

A REVIEW OF MUSCULOSKELETAL INJURIES IN THE UNITED STATES ARMY: DEMOGRAPHICS, RISK FACTORS, AND THE ROLE OF THE PHYSICAL THERAPIST IN PREVENTION AND RETURN TO DUTY

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THE BURDEN OF MUSCULOSKELETAL INJURIES IN THE UNITED STATES ARMY

Musculoskeletal injuries (MSI) are the leading source of ambulatory encounters among active duty service members (1). In 2016, there were 19,158,557 reported ambulatory visits, and 4,198,896 (21.9%) were classified as MSI (1). The Defense Health Agency (DHA) reports that this is the highest annual total of MSI in the past 13 years, and the rate (approximately 15 outpatient visits per person) was 5.0% higher than the 2014 rate and 40.9% higher than in 2007 (1). It is estimated that MSI result in approximately 25 million lost duty/training days annually (3,8,23). Moreover, decreased readiness, medical evacuation from theater, and disability in the military can often be the result of MSI (1,2,3,6,8,15,23). Therefore, MSI are an enormous burden to the military services.

According to data from 2006, approximately 75,000 U.S. Army Soldiers were unable to deploy on any given day (4). This was approximately 13% of the Army's end strength, or the maximum number of Soldiers authorized by Congress. While this includes administrative, legal, and medical reasons, 42.5% of those 75,000 Soldiers (31,900) were non-deployable due to medical reasons, primarily MSI (4). This was equivalent to 5.78% of the Army's end strength. These numbers become especially noticeable in the Army's primary operational units, which are also known as brigade combat teams (BCT). In fiscal year 2010, approximately 14.5% of Soldiers in BCT were unable to deploy primarily due to MSI (4).

As surmounting as these numbers already are, it may only be half the story. There is reasonable evidence to suggest that medical conditions, namely MSI, are left unreported by 49 – 58% of Soldiers serving in a BCT setting (24,26). The primary reasons these Soldiers cite for not reporting their injuries are: a) fear of it hindering future career progressions or job opportunities; and, b) wanting to avoid being placed on a profile, which places restrictions on participation in unit-level physical training activities (26). The vast majority of these Soldiers (greater than 80%) admit to self-medicating as a primary means of treatment (24).

CAUSES AND RISK FACTORS FOR MSI

Results from a 2006 review of non-deployed, active-duty military personnel indicated there were 743,547 musculoskeletal injuries, of which 82% were classified as overuse (8). In a randomized, retrospective review of 3,195 light infantry Soldiers over a 13-month period, it was established that physical training was the cause of 50% of all injuries—30% of those were linked to running, 19% to other activities (sports, calisthenics, and strength training), and 16% to foot marching (27). During the 8-week Army Basic Training Course, these numbers appear to increase. Knapik and colleagues demonstrated that 25% of male and 55% of female basic trainees experienced one or more MSI, of which 80 – 90% were directly related to physical training (9). It is plausible to surmise the following regarding MSI in a garrison setting: a) the most common type of MSI is microtraumatic or overuse in nature; and, b) the most frequently reported activity associated with overuse MSI is physical training, namely running (8,9,16,28). In their randomized, retrospective review of operational Soldiers, Smith and Cashman highlighted that those suffering from running-related lower extremity injuries (primarily to the knee and secondarily to the foot/ankle) spent seven times more days on activity-limiting profiles versus those with MSI unrelated to running (27). Specific diagnoses for the types of knee, foot, and ankle injuries were not mentioned. Moreover, running was attributed as the cause of 45% of all the lower extremity injuries and 54% of the lower extremity days on profile (27).

In a U.S. Army basic training setting, commonly cited potentially modifiable risk factors for MSI include, but are not limited to, the following: poor baseline fitness levels (low cardiorespiratory endurance, defined as slow 1-mi run times, and low muscular endurance, defined as low number of sit-ups and push-ups during the Army Physical Fitness Test), sedentary lifestyle prior to entering service (those who self-reported being inactive compared to being very active, relative risk of 2.5; those self-reporting running <1 time per week compared with 4 or more times per week, relative risk of 2.2), higher running volume (defined as an average of 11 mi per week versus 5 mi per week; those in the higher mileage group sustained 27% more lower extremity injuries but actually had slightly lower 2-mi run times of 13.8 versus 13.5 min), cigarette or tobacco use (smokers of 20+ cigarettes/day compared to non-smokers, relative risk of 1.7), and the extremes of high or low levels of flexibility (toe-touching ability; relative risk

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of 2.2) (9). According to the same study, the most consistently cited risk factor for MSI in the U.S. Army was low cardiorespiratory endurance (9).

