discectomy in the military health system. *The Spine Journal*. Sept 2019;19(9):S89-S90.

² Murray MM, et al. Abstract 7. Presented at: Arthroscopy Association of North American and American Orthopaedic Society for Sports Medicine Specialty Day at the American Academy of Orthopaedic Surgeons Annual Meeting; March 16, 2019; Las Vegas.

ARMY INSTITUTES PROGRAMS TO MINIMIZE SOLDIERS' TRAINING INJURIES

ABERDEEN PROVING GROUND, MD—How can the Army maintain fitness, promote combat-readiness and minimize injuries? The Army Public Health Center at the Aberdeen Proving Ground in Maryland has been investigating options and sharing ideas for three decades, with mixed results.

“It is a paradox that the very physical training activities required or encouraged by the U.S. Army to improve soldiers’ physical performance, are also what can most detract from their physical readiness by causing injuries,” noted APHC researchers in an article on musculoskeletal training injury prevention.¹

Training properly essentially employs the Goldilocks principle: Not too much and not too little. The challenge is that the “just right” level varies by individual. Clear thresholds above which injuries increase while fitness plateaus or declines have not been established, noted Bruce Jones, MD, MPH, senior scientist at APHC. For the individual, current level of fitness, previous injuries, body mass and age all factor in.

FOCUS ON AEROBIC FITNESS

Perhaps most important is aerobic fitness. “Recent data show that

soldiers who have slow two-mile run times (i.e., men who take more than 15 minutes and women who take more than 19 minutes) have a higher risk of injury. Even soldiers who ‘look’ fit and are within body fat standards have a higher injury risk if they run slow,” according to Sarah Dobson and Veronique Hauschild, MPH, of the APHC.

For these soldiers, however, the seemingly logical strategy of just running more actually leads to worse results, the Army has found. “We can show that greater amounts of training (for example, of running or road marching) result in more injuries,” said Michelle Chervak,

PhD, MPH, acting manager for the APHC Injury Prevention Program. In part, that’s because slow runners take more steps, increasing the stress on their joints.

Instead of telling slower soldiers to “hit the road” to get up to speed, the APHC recommends referring them to one of the Army’s 35 Wellness Centers. The centers help soldiers develop individualized plans to increase their overall fitness—and reduce their risk of musculoskeletal injuries associated with overuse.

A key component of the plans is high-intensity interval training, which maximizes cardio fitness

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—Sarah Dobson and Veronique Hauschild, MPH



Soldiers from 1st Engineer Brigade complete the leg tuck event while testing the Army Combat Readiness Test at Fort Leonard Wood, MO, in 2017. —Army photo by Dawn M Arden

without increasing time and stress on the vulnerable lower body and back, though other kinds of training also improve aerobic fitness with less risk than running.

REDUCED INJURIES

The movement away from running to improve fitness in at-risk soldiers continues a trend begun more than 15 years ago when an Army study found that a group

employing a physical training program designed to minimize overuse injuries during nine weeks of basic combat training performed better on the Army Physical Fitness Test than a group that trained using traditional methods, including running, calisthenics, pushups and situps.

The Army adopted the new physical training program for basic training in 2004, which reduced

the amount of running required, divided units into ability groups for longer runs, increased training time and intensity more gradually and incorporated a wider range of exercises. According to the APHC, the changes resulted in a 46% decline in all injuries and 54% drop in musculoskeletal overuse injuries among recruits over the next decade.

Still, not all commanders or

soldiers have gotten the message that more isn't necessarily better and continue to focus on frequent, long runs.

"High or increasing injury rates should be a wake-up call to leaders, indicating a need to adjust the physical training program to prevent over-training. This will reduce injuries and ultimately enhance fitness and physical performance," Jones said.

Likewise, soldiers should be educated on the risk of "pushing through the pain." Highly competitive or motivated servicemembers

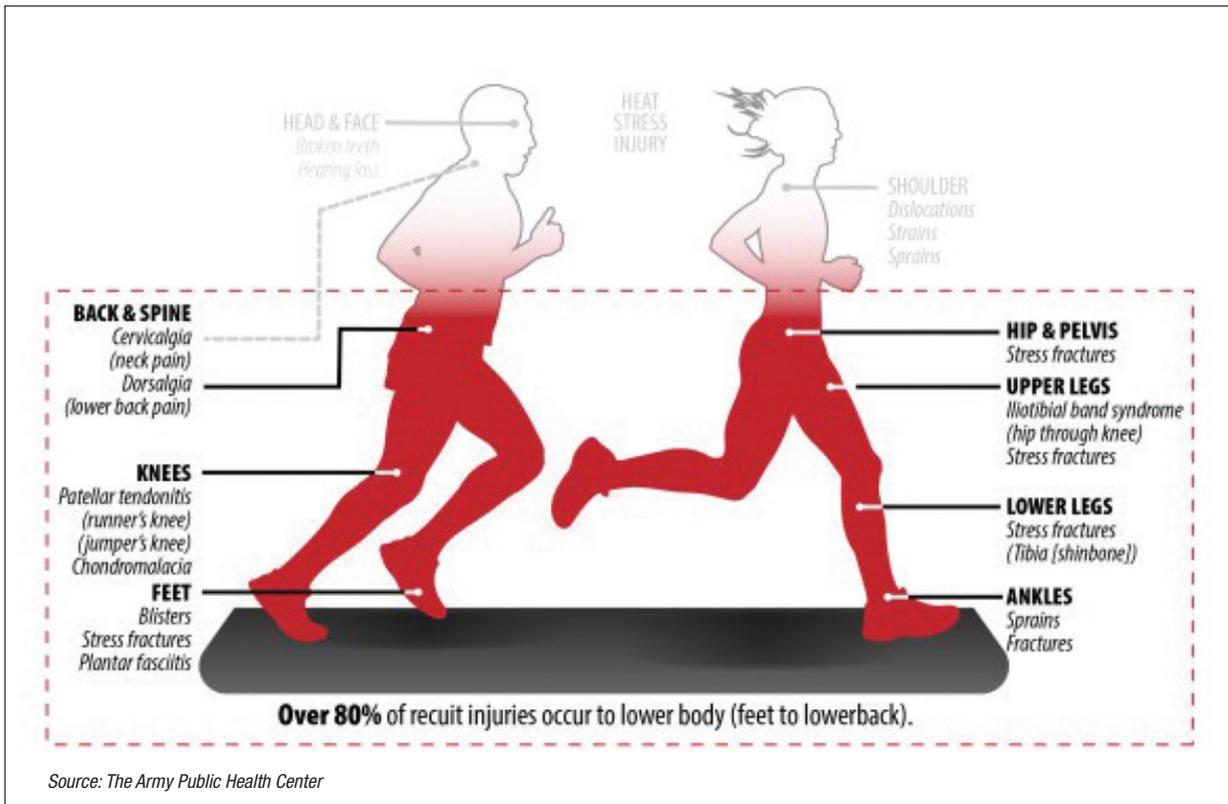
may suffer more serious injury by ignoring signals from their bodies to stop an activity.

