Sport injuries of the lower extremities

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CONTENT

1. List of abbreviations

ACL	Anterior Cruciate Ligament
CO2	Carbon dioxide
CT	Computer tomography
MRI	Magnetic resonance imaging
NSAIDs	Non-steroidal anti-inflammatory drugs
O2	Oxygen
RICE	Resting, Icing, Compression, Elevation
US	Ultrasound

2. Introduction

The benefits of engaging in sports for our body and mind have long been known. Physical activity contributes to strengthening the immune system, maintaining vitality, improving posture, and reducing stress because physical activity stimulates the secretion of happiness hormones. However, one of the challenges associated with sports is the risk of sports injuries, which affect both professional and recreational athletes. Sports injuries are injuries to the musculoskeletal system that occur because of exercise or any sports activity. From muscle strains to joint injuries, every injury has its cause like inadequate warm-up, overtraining, poor training conditions, unhealed previous injuries, excessive effort, and inadequate equipment.

Ankle sprains, or "distortions," are one of the most common sports injuries, but they can also occur in everyday situations. Knee injuries are very common in any type of sports activity. The knee is one of the most complex joints in our body and constantly bears 70-90% of our weight. The most common sports-related knee injuries include ACL and meniscus injuries, as well as overuse syndromes like jumper's knee. Jumper's knee is an overuse syndrome typical for runners, both professionals and amateurs, and its most obvious symptom is pain caused by inflammation of the patellar ligament at the lower pole of the patella. ACL injuries are common sports injuries that affect women more than men. Depending on the severity of the injury, it can be treated conservatively or surgically. Meniscus injuries are the most common knee injuries and the most frequent reason for knee surgery. Bone fractures are serious sports injuries caused by sudden impacts or falls. These injuries require prolonged treatment and immediate orthopedic intervention. Strains of ligaments, tendons, and muscles are common sports injuries leading to pain, swelling, and reduced mobility.

Depending on the severity, recovery can take from several days to several months. Treatment varies accordingly and can range from home care to tailored treatments and therapies. The risk of sports injuries always exists, but some preventive measures include stretching before and after training, warming up, stopping activity when feeling pain, and taking proper breaks during training. Equally important are proper and complete rehabilitation of previous injuries, consistency in training, detecting anatomical anomalies and training errors, proper nutrition, and supplementation. Sports injuries are common but not inevitable when it comes to engaging in sports.

3. Aims and objectives

This thesis aims to explore the various aspects of sports injuries of the lower extremities, focusing on their diagnosis, therapeutic interventions, preventive measures, and rehabilitation protocols. Through a comprehensive review of current literature and evidence-based practices, this study seeks to provide a detailed understanding of the mechanisms underlying these injuries, the best practices for their management, and the latest advancements in prevention and rehabilitation techniques. By addressing these critical areas, the thesis will contribute valuable insights to the field of sports medicine, aiming to enhance the health, performance, and well-being of athletes.

4. Literature review

4.1. Sports medicine

The evaluation and significance of any medical discipline requires a clear definition of its scope. In sports medicine, this definition is vital due to the field's tendency to expand and become a "jack-of-all-trades" discipline. In today's era of increasing specialization, it is crucial to accurately delineate the areas covered by sports medicine. Historically, sports medicine has evolved into a multifaceted discipline because it was not initially established by sports doctors. Instead, it developed through the contributions of surgeons, orthopaedist, internists, radiologists, and other specialists. Classical textbooks often include kinesitherapy therapy through movement as part of sports medicine, reflecting the field's broad scope. The first Congress of Sports Medicine in 1915 highlighted kinesitherapy as a significant topic, influenced by historical perspectives on sports medicine (1).

It points out that the roots of sports medicine trace back to ancient times, where gymnasts treated ailments through movement. Kinesitherapy, although sometimes overshadowed by other physical methods, remains a fundamental aspect of physical medicine. Sports doctors should promote health and functional abilities, emphasizing the importance of defining sports medicine's scope. In modern times, it is essential to "clean up" sports medicine by ensuring it encompasses the appropriate areas and avoids unnecessary aspects. Preventive measures, such as injury prevention and collaboration with coaches, should be prioritized. Unfortunately, there is a shortage of sports doctors actively engaged in these preventive efforts. Curative sports medicine, which includes both preventive and curative measures within clinical settings, is only one aspect of the field (1).

Sports trauma is a particularly attractive area within sports medicine, involving both preventive and curative measures. Preventive efforts should focus on injury prevention, especially for athletes engaged in regular sports activities. Key activities for sports doctors include testing physiological functions and conducting biochemical analyses during training to assess and optimize athletes' physical capabilities and identify any metabolic or nutritional deficiencies. They monitor physiological changes and implement medical interventions to address health issues promptly, ensuring athletes maintain peak performance levels and avoid overtraining. Collaborating with coaches and psychologists, sports doctors optimize training processes by integrating physical conditioning with mental and emotional well-being strategies, addressing stress, anxiety, and motivation. Additionally, they develop and manage personalized nutritional plans and regimes, tailored to meet the specific energy demands and dietary needs of athletes, thereby enhancing performance, supporting recovery, and maintaining overall health. The future of sports medicine necessitates collaboration among various medical professionals, such as physiologists, biomechanics experts, and electro cardiographers, to enhance the field's effectiveness and scope (2).

4.2. Anatomy of the lower extremities

4.2.1. Skeletal system

The skeletal system of the lower extremities plays a pivotal role in providing structural support, enabling locomotion, and maintaining balance. This chapter provides an in-depth exploration of the bones in the lower limb, encompassing the pelvis, femur, patella, tibia, fibula, and the various bones of the foot. Understanding these structures is essential for comprehending their functional implications and their involvement in various clinical conditions.

The Pelvic Girdle -or pelvis, serves as the foundational structure connecting the axial skeleton to the lower limbs. Pelvic is composed of ischium, ilium and pubis. Together they create a sturdy, ring-shaped structure that bears the upper body's weight and connects with the muscles and ligaments of the lower limb. Ilium is the largest and uppermost portion of the pelvis, the ilium includes the iliac crest, which serves as a critical site for muscle attachment. The ischium is located posteriorly; the ischium provides support when sitting and includes the ischial tuberosity. Pubis is the front portion of the pelvis, where a cartilaginous joint that absorbs shock during walking and running.