In a deployed setting, MSI remain the leading source of healthcare visits and medical evacuations, accounting for 87% of non-battle injuries, and physical training and sports continue to be primary activities linked to MSI (2). However, at least in Soldiers attached to a Stryker BCT, the most common activities linked to MSI shift to lifting and load carriage rather than to running, which is plausible considering the frequency and volume of running are typically decreased while deployed (19,21). According to survey results of 593 Soldiers of a Stryker BCT upon completion of a 12-month deployment to Afghanistan, 45% sustained an injury, which led to 5,049 days of limited duty, averaging 8.5 days per injury (19). Sixty-five percent of these injuries occurred while working, and the most frequently reported causes were: lifting and carrying (9.8%), dismounted patrolling (9.6%), and physical training, defined as “structured group exercise sessions” (8.0%) (19). Associated risk factors identified from this cohort included but were not limited to: heavier (>36.4 kg on average) or more frequent lifting tasks (5 – 6 times/day), more time spent standing (>12 hr/day), engaging in strength training sessions >30 min, female sex, older age (35 years and older), and heavier loads worn. Regarding load carriage, the Soldiers with the greatest probability and incidence of injury were those who wore average loads of >34.1 kg or wore the heaviest loads of >45.5 kg, or >25% of their bodyweight (19). To note, while those who engaged in strength training sessions lasting >30 min on average sustained 13.5% more injuries than those whose sessions were <30 min, they also wore their body armor longer, wore heavier equipment, lifted heavier objects at work, and spent more days per week lifting objects for work (19). Therefore, one must use caution when interpreting slightly longer strength training sessions as a potentially dangerous or harmful activity and not use this as an excuse to avoid strength training. Regardless, the authors of the study suggest that loads being carried and/or lifted may exceed many Soldiers’ work capacity, or ability to repetitiously lift and/or carry such loads (19). Similarly, a prospective cohort of deployed BCT Soldiers investigating risk factors for low back pain, the most common injury in the military, found that being older, having lower fitness levels, and wearing heavier loads for longer periods of time were related to increased risk (1,20).

MOST COMMONLY INJURED REGIONS

In 2016, as in previous years, MSI (especially of the back, knee, shoulder/arm, and leg/ankle/foot) comprised a large percentage of the morbidity and healthcare burden impacting the active component U.S. military (1). “The three burdens of disease-related conditions that accounted for the most medical encounters (i.e., other back problems, all other musculoskeletal diseases, and knee injuries) accounted for one-fourth (25.1%) of all illness- and injury-related medical encounters overall,” (1). “Other back problems” ranked as the number one overall condition, which

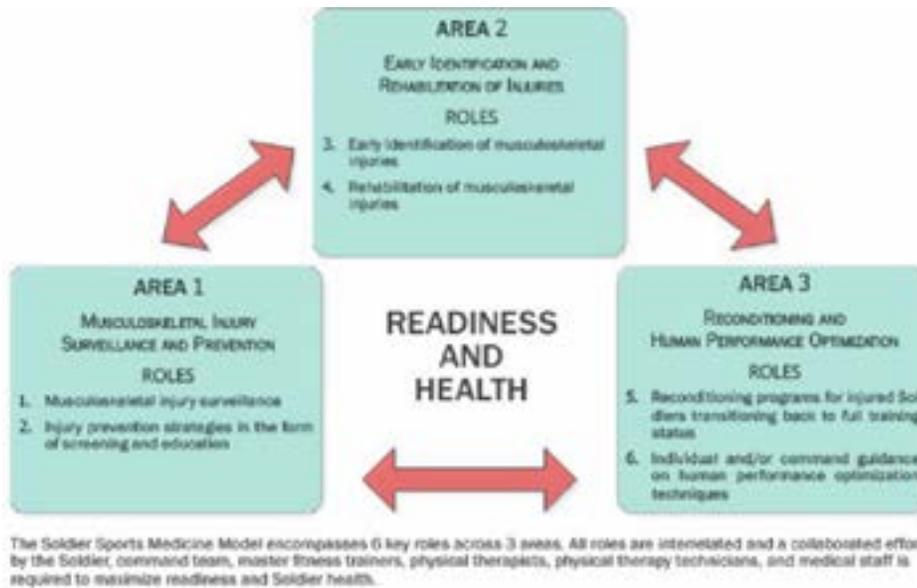
affected 239,458 individuals and accounted for 1,256,152 medical encounters (1). While “all other musculoskeletal diseases” ranked first in terms of individuals affected (246,426), it accounted for the second most medical encounters at 797,738. Lastly, knee injuries affected 157,304 individuals, which accounted for 736,591 medical encounters in 2016 (1). Of the top 10 conditions that impacted the most active component service members, five were musculoskeletal, and the remaining fell under the major categories of “mental disorders” (anxiety, adjustment and mood disorders) and “signs and symptoms” (organic sleep disorders and all other signs and symptoms) (1).

