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Epidemiology of Orthopedic Injuries, Mechanisms of Injury in Athletes and the Importance of Preventive Medicine

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RESUMO

Injuries caused by high-intensity exercise are influenced by many variables. When analyzing sports injuries, the type of sport and its biomechanics are taken into account. Objectives: To carry out a study on the incidence of sports injuries in high-performance athletes in five sports (Football, Athletics (Street Running), Volleyball, Basketball and Swimming), presenting the types of injury mentioned in the selected scientific articles and the location of the affected body region, as well as the mechanisms of injury by body segment. Methodology: A bibliographical review was carried out of (39) thirty-nine articles, presenting the type of injury and the body region affected in each sport. Finally, the mechanisms of injury by affected body segment were discussed. Final considerations: Sports medicine and preventive medicine can work together to reduce the high incidence of sports injuries.

Keywords: sports injuries; high performance in sport; Incidence of injuries; Sports medicine; Preventive medicine.

INTRODUCTION

Constant exposure to physical training and various sports at any level of performance is in itself a risk situation for injuries. The frequency of injuries can vary according to the length of time spent practicing sport and the number of hours of training per week. Sports-related injuries are classified according to their mechanism. There are those caused by acute trauma and those that result due to repetitive movement of the joint (KRAUS et al, 2012; ECKARD et.al, 2018; ARNER & MCCLINCY, 2019).

The causal factors for injuries have been characterized in the biomechanical sphere; however, there are important limitations to obtaining a clearer epidemiological view of the issue in question. Initially, attention should be paid to the difficulty of accessing information about athletes and their injuries.

According to Bezerra et.al (2022), the epidemiology of sports injuries is an area of research interest throughout the sports world. Researchers gather information on injuries observed in training centers.

According to Madhar et.al (2013), a high-performance athlete needs adequate physical preparation and expertise in the technique of the sport they play in order to avoid injury.

Several studies examine retrospective data on injuries sustained during a given time or in a given sport. Others investigate data from numerous teams over several years. The collection of epidemiological data by groups helps us to understand possible relationships between injuries and sports.

However, not all data can be applied to all participants in a given sport (KRAUS et al, 2012).

The issue of safety during sports practice helps to understand the risks of such participation. If sufficient data could be obtained, every injury-causing situation would be known and analyzed so that those interested could participate in the same activity, and could take steps to avoid injury. However, it seems impossible to obtain enough information to provide low-risk physical activities in the case of high-performance sports (SANTOS et.al, 2023).

According to Lemme et.al (2017), as sport becomes more professional in various areas, the performance of athletes increases. Records are broken, and scientific progress in the areas of high-performance sports is remarkable.

According to Bassett et.al (2022), athletes are turned into machines and their bodies are subjected to vigorous efforts. But the author discusses the biological limit for each sport and wonders whether we will still have records in the near future, or whether man is reaching his limit.

Since we don't have this answer, Sports Medicine and Preventive Medicine are concerned, especially in the area of Orthopedics and Traumatology, with trying to help sport in the search for rapid recovery of injured athletes (KRAUS et al, 2012).

According to Dos Santos et. al (2019), injuries have been on the rise, since many sports are characterized by intense physical contact, or short but quick and non-continuous movements, such as acceleration, deceleration, jumps and abrupt changes of direction.

It would be practically impossible to analyze the incidence of injuries in all sports in such a diverse subject.

Sports Medicine can be defined as the medical specialty that deals with performance and sports-related injuries. This field of medicine has been growing rapidly in recent years. Its main function is to help people, professional athletes or not, to treat and prevent injuries that may occur during sports practice, and also to improve their physical performance (SILVA, 2019; LI, 2022; HARMON et.al, 2019).

The sports doctor is a highly qualified clinically trained professional with a wealth of knowledge in various areas, including exercise physiology, biomechanics, orthopedics, cardiology and sports performance, among others. He is a specialist in prevention, able to diagnose and treat various types of injuries that can occur during sports practice (HARMON et.al, 2019).

Another extremely important factor is that the sports doctor doesn't just treat the injury, he has a vast experience that allows him to identify the type of injury and its severity quickly and accurately, so he can direct the best treatment to prevent the injury from worsening (SILVA, 2019; LI, 2022; HARMON et.al, 2019).