Femur - most robust and lengthy bone. This robust structure is designed to support considerable weight and withstand the forces generated by muscle contractions and physical activity. Looking at the proximal end of the femur we can observe how. The femur head connects with the socket of the pelvis, creating a hip joint. The long, cylindrical component of the femur, which supports weight and provides structural integrity, is known as the shaft of the femur. At the lower extremity, the femur expands to create the inner and outer condyles, which interface with the tibia and the patella, forming the joint of knee.

Patella (kneecap) - sesamoid bone with a three-sided shape encased in the tendon of the thigh muscle. It protects the knee joint and enhances the mechanical advantage of the quadriceps muscle. It is convex and rough on the anterior surface, providing attachment for the quadriceps tendon. Unlike the front surface, the back surface is even and concave, connecting to the femur to form the patellofemoral joint.

Tibia- the bigger and more centrally located bone in the lower leg supports the majority of the body's weight and is essential for movement. Looking from top to bottom at the proximal end of the tibia features the inner and outer condyles that connect with the femur to create the joint of knee. Long, straight portion of the tibia, providing strength and support is the shaft of tibia. The distal part includes the medial malleolus, which forms part of the tibiotalar joint and offers anchorage t for connective tissues.

Fibula- narrow, outer bone. While it doesn't support much weight, it acts as an attachment site for muscles and aids in stabilizing the ankle joint. At the upper end, it connects with the shinbone. Long, slender part is called shaft. The distal end includes the lateral malleolus, which forms part of the ankle joint.

Foot bones- composed of twenty-six parts, organized into three groups: tarsals, metatarsals, and phalanges. This intricate arrangement provides support, flexibility, and balance. The tarsals are seven bones forming the ankle and proximal foot. Metatarsals are five long bones in the middle of the foot, forming the plantar arches. The phalanges consist of fourteen bones in the toes. Every toe has three segments, except for the large toe (hallux), which contains two segments (3).

4.2.2. Joints

The joints of the lower extremities are crucial for facilitating movement, bearing the body's weight, and providing stability. Each joint plays a unique role in enabling the complex motions required for activities such as walking, running, jumping, and balancing. The primary joints of the lower extremities include the hip joint, knee joint, ankle joint, and various joints within the foot.

Hip Joint- connects the upper end of the femur and the pelvic bone, and the concave articular body is the pelvic cup. Mechanically, it is a pelvic joint, so like the ball joint, it has many axes, but in the hip joint, movements are still limited. The hip joint is where the most important function of the lower limbs takes place, i.e. shifting the weight of the body when walking. That is why a strong muscle mass has been developed around that joint, which surrounds the joint (3).

Knee Joint- biggest and most intricate hinge joint in the human body, mainly constituted by the connection between the thighbone, shinbone, and kneecap. It permits bending and straightening, along with a minor degree of rotational motion when the knee is bent. Stability is upheld by several essential structures, including the front and back cruciate ligaments that prevent forward and backward displacement, and the inner and outer collateral ligaments that prevent inward and outward stresses. The menisci, crescent-shaped cartilaginous structures, act as shock absorbers and provide additional stability by distributing load across the joint surface (3).

Ankle Joint- created by the junction of the tibia, fibula, and talus. This joint mainly permits upward and downward foot movement. Connects the lower leg region and the foot region and one of the key parts of the propulsion system. The joint itself consists of three different smaller joints, whose basic functions and range of motion are connected to each other, enabling the proper functioning of the ankle joint. These ligaments prevent excessive movement and maintain the integrity of the joint during various activities (3).

Joints of the Foot- The foot contains numerous joints that contribute to its complex movements and functions. Situated between the talus and calcaneus, subtalar joint permits inward and outward movement of the foot, aiding in its adaptation to uneven surfaces. Followed by the transverse tarsal joint, which comprise the talonavicular, and calcaneocuboid joints, this complex joint allows for additional inward and outward rolling movements, enhancing the adaptability and stability. Next in line are the metatarsophalangeal joints, which are positioned between the metatarsal bones and the nearest phalanges of the toes. Flexion, extension, abduction are essential for the push-off phase of walking and running. Finally, the interphalangeal joints are hinge joints contributing to the overall functionality and dexterity of the foot (3).

4.2.3. Muscles

The muscles of the lower extremities are essential for movement, posture, and balance. They are organized into groups based on their location and primary functions, including muscles of the hip and thigh, knee, and lower leg and foot. Understanding the anatomy and function of these muscles is critical for diagnosing and treating injuries, enhancing athletic performance, and improving overall mobility.

Muscles of the Hip and Thigh - categorized into several groups: anterior, posterior, medial, and lateral muscles. These muscle groups work synergistically to provide stability and facilitate a variety of motions at the hip joint *(3)*.

Anterior Muscles- iliopsoas, comprising the iliacus and psoas major muscles, is the primary hip flexor. Another significant muscle involved in hip movement is the straight thigh muscle. It starts at the anterior inferior iliac spine and attaches to the patella through the quadriceps tendon, allowing it to perform hip bending and knee straightening. Additionally, the sartorius, plays a crucial role in multiple movements. The sartorius aids in hip bending, outward movement, and outward rotation, as well as knee flexion, making it a vital component in the complex mechanics of the lower limb (3).

Posterior Muscles- the gluteus maximus, the biggest and outermost gluteal muscle, begins at the ilium, sacrum, and coccyx, and connects to the gluteal tuberosity of the femur as well as the iliotibial tract. Serves as the primary extensor of the hip, playing a crucial role in movements that require powerful hip extension. The hamstrings, which include the biceps femoris, semitendinosus, and semimembranosus muscles, start at the ischial tuberosity and connect to the upper portions of the tibia and fibula. These muscles function in both hip extension and knee flexion, making them essential for activities that involve bending the knee and extending the hip, such as running and jumping (3).

Medial Muscles- the adductor group, comprising the longus, brevis, magnus, gracilis, and pectineus muscles, is vital for movement of hip. These muscles start from the pubis and ischium and insert along the femur's linea aspera and the medial tibia. Their primary function is hip adduction, which is the motion that draws the thigh closer to the body's centreline. This muscle group is essential for stabilizing the pelvis during physical activities (3).