These 2016 data are consistent with previous combat-setting data published in 2011, 2013, and 2015, which identified the top five body regions most commonly injured as: lower back, knee, leg/ankle/foot, shoulder, and neck (14,18,22). According to research by Roy et al., the most commonly injured body regions and mechanisms of injury vary between males and females serving in a BCT while deployed (22). Females tended to injure their lower extremities more frequently (foot/ankle 22%, knee 17%, and hip 11% for females; compared to: foot/ankle 19%, knee 8%, hip 1% for males); whereas, males more commonly injured their lower backs (32% versus 22% in females) (22). Moreover, one’s military occupational specialty (MOS) may predispose one to mechanisms of injury and body regions injured. Namely, the infantry MOS was found to be significantly associated with meniscus tears and former injuries, maintenance MOS with contusions, signal and transportation MOS with weightlifting, and administrative MOS with running-related injuries (18).

READINESS, REHABILITATION, AND RECONDITIONING OF THE INJURED SOLDIER: THE ROLE OF THE PHYSICAL THERAPIST

Due to the logistical burden of MSI and the demand for orthopaedic surgical interventions during and after the Vietnam War, the Army began utilizing physical therapists in a direct access role to serve as physician extenders in the management of MSI (14). After realizing the value of having physical therapists serving in this capacity, the Army began to assign them into more operational units: Army Ranger battalions in 2000, U.S. Special Operations Command (USSOCOM) in 2003, and BCTs in 2005. Within a 10-month period, the original physical therapists assigned to the Ranger battalions helped to improve overall unit readiness (capability of deploying) from 88% to 95% (14). This raises the question of how this was achieved. Success has been attributed to the implementation and utilization of a Soldier Sports Medicine (SSM) model, which has significantly expanded upon the primary role of the Army physical therapists as a mere rehabilitation provider. The SSM continues to be the predominant model utilized by operational Army physical therapists (14). In this model, Army physical therapists function autonomously and interdependently as an integral member of a multi-disciplinary medical team, and they have been tasked with six key roles within three overarching

FIGURE 1. A GRAPHIC DEPICTION OF THE SSM MODEL (REPRODUCED COURTESY OF THE U.S. ARMY MEDICAL DEPARTMENT JOURNAL) (25)



domains aimed at improving overall readiness (25). A graphic depiction of the SSM model is provided in Figure 1.

The first domain, MSI surveillance and prevention entails the roles of deliberate observation of injury trends, data collection, identification of potential underlying risk factors of those injuries, and finally efforts at prevention. Research and injury surveillance, as well as education and leadership support, have been identified as critical steps in any injury prevention initiative (5,28). How can one prevent something without first empirically identifying what is happening and what factors are contributing to it? While it is true that lower backs and knees are the most frequently injured body regions throughout the military as a whole, this may not be the case within the unit where a physical therapist is assigned. Moreover, even if that does hold true, the most frequent mechanisms of injury may vary from unit to unit. Therefore, there must be objective specificity in how one approaches the implementation of injury prevention strategies, which greatly depends on the surveillance outcomes.