Preventive medicine, in turn, is a medical specialty focused on preventing the development of diseases, reducing the impact of illnesses on the health of individuals and improving the quality of life of patients undergoing treatment (GIZAW, 2019).

OBJECTIVES

To carry out a study on the incidence of sports injuries in high-performance athletes among the five sports (Football, Athletics (Street Running), Volleyball, Basketball and Swimming) and their respective injury mechanisms.

SPECIFIC OBJECTIVES

- ✓ To present the types of injuries mentioned in the selected scientific articles and the location of the affected body region.
- ✓ To discuss and present the mechanisms of injury by body segment.

METHODOLOGY

This article was carried out by means of an indirect literature review.

The bibliographic survey consisted of selecting thirty-nine (39) published articles on the subject of the research. They were selected according to the following themes: sports injuries; high performance in sport; incidence of injuries. Textual analysis and thematic and interpretative analysis were carried out.

After selecting the articles, a tabulation was made of the characteristics of the sports injuries found in these sports (soccer, volleyball, basketball, street running and swimming). For the study, the type of injury, body site affected and mechanism of injury were observed.

Finally, the mechanisms of injury by body segment were presented and discussed.

RESULTS AND DISCUSSION

We can identify good evidence regarding the types of injuries (Table 1) and the body region affected (Table 2).

It can be seen that muscle contracture, contusion, muscle sprain and calcaneal tendon rupture were cited as types of injury in the sports analyzed. However, depending on the sport, the chance of one specific injury may be higher than another.

Table 1. Types of injury cited in the selected scientific articles analizeded

Types of Injury	Soccer	Voley	Basketball	athletics	swimming
Contracture	✔	✔	✔	✔	✔
Contusion	✔	✔	✔	✔	✔
Muscle sprain	✔	✔	✔	✔	✔
Sprain	✔	✔	✔	✔	✔
Strain	✔	✔	✔	✔	✘
Dislocation	✔	✔	✔	✘	✔
Tendonitis		✔	✔	✔	✔
Ruptured cruciate knee ligament	✔	✔	✔	✘	✘
Calcaneal tendon rupture	✔	✔	✔	✔	✔
Shoulder injuries	✘	✔	✔	✘	✔
Cervical trauma	✔	✔	✘	✘	✔

Legends;

✔ Injuries cited

✘ No Injuries cited

It can be seen that athletics (street running) and swimming received the fewest mentions in relation to the types of injuries indicated.

Table 2. Localization of injury cited in the selected scientific articles analizeded

Types of Injury	Soccer	Voley	Basketball	athletics	swimming
Upper Arm	✘	✔	✔	✘	✘
Head	✔	✘	✔	✘	✘
Neck	✘	✔	✔	✘	✔
Pelvic Girdle	✔	✔	✔	✔	✔
Knee	✔	✔	✔	✔	✘
Shoulder	✔	✔	✔	✔	✔
Ankles	✔	✔	✔	✔	✔
Foot	✔	✔	✔	✔	✘
Cervical Spine	✔	✔	✔	✔	✔
Lombar Spine	✔	✔	✔	✔	✔

Legends;

✔ Injuries cited

✘ No Injuries cited

Table 2 shows the lowest number of citations in athletics (street running). It was interesting to see that in most of the sports studied, injuries to the knees, pelvic girdle and lumbar spine are most commonly found.

In a study involving orthopaedic injuries, he mentions that the majority occur in contact sports. The same author points out that match injuries are more frequent than training injuries. It was also observed that mild injuries predominate in relation to injuries that may indicate surgery (MADHAR et.al, 2013).

Epidemiological studies, in most cases, provide knowledge of the facts relating to a situation and do not always allow us to understand the real causes of the problem. Characterizing intrinsic and extrinsic risk factors is the first step in implementing preventive measures, which must include understanding the mechanisms of injury (LUTTER et. al, 2020).