Lateral Muscles- The gluteus medius and minimus muscles arise from the ilium and attach to the greater trochanter of the femur. They are vital for hip abduction and medial rotation, contributing significantly to pelvic stability and coordinated movement during activities like walking and running. The tensor fasciae latae, which starts at the anterior iliac crest and inserts into the iliotibial tract aids in hip abduction and medial rotation. It further supports pelvic stability during gait, enhancing the balance and stability of the lower limbs (3).

Knee Muscles- The main muscles influencing the knee joint are the quadriceps femoris and hamstring groups, as well as several smaller muscles that provide stability and assist in knee movements. The quadriceps femoris group, comprising the rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius, originates from the femur and pelvis and enters the patella via the quadriceps tendon. These muscles are the main extensors of the knee, crucial for activities such as walking, running, and jumping. Additionally, the popliteus muscle, a small muscle located posteriorly, arise from the lateral femoral condyle and inserts into the posterior tibia. This muscle serves a crucial role in stability and operation, particularly during the initial phase of knee bending *(3)*.

Lower Leg and Foot Muscles- the muscles connect the lower leg bones to the foot bones facilitate foot movement and are categorized into three groups: anterior, lateral, and posterior. The anterior group consists of four muscles that are responsible for dorsiflexion or bending the foot towards the front of the lower leg. The lateral group includes two muscles that elevate the outer edge of the foot. The posterior group is divided into superficial and deep layers. The deep layer of muscles is responsible for plantarflexion, or extending the foot, and flexing certain toes. Overall, the foot muscles act primarily as active ligaments, maintaining the arches of the feet (3).

Lateral Compartment- fibularis longus and brevis muscles are essential for the movements and stability of the foot. Both muscles originate from the fibula, but they have different insertion points and slightly different functions. The fibularis longus originates from the top section of the fibula and attaches to the initial metatarsal bone and the inner cuneiform bone. It plays a key role in eversion, which involves turning the bottom of the foot outward, and plantarflexion, which points the toes downward. This muscle also supports the foot's curvature and ensures side stability during walking and running. The fibularis brevis, on the other hand, arises from the lower part of the fibula and attaches to the fifth metatarsal. Like the fibularis longus, it functions in eversion and plantarflexion of the foot. The fibularis brevis is particularly important for balance and preventing ankle sprains by stabilizing the foot and ankle during lateral movements. Together, these muscles contribute to the dynamic control and stabilization of the foot, enabling efficient and safe locomotion (3).

Posterior Compartment- the gastrocnemius, soleus, tibialis posterior, flexor hallucis longus, and flexor digitorum longus are crucial muscles for the movement and stability of the lower leg and foot. Inner and outer femur knobs and connect to the heel bone through the Achilles tendon where the gastrocnemius muscle begins. It plays a significant role in plantarflexion of the foot, which is the movement that points the toes downward, and in flexion of the knee. This muscle is essential for powerful movements such as jumping and running. The soleus muscle, located beneath the gastrocnemius, arises from the proximal tibia and fibula and attaches to the calcaneus via the Achilles tendon. The soleus is a strong plantar flexor of the foot and is particularly crucial for maintaining posture and balance during standing and walking. The tibialis posterior muscle arises from the posterior tibia and fibula and inserts into the navicular and medial cuneiform. It functions in both plantarflexion and inversion of the foot, which involves turning the sole inward. This muscle is essential for maintaining the foot's arch and regulating its movements. The flexor hallucis longus muscle originates from the posterior fibula and inserts into the distal phalanx of the great toe. It is accountable for flexing the great toe and assists in plantarflexion of the foot. This muscle is essential for activities that require pushing off the ground, such as walking and running. This muscle contributes to the grip and push-off phases of gait, providing stability and power during movement. Together, these muscles coordinate to facilitate complex movements of the foot and ankle, ensuring efficient locomotion and stability in various activities (3).

4.2.4. Nerves

The nervous system of the lower limb is essential for sensory perception, motor control, and reflex actions. It comprises several major nerves originating from the lumbar and sacral plexuses, which innervate the muscles, skin, and joints of the lower extremities. Understanding the anatomy and function of these nerves is critical for diagnosing and managing neurological and musculoskeletal disorders.

Lumbar Plexus- "network" of nerves that pass towards the periphery after "exiting" the spinal canal. On their way, they pass through different structures, which, if they are weak, can pinch certain parts of the nerve. That is why it is very important to know whether the pain is related to some kind of radiculopathy or is the result of a pinched nerve somewhere "along the way" (3).

Femoral Nerve- one of the largest nerves in the body and is located in the groin and controls the muscles that help straighten the leg and move the hips. It is also responsible for sensation in the lower front part of the thigh. The femoral nerve arises from the spinal nerve roots of L2 to L4. It originates at the lateral edge of the psoas major muscle, travels under the inguinal ligament, and enters the femoral triangle. Regarding innervation, the femoral nerve provides motor control to the anterior thigh muscles, such as the quadriceps femoris, sartorius, and pectineus. These muscles are essential for activities like walking, running, and stair climbing, as they manage knee extension and hip flexion. Moreover, the femoral nerve delivers sensory input to the front and inner parts of the thigh and leg through its anterior cutaneous branches and the saphenous nerve. This sensory coverage is crucial for detecting touch, pain, and temperature in these areas, thereby enhancing overall proprioception and balance (3).

Obturator Nerve- nerve is a vital nerve of the lower limb, with specific origins, pathways, and innervation patterns. It arises from the spinal nerve roots of L2 to L4. Emerging from the inner edge of the psoas major muscle, the obturator nerve navigates through the pelvis and exits via the obturator foramen. In terms of motor innervation, the obturator nerve supplies the medial thigh muscles, including the adductor longus, adductor brevis, adductor magnus, gracilis, and obturator externus. These muscles are crucial for thigh adduction, playing a significant role in bringing the legs together and stabilizing the pelvis during walking and other movements. Additionally, the obturator nerve provides sensory input to the inner part of the thigh. This sensory role is important for detecting touch, pain, and temperature in this area, contributing to the comprehensive sensory and motor control of the lower limb (3).