The second domain, early identification and rehabilitation of injuries, obligates that physical therapists provide acute care for MSI within a direct access setting. Army physical therapists are routinely credentialed by their healthcare facilities and hospitals to examine/evaluate patients with and without referral, order diagnostic imaging and laboratory tests, prescribe limited medications (i.e., analgesics, nonsteroidal anti-inflammatories, and muscle relaxants), write profiles, refer to other providers, perform specialized interventions such as spinal and joint mobilization/manipulation and dry needling, and in some cases perform electromyographic and nerve conduction studies (7,14). In both combat deployments and peacekeeping operations,

evaluating Soldiers and initiating evidence-based rehabilitation closer to the point and time of injury has resulted in the following benefits: reduced costs (fewer overall visits, hospitalizations, and medical evacuations), enhanced recovery time, decreased work absence (fewer lost duty days and higher return to duty rates), and prevention of chronic morbidities (10,12,14,17). Overall, this has translated into higher quality of care with improved patient satisfaction outcomes (14).

Between 2001 and 2011, 162 Army physical therapists were deployed, and from July 2004 through March 2011, injury surveillance data was centrally collected from 74 of those physical therapists (13,14). Over that 6-year 8-month period, 84,790 U.S. military personnel had healthcare visits at a combat support hospital (CSH), and Army physical therapists assumed 45.3% (38,410) of the total outpatient workload (13,14). Of these physical therapist encounters, 58.4% were first-time evaluations, with 44.9% seen via direct access and 96.1% returned to duty. Despite being staffed with at least one orthopaedic surgeon, family medicine physician, and emergency physician, physical therapists treated 91% of the MSI (14). To highlight the effectiveness of care in this setting, it was estimated that 17.7% (3,979) of their initial evaluations would have been evacuated to Germany or to the U.S. without their presence (this translates into a conservative estimated cost savings of \$28.7 million) (14). Similarly, data collected between August 2005 and March 2011 from Army physical therapists assigned to deployed BCT, showcased their utility in austere combat zones (14). Of the 332,197 outpatient encounters, physical therapists accounted for 35.8% of the total workload. Of the 48,879 new evaluations, 44.3% (21,653) were seen through direct access and 97.9% were returned to duty. Had the physical therapist not been present, it was estimated that

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30.9% (15,084) of Soldiers being seen initially would have been evacuated to a CSH (14).

Lastly, the third domain, reconditioning and human performance optimization, entails the roles of consultant and persuasive educator. In this area of emphasis, the Army physical therapist is tasked with facilitating the creation and implementation of multiple unit-level reconditioning programs for injured Soldiers. These injured Soldiers are still required to report to daily morning physical training sessions, however, they will be restricted from performing certain exercises and drills as indicated by the medical provider's profile recommendations. They will be expected to perform non-harmful modes of exercise that will maintain and/or improve upon other areas of fitness, while simultaneously protecting the injured body region. For example, if a Soldier has a sprained ankle, he or she will be restricted from lower extremity impact activities, such as running, ruck marching, and jumping. However, it would not be contraindicated for him or her to perform upper body and core strengthening exercises and to conduct non-impact modes of cardio, such as stationary cycling, seated (or potentially standing depending on acuity and severity of the injury) battle ropes, or even aquatics.

These reconditioning programs will inevitably vary depending on multiple factors, such as command support, gym space/equipment, and available personnel to assist with execution; however, they typically entail multiple groups of Soldiers who are separated based on both the body region injured and severity of injury. In this manner, Soldiers with similar injuries will be able to conduct parallel physical training/exercises without sustaining additional harm. Details of the Army's standard reconditioning program can be easily accessed in Chapter 6 ("Special Conditioning Programs") of the Physical Readiness Training (PRT) Field Manual (FM) 7-22, or online at armyprt.com. Regardless of how these programs are implemented, they involve a great deal of education, training, and follow-up with the unit-level leaders who are executing the program at the ground level.

Moreover, an additional challenge to consider is having systems in place to ensure the activity restrictions/modifications set forth by the medical provider in the profiles are being adhered to by Soldiers during their off-duty hours. Here, education is once again paramount. Physical therapists and providers must ensure Soldiers thoroughly understand the nature of their injuries and the potential adverse effects of being non-compliant with their plan of care. They must understand that when it comes to recovery, what they do not perform is often equally (if not more) important than what they do perform. Profiles are never intended to be punitive. However, if Soldiers continue to deliberately ignore profile restrictions and contribute to re-injury, or at minimum cause delayed recovery, then they can be held accountable and subject to disciplinary action.