According to Hauschild, a strong training program that minimizes injuries:

- Avoids excessive running by mixing low-impact aerobic activities such as swimming or biking with running and slowly increasing the distance and time spent running. Running or running followed by a ruck march should be avoided on consecutive days. Injured servicemembers should not

run, and group runs should cluster runners by speed and endurance.

- Includes a variety of exercises that focus on aerobic fitness, strength, agility and conditioning.
- Encourage semirigid ankle braces and mouth guards during basketball and training for parachuting and combatives.
- Slowly increase weight and focus on form in weightlifting and other conditioning programs.



The Army introduced the six-component Army Combat Fitness Test in October, which will replace the Army Physical Fitness Test in October 2020. The new test is designed to better evaluate combat readiness and promote more balanced training.

It has another purpose as well. “The new fitness test is a response to high rate of injuries,” said Melvin Helgeson, MD, chief of orthopedics at Walter Reed National Military Medical Center in Bethesda, MD.

OLD METHODS

Despite studies that demonstrate that the Physical Readiness Training program rolled out in 2012 reduces injuries compared to running-centered training programs, many units continue with the old training methods and continue to rack up high rates of injury. Changing the way fitness is officially measured may stimulate broader adoption of the PRT to better prepare for a more comprehensive physical assessment, Hauschild said.

The ACFT keeps the 2-mile run but drops the situp and modifies the pushup component. It adds a standing power throw, sprint drag and carry and leg tuck hold.

In addition, “the new fitness test has a deadlift on it. That’s a unique activity,” Helgeson told *U.S. Medicine*, and one that could prove problematic. “Lifting weight increases intradiscal pressure and we don’t know if that will increase

back injuries. It matters how people train for it, too,” he noted.

The test limits the weights to 340 pounds, but gradual increase in weight is recommended to minimize the risk of disc herniation and knee injuries. The APHC recommends against use of a back brace, as they can increase the risk of injury, and advises that training by bench-pressing heavy weights has a greater risk of rupturing muscles or tendons than other options.

The APHC’s list on potential injury concerns associated with the new test suggests that lower body injuries could be exchanged for upper body issues and more back and spine injuries. In addition to the inherent challenges of the deadlift, the standing power throw and hand-release pushup also could cause back, neck or shoulder

injury. The sprint-drag-carry raises concerns about damage to the knees, shoulders, elbows and back, and the leg tuck has the potential to injure shoulders, elbows and wrists.

“It’s probably the leg tuck that’s giving people the most problem,” so far, Helgeson said. That component drove high overall failure rates on the ACFT during testing.

To minimize the risk of fractures, sprains or tears in the muscles, ligaments or tendons associated with falling from the 7-foot-high pullup bar used for the leg tuck, the test should always be performed with a spotter. 

¹ Jones BH, Hauschild VD, Canham-Chervak M. Musculoskeletal training injury prevention in the U.S. Army: Evolution of the science and the public health approach. *J Sci Med Sport*. 2018 Nov;21(11):1139-1146.

“High or increasing injury rates should be a wake-up call to leaders, indicating a need to adjust the physical training program to prevent over-training. This will reduce injuries and ultimately enhance fitness and physical performance.”

—Bruce Jones, MD, MPH,
senior scientist, APHC Acting Manager,
APHC Injury Prevention Program

NOTES

NOTES

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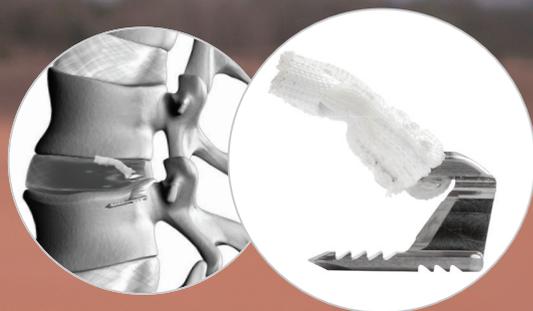
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