Sacral Plexus- composed of the anterior rami of the L4-S4 spinal nerves. It is located on the back wall of the pelvis, positioned in front of the piriformis muscle, and gives rise to several significant nerves that serve the lower limb. P provides neural connections to the pelvis, buttocks, genital area, thighs, calves, and feet. Due to the interconnection between the lumbar and sacral plexuses, they are often referred to collectively as the lumbosacral plexus. The spinal nerves in the thoracic region do not contribute to the plexus. Instead, they form the intercostal nerves, which are situated between the ribs (3).

Sciatic Nerve- a large nerve that starts in the buttock area and descends along the leg. Human body has one on each side. Five nerve roots emerging from the lower lumbar and upper sacral spine L4, L5, S1, S2 and S3. These 5 nerves group are together deep in the buttocks, near the anterior surface of the piriformis muscle, and join into one large, thick sciatic nerve. In terms of innervation, the sciatic nerve supplies motor innervation to the posterior thigh muscles, including the hamstrings (biceps femoris, semitendinosus, and semimembranosus). These muscles are crucial for hip extension and knee flexion. The sciatic nerve's branches also provide motor innervation to all muscles below the knee, including those involved in foot and toe movements, through the tibial and common fibular nerves. This sensory distribution is vital for the perception of touch, pain, and temperature in these regions, contributing to overall proprioception and the sensation of the lower extremity (3).

Tibial Nerve- a major continuation of the sciatic nerve. It originates as the sciatic nerve bifurcates and then travels through the popliteal fossa. From there, it descends in the rear compartment of the leg and passes rear to the medial malleolus into the foot. I is the strongest branch of the sciatic nerve and arises from the spinal nerve segments L4-S3. The tibial nerve has both somatomotor and somatosensory fibre qualities. Its main task is the innervation of the flexors of the lower leg and the intrinsic foot muscles as well as the sensitive supply of the sole of the foot. These muscles are essential for plantarflexion of the foot, inversion of the foot, and flexion of the toes, which are crucial actions for walking, running, and maintaining balance. Additionally, the tibial nerve innervates intrinsic foot muscles control of the toes and the maintenance of the foot's arches. The tibial nerve also supplies sensory innervation to the skin[i] of the heel and sole of the foot via its medial and lateral plantar nerve branches. This sensory innervation is critical for the perception of touch, pain, and temperature in these areas, contributing to the overall sensory feedback necessary for activities such as standing and walking (3).

Common Fibular Nerve- plays an essential role in innervating the lower leg. It originates from the sciatic nerve and encircles the neck of the fibula, where it splits into the superficial and deep fibular nerves. The superficial fibular nerve provides motor innervation to the lateral leg muscles, specifically the fibularis longus and fibularis brevis. These muscles are vital for the eversion and plantarflexion of the foot, which contribute to balance and gait. Additionally, the superficial fibular nerve supplies sensory innervation to the skin on the top of the foot, enabling the perception of touch, pain, and temperature in this area. On the other hand, deep fibular nerve innervates the frontal leg muscles, including the tibialis anterior, extensor digitorum longus, extensor hallucis longus, and fibularis tertius. These muscles are crucial for dorsiflexion of the foot and extension of the toes, actions that are essential for walking and running. The deep fibular nerve also supplies the intrinsic muscles of the top of the foot, such as the extensor digitorum brevis, which assists in toe extension. Furthermore, it provides sensory innervation to the skin between the first and second toes, an area critical for proprioception and maintaining balance during movement (3).

Other Significant Nerves- the superior gluteal nerve, inferior gluteal nerve, and posterior femoral cutaneous nerve are crucial components of the lower limb's nervous system, each with unique origins, pathways, and innervation patterns. The superior gluteal nerve, arising from the spinal nerve origins of L4 to S1 (3).

4.2.5. Blood Vessels

The blood vessels of the lower limb are critical for providing oxygen and nutrients to the tissues, as well as for removing waste products. The vascular system of the lower extremities includes arteries, veins, and capillaries that facilitate the circulation of blood.

Arteries of the Lower Limb- originate from the abdominal aorta, which bifurcates into the common iliac arteries. These further divide to provide the main arterial branches to the lower extremities.

Iliac arteries are blood vessels that supply the back and abdominal muscles, lower extremities, pelvis, reproductive organs and other pelvic organs. There are two iliac arteries - one on the right side of the body and one on the left side of the body. Both common iliac arteries branch off from the floor of the aorta and each of the two arteries travels down about 3 centimetres before dividing into the internal and external iliac arteries. This transition marks a significant point in the vascular supply to the lower extremities (3).

The femoral artery is a major artery that supplies oxygen-rich blood to the tissues of the lower extremities and partly to the frontal abdominal lining. The femoral artery begins as a prolongation of the external iliac artery after moving beneath the inguinal ligament. In addition to providing critical blood flow, branches into several important arteries, including the deep femoral artery (3).

The popliteal artery travels through the popliteal fossa at the back of the knee, serving as a major conduit for blood flow to the lower leg. As it travels through this region, it branches out to supply several key structures of the knee and lower limb. Among its branches are the genicular arteries, which supply the knee joint and the surrounding structures, ensuring adequate blood flow to support the complex movements and demands placed on the knee during activities. It further brunches into the anterior and the posterior tibial artery. The anterior travels down through in the frontal part of the leg and continues as the dorsalis pedis artery. Providing essential blood flow to the frontal structures of the lower limb. The posterior tibial artery, on the other hand, follows along the backside of the leg and branches into the medial and lateral plantar arteries. These branches provide the sole, playing a crucial role in sustaing the function and health of muscles and tissues. Additionally, the fibular artery, delivers blood to the outer section of the leg, ensuring that the muscles and tissues in this area receive adequate blood supply for their metabolic needs (3).

Veins of the Lower Limb- involve surface and internal veins, which work together to return deoxygenated blood to the heart. The surface veins are crucial in the venous return of blood to the heart. The saphenous vein serves as the principal vein in the superficial venous system of the leg. Starting at the inner end of the venous arch in the foot, it travels up the inner side of the lower leg, knee, and thigh, eventually emptying into the femoral vein near the oval fossa. In the thigh, it is joined by another superficial vein, known as the accessory saphenous vein. The saphenous vein is interconnected with the small saphenous vein through numerous anastomoses, and several perforating veins link it to the deep venous system of the leg. This vein is often utilized as an autograft in cardiac surgery for coronary artery bypass grafting, as well as in vascular surgery for peripheral arterial bypass procedures (3).

