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## **Marathon Health Pitfalls: What Every Runner Needs to Know**

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## **Abstract**

**Introduction and Purpose:** Long-distance running, especially marathons, tests human endurance and physical limits. While the benefits of marathon running are well-documented, the associated health risks often go unnoticed. This review aims to synthesize current knowledge on the health risks and complications faced by marathon runners, providing crucial insights for both amateur and professional athletes.

**State of Knowledge:** Marathon running imposes significant stress on the cardiovascular system, musculoskeletal structure, and metabolic processes. Issues such as acute myocardial injury, overhydration leading to hyponatremia, and musculoskeletal injuries are prevalent. The review also examines less common but severe risks like rhabdomyolysis and marathon-related cardiac arrests. Despite the robust fitness levels of runners, these health risks remain a serious concern, necessitating preventive strategies and proper health monitoring.

**Summary:** Marathon runners must be aware of the potential health risks associated with prolonged endurance activities. Precautionary measures, including tailored training programs, dietary adjustments, and regular medical check-ups, are essential to mitigate these risks. Additionally, further research is required to develop more effective interventions and guidelines that can safeguard the health of marathon participants. This review underscores the need for a balanced approach that respects the physiological demands of marathon running while ensuring the health and safety of the runners.

**Key Words:** Endurance Training; Sports Medicine; Musculoskeletal Injuries; Cardiovascular Diseases

## I. Introduction and Purpose

Running marathons, although a popular form of physical activity and considered beneficial for cardiovascular health, is associated with the risk of specific health complications. With the growing popularity of long-distance running, understanding the effects of intense exercise on the body is key to promoting safe sports practices. A review of the literature can also contribute to better preparation of medical support during competitions and during training, which is important from the point of view of medical prevention and rapid response to health emergencies.

Health Aspect	Health Benefits and Mechanisms of Action
<b>Cardiological</b>	<ul style="list-style-type: none"> <li>- <b>Increased cardiac output:</b> Enhances heart efficiency by improving oxygen delivery to tissues.</li> <li>- <b>Lower resting blood pressure:</b> Regular running helps relax blood vessels and improve their elasticity.</li> <li>- <b>Reduced risk of cardiovascular diseases:</b> Improved blood flow and better management of lipids and blood pressure reduce heart strain.</li> </ul>
<b>Metabolic</b>	<ul style="list-style-type: none"> <li>- <b>Improved glucose metabolism:</b> Increases insulin sensitivity and more effective glucose usage.</li> <li>- <b>Weight management:</b> High calorie burning and increased metabolism help maintain a healthy weight and prevent obesity.</li> </ul>
<b>Muscular and Skeletal</b>	<ul style="list-style-type: none"> <li>- <b>Strengthening muscles and joints:</b> Develops muscle mass, particularly in the legs and core, contributing to greater endurance and stability.</li> <li>- <b>Increased bone density:</b> Continuous mechanical loading stimulates bone mineralization, reducing the risk of fractures and osteoporosis.</li> </ul>
<b>Immune</b>	<ul style="list-style-type: none"> <li>- <b>Regulation of the immune response:</b> Moderate running can strengthen the immune system through better lymph circulation and increased lymphocyte activity.</li> <li>- <b>Reduction of inflammatory states:</b> Decrease in inflammatory markers in the body due to regular physical activity.</li> </ul>
<b>Neurological and Psychological</b>	<ul style="list-style-type: none"> <li>- <b>Stress and depression symptom reduction:</b> Activation of the brain's endorphin system, which improves mood and overall well-being.</li> <li>- <b>Increased neuroplasticity:</b> Long-term physical activity can stimulate the formation of new neural connections and promote brain health.</li> </ul>
<b>Longevity and Overall Condition</b>	<ul style="list-style-type: none"> <li>- <b>Reduced risk of premature death:</b> Strengthening major body systems, improving metabolic and hormonal profiles contribute to longer life.</li> <li>- <b>Improved quality of life:</b> Greater independence and functionality in old age due to maintained good physical condition.</li> </ul>

Table 1. The potential health benefits of running and training for marathons [1-4]

Table 1. highlights the multifaceted health benefits of regular marathon training, showing that a properly managed training regimen can have a significant positive impact on health and well-being. It is important that each training plan be individually tailored, taking into account the runner's health limitations and needs, which minimizes the risk of overtraining and injuries while maximizing health benefits.