On the other hand, the identification of intrinsic risk factors in the genesis of sports injuries is well established in many situations. Knowledge of previous injuries, obtained from the athlete's simple clinical history, is an important prognostic factor for future injuries. Even in countries where sports medicine is better structured, there are still problems with effective pre-participation assessment, in the opinion of the athletes themselves. The level of physical conditioning, although it suggests a clear association with the risk of injury, still lacks scientific documentation in this regard.

During the course of high-performance sports, athletes are involved in a series of cognitive and physiological stimuli, and their motor response can be impaired by a series of motor, psychological and behavioral pressures, increasing the risk of injury (MADHAR et.al, 2013).

Several authors agree that sports injuries are a physical and psychological adversity to be faced by athletes. It is therefore important that the health professionals responsible for their physical recovery understand that this rehabilitation process involves clinical, psychological and social components (LUTTER et. al, 2020).

The practice of physical activities or competitive sports is associated with an increase in the incidence of sports injuries. However, these injuries are no longer just a matter for sports health sciences, but have become a public health issue, due to the increase in their incidence in the general population and the severity with which they affect sportspeople, making them excessively fragile (LUTTER et. al, 2020).

The fear of a new injury can be a serious limitation to the individual's kinetic function, hindering them from regaining the functional states of movement, safety and strength they had before the injury (MACINTYRE & SCHROEDE, 2006).

MAIN MECHANISM OF FOREARM INJURY

The mechanism of injury is usually a fall with the hand flat and the forearm in pronation. With the hand fixed to the ground, the rotation of the body during the fall causes hyperpronation and the resulting forces cross the radiocarpal joint, which is fixed, producing a fracture of the radius diaphysis. Lateral epicondylitis is considered one of the main forearm injuries. It results from inflammation and micro-tearing of fibers in the extensor tendons of the forearm. Symptoms include pain in the lateral epicondyle of the elbow, which can radiate into the forearm. Diagnosis is made by examination and provocative testing. Treatment is by rest, anti-inflammatory drugs (NSAIDs) and physiotherapy (MADHAR et.al, 2013; CUENCA et.al, 2003).

Theories on the pathophysiology of lateral epicondylitis include non-sporting and occupational activities that require repetitive supination and pronation force on the forearm, as well as overuse or weakness (or both) of the extensor carpi radialis brevis and the long muscles of the forearm, which originate in the lateral epicondyle of the elbow. For example, during a backhand movement in racket sports such as tennis, the elbow and wrist are extended, and extensor tendons, especially the extensor carpi radialis brevis, can be injured as they pass through the lateral epicondyle and head of the elbow of the radius. Contributing factors include weak shoulder and wrist muscles, very tight racket strings and small grip size, hard hits on wet balls and off-center racket. In endurance training, injuries are caused by overuse (too much activity or performing the same movements too often) or muscle imbalance between extensors and flexors of the forearm. Sports activities that can cause or contribute to lateral epicondylitis include repetitive holding and twisting of the elbow (e.g. turning a screwdriver, perhaps typing). Over time, subperiosteal hemorrhage, calcification, nodule formation in the lateral epicondyle and, most importantly, degeneration of the tendon can occur (CUENCA et.al, 2003).

MAIN MECHANISM OF NECK INJURY

Also known as the cervical acceleration-deceleration mechanism or whiplash effect, upon impact the neck suddenly jerks forward or backward. There is hyperextension, which can lead to muscle and tendon tears, soft tissue damage or damage to the cervical vertebrae (PROCTOR & CANTU, 2000).

Neck injuries can occur during automobile accidents, other traumatic events or even when playing sports. Symptoms of these injuries include stiff neck, shoulder or arm pain, headache, facial pain and vertigo (BAILES et.al, 2007).

MAIN MECHANISM OF INJURY TO THE PELVIC GIRDLE

Pelvic fractures are injuries that occur in the hip bones and possibly the adjacent bones (sacrum and coccyx). They are mainly caused by severe traumatic mechanisms or bone fragility. The pelvis is a fundamental region which protects and supports the pelvic and abdominal organs and connects to the lower limbs, as well as having important vessels and nerves. Therefore, a fracture in this area can compromise several of the body's functions. Open pelvic fractures have a mortality rate of 50%. Because of this, pelvic fractures must be managed carefully so that they do not progress to complications. A fracture is the loss of bone continuity, even if it is not complete. Fractures can be open (contact between the bone and other tissues, which may or may not be exposed beyond the skin) or closed (SAWLE et.al, 2013; KELLY et.al, 2000).