The small saphenous vein begins at the outer side of the dorsal venous arch of the foot. It travels up along the back of the leg and empties into the popliteal vein. This vein plays a key role in draining blood from the outer and back parts of the lower leg. The deep veins follow the same path as the matching arteries and are essential for draining blood from the deeper tissues of the lower limbs. The femoral vein runs alongside the femoral artery and drains the profound tissues of the thigh. As it continues upward, it eventually transitions into the external iliac vein (3).

The popliteal vein is created by the merging of the anterior and posterior tibial veins. It removes blood from the knee structures and continues as the femoral vein. This vein is crucial for evacuating blood from the knee and lower leg regions. The anterior tibial vein clears the front part of the leg, collecting blood from the muscles and tissues in this area. The posterior tibial vein manages drainage from the rear compartment, ensuring that blood from the back muscles and tissues is effectively returned to the heart. The fibular (peroneal) vein removes blood from the outer section of the leg, collecting blood from the lateral muscles and structures, and contributing to the overall venous return system of the lower extremity. Together, the surface and internal veins of the lower extremities form a comprehensive network that ensures efficient blood return from the legs to the heart, maintaining proper circulation and preventing venous stasis (3).

Capillary Networks- the capillary networks of the lower limb are the sites of nutrient and gas exchange. These microscopic vessels connect the arterial and venous systems, ensuring that tissues receive adequate O2 and nutrients while removing CO2 and metabolic waste products (3).

4.3. Risk Factors of sports injuries

Injuries to the lower extremities can arise from a multitude of risk factors that encompass intrinsic and extrinsic elements. Intrinsic factors include individual physiological characteristics such as age, gender, anatomical anomalies, muscle imbalances, and previous injury history. Age-related changes, such as decreased bone density and reduced muscle strength, can predispose older individuals to fractures and soft tissue injuries. Gender-specific differences, are often attributed to hormonal influences, anatomical variations, and neuromuscular control disparities.

Anatomical anomalies, such as limb length discrepancies or malalignments (e.g., flat feet or high arches), can alter biomechanics and increase stress on specific structures, leading to overuse injuries. Muscle imbalances, where certain muscles are stronger or more flexible than their antagonists, can cause joint instability and improper movement patterns, further elevating the risk of injury. Previous injuries are significant predictors of future injuries, as they may result in residual weakness, proprioceptive deficits, or scar tissue formation, which can compromise the integrity of the affected area (4).

Extrinsic factors include environmental and activity-related elements such as type of physical activity, training intensity, surface type, footwear, and equipment use. High-impact sports or activities with sudden directional changes, such as basketball, soccer, and running, inherently carry a higher risk of lower extremity injuries due to the demands they place on muscles, ligaments, and joints. Inadequate training intensity, whether it be excessive or insufficient, can lead to overuse injuries or insufficient conditioning, respectively. The type of surface on which activities are performed also plays a crucial role; hard, uneven, or slippery surfaces can increase the likelihood of falls, sprains, and stress fractures. Footwear that lacks proper support or is inappropriate for the specific activity can exacerbate biomechanical issues and lead to injury. Additionally, improper or lack of protective equipment can leave the lower extremities vulnerable to trauma (4).

Comprehending these risk factors is crucial for creating effective prevention strategies, such as tailored strength and conditioning programs, biomechanical assessments, proper training regimens, and the use of appropriate footwear and equipment. By addressing both intrinsic and extrinsic risk factors, healthcare professionals, coaches, and athletes can work towards minimizing the incidence of lower extremity injuries and enhancing overall performance and safety.

4.4. Knee Injuries

Knee injuries are prevalent among athletes and individuals engaged in physical activities, as well as in the general population due to various intrinsic and extrinsic factors. These injuries can range from acute traumatic incidents to chronic overuse conditions. Effective management of knee injuries requires a comprehensive approach that includes accurate diagnosis, appropriate therapy, preventive strategies, and structured rehabilitation (5).

4.4.1. Diagnosis

Accurate diagnosis of knee injuries is crucial for determining the appropriate treatment plan. Gathering a detailed patient history is the first step in diagnosing knee injuries. This includes understanding the mechanism of injury, the onset of symptoms, and any previous knee problems. It is essential to ask questions regarding the type and intensity of physical activity involved, any audible sounds at the time of injury (such as a "pop"), and the presence of swelling or instability. This information helps in forming a preliminary understanding of the potential injury and its severity. A thorough physical examination is the next crucial step. This involves inspection, palpation, and specific manoeuvres to assess the range of motion, ligament integrity, and the presence of effusion or tenderness. Commonly included tests are Lachman, anterior drawer and McMurray's test, which are instrumental in assessing ligament and meniscal injuries. The Lachman and anterior drawer test help evaluate the stability of the anterior cruciate ligament. McMurray's test is used to detect meniscal tears. Imaging studies provide detailed insights that are essential for a comprehensive diagnosis. Radiographic imaging, such as X-rays, can identify fractures and degenerative changes in the bone structures. However, for a more detailed assessment of the soft tissues, including ligaments, menisci, and cartilage, MRI is particularly valuable. Magnetic Resonance Imaging scans offer a clear view of these structures, allowing for an accurate evaluation of the extent and nature of the injury (6).

4.4.2. Therapy

Therapeutic interventions for knee injuries are categorized into non-surgical and surgical approaches.

Non-Surgical Therapy- many knee injuries can be managed conservatively using the RICE protocol. NSAIDs are commonly prescribed to alleviate the symptoms. Physical therapy is a crucial component of non-surgical management, focusing on exercises that enhance strength, flexibility, and proprioception. These exercises are tailored to restore function and prevent future injuries. Additionally, bracing or taping the knee may be recommended to provide support and stability during the healing process, ensuring that the knee is protected from further damage while allowing for gradual rehabilitation (7).

