Ultramarathon and Ultra-endurance Sports

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Key Points

- Acute traumatic injuries are rare in ultramarathons.
- Traumatic injuries are relatively common in high-speed ultra-endurance sports such as ultra-cycling.
- Clinicians taking care of athletes at ultra-endurance events should be familiar with medical issues such as exercise-associated hyponatremia and rhabdomyolysis.
- Foot blisters are the most common problem among ultra-distance runners.

Table 75.1 Ultra-endurance sports

Ultramarathon foot races
Ultra-distance cycling (road or mountain)
Ultra-swimming
Offshore sailing
Ultra-Nordic skiing
Ultra-paddling
Ultra-sledding
Triathlons
Ultra-adventure races
Other multisport competitions
Fastest known time efforts

Introduction

Ultra-endurance events are defined as sporting events lasting longer than 6 h. Due to the duration, these activities place considerable stress on the body in terms of physiological and psychological demands during training and competition. Adaptation to high training loads and development of nutritional strategies are important to reduce the risk of acute and overuse injuries. A summary of some ultra-endurance events can be seen in Table 75.1. This chapter gives an overview of the most common problems of ultra-endurance events and most specifically of ultramarathon running events. Issues in ultramarathons share some of the same principles as for other ultra-endurance events (e.g., triathlon), which are discussed in more detail elsewhere in this book.

An ultramarathon is any race over the traditional marathon distance of 42.195 km. Participation in ultramarathon races has increased in recent times with an approximate five-fold increase in ultramarathon race finishes over the last 10 years. Ultramarathons are carried out all over the world, many in remote and challenging environmental conditions that place the human body under enormous physiological demands and can compromise provision of medical support (Fig. 75.1) [1–3].

Types of Races

There is significant variability among ultra-endurance races. That is, most ultra-endurance events are unique in terms of distance, environmental challenges, level of aid and medical support provided, and the activity – single activity (e.g., running, sailing, swimming) or a combination of multiple sports (e.g., Ironman triathlon). Among all ultra-endurance sports, foot races and Ironman triathlons may be the most consistent across events.

Ultramarathon races can be divided into continuous and multiple-day staged (discontinuous) events. Typical race dis-

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Fig. 75.1 Runner during the 230-km Al Andalus Ultimate Trail Run in a remote part of Spain

tances in continuous events include 50 km, 80 km (50 miles), 100 km, and 161 km (100 miles), and multiple-day staged events typically range from 3 to 7 days with distance of 250 km or more. These races can range from being fully supported to nonsupported by the race organizers, with the latter meaning that runners are required to cater and carry their own nutrition and support materials, adding to the weight and stress on the human body. Many races take place in the desert, jungle, mountains, or high-altitude locations, placing additional challenges on the body resulting in various types of injuries and illnesses [2, 3].

Injury Epidemiology

Most medical issues are minor in nature, but they can often have a serious effect on race performance. Serious injuries are rare but need to be recognized early and treated appropriately.

Musculoskeletal (MSK) Problems

Most MSK injuries affect the lower limbs and are typically overuse in nature. They can present acutely during the race and include:

- Acute MSK injuries are less common in ultramarathon running but may be related to running through rough terrain or mountainous areas and may include twisting injuries of the ankle or knee or accidental falls with grazes of the skin or even fractures.
- Often acute exacerbations of chronic overuse injuries can be seen during competition. These include anterior knee pain (patella femoral pain syndrome in up to 31% of runners), lateral knee pain due to iliotibial band syndrome (up to 12%) and lower limb stress reactions (medial tibial stress syndrome in up to 10%), stress fractures, or chronic exertional compartment syndrome (up to 11%). Acute pain in the heel due to Achilles tendinopathy (up to 19%) can also be frequently observed during races [2, 4–6].
- Ultramarathon ankle is a specific injury to ultramarathon participants that may happen in approximately 1.4% of runners. It is due to repetitive plantar flexion and dorsiflexion when running that causes a tenosynovitis of the tendons passing under or adjacent to the extensor retinaculum of the ankle on the anterior aspect. It presents with anterior ankle pain that is vague initially but can become sharper and more localized with continued running. Swelling over the anterior ankle is sometimes observed, and on clinical examination, there may be crepitus and pain on resisted dorsiflexion [2, 4, 5].