A pelvic fracture (FIGURE 1) is one that occurs in the bones of the hip, sacrum and coccyx, which form the pelvic ring. It may or may not break the ring; when it does, it means that there has been a fracture in at least two places and results in greater instability (GERACI, 1994).

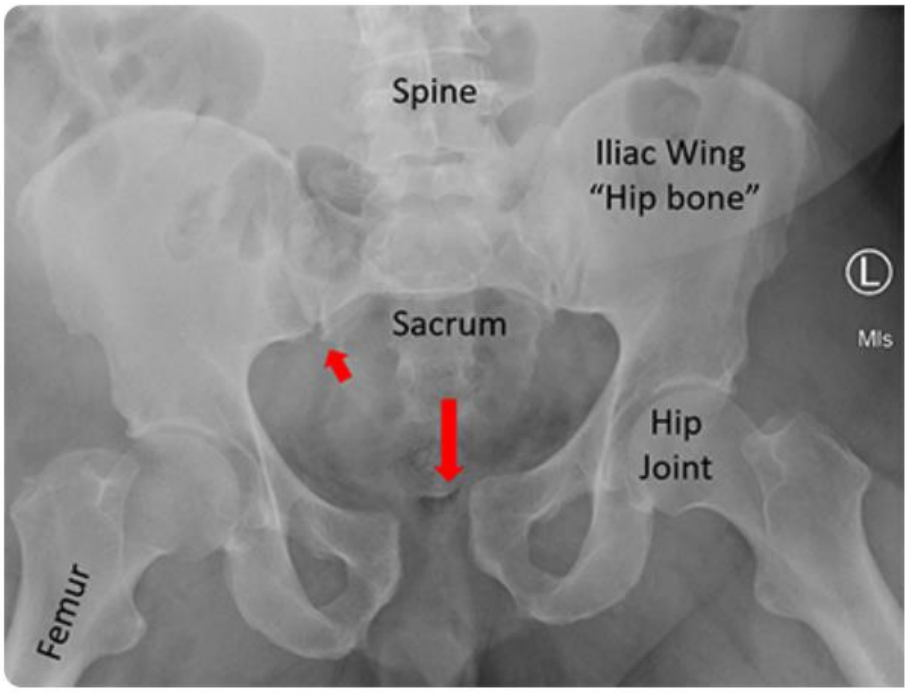

Figure 1: X-ray of a pelvis with an injury to the pelvic ring. The pubis (large red arrow) does not line up and also has too much space between the bones. **Source:** Orthopaedics Trauma Associacion, 2023.

MAIN MECHANISM OF KNEE INJURY

Knee injuries can be caused by a variety of factors, ranging from a sedentary lifestyle to intense physical activity. Trauma from blows or rotations to the knee (resulting from accidents or falls, for example) can hit bones and menisci, tear ligaments or dislocate the patella (SENTER & HAME, 2006; LAPRADE & WIJDICKS, 2012).

Several ligaments help keep the knee in place: Collateral ligaments: these ligaments, located on each side of the knee, prevent the knee from moving too much from side to side. The medial collateral ligament is located on the inside of the leg, and the lateral collateral ligament is located on the outside of the leg (INGRAM et.al, 2008).

Cruciate ligaments prevent the knee from moving too far forwards or backwards. The anterior cruciate ligament (ACL) crosses in front of the posterior cruciate ligament (PCL) to form an X (INGRAM et.al, 2008).

The menisci in turn act as "cartilage shock absorbers" and fill the space between the thigh bone (femur) and the shin bone (tibia). They help stabilize and cushion the knee joint (LUTTER et. Al, 2020).

The anterior cruciate ligament can be injured in a number of ways such as; rapid change of direction; stopping all at once; reducing speed during a run; incorrectly supporting the feet after a jump; direct contact or collision, such as a tackle in soccer (LUTTER et. Al, 2020).

The most commonly injured structures in the knee are the medial collateral ligament and the anterior cruciate ligament (LUTTER et al, 2020).

