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Foot Marching and Load-Carriage Injuries

What are foot marching injuries?

Terms used by the Army to describe activities associated with foot marching injuries include "ruck marches," "forced marches," "loaded marches," "road marches," and "patrolling." During these activities as well as other training and operational activities, heavy loads are carried on the back in backpacks or rucksacks. Body armor, protective clothing, ammunition, and other supplies are also worn on other parts of the body. This load-carriage puts repeated stress on the body's skin, bones, muscles, and nerves and can cause numerous types of injuries. The *lower extremities* (hip, knees, lower leg, ankles, feet) and *back* are most frequently affected. Specific injuries include:[1-6]

- Knee pain and various musculoskeletal knee injuries
- Back pain, strains, and other lower and upper back injuries
- Stress fractures to feet, lower leg, hip, and pelvis
- Nerve compression injuries causing numbness, tingling, pain, weakness, or temporary paralysis in:
  - Shoulder or arms (*brachial plexus palsy*) or "rucksack palsy" from straps compressing neck/shoulder nerves
  - Thigh (*meralgia paresthetica*) from hip belts, harnesses, or body armor
  - Feet (*metatarsalgia*) pain in middle or front of sole
  - Toes (*digital paresthetica*)
- Ankle injuries, often as a result of acute strains, sprains, or fractures from slips, trips, and falls‡, or attributed to environmental hazards including heat illness‡, cold weather injuries‡, and insect/animal bites [2-5,7]
- Foot blisters‡

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Why are these injuries a concern to the Army?

Because military mission success often depends on the efficiency by which personnel carry needed equipment over long distances, marching remains a core element of military training.[1-4,6,8,9] Ideally, this training should enhance Soldiers performance without increasing injury risk. Yet, foot marching activities are a common cause of Army injuries and can lead to more injuries per mile than running.[1,2,6,7,10] Training loads typically range from 40 to >100 pounds, and distances of 2-12 miles. Speed may vary depending on terrain and time of day, though a common goal is 12 miles in 3 hours (4 mph).[7] Yet improvements in weaponry, body armor, and other carried equipment continue to add to the typical military load.[5,6] Loads averaged over 100 pounds in recent combat operations, and weights were higher for certain units, such as anti-armor or mortar teams.[11,12] Awareness of risk factors and prevention tactics can help reduce injuries.

What affects risk of foot marching injuries?

- **Individual physical factors** such as body size, bone structure, gender, age, prior injury, and fitness levels can put some people at greater risk of foot marching injuries. For example, those of smaller build, which often includes women, appear to be at greater risk of stress fractures.[1,2,5-7,13] Factors such as fitness or strength may be improved.
- **Training program parameters**. Proper training is considered a primary means to prevent foot march-related injuries. Key training factors include load weight, speed (pace), distance per session, and frequency (i.e., number of marching sessions per week or month).[1,2,5-7] Increasing *any* of these factors too rapidly can increase risk of injury. Stresses can be exacerbated by types of terrain especially steep rocky hills, sand, or snow.[3,4,6] All of these factors should be considered when designing training for specific units and operations.

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- **Equipment.** Ill-fitting or improper footwear can exacerbate the pressure and repetitive rubbing of skin on the feet, causing injuries. The rucksack worn on the back increases forward lean and may increase back injury risk.[1-5,7] Different backpack designs can change load distribution. Though military pack options include front-back double packs, which can reduce back strain, they are often not conducive to movements needed for military tasks. The Army recommends a lightweight external frame system (see next page). However, the best equipment and distribution can depend on a person's size and the terrain (e.g., hills versus flat surfaces).[1-4,6,7,12] Injuries can also occur if a pack is not correctly lifted or put on. Straps and belts can help redistribute load and reduce strain; however, excessive pressure from straps and armor can also cause injury.

How can foot-marching injuries be prevented?

While some factors cannot be changed, personnel can modify certain behaviors to reduce the chance or severity of marching and load carriage injuries.[1,7] Examples include:

- Precondition: increase distance and weight *progressively*; practice with proper equipment and boots.[1-8]
- Keep feet dry and reduce friction: use synthetic socks instead of cotton; consider inner sock liners.[1-5,7]
- Improve fitness: include a mix of aerobic and muscular strength and endurance exercises.[1-5,7,8]
- Use right equipment the right way: use properly fitted external frames and straps to redistribute load.[2,5,14]
- Avoid tobacco to maximize health.

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See next page for additional prevention details.