Treatment for all acute MSK injuries follows the same basic principle of protection, rest, ice, compression, and elevation (PRICE). Analgesia, taping, physiotherapy, and early rehabilitation may be further strategies to employ that prove beneficial in long-term management. During race, management is generally limited to massage, stretching, and taping.

Trauma

- Major trauma at ultramarathon events is extremely rare, but falls are common and can result in lacerations and fractures. Car accidents involving runners are also possible when race courses cross or include roadways. In remote environments, treatment may be challenging but should be orientated to current trauma life support guidelines.

Skin Problems

The skin is the largest organ in the human body and susceptible to injuries during ultramarathon running, mainly through friction (also see Chap. 40).

- *Foot blisters.* Most common problem in ultramarathon runners (generally between 26% and76% but even up to 100%). Incidence increases with race distance. They are due to shear forces within the epidermis, resulting in separation of skin layers and collection of fluid (Fig. 75.2). The main locations are the toes, heel, and ball of the foot. Causative factors may include poorly fitting shoes, unaccustomed levels of stress, various environmental factors, callous build up, hydration status, and individual factors. Preventative measures include taping, antiperspirants, lubricants, measures to keep the skin dry and shoes free of particulate accumulation, low-friction socks, double layers of socks, toe socks, and good foot care/maintenance including removal of callouses. Painful blisters should be drained under sterile conditions, lancing them in the periphery with a needle assuring adequate hole size and number for continued drainage, taping, or injecting them with iodine. Local skin infection and cellulitis can be a complication in a small number of runners if not treated appropriately [2, 3, 7–12].
- *Chafing.* Superficial skin inflammation due to increased friction on the skin with fabrics or back packs, mostly affecting the nipple, groin, and back area (up to 41.9%). Use of lubricants is a useful preventative measure and may provide some relief during races [2].
- *Subungual hematomas.* Fluid/blood collection under the nail of the feet due to repetitive impact with the running shoe (up to 10%). These can be very painful and the pressure under the nail can be released by piercing it with a needle [2, 9].

Fig. 75.2 Foot blister after a 161-km ultramarathon

Gastrointestinal (GI) Distress

- GI problems are quite common, affecting up to 85% of runners [13, 14]. Symptoms include nausea, vomiting, abdominal cramps, reflux symptoms, and diarrhea. They have been linked to performance decrements, race withdrawal, and decreased nutritional intake. The origin is usually benign, related to decreased blood flow to the intestine during running, nutritional intake, food intolerances, or infection. However, they can also be early signs of more serious pathologies such as exercise-associated hyponatremia, heat illness, cardiac pathologies, and altitude illness which need to be recognized. Typical during race treatment involves supportive care, recognizing that these conditions tend to improve with reduced exercise intensity. Antiemetic medications (e.g., ondansetron or metoclopramide) also have been used successfully to help with nausea and vomiting [3, 13, 14].

Exercise-Associated Hyponatremia (EAH)

- The incidence of EAH can be as high as 31%–51% in ultra-endurance events [15, 16]. Symptomatic EAH is much less common but is potentially life-threatening if not promptly recognized and appropriately managed. The main causative factor is excessive fluid ingestion in the form of either water or sports drinks. Secretion of arginine vasopressin (AVP) due to various non-osmotic stimuli (nausea, vomiting, exercise, thermal stress, and rhabdomyolysis) leads to retention of the excess fluid and development of a dilutional hyponatremia. Early symptoms are nonspecific, such as headache, nausea, and vomiting, progressing to confusion, seizures, cerebral and pulmonary edema, and death if not properly treated. Prompt recognition and confirmatory on-site determination of plasma sodium concentration is ideal, but empiric treatment should not be delayed if point-of-care blood analysis is not available. Treatment is with intravenous or

oral (if possible) hypertonic saline. Further treatment in a medical facility is advisable. Preventative measures include ad libitum fluid intake (drinking to thirst) and educating runners and aid station workers about the potentially fatal consequences of EAH, which has been demonstrated to significantly reduce the incidence of EAH [3, 14–18].