This review aims to comprehensively examine the health risk factors and health complications that occur in marathon runners. By analysing available data from the scientific

literature, we aim to identify the main health risks associated with regular marathon participation and to understand how to minimise the potential negative effects on the health of marathon runners. The work also aims to provide recommendations that can be used by doctors, trainers and runners themselves to optimize training and improve overall health.

Marathon is a 42.195 km (26.2 mi) long-distance run that is considered one of the most demanding physical and mental endurance tests in athletics. The history of the marathon goes back to ancient Greece, where its name comes from and the legend of Philippides, who was supposed to run from the Marathon to Athens to deliver the message of the victory of the Greeks over the Persians in 490 BC. Today marathons are held all over the world and attract both professionals and amateurs who want to test their limits [5].

Marathon running requires intense, long-term aerobic effort. Runners must maintain a relatively high pace throughout the run, which makes the marathon an extreme challenge both physically and mentally. It primarily involves the muscles of the lower body – mainly quadriceps and double-headed thighs, calf muscles, buttocks, as well as torso stabilizers, which help to maintain proper posture and balance during running. Preparing for a marathon requires not only developing muscle strength and endurance, but also focusing on running tactics, nutrition and hydration strategies, and mental training to deal with fatigue and pain during the race [6,7].

Marathon is therefore a unique combination of physical effort, sports tactics and mental endurance. Proper preparation for it is a process of many months, often taking up to a year, in which the key are proper training, diet, rest and systematic increase of loads. This makes the completion of a marathon often seen not only as a sporting achievement, but also as an important milestone in a runner's personal life [7].

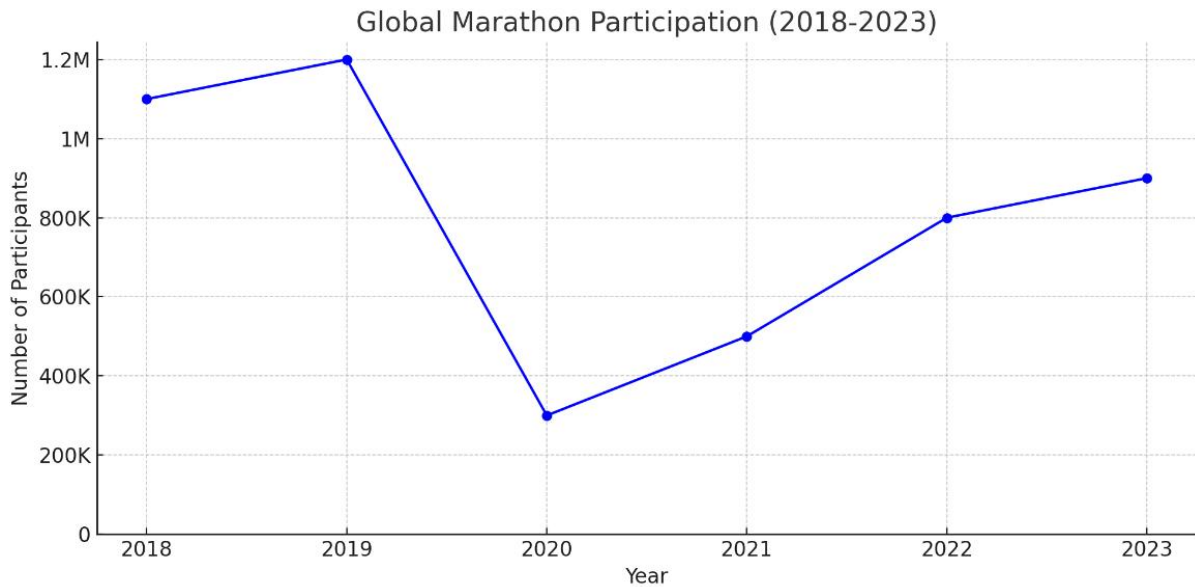


Figure 1. Global Marathon Participation [8]

