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PREVENTION OF ANKLE SPRAINS WITHIN MEN'S FOOTBALL  
TEAM – AN EXERCISE PACKAGE

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## PREVENTION OF ANKLE SPRAINS WITHIN MEN'S FOOTBALL TEAM – AN EXERCISE PACKAGE

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The purpose of this thesis was to create an ankle stability exercise package containing evidence based, research proven exercises for the prevention of ankle sprains in men's football that can be used by both coaches and players.

The thesis was done in collaboration with the second team of a local football club that compete in 4<sup>th</sup> division in Satakunta region, Musan Salaman RY. The exercise package was done by using recent studies that have shown the importance of different factors in prevention of ankle sprains. The literature supports the exercises chosen. Moreover, the thesis explores the reasons ankle injuries are the most common sport injuries in the world.

The theoretical part of the thesis consists of the ankle anatomy, mechanism of ankle injury, football as a sport and its injury factors, and the importance of therapeutic exercises in prevention of ankle injuries.

Through written instructions and coherent pictures in the exercise package, football players and coaches can learn more about the right kind of exercises when strengthening and improving mobility in the ankle. The exercises can also act as a motivational tool when the players and coaches can see the positive impact of implementing therapeutic exercises into the normal training program.

## CONTENTS

1	INTRODUCTION .....	4
2	THE PURPOSE AND AIM OF THE THESIS .....	5
3	THE ANKLE ANATOMY .....	5
3.1	Bones of the ankle.....	6
3.2	Joints of the ankle .....	7
3.2.1	The talocrural joint .....	7
3.2.2	The subtalar joint.....	8
3.2.3	The tibiofibular joint.....	8
3.3	Ligaments of the ankle.....	8
3.4	Muscles of the ankle .....	10
4	MECHANISM OF LOWER EXTREMITY INJURY AND ANKLE SPRAIN .....	11
4.1	Biomechanics of the ankle .....	12
4.2	Inversion sprain.....	14
4.3	Eversion sprain.....	15
4.4	High ankle sprain .....	15
5	FOOTBALL AS A SPORT.....	15
6	FOOTBALL INJURY FACTORS .....	19
6.1	Intrinsic factors .....	21
6.2	Extrinsic factors .....	22
6.3	Economic costs of injury .....	23
6.4	Injury effects .....	24
7	THERAPEUTIC EXERCISE.....	25
8	THE EXERCISE PACKAGE .....	28
9	THE PROCESS OF THE THESIS .....	30
10	DISCUSSION .....	32
	REFERENCES.....	34
	APPENDICES	

## 1 INTRODUCTION

Football is great for fitness and cardiovascular health. It is for players of all ages. (Website of Betterhealth 2015). As the competitiveness of the sport gets higher, the risk of injury increases. The costs of injuries to football players are huge. To minimize the injuries and the associated costs, preventive programmes are recommended. (Rahnama, Reilly & Lees 2002, 354.)

Ankle sprain has been the most common football injury since 1980. It has been reported that the average annual rate of ankle sprains is decreasing. The explanation for this positive trend is the implementation of exercise program strategies in the football clubs. Another factor contributing is that these days the training is more focused on “low-risk” activities such as recovery sessions, resistance training and physical conditioning. (Waldén, Hägglund & Ekstrand 2013, 3.) As most studies have found, implementing a good injury prevention exercise program can make a huge positive difference in the injury rates of football players.

Even though the occurrence of ankle sprains is decreasing the amount of them is still high when compared with other musculoskeletal injuries caused by football every year. Consequently, an injury prevention program is clearly needed. The program is useful whether the player is playing at a pro or amateur level of football. A good prevention program would help reduce the risk of injuries, cut down economic costs for teams and reduce the consequences of re-injury. An exercise package is very convenient, yet rarely used, for any team playing competitive football.

The thesis has been done in collaboration with the second team of Musan Salama RY. The team is called Musan Salama 2, and it is a men’s football team playing in the 4<sup>th</sup> division of Satakunta region. The average age of players is around 30 years of age. Some players are past semi-professionals whereas some are there just to have fun. The main aim of the team is to compete for a promotion to 3rd division after next season is over. The thesis aims to help the players to be more prepared for the physical challenge and avoid the risk of injuries.

## 2 THE PURPOSE AND AIM OF THE THESIS

The purpose of the thesis is to increase the knowledge about beneficial exercises in prevention of ankle sprains in football. The information gathered here can be used by both the players and the coaches in a format of an exercise package booklet. This booklet will allow individuals to reduce the risk of injury and create more stable ankle to enhance performance in a game of football

The thesis will highlight the importance of good ankle proprioception, balance and stability in prevention of ankle sprains in football. Properly designed exercise program would help football players to prevent and rehabilitate ankle sprains. In the theoretical part of the thesis, the specific need for this kind of package will be explained. Subsequently the type of exercises used and the reason for choosing them will also be explained. The result of the thesis will be an exercise package booklet with both photos and explanations to maximize the learning potential.

## 3 THE ANKLE ANATOMY

The musculoskeletal system of human beings is comprised of bones, joints and muscles (Tortora & Derrickson 2009, 198). The purpose of these three tissues, is to provide mobility and stability to the terminal structures (Kisner & Colby 2012, 849).

The ankle joint is a hinged synovial type of joint (Website of Medscape 2015). In synovial joint, you have a space called synovial cavity between the articulating bones. This allows the joints to be freely moveable. (Tortora & Grabowski 2000, 243.) The ankle is comprised of number of different joints (figure 1) and is one of the most important joints of the foot. The joints in the foot make it able to orientate in every direction, thus also making it very flexible and mobile. (Dimon 2008, 223.)