Severe Dehydration

- Mild dehydration is a fairly common phenomenon in ultramarathons, and it has been well demonstrated that endurance athletes can lose 4% or greater body weight during competitions without significant clinical symptomatology or adverse consequences [3]. Thus, the level of dehydration suggested by weight loss of a few percent of body weight is generally not hazardous and rarely requires intravenous (IV) rehydration when oral fluids can be tolerated. Because IV hydration with isotonic or hypotonic fluids can have adverse consequences in an athlete with EAH, and the clinical assessment of dehydration in athletes is challenging, a cautious approach to the field management of presumed dehydration is recommended. IV fluid replacement is best reserved for the severely dehydrated athlete (persistent tachycardia, poor skin turgor, and lightheadedness with standing) who is not recovering with oral fluid replacement or is having ongoing fluid losses with vomiting or diarrhea. When point-of-care analysis of plasma sodium is unavailable to confirm that the athlete is not hyponatremic, caution with IV hydration is warranted, and the athlete should be closely observed, with hypertonic saline readily available to use if neurologic deterioration suggestive of EAH occurs [3, 15].

Exercise-Associated Collapse (EAC)

- This is one of the most frequent causes of collapse mostly at the finish line or at checkpoints when running ceases abruptly. It may affect approximately 1%–4% of ultramarathon finishers. Symptoms are lightheadedness, faintness, dizziness, and collapse due a transient postural hypotension caused by the combination of peripheral vasodilation and blood pooling in the lower legs due to loss of muscle pump activity. Neurological, biochemical, or thermal abnormalities are absent, and treatment involves placing the runner in the supine position with legs elevated to increase central perfusion while assuring the athlete is breathing and has a pulse. Oral rehydration may be helpful once the athlete is alert, but intravenous fluid replacement is rarely necessary unless the runner cannot tolerate oral fluids or is not improving with these simple measures. Runners generally recover quickly and fully, so an athlete who does not quickly recover should be reassessed for other causes of collapse [2, 3, 19, 20].

Muscle Cramping

- Muscle cramping is common during ultramarathon participation (up to 40%) and can have serious effects on performance. Despite this high prevalence, the etiology, risk factors, and prevention strategies for the condition are not well understood. While the traditional hypotheses include heat strain, and fluid or electrolyte imbalance, recent work has demonstrated that muscle cramping in an ultramarathon is unrelated to an altered fluid and sodium balance. Currently, the most compelling theory on the underlying cause of exercise-associated muscle cramping (EAMC) relates to abnormal neuromuscular control as a result of muscle fatigue. It is also recognized that muscles are more vulnerable to cramping when in a shortened position. As such, appropriate management may include stretching, temporarily altering gait to avoid placing the involved muscle in a shorted position, and temporary reduction in exercise intensity. There is also some evolving research suggesting that sodium or select spices may stimulate receptors in the oropharyngeal region, causing a neurally mediated reflex to inhibit the firing of alpha motor neurons of cramping muscles [14, 19].

Acute Kidney Injury (AKI) and Rhabdomyolysis

- Few athletes have clinically significant kidney injuries that require medical attention but up to 50% temporarily fulfil the diagnostic criteria for AKI. It is not unusual that muscle damage, especially associated with downhill running, can increase plasma creatine kinase (CK) concentrations to well over 20,000 IU/L [3]. This extent of rhabdomyolysis is a risk factor for kidney injury, especially in association with reduced perfusion, dehydration, heat stress, underlying renal problems, and ingestion of NSIADs. Runners usually recover with oral rehydration based upon thirst. And at present, the limited research seems to indicate that there is no cumulative damage from these insults to the kidney. It is those athletes with poor urinary output and/or hematuria beyond 24 h post-event who would be wise to seek medical attention [3, 21–24].