The Figure 1. depicts a clear trend in global marathon participation from 2018 to 2023, illustrating the growing interest in marathons over the years. Initially, we see a significant increase in participation, peaking in 2019, as marathons continued to gain popularity worldwide. However, in 2020, there was a dramatic decline in the number of participants due to the outbreak of the COVID-19 pandemic, which led to cancellations and postponements of major public events globally. This decline reflects the direct impact of health concerns and travel restrictions during the pandemic. Subsequently, as conditions began to improve and events slowly resumed, there has been a gradual recovery in participation numbers, indicating a resilient interest in marathons and an eagerness among runners to return to racing. The recent uptick in 2023 suggests that marathon participation is approaching pre-pandemic levels, highlighting the enduring popularity of marathons as both competitive sports and community events [8].

### Materials and Methods

As part of a systematic review of the literature on health risk factors and complications in marathon runners, specific inclusion and exclusion criteria were defined. The review included original papers that focus on marathon runners and describe both the physical and health aspects of the risks and complications associated with running marathons, published in English between 2000 and 2023. Materials that did not provide specific useful information, such as reviews, commentaries and studies that did not focus exclusively on marathon runners, were excluded.

A literature search strategy has been developed to effectively browse research from

multiple databases. Advanced search techniques were used, including the use of complex queries with keywords such as "marathon runners", "health risks", "physical complications", "cardiovascular risk", "musculoskeletal injuries", and "endurance athletes". The search was carried out in such databases as PubMed, Scopus, Web of Science and Google Scholar, which allowed for a wide range of information from various scientific sources.

The quality assessment of the studies was performed using study quality assessment scales such as the Jadad Scale for randomised controls and the Newcastle-Ottawa Scale for observational studies. This approach allowed for a thorough examination of each article in terms of methodology, sample size, adequacy of statistical procedures and clarity and relevance of conclusions.

Data analysis was carried out both quantitatively and qualitatively, depending on the data available. For quantitative data, statistical techniques were used to integrate results from different studies to draw general conclusions for marathon runners. The qualitative analysis focused on synthesizing thematic data, which enabled the identification of major patterns and trends in the literature, helping to understand which health factors most affect marathon runners and which health complications are most commonly observed.

## **II. State of Knowledge**

### **Health Risk Factors Among Marathon Runners**

The chapter on health risk factors in marathon runners focuses on the complex interactions between genetic predispositions, the effects of exercise and diet, age and gender, and the psychological aspects of long-distance running.

#### **Genetic predisposition**

Marathon runners, like any group of athletes, exhibit a variety of genotypes affecting performance, recovery and injury risk. Specific alleles, such as those associated with the ACE gene or the ACTN3 gene, have a direct impact on muscle performance, the efficiency of oxygen utilization and the rate of recovery after intense exercise. Genetic testing can help understand individual differences in response to marathon training, which is crucial for personalizing training programs to minimize the risk of injury and optimize performance [9,10].

#### **Effect of training and diet**

Marathon training requires the body to adapt at both the microstructural and metabolic levels. Prolonged physical exertion leads to cardiovascular adaptations, such as increasing the

volume of the heart and its efficiency, as well as changes in the muscles that become more efficient in using oxygen sources of energy. Diet plays an equally important role, providing the necessary macro- and microelements that support intense effort and regeneration. Improper nutrition can lead to energy deficits, electrolyte disturbances, as well as chronic fatigue and increased risk of injury [11,12].

### **Age and gender as risk factors**

Both age and gender are important determinants of fitness and health risk among marathon runners. Younger athletes are less likely to suffer from overload injuries, but their risk of injury due to inexperience and over-ambition is higher. Older runners may suffer from muscle and bone degeneration, which increases the risk of osteoporosis and stress fractures. Women in endurance sports may experience specific challenges, including the female athlete triad, which is associated with low bone mass, menstrual disorders and malnutrition [13,14].

### **Psychological aspects of long distance running**

The psychological aspects of long distance running include both benefits and potential risks. Marathons are often seen as a way to cope with stress and improve mental well-being, but they can also lead to burnout, mood disorders and excessive psychological pressure associated with the constant pursuit of self-improvement and performance. Proper training load management, psychological support and relaxation techniques are key to maintaining the mental health of marathon runners [15,16].