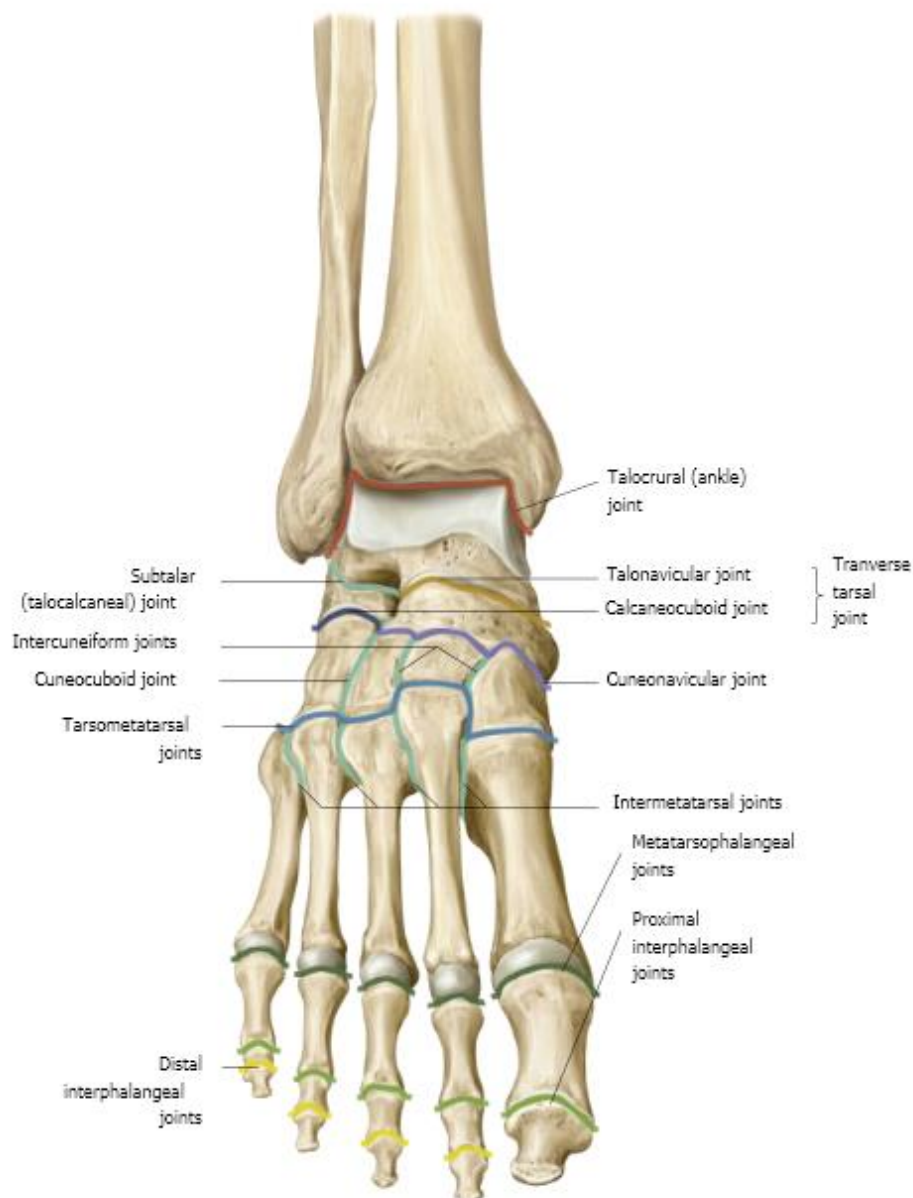


Figure 1. Joints of the ankle and foot (Website of Foundationpilates 2015)

### 3.1 Bones of the ankle

The bony frame of the ankle and foot consists of 28 different bones from front to back: one lateral and one medial sesamoid, 5 proximal; 4 middle and 5 distal phalanges, 5 metatarsals, 3 cuneiforms, cuboid, navicular, calcaneus and talus. The foot is divided into three segments: hindfoot (talus, calcaneus), midfoot (3 cuneiforms, cuboid, navicular) and forefoot (5 metatarsals, 14 phalanges). (Bouysset 1998 14-20.)

The talus is the bone that forms the ankle joint by articulating with the leg bones, forming the hinge. The sideways motions occur between the talus and the rest of the foot. Talus of the foot, is the only bone that articulates with tibia and fibula (Figure 1). Talocrural (ankle) joint is formed by the talus articulating on one side with the medial malleolus of the tibia and on the other side with the lateral malleolus of the tibia. (Tortora & Grabowski 2000, 234.)

### 3.2 Joints of the ankle

Three articulations work together in ankle complex: the talocrural joint, the subtalar joint and the distal tibiofibular syndesmosis. These three joints work together to make coordinated movement of the rearfoot possible. The different movements of the ankle are as follows: dorsiflexion, plantarflexion, eversion, inversion, and pronation (internal rotation) and supination (external rotation.). (Hertel 2002, 365.)

The joints that allow the eversion and inversion of the ankle are the subtalar joint, talocalcaneoclavicular joint and transverse tarsal joint (Agur & Dalley 2013, 466). According to Penny, J. (Website of Global Club Foot 2011) Subtalar joint complex plays a vital role in adapting the foot to uneven ground surfaces and adapting the ground reaction force during gait to rotation of the lower limb.

During weight-bearing, pronation of the subtalar and transverse tarsal joints (Figure 1) causes the arch of the foot to lower and is called loose-packed position of the joints of the foot. The supination in the same joints similarly increase the arch of the foot and is known as closed-packed position. (Kisner & Colby 2012, 851.)

#### 3.2.1 The talocrural joint

The talocrural, also known as the tibiofibular joint, is formed by the articulation of the dome of the talus, the tibial plafond, the medial- and the lateral malleolus. The shape of the joint lets the weight from the leg to be transmitted to the foot during weight bearing. Talocrural joint is a hinge joint that allows plantar- and dorsiflexion of the foot and receives ligamentous support from joint capsule among several other

ligaments. When comparing ATFL (anterior talofibular ligament) with the two other articulations in the ankle, the AFTL demonstrates lower maximal load and energy to failure values, which might explain why it is the most frequently injured of the ligaments. (Hertel 2002, 365.)

### 3.2.2 The subtalar joint

The articulations between the talus and the calcaneus forms the subtalar joint. Like the talocrural joint, this one converts the torque between lower leg and foot as well. The subtalar joint allows the motions of supination and pronation. Moreover, it consists of two separate joint cavities: the posterior- and the anterior subtalar joint. The deep ligaments stabilize the joint and form a barrier between the anterior- and posterior subtalar joint. (Hertel 2002, 366.)

### 3.2.3 The tibiofibular joint

Tibiofibular joint is the distal articulation between the tibia and fibula. Unlike the previous two joints discussed, this one is a syndesmosis type of joint and allows limited movement between tibia and fibula. The accessory gliding of this joint is very important to normal mechanics throughout the whole ankle complex. A thick interosseous membrane and the posterior- and anterior inferior tibiofibular ligaments stabilize the joint. The syndesmosis ankle sprain, or high ankle sprain, is caused by damage to the anterior inferior tibiofibular ligament. (Hertel 2002, 367.)

## 3.3 Ligaments of the ankle

Posterior talofibular and transversely oriented posterior tibiofibular ligaments strengthen the posterior aspect of the ankle. Lateral stability for the ankle comes from the calcaneofibular ligament. The posterior tibiocalcaneal and tibiotalar parts of the medial (deltoid) ligament stabilize it medially. (Agur & Dalley 2013, 458.)