The direction of the force against the knee determines which structures will rupture. The medial collateral and anterior cruciate ligaments: one or both of these ligaments can rupture if the side of the knee is hit when people are resting their weight on a foot firmly on the ground, such as when preventing a lunge. Damage is more likely if the knee is also twisted. The lateral collateral and anterior cruciate ligaments can be damaged when the force against the knee is directed outwards. This type of injury can occur when the leg is pushed from the inside. The anterior and posterior cruciate ligaments can be damaged when the knee is extended with force. Finally, the Meniscus can be damaged when people put their weight on one foot and their knee twists when it is injured (HEWETT et.al, 2006; LUTTER et. Al, 2020; INGRAM et.al, 2008; SENTER & HAME, 2006; LAPRADE & WIJDICKS, 2012).

Total or partial rupture of the anterior cruciate ligament (ACL) (FIGURES 2 and 3) has a high incidence in sports, and can be damaged when the knee is extended with force, when the knee is hit from the side or when the leg is pushed from the inside (LAPRADE & WIJDICKS, 2012).

The ACL connects the thigh bone (femur) at the back of the knee joint with the front of the shin bone (tibia). The ACL crosses in front of the posterior cruciate ligament (PCL) to form an X ((INGRAM et.al, 2008).

Figure 2. Lateral femoral and tibial bone edema and bone bruising secondary to ACL tear **Souce:** Orthopaedics and trauma london, 2023.

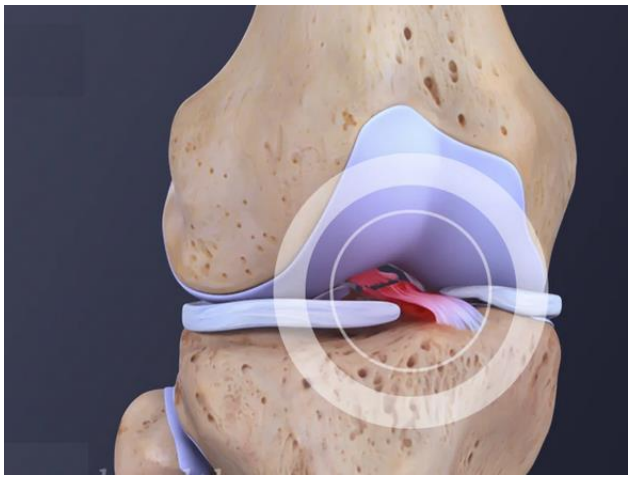

Figure 3. ACL tears may be partial or complete. A complete tear of the ACL is also known as an ACL rupture. Source: Sports Health, 2019.

MAIN MECHANISM OF SHOULDER INJURY

Injuries to the upper limbs account for 75% of the total and the shoulder joint is the most frequently affected. These are common complaints among athletes and can be caused mainly by repetitive movements, inadequate posture, throws and impacts during sporting activities (BONZA et al, 2009).

The mechanisms of athlete shoulder injuries are atraumatic and traumatic. Repetitive movements, especially those of throwing athletes.

Scher et.al (2010) showed in their study that shoulder problems affect 66% of swimmers, 57% of baseball players, 44% of soccer players and voleibol and 7% of golfers. The high incidence of injuries is caused by excessive training and the demands of the sport itself.

According to Bahr et al (2017) shoulder pain was present in 63.4% of elite swimmers at a certain stage of their career. In athletics, throwers suffer 50% of injuries to the trunk and upper limbs.

The mechanisms of athlete shoulder injuries are atraumatic and traumatic. Repetitive movements, especially in throwing athletes and non-contact sports (baseball, swimming, tennis and volleyball), are responsible for a large number of injuries. Direct or indirect trauma occurs mainly in sports that prioritize physical contact (SCHER et.al, 2010).

MAIN MECHANISM OF FOOT AND ANKLE INJURIES

Ankle injuries can occur in patients of all ages and, in most cases, cause pain, a feeling of looseness, swelling and difficulty moving the area (AGEL et al, 2007). The ankle is an essential structure for our body, connecting the feet and the lower leg. The tibiotarsal joint is made up of the talus, fibula and tibia bones, and the talotarsal joint is made up of the talus, calcaneus, cuboid and navicular bones (YARD et.al, 2008). There are several mechanisms for ankle injuries, the main one being physical activity (ROOS et.al, 2017).