Like the reconditioning programs, the human performance optimization initiatives will vary greatly based on the needs and desires of the unit leadership and the available resources. For example, these initiatives may come in the forms of one-time or revolving didactic and/or practical classes on the following topics: "pre-habilitation" drills, running form, mobility and/or motor control assessments with associated corrective strategies, powerlifting/weightlifting techniques, and physical training programming aimed at well-balanced programs devoid of overtraining.

It is important to note that even though the physical therapist is responsible for these roles and initiatives, his or her effectiveness and success heavily rely on a host of other personnel and resources. This is by no means a single-person show! There must be a concerted, collaborated effort at all levels from the top down, from the bottom up, and from collateral angles. Unit leadership, both on the enlisted and commissioned sides, from commander down to team leader, Army Master Fitness Trainers, physical therapists, assistants/technicians, surgeons, physicians, physician assistants, athletic trainers (if available), strength and conditioning coaches (if available), dietitians (if available), and other primary and ancillary medical staff, must work together as a team to ensure health and readiness are achieved. A prime example of a comprehensive program that encompasses all of this is USSOCOM's Tactical Human Optimization Rapid Rehabilitation and Reconditioning (THOR³) program.

The objectives of the THOR³ program are implied in its name, and it incorporates everything from general health/wellness, to injury prevention and rapid (yet safe) return to duty with peak performance. In many ways, THOR³ mirrors professional and elite collegiate athletic models. It exists as a unit-level program and is typically comprised of a sports medicine staff which includes: a human performance program coordinator (Certified Strength and Conditioning Specialist® [CSCS®]), two additional CSCS, one or more certified athletic trainers, three physical therapists (typically board-certified in orthopaedics and/or sports with advanced manual therapy and dry needling skills), one sports nutritionist, one sports psychologist, and an orthopaedic surgeon (11).

Two unique programs that exist within THOR³ are the bridge program and return to duty functional assessments. The bridge program highlights the interdependence of physical therapists and CSCS and aims to provide a seamless transition from the realm of rehabilitation to performance optimization (11). The physical therapist and strength coach collaborate from the initial stages of a Soldier's injury to design and implement the most effective, comprehensive program, and one that is individually tailored to the Soldier's job requirements. Then, once it is time to decide if the Soldier is ready for a combat deployment, specific testing is conducted to assess functional capacities. For example, the 7th Special Forces Group utilizes an 8-event functional fitness

assessment, which must be completed in 35 min or less while wearing full kit (individual body armor of 35-lb uniform, helmet and boots). Events include: agility sprint (prone to 30-yd sprint twice and then a 90-lb sled sprint for 30 yd), 125-lb dummy carry for 30 yd, farmer carry for 30 yd holding a 60-lb dumbbell in each hand, 180-lb sled push/drag 30 yd each way, stairwell (8 trips up and down, every other step without use of handrails), 47-in. to 31-in. to 47-in. round trip box “wall climbs” (no jumping), 50-lb sandbag loads from floor to 47-in. box for 5 reps, and finally 18-min, 4-stage treadmill walk (Stage 1: 0 – 5 min at 3.5 mph and 4% grade; Stage 2: 5 – 10 min at 3.0 mph and 8% grade; Stage 3: 10 – 15 min at 3.0 mph and 12% grade; Stage 4: 15 – 18 min at 3.5 mph and 0% grade) (11). If able to successfully pass these demanding tests, then the belief is that the Soldier has achieved a state of readiness and is at reduced risk for sustaining immediate or short-term re-injury. This solves a common training error in which Soldiers come off profile prematurely without having met specific, functional criteria and sustain re-injury.

CONCLUSION

Despite best efforts, MSI among active duty service members continue to be pervasive and on the rise. Poor baseline fitness prior to entering active duty and overtraining, primarily in the form of running volume, once in active duty appear to be key modifiable factors contributing to the MSI epidemic (5,9,28). Regardless of military service branch, sport, or profession, it is essential to properly train up for the job requirements and to avoid unidimensional training programs once in the job.

There is a time and place for all domains of fitness, and Soldiers especially need to be well-rounded in occupationally-specific physical training. Their mission-essential tasks demand that they are agile and quick enough to sprint to cover, strong enough to lift and carry a battle buddy, conditioned enough to overcome fatigue when marching over long distances under load, and powerful enough to leap over an obstacle while wearing equipment. Simply performing low to moderate intensity steady-state distance running, sit-ups, and push-ups to train for the Army Physical Fitness Test is insufficient to build the well-rounded Soldier-Athlete.