This chapter highlights that marathon runners are a heterogeneous group, and the variety of health risk factors requires an individualised approach to training, diet, injury prevention and psychological support. Understanding and managing these factors is key to ensuring long-term performance and good health.

## **Common health complications in marathon runners**

Special attention was paid to the analysis of typical health complications occurring among long-distance runners. The most commonly observed are acute renal failure, skeletal muscle damage, cardiovascular problems, electrolyte disturbances with dehydration, and musculoskeletal injuries.

### **Acute renal failure**

Acute renal failure in marathon runners can occur as a result of severe dehydration, rhabdomyolysis, or breakdown of skeletal muscle, and prolonged reduction of blood flow through the kidneys during a marathon. This complication is characterized by a sudden

decrease in kidney function, which results in disorders in the elimination of metabolic waste and regulation of water and electrolytes in the body [17,18].

### **Skeletal Muscle Injury**

Marathon runners are exposed to micro-damage to muscle fibers caused by prolonged, intense exertion. Repeated micro-injuries and inflammation in the muscles can lead to soreness, reduced muscle strength and disruption of metabolic mechanisms. In extreme cases, rhabdomyolysis may occur [19,20].

### **Cardiovascular problems**

Although regular running has a positive effect on the heart, prolonged exercise such as a marathon can contribute to cardiovascular problems such as arrhythmias, heart attack, or even sudden cardiac death, especially in people with undiagnosed heart disease [21,22].

### **Electrolyte disturbances and dehydration**

Prolonged exercise without adequate hydration can lead to electrolyte imbalances, including hyponatraemia, which is caused by excessive water intake and dilution of sodium in the body. These disorders can manifest as fatigue, lethargy, headaches, coordination problems, and in extreme cases lead to cerebral edema and coma [23-25].

### **Musculoskeletal injuries**

Injuries such as tendonitis, overload syndromes, joint injuries (e.g. knee, hip) are common complications among marathon runners. Chronic overload, improper running technique and lack of adequate muscle strengthening can increase the risk of such injuries.

Identifying these complications and treating them appropriately is critical to ensuring the long-term health and performance of marathon runners. Regular medical check-ups, proper training planning, hydration strategies and supplementation can help minimize the risk of these serious health complications [26,27].

### **Risk management and prevention**

An important aspect is risk management and the prevention of health complications, which are integral elements of training and competition in marathons. The following sections discuss key strategies to minimise health risks.

#### **Risk-minimizing training strategies**

Optimizing your training plan is the foundation for preventing injuries and health problems among marathon runners. An individually tailored training plan should take into account the level of the runner's progress, his/her medical history and sports goals. Workouts should be progressive to avoid overloads and injuries, with sufficient time for recovery.



Incorporating strength training that strengthens stabilizing muscles, as well as flexibility training that improves range of motion, can significantly reduce the risk of injury. In addition, running techniques should be regularly evaluated by professionals to minimize inefficient movement patterns that can lead to overstrain [28-30].

### **The importance of nutrition and hydration**

Adequate nutrition and hydration are key to maintaining the performance and health of marathon runners. A diet rich in carbohydrates, proteins, healthy fats and micronutrients is essential to support long-term effort and post-workout recovery. Irrigation strategies should be tailored to the individual needs of the runner, taking into account weather conditions and effort intensity. Monitoring of electrolytes, especially sodium, is important in preventing electrolyte disturbances such as hyponatraemia [31,32].

### **Health monitoring**

Regular health assessments, including cardiac and orthopedic examinations, are recommended for marathon runners to detect potential health problems early. Monitoring biomarkers such as indicators of inflammation, myoglobin (measurement of muscle damage), and creatinine (measurement of kidney function) may help monitor the effects of exercise on the body and prevent serious health complications [33,34].

### **The role of sports doctors and physiotherapists**

Sports physicians and physiotherapists play a key role in the prevention, diagnosis and treatment of marathon runners' injuries. Regular consultations allow for early identification of health problems and prevent their escalation. Physiotherapists, with their knowledge of biomechanics and rehabilitation, can design specific prevention programs that minimize the risk of injuries and promote faster recovery after exercise [35-37].