Surgical Therapy- in cases of severe knee injuries, such as complete ligament tears, significant meniscal damage, or fractures, surgical intervention may be necessary. Common surgical procedures include arthroscopic repair or reconstruction of ligaments, such as anterior cruciate ligament reconstruction, which is often required for athletes and individuals with high activity levels. Meniscectomy or meniscal repair is performed to address meniscal tears, preserving as much of the meniscus as possible to maintain knee function and prevent long-term joint issues. Fracture fixation is necessary for stabilizing broken bones and ensuring proper healing. Advances in minimally invasive surgical techniques have significantly improved outcomes, reducing recovery times and minimizing the risks associated with surgery. These techniques involve smaller incisions, less tissue damage, and quicker rehabilitation, allowing patients to return to their normal activities more rapidly (8).

4.4.3. Prevention

Preventive strategies aim to reduce the risk of knee injuries by addressing modifiable factors and enhancing protective measures. Regular strength training is crucial, particularly focusing on the quadriceps, hamstrings, and core muscles, as these helps support the knee joint and improve stability. Conditioning programs should incorporate exercises that enhance flexibility and balance, which are vital for maintaining proper joint function and preventing injuries. Educating athletes and individuals on the correct techniques for jumping, landing, and pivoting is essential for minimizing stress on the knee joint (5).

Coaches and trainers should emphasize maintaining proper alignment and avoiding excessive knee valgus during activities, as improper technique can lead to undue stress and potential injury. Using appropriate footwear that provides adequate support and cushioning is fundamental in preventing knee injuries. The right shoes can help absorb shock and reduce the impact on the knee joints. For those participating in high-risk sports, wearing knee braces or supports can offer additional protection, helping to stabilize the knee and prevent excessive movements that could result in injury. It is important to increase the activity step by step to avoid recurrent injuries. Implementing proper warm-up and cool-down routines is also crucial for preparing the muscles and joints for activity and facilitating recovery. Warm-up exercises help increase blood flow to the muscles and enhance flexibility, while cool-down exercises help reduce muscle stiffness and promote recovery after physical exertion (5).

4.4.4. Rehabilitation

Rehabilitation is a critical component of the recovery process, aimed at restoring function, reducing pain, and preventing recurrence. In the initial phase of rehabilitation, the focus is on reducing pain and swelling.

In the last phase, the emphasis changes to sport-specific or activity-specific training to prepare the individual for a return to their desired activities. This phase emphasizes plyometric exercises, agility drills, and dynamic stability exercises to ensure the knee can handle the physical demands of the activity. A gradual return to full activity is recommended, with ongoing monitoring and assessment to ensure the knee can withstand the stress of the activity. Continued adherence to a maintenance exercise program is important for long-term knee health, helping to prevent future injuries and maintain optimal function. This comprehensive approach to rehabilitation ensures a safe and effective recovery, allowing individuals to return to their activities with confidence (9).

Knee injuries are complex and require a multifaceted approach to ensure optimal outcomes. Accurate diagnosis, appropriate therapeutic interventions, preventive strategies, and comprehensive rehabilitation are essential components of effective knee injury management. By addressing each of these aspects, healthcare professionals can enhance recovery, prevent recurrence, and improve the quality of life for individuals with knee injuries (9).

4.5. Ankle injuries

Ankle injuries are prevalent in musculoskeletal injuries, especially in sports and physical activities. They can range from mild sprains to severe fractures and ligament tears. Effective management of ankle injuries necessitates accurate diagnosis, appropriate therapy, preventive measures, and structured rehabilitation to ensure optimal recovery and prevent recurrence.

4.5.1. Diagnosis

Accurate diagnosis of ankle injuries is crucial for determining the appropriate treatment plan. The diagnostic process typically involves a detailed anamnesis. Gathering a comprehensive history of the injury is the first step, which includes understanding the mechanism of injury, the onset of symptoms, and any previous ankle problems. Important questions include the nature of the activity at the time of injury, any audible sounds such as a "pop," and the presence of swelling, bruising, or instability. This information helps form an initial understanding of the potential injury and its severity. A thorough physical examination is the next crucial step. This involves inspection, palpation, and specific manoeuvres to assess the range of motion, ligament integrity, and the presence of tenderness or deformity (10).

Frequently utilized assessments include the anterior drawer test and talar tilt examination, which are instrumental in assessing ligament stability. These tests help determine the extent of ligament damage and the overall stability of the ankle joint. Imaging studies provide detailed insights essential for a comprehensive diagnosis. Radiographic imaging, such as X-rays, is essential for identifying fractures and assessing joint alignment. However, for a more detailed assessment of soft tissues, including ligaments, tendons, and cartilage, MRI is particularly valuable. Magnetic Resonance Imaging scans offer a clear view of these structures, allowing for an accurate evaluation of the extent and nature of the injury. Additionally, ultrasound can be used to assess ligamentous injuries and tendon pathology, providing a real-time evaluation of the soft tissues (10).

4.5.2. Therapy

Therapeutic interventions for ankle injuries can be categorized as non-surgical and surgical approaches. Many ankle injuries can be managed conservatively. Initial treatment is to reduce pain and swelling. NSAIDs can help manage pain and inflammation. Physical therapy is crucial for restoring function, involving exercises that improve strength, flexibility, and proprioception. In cases of severe sprains, immobilization with a brace or splint may be necessary to allow for proper healing and to stabilize the ankle joint. Surgical intervention may be necessary for severe injuries, such as complete ligament tears, significant fractures, or chronic instability that does not respond to conservative treatment. Common surgical procedures include ligament repair or reconstruction, fracture fixation, and tendon repair. Advances in arthroscopic techniques have significantly improved outcomes and reduced recovery times for many ankle surgeries, offering less invasive options with faster recovery periods (10).

4.5.3. Prevention

Preventive strategies aim to reduce the risk of ankle injuries by addressing modifiable factors and enhancing protective measures. Regular strength training is essential, particularly focusing on muscles around the ankle, like the peroneal, tibialis anterior, and tibialis posterior. These exercises help support the joint and improve stability. Conditioning programs should incorporate exercises that enhance flexibility, balance, and proprioception, which are critical for maintaining proper joint function and preventing injuries.