SPRAINS

Popularly known as ankle sprains, sprains occur when there is a forced movement of the ankle and foot, resulting in the ligaments stretching beyond the limit they can withstand (ROOS et.al, 2017).

These structures can then be damaged to three different degrees:

- Grade 1 - stretching;

- Grade 2 - extensive but incomplete injury;

- Grade 3 - complete injury, with ligament rupture.

Ankle fractures are a common occurrence in the emergency room. They occur mainly as a result of sprains, sports injuries, automobile and motorcycle accidents, among others. They can affect the distal third of the tibia and fibula bones. The terms medial, posterior and lateral malleolus refer to the rounded bony prominences that are located in the distal third of the tibia and fibula. The main symptoms are pain, swelling and deformity of the ankle, as well as the inability to support the weight of the body (ROOS et.al, 2017).

LUXATIONS

Dislocation occurs when the articular surface of a bone moves out of its anatomical position, resulting in loss of joint congruence. There are cases of subluxation with partial loss and complete dislocation with total loss of joint congruence. Most ankle dislocations occur in conjunction with fractures and are a serious situation that requires emergency care. In these cases, the joint needs to be reduced and stabilized, placed in the correct position and secured. At this stage of treatment, some patients may undergo surgery and external fixation (AGEL et al, 2007; YARD et.al, 2008).

MAIN MECHANISM OF BACK INJURY

Injuries to the lumbar spine have been observed in young athletes and are currently increasing in frequency in sports clinics. Injury and recurrent back pain can drastically limit an athlete's ability to participate in their sport. While the relatively normal anatomy of the spine may allow for increased range of performance before structural damage occurs. Anteriorly, the lumbar spine has five vertebral bodies connected by intervertebral discs. The neural canal lies centrally, containing peripheral nerves with a dural lining. Dorsally, the posterior elements of the spine are located: the facets, transverse processes, articular processes and pedicles. Normal lumbar lordosis is 45 to 50 degrees. Abnormal structural alignments, such as hyperlordosis of the lumbar spine or "structurally flat spine", can be factors in causing low back pain (BAILES et.al, 2007

Injuries to the lumbar spine generally result from two patterns of force generation: single event, acute macrotrauma or repetitive microtrauma resulting in overuse injuries. Overuse injuries are most commonly seen in the posterior bony elements, particularly the articular processes. Some researchers have suggested that it is repetitive flexion and extension that leads to the concentration of stress in this region, as this is the site of spinal rotation during flexion and extension. A number of recent studies have used magnetic resonance imaging (MRI) to demonstrate changes in the spine caused by repetitive microtrauma.

The pattern of lumbar injuries is completely different in the elderly athlete, in whom the spine has already undergone age-related segmental degeneration. The injury is most commonly initiated in the elements of the anterior part of the disc, causing discogenic pain and sciatica. Excessive bone growth on the facets can compromise the lateral recesses or the intervertebral foramen, resulting in compression of the spinal nerve. A minimal twist or injury can result in spinal nerve injury or irritation associated with swelling and pain (JAGANNATHAN et.al, 2007; BARILE et. Al, 2017).

FINAL CONSIDERATIONS

The future of sports medicine and science lies in the adaptation of neuromuscular control and physical activity.

Although neuromotor reprogramming in sports medicine has progressed in recent years, it is still inaccessible to the majority of high-performance athletes.

In relation to sports trauma, epidemiological knowledge of injuries and early identification of risk factors in each situation can mitigate risks and minimize the time and financial resources spent on treatment.

The future prospects for sports medicine and prevention must include research into neuromotricity and bioengineering, particularly in assessing the feasibility of using stem cells in the locomotor system. In this sense, in addition to prevention, other problems are clearly emerging. In their presence, which treatment alternatives best apply to each situation and how to allow a quick, safe and not premature return to competition. The training of good doctors, physiotherapists and physical education professionals is fundamental in assessing the prospects for sports trauma in high-performance sport.

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