Environmental Issues

Many ultramarathons take place in remote and challenging environments, and runners can be exposed to heat, cold, or high altitude which poses additional risks.

- *Heat*: Heat acclimatization is important but may not be fully achieved if not exposed to hot conditions for about 10–14 days. While very rare in prolonged endurance events in which the exercise intensity is relatively low, the potentially life-threatening condition of exertional heat stroke (EHS) should be considered in thermally stressful environments. EHS is the result of heat accumulation when the heat generation through exercise sufficiently exceeds the removal of the heat. It is characterized by a core temperature reading over 40 °C and altered mental state. Early signs are nonspecific with headaches, nausea, vomiting, and confusion that can progress to collapse, seizures, multiorgan failure, coma, and death (3). It is a medical emergency, and immediate cooling is recommended either with cold water immersion or cooling via ice packs to glabrous skin surfaces. Transfer to a medical facility for further care and treatment is recommended [2, 3, 25].
- *Cold*: Prolonged exposure to cool or cold environments, especially when it is wet and/or windy, poses the risk of hypothermia. Early symptoms can be observed when core body temperature drops <35 °C with shivering, fatigue, weakness, and cardiovascular compromise. When core body temperature drops <32 °C, severe hypothermia is present and can lead to cardiac arrhythmias, coma, and death. Stopping heat loss and rewarming the body is the priority of treatment. Provision of oral glucose (e.g., warm sweet drinks) as fuel for intrinsic heat generation is also helpful [3, 26, 27].
- *Altitude illness*: Symptoms of acute mountain sickness can be observed at elevations above 2500 m with headaches, nausea, vomiting, dizziness, and fatigue. Halting further ascent or descent is a key initial intervention. More severe cases may require supplemental oxygen and specific therapy (e.g., dexamethasone and nifedipine) [3].

Vision Problems

- Visual dysfunction during ultramarathons is not very common (<4%) but can impact race performance and safety and may be severe enough that the runner is unable to continue running [7]. When eye pain is present, considerations include foreign bodies, keratoconjunctivitis, or even ulcers. Painless clouding of vision is thought to be due to corneal edema and typically resolved without intervention within a few hours [3, 7, 28, 29].

General Rules About Continuation in the Race

A discussion about whether or not to continue the race is reasonable and is also an important aspect of the medical care in this environment. The medical team should decide when an athlete is unable to continue the race due to medical reasons and needs to be withdrawn from competition. This is to prevent harm coming to the athlete and others. Often it can be helpful to involve friends or family of the athlete in the discussion, but ultimately it is the responsibility of the medical team.

What Is Unique About Ultramarathon and Ultra-Endurance Sports Injuries?

Ultramarathon and ultra-endurance races are extreme forms of exercise that test the limits of human endurance and particular stress the body, resulting in MSK injuries and other medical problems (e.g., EAH, EAC, dehydration, cramping). Adding to the demands on the clinician, many of these races take part in remote and challenging environments with limited resources.

What Do the Physicians Need to Know While Covering These Events

Pre-race medical planning is important to establish the extent of medical coverage needed for each event taking into consideration participant numbers, location of event (remoteness to medical facilities), and environmental issues. Included in the planning should be medical protocols for lost or seriously injured athletes. Medical supplies, equipment, and staffing level and skill mix should be appropriate for the event. Participants should be informed about the level of care they can expect to find at the event. Medical supplies should be stored in a way that is easy to access and identify, but able to withstand environmental conditions and transport. Medical supplies to treat serious medical conditions need to be available (e.g., intravenous setups and fluids, hypertonic saline for EAH, glucose for diabetic athletes, albuterol inhaler for asthmatic athletes, and epinephrine, steroids, or antihistamines for allergic reactions). Supplies to treat minor and common medical problems such as blister kits, antiemetics, analgesics especially for MSK injuries are also important. Athletes should be briefed about common medical conditions and advised to bring their own regular and acute medication to treat common medical problems. Pre-race medical briefings and ongoing athlete education have been associated with reduction in the incidence of EAH [3].

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