Educating athletes and individuals on the correct techniques for jumping, landing, and cutting manoeuvres is vital for minimizing stress on the ankle joint. Coaches and trainers should emphasize maintaining proper alignment and avoiding excessive inversion or eversion during activities. Proper technique helps distribute forces evenly across the ankle, minimizing the risk of injury during high-impact movements. Using appropriate footwear that provides adequate support and cushioning is crucial in preventing ankle injuries. Footwear should be chosen according to the requirements of the sport or activity to guarantee optimal support (10).

For high-risk sports, wearing ankle braces or supports can offer additional protection by stabilizing the joint and preventing excessive movements that could lead to injury. Taping techniques can also provide extra stability during physical activity, helping to secure the ankle and reduce the likelihood of sprains. Gradually increasing the intensity and duration of physical activities stabilizes the body which results in a lower risk of injuries. A sudden increase in activity can place excessive strain on the ankle joints, leading to injury. Implementing adequate warm-up and cool-down routines is also important for preparing the muscles and joints for activity and facilitating recovery. Warm-up exercises increase blood flow to the muscles and enhance flexibility, while cool-down exercises help reduce muscle stiffness and promote recovery after physical exertion (10).

4.5.4. Rehabilitation

Rehabilitation is a critical component of the recovery process, aimed at restoring function, reducing pain, and preventing recurrence. In the early phase, the focus is on reducing pain and swelling. As symptoms improve, the rehabilitation program progresses to include weight-bearing exercises, more advanced strengthening exercises, and proprioceptive training. These exercises help build strength and stability, preparing the ankle for more demanding activities. In the late phase, the focus shifts to sport-specific or activity-specific training to prepare the individual for a return to their desired activities.

This phase emphasizes plyometric exercises, agility drills, and dynamic stability exercises to ensure the ankle can handle the physical demands of the activity. These targeted exercises help improve coordination, strength, and stability in dynamic movements. A gradual return to full activity is recommended, with ongoing monitoring and assessment to ensure the ankle can withstand the stress of the activity. Continued adherence to a maintenance exercise program is important for long-term ankle health, helping to prevent future injuries and maintain optimal function. This comprehensive approach to rehabilitation ensures a safe and effective recovery, allowing individuals to return to their activities with confidence (9).

Ankle injuries are complex and require a multifaceted approach to ensure optimal outcomes. Accurate diagnosis, appropriate therapeutic interventions, preventive strategies, and comprehensive rehabilitation are essential components of effective ankle injury management. By addressing each of these aspects, healthcare professionals can enhance recovery, prevent recurrence, and improve the quality of life for individuals with ankle injuries (9).

4.6. Shin and foot injuries

Shin and foot injuries are common among athletes and active individuals, often resulting from overuse, trauma, or improper biomechanics. These injuries can significantly impair mobility and function, necessitating a comprehensive approach for effective management. This chapter explores the diagnosis, therapy, prevention, and rehabilitation of shin and foot injuries.

4.6.1. Diagnosis

Precise diagnosis is essential for effective management of shin and foot injuries. The diagnostic process involves a detailed anamnesis. A thorough patient history is the first step in diagnosing shin and foot injuries. This includes understanding the onset of symptoms, the mechanism of injury, and any previous issues. Questions should cover the type and intensity of physical activities, the type of footwear used, and any changes in training patterns. Specific symptoms such as the location of pain, swelling, numbness, and functional limitations provide valuable clues that can help in forming an initial understanding of the injury. A comprehensive physical examination is the next crucial step. This includes inspection, palpation, and functional tests. For shin injuries, tenderness along the tibia and pain during weight-bearing activities are key indicators (11).

Foot injuries may present with deformities, localized tenderness, and restricted range of motion. Special tests, such as the Thompson test for assessing Achilles tendon integrity or the tuning fork test for detecting stress fractures, help pinpoint specific injuries and determine the severity of damage. Diagnostic imaging is essential for a detailed assessment and accurate diagnosis. Radiographs are crucial for identifying fractures and bony abnormalities. MRI and US are valuable tools for evaluating soft tissue injuries, such as tendonitis or plantar fasciitis, providing detailed images of ligaments, tendons, and other soft tissues. Bone scans and CT scans are particularly useful for detecting stress fractures and complex bony injuries, offering detailed insights into bone integrity and the presence of microfractures (11).

4.6.2. Therapy

Therapeutic interventions for shin and foot injuries depend on the type and seriousness of the injury. It can be categorized into non-surgical and surgical approaches. Many shin and foot injuries can be managed conservatively. The first-line treatment typically should follow the RICE procedure to reduce swelling. NSAIDs are used to manage inflammation and pain. Physical therapy is crucial in rehabilitation, including activities to enhance strength, flexibility, and proprioception. Orthotics and supportive footwear can correct biomechanical issues and provide relief from symptoms. For shin splints, activity modification to reduce impact is essential, along with flexibility and muscle-building exercises for the lower leg muscles and using shock-absorbing insoles. In cases of Achilles tendonitis, eccentric strengthening exercises, heel lifts, and immobilization in severe cases are recommended to alleviate symptoms and promote healing. Surgical intervention may be necessary for severe or refractory injuries that do not respond to conservative treatment. Common surgical procedures include fasciotomy for chronic compartment syndrome, reconstruction of complete tendon ruptures, and excision of bone spurs or neuromas (11).

4.6.3. Prevention

Preventive strategies aim to reduce the risk of shin and foot injuries by addressing modifiable factors and enhancing protective measures. Regular strength training, particularly for the muscles of the lower extremities, is crucial for supporting joints and improving stability. Conditioning programs should incorporate exercises that enhance flexibility, balance, and proprioception, ensuring that the muscles and joints are well-prepared for physical activity and can handle the stresses placed upon them. Educating athletes and individuals on proper techniques for running, jumping, and landing is essential for minimizing stress on the shin and foot.

Highlighting the significance of gradually increasing training intensity and duration enables the body to adapt progressively, thus lowering the likelihood of repetitive strain injuries. This approach helps prevent injuries by ensuring that the body is not subjected to sudden, excessive demands. Using appropriate footwear that provides adequate support and cushioning is fundamental in preventing shin and foot injuries. Selecting the right shoes based on the specific demands of the sport or activity can help absorb shock and reduce impact on the joints. Custom orthotics may be recommended to correct biomechanical issues and provide additional support, enhancing overall foot function and reducing injury risk. Adequate warm-up and cool-down routines are also critical for injury prevention. Warm-up exercises prepare the muscles and joints for activity by increasing blood flow and enhancing flexibility, while cool-down exercises help facilitate recovery by reducing muscle stiffness and promoting relaxation. These routines ensure that the body is ready for physical exertion and can recover effectively afterward, minimizing the likelihood of injuries (11).