For efficient and effective management of MSI, it is critical to have a physical therapist close to the point of contact. This quote from COL (Ret) Josef Moore sums up the impact of the Army PT well, “war is not sport, but the delivery of skilled musculoskeletal physical therapy services as close to the point of injury as possible parallels the sports medicine model for on- or near-field practice. This model that mixes direct access with near-immediate access enhances outcomes, reduces costs, and allows other health care team members to work at the highest levels of their licensure,” (14).

We can each do our part as a member of one team to prevent the injuries that are preventable and to rehabilitate, recondition, and

optimize performance in the ones that do occur and are treatable. As providers, coaches, and tactical facilitators, this is our mission and we must never accept defeat or quit.

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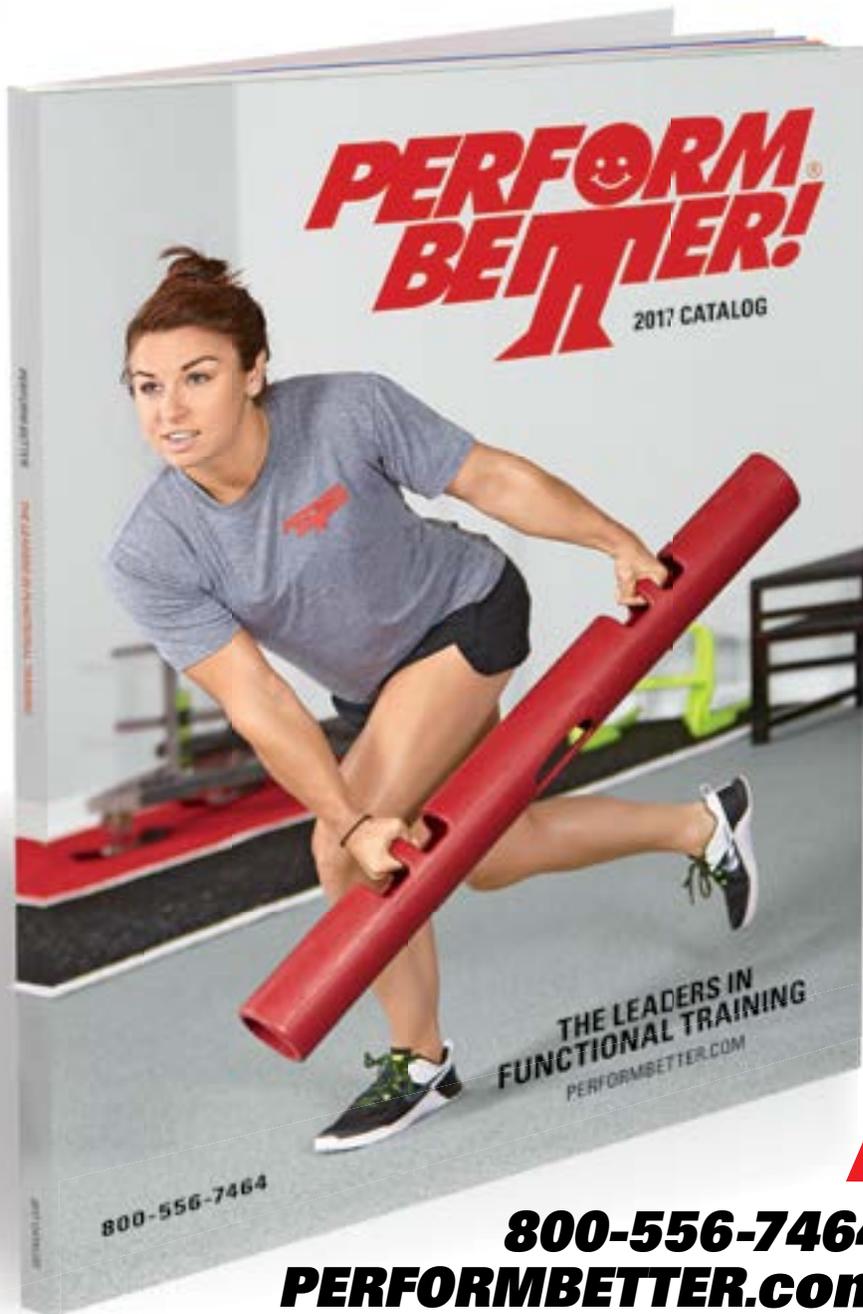
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