The ligaments of the ankle (figure 2) that prevent anterior displacement of the leg bones are the strongest ligaments. These ligaments are: the posterior part of the medial ligament, the posterior talofibular, and calcaneofibula and tibiocalcaneal parts. (Agur & Dalley 2013, 459.)

The rigid medial ligament reinforces the joint capsule of the ankle. It attaches proximally to the medial malleolus and fans out from it to attach distally to the talus, calcaneus navicular. During the eversion of the foot, the medial ligament stabilizes and prevents subluxation of the ankle joint. (Agur & Dalley 2013, 460.)

Lateral ligaments reinforce the ankle joint laterally. Lateral ligaments consists of three separate ligaments: anterior talofibular ligament, calcaneofibular ligament and posterior talofibular ligament. (Agur & Dalley 2013, 462.)

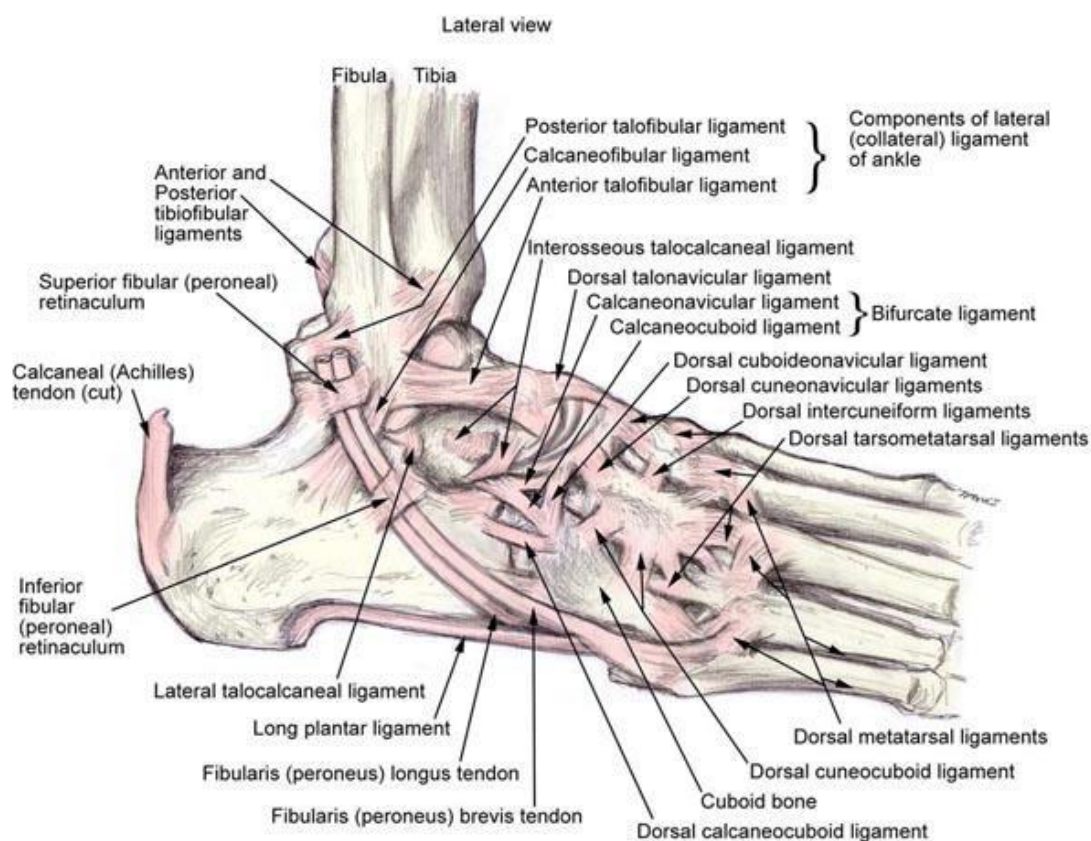


Figure 2. Anatomy of the lateral ankle ligamentous complex and related structures (Website of Medscape 2015)

### 3.4 Muscles of the ankle

The ankle motion is caused by the muscles in the lower leg (figure 3) whose tendons run through the ankle and connect in the foot. Two important muscle groups for the ankle motion are the peroneals and the calf muscles. In addition to these two groups, the posterior- and anterior tibialis are crucial for supporting and moving the ankle. (Website of eOrthoPod 2015.) Stability of the ankle complex is formed by the adjacent musculature and laterally consists of the peroneus longus and brevis. Ankle plantar flexion is actively controlled by the extensor digitorum longus and brevis, and the tibialis anterior. These muscles protect the ankle from injury since most ankle sprains occur in plantar flexion. (Martin, Davenport, Paulseth, Wukich & Godges 2013, 9.)



Figure 3. Foot muscles (Website of Joint Pain Expert 2015)

Contracted muscles create stiffness which results in dynamic protection of joints. The peroneal muscles are essential to the control of supination of the rearfoot and protection against lateral ankle sprains. Moreover, the muscles of the anterior part of the lower leg create stability for the lateral ankle complex, slow the plantar flexion component of supination and thus prevent injury to the lateral ligaments. (Hertel 2002, 367.)

Table 1. Muscles of anterior and posterior compartment of leg (Agur & Dalley 2013,430-440)

<b>Muscle</b>	<b>Movement (ankle)</b>
<b>Tibialis anterior</b>	Dorsiflexion, inversion
<b>Tibialis posterior</b>	Plantarflexion, inversion
<b>Peroneus longus</b>	Eversion, dorsiflexion
<b>Peroneus brevis</b>	Eversion, dorsiflexion
<b>Peroneus tertius</b>	Eversion, Dorsiflexion
<b>Soleus</b>	Plantarflexion
<b>Gastrocnemius</b>	Plantarflexion
<b>Extensor digitorum longus</b>	Dorsiflexion
<b>Extensor hallucis longus</b>	Dorsiflexion
<b>Flexor digitorum longus</b>	Plantarflexion
<b>Flexor hallucis longus</b>	Plantarflexion

Plantarflexion is mainly caused by Gastrocnemius and soleus (table 1). Tibialis posterior, flexor hallucis longus, flexor digitorum longus and peroneal muscles contribute little to plantarflexion but have other functions as well. Dorsiflexion of the ankle is caused by tibialis anterior (inverts the ankle), extensor hallucis longus, extensor digitorum longus (extends the toes) and the peroneus tertius muscles. Intrinsic muscles of the foot (not shown above) act in a similar way to those in hand. Moreover, they contribute support to the arches during gait. When standing, the gravitational line is anterior to the axis of the ankle joint which creates dorsiflexion. Other extrinsic foot muscles stabilize the foot during postural sways. (Kisner & Colby 2012, 854.)