In summary, effective risk management and prevention in marathons requires an integrated approach that includes individually tailored training, appropriate nutrition and hydration strategies, regular health monitoring and collaboration with qualified medical professionals. This allows marathon runners to enjoy the sport while minimizing health risks.

## **Discussion**

Analysis of the data collected from numerous studies shows the complex interaction between physical exertion and health risk factors and complications among marathon runners. The results indicate a significant risk of acute renal failure, skeletal muscle damage, and cardiovascular problems that are a consequence of extreme stress [17-27]. However, these data contrast with studies highlighting the long-term health benefits of regular running, such

as improved cardiovascular function and reduced overall mortality risk [38-39]. The discrepancy between short- and long-term effects points to the need for a deeper understanding of the adaptation mechanisms induced by long-term effort.

### **Implications for clinical practice**

Knowledge of the specific health risks associated with marathons has direct implications for clinical practice. Physicians should be aware of possible complications, especially in patients who are active marathon runners and those who start their marathon adventure at a later age. This includes the need for a thorough health assessment prior to training, regular monitoring of health indicators during training, as well as educating patients on the importance of proper diet, hydration and rest strategies [40]. In addition, there is a need to develop interdisciplinary teams of specialists, including sports physicians, dietitians, and physiotherapists, who will work together to provide optimal care for marathon runners [36,37].

### **Research gaps and opportunities for further research**

While numerous studies are available on the health effects of marathons, there are significant gaps that require further exploration. Most of the available research focuses on the physiological aspects of running, while less attention is paid to the psychological and behavioural effects of running. Future research should seek to understand how psychological factors, such as motivation and perception of exertion, affect the performance and health of marathon runners [41]. In addition, more research is needed to focus on the long-term effects of marathons across different age and ethnic groups, which could contribute to a more diverse understanding of the risks and benefits of marathons. Finally, comparative studies evaluating different training strategies can provide valuable guidance for developing individually tailored training plans that minimize risk and maximize health benefits.

In summary, a systematic review of the literature shows that marathon running is a complex activity with potential risks and benefits. Effective risk management and further research can help improve the health and performance of marathon runners around the world.

### **III. Summary**

As part of a systematic review of health risk factors and complications in marathon runners, many important findings have been identified that have significant implications for sports and medical practice. The review found that marathon runners are exposed to specific health risks, including acute kidney failure, skeletal muscle damage, cardiovascular problems, electrolyte disturbances and dehydration, and musculoskeletal injuries. At the same time, running long distances, including marathons, brings significant health benefits such as improved cardiovascular performance and overall longevity.

Based on the accumulated scientific evidence, recommendations for marathon runners and their coaches should focus on a few key areas. First, it is important that marathon runners undergo regular medical examinations to help detect potential health problems at an early stage. Secondly, an appropriate training plan that takes into account appropriate load progression and provides adequate recovery time is key to minimizing the risk of injuries and complications. In addition, marathon runners should pay great attention to their nutrition and hydration, adapting their diet and drinking habits to the intensity and conditions of training and competition.

In the context of future research, there is a need to further explore the impact of long-distance running on different demographic groups, including differences related to age, gender and ethnicity. In addition, taking into account the psychological aspects of endurance in sports such as marathons, future research should also examine how motivational factors and stress management strategies affect marathon runners' performance and health. Finally, it is worth exploring the variety of training strategies to better understand which methods are most effective in minimizing the health risks and maximizing the health benefits of long distance running.

In summary, marathons are both a challenge and an opportunity for runners. Through careful training management, health monitoring and continuous research, you can improve the safety and performance of marathon runners, contributing to their health and athletic success.

## **Disclosures**

### **Author's contribution:**

**Conceptualization-** Daniel Gondko

**Formal analysis-** Patrycja Dębiec, Daniel Gondko, Jakub Roman

**Investigation-** Patrycja Dębiec, Nikodem Pietrzak, Jakub Roman

**Writing-rough preparation-** Jakub Roman, Daniel Gondko, Patrycja Dębiec

**Writing-review and editing-** Daniel Gondko, Patrycja Dębiec, Nikodem Pietrzak

**Visualization-** Daniel Gondko, Jakub Roman, Patrycja Dębiec, Nikodem Pietrzak

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