U.S. Army Public Health Center, Injury Prevention Branch
8252 Blackhawk Road, APG, MD 21010-5403
410-436-4312 or DSN 584-4312
usarmy.apg.medcom-aphc.mbx.injuryprevention@mail.mil

How can you prevent foot-marching injuries?

Prevention Tactic	Supporting Information
Reduce load and distance	**Excess weight increases injury risk and also reduces speed to get to a location, increases energy needs, and reduces combat perfomance**.[7,8] Soldiers should limit loads to mission-essential items only. Decisions as to what equipment is essential and how to transport it *is best done at the lowest unit level possible:* ▪ Senior leaders should encourage that Soldiers train with individualized load carriage weights, based on physical fitness and size, and increase weights gradually. ▪ Unit leaders should minimize load weights and distances to the extent necessary, given the unit condition, mission, terrain, and duration. ▪ Leaders should encourage use of vehicles and wheeled carts when possible and appropriate.
Use proper equipment and adjustments	**Use the best pack.** Packs may have internal, external, or no frames. Frames can add weight, but help distribute loads. The **Modular Lightweight Load-Carrying Equipment (MOLLE)** pack is currently recommended for the Army.[3,4] It includes a main rucksack with a lightweight external frame, adjustable shoulder straps, waist belt, and vest with pockets and detachable compartments to allow unit-specific customization. **Adjust sternum, shoulder, and waist/hip straps, and armor** for better load distribution. For example, a properly adjusted hip strap can take 30% of the load, reducing strain on the back. Proper use of the sternum straps can move strain to different parts of the shoulder and reduce the risk of *rucksack palsy.* Compression from straps or armor can cause nerve injury or blisters; therefore, pay attention to early signs of rubbing, strain, or numbness and adjust equipment as needed during march and when sitting (armor can press on thighs).[2,5,14] **Learn and follow proper technique to put packs on and off** to avoid sudden shoulder and back injuries. **Place commonly used items in front pockets** for easy access and to minimize back load for a more upright walking posture that may reduce back injuries.[1-5] **Move locations of items in backpack based on the expected terrain.**[1,2] ▪ *Even terrain*: Heavy items packed high in the backpack may help one stay upright. ▪ *Uneven terrain*: Distribute load more equally to help keep the body stable. **Take care of your feet**! Ensure boots fit (about ½ inch from big toe to boot end, wide enough but not loose in heel); lace cross-ways, snug but not too tight; cut toenails short and square; wear clean, cushioned, well-fitting, synthetic socks with nylon or polypropylene inner liners (seams/knots to outside); keep feet clean and dry; use coatings or taping covers for blisters‡; during rest breaks, prop up feet, loosen laces, and massage if time permits.[2-4]
Precondition with an adaptive march training program	**Begin and add to foot march training programs slowly, spacing sessions out at least weekly.** Foot marching performance has been shown to improve with regular march training at least every 2 weeks in conjunction with aerobic and strength training. More than four marches per month may be excessive.[8,9] **Increase intensity (load weight) and distances slowly** toward goals expected for real-world operations and specific sub-unit mission. If speed is maintained (e.g., 4 mph), increase distance and load weight on separate days by 10% each time. Speeds greater than 4 mph are not recommended.[4] Allowing 2 to 6 months' time from initial activity for maximum distances and load weights is recommended to minimize injury for most units.[6] However, unit mission, baseline fitness levels, other physical activities/training, terrain, and climate should be factored into design of a march training program.[5,6] ▪ While studies have not yet provided adequate evidence to establish an Army-wide load march progression program,[1,6] a suggested example for initiated trainees might include progressive distances of 2, 5, 10, and 12 miles, alternating with a progressive increase of loads (initial 10-20 pounds, then to 40 pounds, and 60 pounds or more).
Maximize fitness and health	**Engage in a balanced physical training program.**[1-7,15] In addition to training marches, a combination of aerobic (running and low-impact elliptical, biking, or swimming) and muscle strength and endurance activities have been shown to improve road marching performance. Agility and balance drills are also recommended. Be sure to avoid excessive distances and frequency of long runs and marches especially with trainees.[1] **Follow healthy behaviors**. Staying hydrated, wearing clothing or layers appropriate for the weather to avoid heat/cold injuries‡, and avoiding smoking can reduce risk of injury.[1,2,5,7] For example, evidence suggests that people who smoke have higher rates of certain types of injuries, including blisters‡.[2-4]

DVIDS-4337502, U.S. Army photo by David Kamm

Note: ‡*Other relevant APHC fact sheets include Falls; Heat Illness; Cold Weather Injury; and Blister Prevention.*

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