#### 4 MECHANISM OF LOWER EXTREMITY INJURY AND ANKLE SPRAIN

The most common traumatic lower extremity injuries in athletes and other active populations is the ankle sprain. Ankle sprain often leads to impairments in ankle mo-

bility with dorsiflexion being most commonly reported ankle impairment. (Fernández-de-las-Penas, Cleland & Dommerholt, 2015, 637.)

Injury mechanisms that were found to be the most common were tackling, being-tackled, running, shooting, twisting and turning, and jumping and landing. The playing surfaces that are uneven may increase the loading on the ligaments and muscles. An injury usually follows, when the external loading is bigger than the ligaments and muscles can tolerate. Moreover, too much frictional force when twisting and turning, creates a lot of torque which also can create and injury. However, according to studies, non-body contact is the main mechanism of injury. The main reason ankle being one of the most injury prone areas in the body is the fact that in football, the body is always very close to the ball being played. According to National Collegiate Athletic Association the three most injured body parts were ankle (20%), upper leg (17%) and knee (15%). (Wong & Hong 2005, 475.) Large torques about the subtalar joint correspond to large torques at the talocrural joint about an axis parallel to the subtalar joint and consequently may lead to sprains if the load exceeds the strength of the ligaments (Wright, Neptune, Van Den Bogert, & Nigg 2000,264).

The most often used terms for describing an ankle ligament injury are mild, moderate and severe. A mild ligament sprain involves a stretch without macroscopic tearing, little swelling and minimal functional loss. A grade II also known as moderate tear, consists of a torn anterior talofibular ligament with an intact calcaneofibular ligament, partial macroscopic tear with moderate discomfort, swelling, loss of joint motion and small joint instability. A severe tear involves the whole lateral ligament complex tear with noticeable swelling, hemorrhage and tenderness. (Mann & Nyska 2002, 168.)

#### 4.1 Biomechanics of the ankle

The motions in the ankle and foot are defined as follows: Sagittal plane motion (dorsiflexion, plantarflexion), Frontal plane motion (eversion, inversion) and transverse plane motion (abduction, adduction). In dorsiflexion, the angle between the leg and the dorsum of the foot, decreases. Plantarflexion is the movement in the opposite di-

rection, the plantar direction. Inversion is the inward movement of the ankle and eversion is the outward movement of the ankle. (Kisner & Colby 2012, 850.) The movement away from the midline is called abduction, and the movements towards the midline is called adduction. In addition, the ankle has two defined triplanar motions which occurs around an oblique axis at each articulation of the ankle and foot. The first one is called pronation. It is a combination of dorsiflexion, eversion and abduction. The second one is called supination. It is a combination of plantarflexion, inversion and adduction. (Kisner & Colby 2012, 851.)

Foot and ankle are a dynamic mechanisms that form a link between the body and the ground (Rodgers 1988,1822). The primary mechanism for an ankle sprain is concomitant talocrural plantar flexion with talocalcaneal inversion. The peroneus longus acts as the most important defence against an inversion of the foot. (Branco de Oliveira 2009,13.) Motion occurs in 3 cardinal planes: 1) sagittal, 2) frontal, and 3) transverse planes. The movement in the sagittal plane is known as dorsiflexion and plantarflexion. The frontal plane motion is known as eversion and inversion. The motion in the transverse plane is adduction and abduction. Eventhough the ankle motion is defined by these 3 different planes, the mechanical axes of the joints of the ankle complex are not perpendicular to these planes. Motion always occurs perpendicular to the axis of the motion, the ankle complex motion occurs in planes other than these 3 cardinal planes. As a conclusion, ankle motion occurs in planes that pass through the 3 cardinal planes and is thus known as triplanar motion. Traditional terms to describe triplanar motion is supination (plantarflexion, inversion and adduction) and pronation (dorsiflexion, eversion and abduction). (Oatis 1988, 1815-1816.)

Subtalar joint is a hinge joint and it provides pronation and supination by gliding the calcaneus in different directions under the talus bone. Functional articulation between the hindfoot (talus and calcaneus) and midfoot (navicular and cuboid) is known as transverse tarsal joint. In supination, navicular glides medially and inferiorly on the head of the talus. The cuboid follows navicular by following the same movements on the calcaneus. In pronation, these motions are reversed. The motions with these two joints is interdependent. (Oatis 1988, 1817-1819.)

The tarsometatarsal joints of the foot are rotatory joints whose motion occurs in specific axes. These joints are divided into 5 different rays. The first and second ray is between the first and second metatarsal and medial cuneiform bones. The third ray is between the third metatarsal and lateral cuneiform. The fourth and fifth rays are formed between their metatarsals only. The motions of tarsometatarsal joints is not very well defined but they are believed to aid in plantar- and dorsiflexion. (Oatis 1988, 1819.)

The motion in the sagittal and transverse planes occur through the metatarsophalangeal joints of the foot. These axes go through each metatarsal providing pure plantar- and dorsiflexion, adduction and abduction in the cardinal planes of the body. (Oatis 1988, 1819.)

The movement of the foot and ankle complex will cause motion in the tibia and fibula which then results in movement on the upper leg aswell. Thus, the motion of the lower leg must be considered in terms of the resulting motion in the upper part of the leg. (Oatis 1988, 1820.) The ankle is subject to varus stress and compression due its lateral positioning when examined from center of gravity point of view. The ankle is exclusively responsible for transmission of all weight-bearing forces between the foot and the rest of the body. (Gross, Fetto & Rosen 2009, 379-380.)

#### 4.2 Inversion sprain

The most common ankle sprain is the inversion sprain. It occurs when the ankle moves outward and the foot turns inward. During these types of sprains, the Anterior talofibular ligament is often times injured. In some cases, where the force is very strong, the calcaneoFibular ligament is also damaged. (Website of Physioroom 2015.)

During an inversion sprain, studies have found that internal rotation occurs when the ankle is inverted at its peak. Research has shown the injury mechanism of inversion sprain is usually caused by supination or talocrural plantarflexion when the subtalar joint adducts and inverts. However, recent evidence shows this is not always the

case. Moreover, numerous studies have found ankle instability being the cause of sprain injury. (Fong, Ha, Mok, Chan & Chan 2011, 4-5.)

#### 4.3 Eversion sprain

Eversion sprain is an injury to the medial ligaments of the ankle. Only 5% of all sprains occur in medial ligaments. This type of injury happens when the foot is turned outward beyond control. Eversion sprains are rare but in most cases occur during jumping and running. (Website of University of Nebraska-Lincoln 2015.)