4.6.4. Rehabilitation

Rehabilitation is a critical component of the recovery process, aimed at restoring function, reducing pain, and preventing recurrence. In the early phase, the focus is on reducing pain and swelling through icing, compression, and electrical stimulation. Gentle movement and isometric fortification exercises are introduced to maintain joint mobility and muscle activation without exacerbating the injury. As symptoms improve, the rehabilitation program progresses to include weight-bearing exercises, more advanced strengthening exercises, and proprioceptive training. Activities such as static cycling and water therapy may be incorporated to improve cardiovascular endurance without overburdening the shin and foot. These exercises help build strength and stability, preparing the injured area for more demanding activities. In the later phase, the focus shifts to sport-specific or activity-specific training to prepare the individual for a return to their desired activities. This phase emphasizes plyometric exercises, agility drills, and dynamic stability exercises to ensure the shin and foot can handle the physical demands of the activity. These targeted exercises help improve coordination, strength, and stability in dynamic movements. A gradual return to full activity is recommended, with ongoing monitoring and assessment to ensure the shin and foot can withstand the stress of the activity. Continued adherence to a maintenance exercise program is important for long-term musculoskeletal health, helping to prevent future injuries and maintain optimal function. This comprehensive approach to rehabilitation ensures a safe and effective recovery, allowing individuals to return to their activities with confidence (9).

Shin and foot injuries are complex and require a multifaceted approach to ensure optimal outcomes. Accurate diagnosis, appropriate therapeutic interventions, preventive strategies, and comprehensive rehabilitation are essential components of effective injury management. By addressing each of these aspects, healthcare professionals can enhance recovery, prevent recurrence, and improve the quality of life for individuals with shin and foot injuries (9).

5. Discussion

The prevalence and impact of sports injuries to the lower extremities demand a multifaceted approach for effective management and prevention. Throughout this thesis, we have examined the various types of injuries that athletes commonly face, including ankle sprains, knee injuries, shin splints. The discussion centers on the complexities of these injuries, the critical need for precise diagnostic methods, and the implementation of comprehensive therapeutic strategies. One of the key findings is the significant role of biomechanics in both the development and prevention of lower extremity injuries. Biomechanical assessments provide valuable insights into the movement patterns and physical stresses experienced by athletes, enabling healthcare professionals to identify underlying risk factors. This knowledge is crucial for tailoring prevention programs that address specific vulnerabilities, thereby reducing the incidence of injuries (1).

The diagnostic process for lower extremity injuries is multifaceted, often requiring a combination of physical examinations, imaging techniques, and functional assessments. The integration of advanced imaging technologies, such as magnetic resonance imaging and ultrasound, has enhanced our ability to accurately diagnose injuries, allowing for more targeted and effective treatment plans. However, the availability and cost of these technologies can be a limiting factor, highlighting the need for continued research into cost-effective diagnostic tools (6).

Therapeutic interventions for lower extremity injuries are diverse, ranging from conservative measures to surgical options. The emphasis on individualized rehabilitation programs underscores the importance of personalized care in the recovery process. Rehabilitation not only focuses on physical recovery but also incorporates psychological support, recognizing the mental toll that injuries can take on athletes. The development of comprehensive rehabilitation protocols that integrate physical therapy, strength training, and psychological support is essential for promoting holistic recovery (7).

6. Conlusion

In the realm of sports, lower extremity injuries represent a significant challenge, impacting athletes across all levels of competition. This thesis has provided a comprehensive examination of these injuries, emphasizing the importance of accurate diagnosis and effective therapeutic strategies to ensure optimal recovery and return to play.

The analysis of common lower extremity injuries, and their stress fractures, highlighted the complexities involved in their management. Through detailed discussion, this paper underscored the critical role of advanced diagnostic tools such as MRI, X-rays, and clinical assessments, which are essential for pinpointing the exact nature and extent of injuries. The integration of these diagnostic methods enables healthcare professionals to formulate precise and effective treatment plans tailored to individual needs.

Therapeutic approaches were explored extensively, showcasing a range of interventions from conservative treatments like rest and physical therapy to surgical options when necessary. The emphasis on evidence-based rehabilitation protocols and personalized rehabilitation plans reflects the importance of a structured and systematic approach to recovery. By adhering to these protocols, athletes can ensure a safe and successful return to their sport, reducing the likelihood of re-injury

7. Summary

In summary, the management of sports injuries to the lower extremities requires a multifaceted approach that considers the intricate interplay of anatomical structures and biomechanical forces. Effective management includes accurate diagnosis, tailored therapeutic interventions, preventive measures, and comprehensive rehabilitation protocols. Precise diagnosis is essential, relying on imaging methods like MRI and ultrasound to offer detailed insights into the injury.

This precision allows for the formulation of effective, individualized treatment plans. Therapeutic interventions range from conservative measures like rest and physical therapy to surgical options when necessary. Personalized rehabilitation programs that incorporate strength training, flexibility exercises, and proprioceptive training are essential for full recovery and prevention of re-injury.

Preventive strategies are equally important, focusing on regular strength and conditioning programs, proper warm-up and cool-down routines, appropriate footwear, and education on correct sports techniques. Biomechanical assessments help identify individual risk factors, allowing for the development of customized prevention programs.

Ongoing research and progress in diagnostic and treatment methods will further improve our capacity to support athletes, enabling them to achieve their highest potential while minimizing the impact of injuries. This holistic approach is vital for the health, performance, and overall well-being of athletes.

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9. CV

Dominik Razmilc, born on October 27th, 1999, in Heilbronn, Germany, embarked on his academic journey in 2004 at primary school. After eight years at Gymnasium, he completed his secondary education with an Abitur in 2017.

Following his high school graduation, Dominik pursued his passion for medicine at the University of Rijeka in Croatia. Alongside his medical studies, he actively participates in sports, including football, judo, and tennis. Since 2019, he has also served as the captain of the futsal team at the medical faculty.