#### 4.4 High ankle sprain

High ankle sprain, also known as Syndesmotic sprain, is one in which the ligaments above the ankle are damaged. Syndesmotic ligaments are situated closest to the lower part of the leg. Outward twisting of the ankle and foot causes a high ankle sprain. These types of sprains are induced by side-to-side running, starting and stopping or turning while in motion. (Website of Footvitals 2015.)

Syndesmosis ankle injuries are far less frequent than lateral ankle sprains. In syndesmosis, the tibia and fibula are working together, providing stability to the lower part of the leg. Sustained intense external rotation of the ankle with abduction and dorsiflexion cause syndesmotic sprain. The mechanism of injury involve damage of the ligamentous structures between the distal tibia and fibula besides the damage of deltoid ligament. (Porter 2009, 575-576.)

## 5 FOOTBALL AS A SPORT

Football is known to be one of the most popular sports in the world. As a way of movements it requires walking, jogging, running and sprinting. In football, you have two teams of 11 players who attempt to score a goal while trying to prevent the op-

ponent of doing so. The game time in total is 90, consisting of two 45 minute halves and 15 minute break between them. According to studies, football has a very high injury rates. The most common injury in football is the ankle. (Wong & Hong 2005, 473.)

The game has to be played on a rectangular field with marked lines. The pitch length must not be shorter than 90 meters and no longer than 120 meters. The width of the pitch is 45 meters at minimum and 90 meters at maximum. Figure 4. shows normal football pitch and it's marked areas. Figure 5. shows the proper dimensions used for each area. (Website of Fifa 2015.)



Figure 4. The field of play (Website of THEFA 2015)



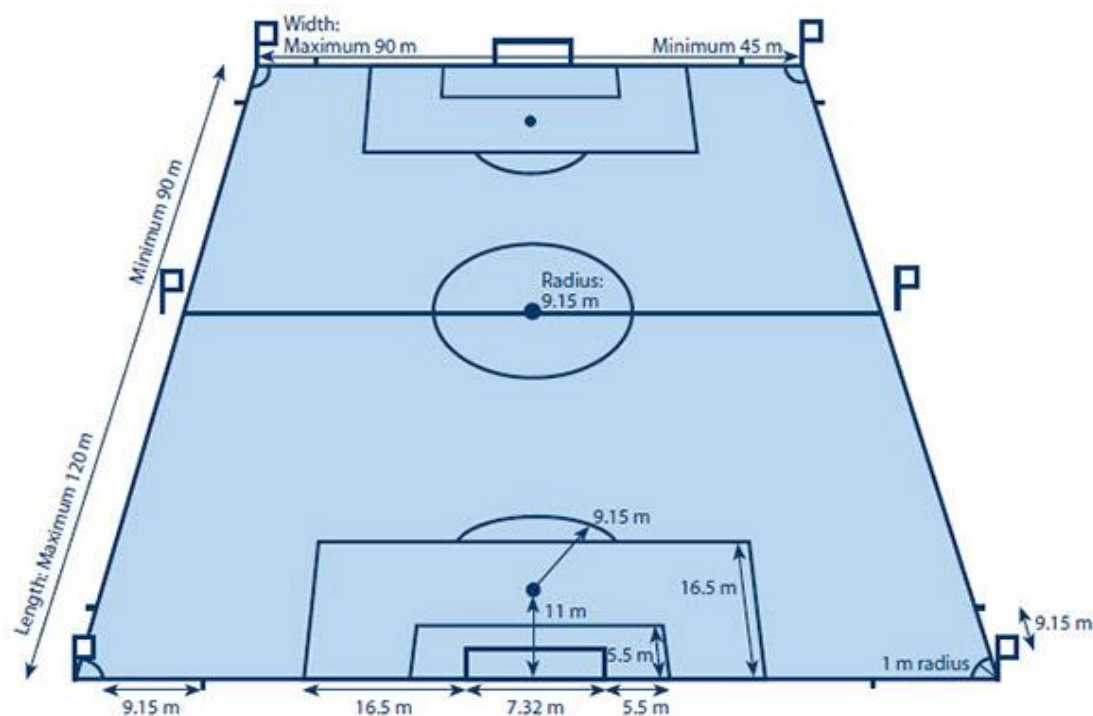


Figure 5. Metric measurements of the pitch (Website of THEFA 2015)

Football is a complex sport with large demands on a player. During a normal football match, a player at elite level covers on the average 10 to 11 km per game. The mean work rate is about 70-75% of maximum oxygen uptake and is very close to the anaerobic threshold. Apart from aerobic capacity, a football player needs adequate strength and power to support the short sprints, rapid acceleration or deceleration, turning, jumping, kicking and tackling. An effective training program must be designed to support all the aspects of these requirements. (Arnason et al. 2003, 278.)

The performance of the team depends upon the skills of individual players (figure 6) apart from their interaction and integration among the different players within the team. Technical and tactical skills are considered to be the most important features of an individual player. (Haugen & Seiler 2015, 10.)

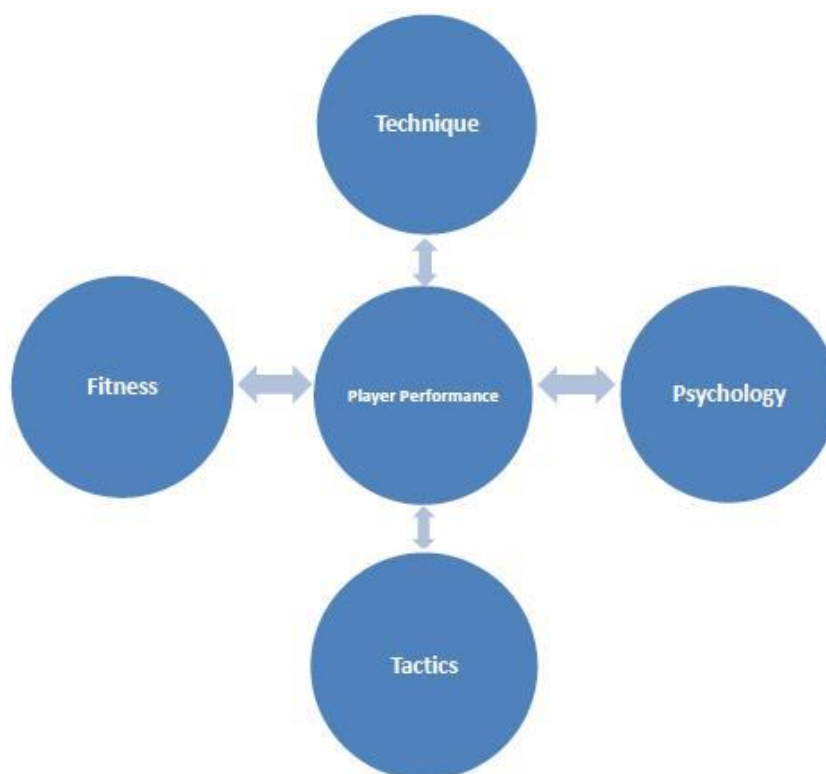


Figure 6. Individual qualities affecting the players performance (Website of Arlington soccer club 2015)

The cornerstone of every good football player is the technical skills. Being a technical players involves multiple different aspects as well e.g. dribbling, ball control, heading, tackling, passing and shooting. Developing fitness for individual players all the following sections should be included: strength and power, flexibility, endurance and pace. In football, the best players apart from technical and physical skills are usually also the smartest. Knowing how to play your position and formation are crucial. Psychological factors of individual players refer to their ability to be focused, disciplined and motivated. (Website of The Soccer Essentials 2015.)

From an individual player point of view, football involves an ongoing change of complex movement patterns. Sprinting, running, walking, sudden changes in direction, jumping and body contact demand a great deal of coordination and body control. The game presents with a vast variety of different injuries. Ankle and foot injuries are known to be the most common ones. (Website of Kitmanlabs 2015.)

Ekstand & Gillquist (1983, 269) stated that ankle sprains in mens football usually occur during running, cutting and in tackling situations. The exact reason for these was previously assessed.

## 6 FOOTBALL INJURY FACTORS

All around the world, people are participating in various kinds of sports for personal reasons and fitness training. Due to this reason, sports has been identified as one of the major cause of injuries. Absence of players due to unexpected injuries for commercial sports teams results in huge economic and match associated losses. Several studies have reported that ankle is the most traumatized body sites in sports. It accounts for 10-30% of all injuries suffered in sports, with ankle sprain being the most common type of injury. (Fong, Hong, Chan, Yung & Chan 2007,2.)

Studies suggest that atleast 40% of ankle injuries are mistreated and poorly diagnosed which in the later life leads to disability and chronic ankle pain. Self-education is crucial in order to lower the risk of this disabling complication. (Website of American College of Sports 2015)

Ankle sprain or lateral ankle ligament injury, is a very common problem in the acute care with an estimated rate of 10 000 people suffering ankle injuries daily. The most often observed injury in the emergency room is the ankle sprain. The total annual costs of ankle injuries in the world has been estimated to be 35 million US dollars per one million people. Ankle injury treatment is performed by emergency and primary health care doctors apart from orthopedic and trauma surgeons. The most often injured part of the lateral ankle ligament complex is the anterior talofibular ligament (AFTL). The posterior part of the ligament is usually uninjured unless there is an actual dislocation of the ankle. The three main modalities used in ankle injury treatment are: 1) Operative treatment 2) Conservative treatment and 3) Functional treatment. (Gino, Kerkhoffs, Pijnenburg & Van Dijk 2003,1)



sic factors one has no control of and non-modifiable factors being extrinsic factors which one can affect on. (Bahr & Holme 2003, 385.)

### 6.1 Intrinsic factors

The overall occurrences of injuries in football usually increase with age. Due to children under 12 years of age having smaller mass, lower velocity and better flexibility compared to older players suffer far less injuries. Studies have also found that the pattern of injury changes with age. (Tator 2008, 476.) A study also revealed that hamstring strains increase with age. Whether the injury risk increases linearly with age was however, not revealed. (Bahr & Holme 2003, 388.)

Football injuries apart from ACL (anterior cruciate ligament) and MTBI (mild traumatic brain injury) are generally similar in male and female players. Moreover, recent studies show that the incidence of concussion is on the rise with female players. (Tator 2008, 476.) Contributing factors for e.g. ACL tears in females when compared with men include joint laxity, core stability, hormonal influence, femoral notch size and hamstring weakness. (Giza & Michaeli 2005)

An increase in body size have been found to produce a proportional increase in the forces that stress articular, ligamentous and muscular structures which could increase the risk of an injury. However, according to a review of 5 different studies, no significant association between a BMI and a risk for muscle injury was found. (Giacchino & Stesina 2013, 278-279.)

Previous injury is one of the most well-known and crucial intrinsic risk factors in football. Research shows that 35% percent of injuries were identified with re-injuries, either an injury to the same location or type of injury being the same. (Tator 2008, 476.) An injury can cause scar tissue to form which might lead to reduced ROM and strength which then indirectly results with increased risk of re-injury. (Bahr & Holme 2003, 388.) According to Engebretsen, Myklebust, Holme, Engebretsen & Bahr (2009, 4) a history of previous acute injury is the sole important risk factor for new injuries to the same body part. Research also shows that players with

less previous injuries have fewer worries about their performance, less competitive anxiety, less peaking under pressure, lower anger trait score and less outward anger expression than players with more previous injuries. (Tator 2008, 476.)

Aerobic fitness plays a big part in risk factors for injuries. As the player fatigues, the muscle recruitment patterns change which may then impair the distribution of forces loading on the articular, ligamentous and muscular structure. Assessment of the players physical condition before the season start is critical for this reason. As a player fatigues, studies have found a decrease of hip and knee flexion and extension when sprinting. This biomechanical factor has been found to further contribute to the increased risk of injury. (Giacchino & Stesina 2013, 285-286.)

The joint forces and the anatomical structures (articular surfaces, menisci, ligaments, tendons and muscles) that work in a resistive way are all related through alignment of the joints and skeletal system. Due to this reason, the alignment of the hip, knee and ankle has been assumed to be a risk factor for lower extremity injuries. (Giacchino & Stesina 2013, 278-279.)

Association between skill level and injury rate has been noticed. Better skill level and knowledge of the game ultimately leads to fewer injuries. Players with better dribbling and long passing skills have been found to suffer less injuries. (Tator 2008, 477.) Moreover, research has found that highly skilled players in 17-18 age group, suffer more injuries than in any other youth groups. Injury rates being higher with more skilled players could be due to the fact that they also train more often and compete more intensely when compared with low-skilled players. (Giza & Michaeli 2005.)

## 6.2 Extrinsic factors

Different playing positions affect to the injury rates. Forwards and midfielders typically have higher risks of injury compared to defenders. Goalkeepers are however, most likely to suffer an injury to the upper extremities. (Tator 2008, 478-479.) Moreover, research found that forwards suffer 40% out of all tibia/fibula fractures (Giza &

Michaeli 2005). Injuries during games occur more often than in training, which is very likely related to the amount of player contact situations. 66% of injuries occur during games with the remainder occurring during training sessions, studies show. (Tator 2008, 478-479.) A research that studied 4 different FIFA tournaments, showed that 63% of tackles that resulted in foot or ankle injury were a result of foul play. Therefore adequate refereeing is important for injury prevention. (Giza & Michaeli 2005.)

Proper equipment e.g. shin guards protect the players from an injury (Tator 2008, 478). Biomechanical studies have shown that shin guards lower the magnitude of force on the tibia by extending the contact time, which as a result protects the players from an injury (Giza & Michaeli 2005). In addition, compression shorts are useful for reducing the risk of injury by increasing the warmth, blood flow and support for the muscles (Website of Sports Injury Clinic 2015).

Playing surface plays a big part in extrinsic injury factors. Studies have reported that 24% of injuries are caused by the poor quality of the playing surface. In addition, more incidence occur on artificial turf when compared to grass and gravel pitches. (Tator 2008, 478.)

Overall 27 injuries have been recorded where goalposts have been involved (Tator 2008, 478). In addition, studies have found most concussions are related to collision with the goal post (Giza & Michaeli 2005).

### 6.3 Economic costs of injury

In 2014 in the United States more than 231,000 football injuries were treated in emergency departments. Over 4,500 of those resulted in hospitalization. 73% percent of all recorded injuries were among men. (Website of U.S. Department of Health & Human Services 2014.)

Ankle sprains are a real public health problem because of the annual amount and economic costs they produce each year. Ankle sprains count 25% of all sports acci-

dents. In France only, 6000 sprains occur every day with the daily costs rising up to 1,2 million Euros. In 2003 in the United States, the annual costs of ankle sprains was estimated to be around 3,65 billion dollars. The costs of treatment for one ankle sprain in Netherlands is evaluated to be around 350 Euros. Functional treatment followed by RICE (rest, ice, compression, elevation) is known to be a good treatment for ankle sprains. This type of treatment is preferred to plastered immobilization and surgery. (Guillodo, Simon, Le Goff & Saraux 2013, 504.)

According to a study, a simple balance training program implemented during high school sport season will reduce the ankle sprains in both males and females by 38% in football and basketball. This program alone would reduce the injury costs by 26 million in health care and 380 million in indirect costs per year. (Mcguine & Keene 2006, 1109.)

#### 6.4 Injury effects

Pathologies like rheumatoid arthritis, juvenile rheumatoid arthritis, degenerative joint disease, and acute joint reactions after trauma, dislocation, or fracture affect foot and ankle complex. Anytime a joint is immobilized, adhesions and post immobilization contractures form in the joint capsule and surrounding tissues making it hypomobile. (Kisner & Colby 2012, 855.) According to Wright, Neptune, Van Den Bogert & Nigg (2000, 264.) however, if the flexibility of the ankle can be restored to the level it was before the injury, no significant change of occurrence of re-injury was found. Nevertheless, the study found that the strength of the ligaments considerably decreased after a sprain which then increased the possibility of re-injury.

Study shows that if a patient goes more than 28 days with immobilization or bracing of the ankle, the residual symptoms double over a period of 6-18 months. Although a proper rehabilitation techniques among young athletes like progressive exercise, neuromuscular training and functional activity training have been found to be very effective treatments for ankle sprain recovery. (Braun 1999, 147.)



Kuijt, Inklaar, Gouttebarga & Frings-Dresen (2012, 485-486.) states that lateral ankle sprains in sports are the main reason for ligamentous posttraumatic Osteoarthritis in ankles. For this reason, prevalence of ankle OA in elite football players have been found to be high compared to general population and other occupations.

## 7 THERAPEUTIC EXERCISE

Therapeutic exercise as a term means planned and organized performance of bodily movements, posture or physical activity. The intention of therapeutic exercises is to prevent impairments, affect positively to physical function and other health related statuses. (Yogitha 2012, 25.)

The exercise methods are constructed by variety of different techniques, actions and activities. The most common types of therapeutic exercise interventions are shown in table 2. (Yogitha 2012, 25.) The ability to function to the best of one's abilities is contingent upon physical as well as psychological and social function (figure 8) (Kisner & Colby 2012,2).

Table 2. Types of therapeutic exercises (Yogitha 2012, 25)

Aerobic conditioning and re-conditioning
Muscle performance exercises
Stretching techniques
Neuromuscular and body awareness training
Postural control, body mechanics and stabilization exercises
Balance and agility exercises
Relaxation techniques
Breathing exercises and ventilator muscle training
Task specific functional training

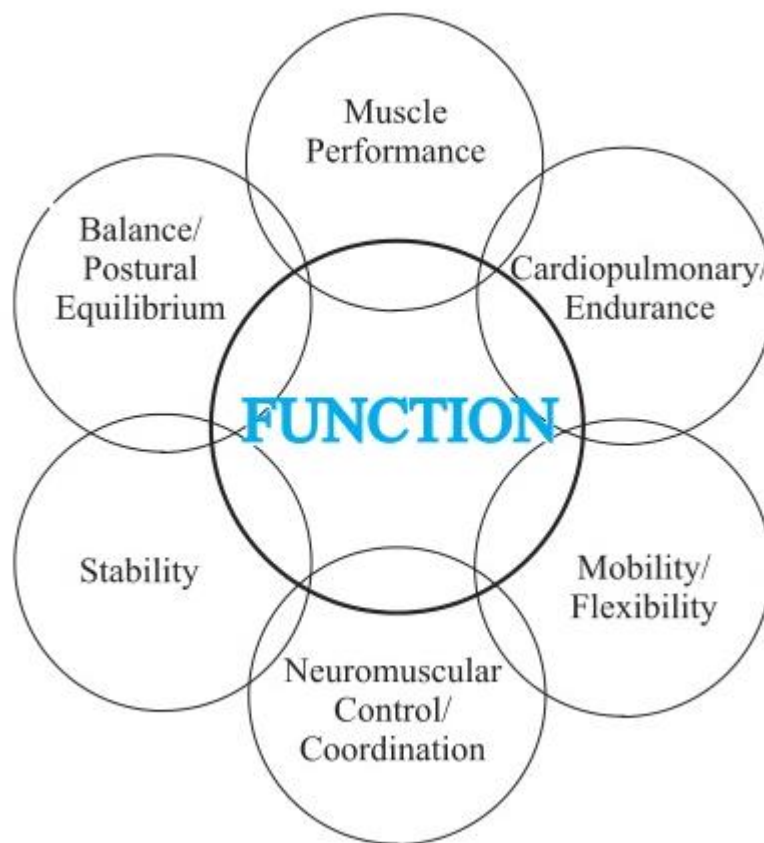


Figure 8. Interrelated components of physical function. (Kisner & Colby 2012,2)

An exercise can also be called a motor task. Integration of motor learning principles into exercise instruction boosts learning the actual exercise or functional task. (Kisner & Colby 2012,27.) A successful exercise program includes performing and learning variety of tasks (Kisner & Colby 2012,28).

Motor learning occurs in three different stages: cognitive, associative, and autonomous. In the cognitive stage, the athlete must learn the requirements and the purpose for the given exercise. In the next phase, associative phase, the athlete makes errors and focuses on repairing them. In the autonomous phase, the movements are automatic. (Kisner & Colby 2012,30-31.)

In football, exercises are usually designed as structured warm-up programs to make sure that all players use the program regularly. Coaches, especially in youth football, are the decision makers when it comes to the implementation of injury prevention programs. If the program takes too much time or isn't football specific, coaches are

less likely to implement it. An effective football program must accomplish 3 goals: 1) Ameliorate known risk factors, 2) be adopted by coaches and players, and 3) be performed on a consistent and ongoing basis. Team or group training is the most feasible way of implementing an injury prevention program. When executing the program, a qualified health care professional should monitor the players for frequency, content and quality of delivery. (Campbell et al. 2014, 265.)

According to Young & Farrow (2013, 42) the use of generic non-sport-specific stimulus in the exercises does not develop sport-specific skills. The neural adaptation received from sport specific strength training develops the force production that can be used in the sport the athlete is training for. (Häkkinen 1990, 119) The immediate effects of strength training to nervous-muscular-system and hormone balance are very individual, which makes the selection of adequate amount of repetitions for different athletes, very hard to define. In the functional circuit type of training, the different sizes of muscle groups can be trained one after another. Moreover, in the functional training, the focus of the exercises should be on the balance of agonist and antagonist muscles, adequate flexibility and mobility of the different joints. (Häkkinen 1990, 207.) The amount of functional exercise sessions the athlete is doing weekly, depends on the current level of the athlete. Persons who have been training for a longer period of time usually need 5-6 training sessions per week to gain the same amount of development that persons who have just started gain in 2-3 training sessions. (Häkkinen 1990, 208)

There isn't any up-to-date research on what the optimal amount of sets and repetitions for the exercises are (Kisner & Colby 2012). However, Mattacola & Dwyer (2002, 425) suggests that for strengthening exercises 3 sets of 10 reps should be performed. Mobilizing exercises should be performed 2 sets of 10 reps to any given direction. Typical amount of sets and repetitions for strength gains are 2 to 3 sets of 6 to 12 repetitions. The amount of repetitions should be increased as high as possible without proper form breaking down. Some sources recommend exercise load that causes fatigue after 8-12 repetitions from 2-3 sets. (Kisner & Colby 2015.)

The stability of the ankle joints is comprised of three different elements. The first is the congruity of the articular surfaces when the ankle is loaded. Second contributor is

the static ligamentous restraints. Third and the last one is the musculotendinous units. (Hertel 2002, 365.) Previously torn ankle presents with mechanical instability and functional instability during weight-bearing activities (Kisner & Colby 2012, 872). Proximal forces originating at the pelvis and hip contribute to the alignment fault of a pronated foot. Most common fault that exerts a pronatory stress on the foot is a poor control of the hip lateral rotator muscles allowing the hip to medially rotate. A supinated and rigid foot directs the forces up the closed kinetic chain rather than down. Stiff foot with inadequate dorsiflexion can stress the knee joint or the hip joint if the knee is stable. (Sahrmann 2002, 134.) Correction of the faulty movement patterns require specific exercises that improve the performance and correction of the impaired movement patterns (Sahrmann 2002, 144).

## 8 THE EXERCISE PACKAGE

The management of ankle sprains occurs in different stages. The first phase is called an acute phase of injury and is defined as the time when symptoms of inflammation start to appear and then begin to diminish. In the second phase, the sub-acute phase, body shifts from inflammation to proliferative stage. In the proliferative phase, the body starts to form new collagen and capillary, and thus repairing the injured tissue. Therapeutic exercises can be started a week from the injury. Currently the best practice for management of ankle sprains includes strengthening, balance and mobilization exercises to restore the function of the ankle and reduce the risk of re-injury. (Thomas et al 2013, 533.)

According to (Mattacola & Dwyer 2002); (Gino, Kerkhoffs, Pijnenburg & Van Dijk 2003); (McGuine & Keene 2006) and (Branco de Oliveira 2009,1) proprioceptive (balance, coordination and strength) exercises in ankle rehabilitation and prevention are the most effective. In addition, flexibility exercises for the ankle are crucial so that full functional exercises can be performed to the preinjury level and beyond (Mattacola & Dwyer 2002).

The evtor muscles (peroneus longus and brevis) of the ankle play an important part in preventing ligamentous injuries. (Branco de Oliveira 2009, 16) Ankle sprains most often re-occur because of incomplete healing of a tear. When an athlete suffers an ankle sprain, the flexibility or compliance of the ankle might not be affected, but the absolute strength of the ankle will. However, there is no evidence of decreased strength without a change in flexibility or compliance in an unstable ankle. (Wright, Neptune, Van Den Bogert & Nigg 2000, 263.)

A more flexible joint has also more range of motion. This increases the lever of arm of external forces towards the ankle which results in increase of occurrences of ankle sprains. If injury prevention is the goal, the exercises should limit the range of motion of supination of the ankle. Impaired proprioception, coordination, or muscle strength have bigger impact on ankle sprains than flexibility or compliance. (Wright, Neptune, Van Den Bogert & Nigg 2000, 264.) However, Fernandez-de-las-Penas, Cleland & Dommerholt (2015, 637) states the importance of good ankle dorsiflexion in ankle sprain prevention.

Proprioception contributes to the motor programming for neuromuscular control, which is required for precision movements. It also contributes to muscle reflex which provides the joints with stability. The main aim of proprioceptive training is to re-train afferent pathways to improve the feeling of joint movement. Proprioceptive training usually involves devices such as tilt boards, ankle disks and balance boards. All these devices demand the use of the muscles that supinate and pronate the feet, simultaneously training coordination, strength and proprioception). (Branco de Oliveira 2009, 24.)

One method for promoting motivation when showing the exercises to the athletes, is to design the program so that the easiest and least stressful exercises are shown first. When showing the exercises to the players, in this instance, the coaches should have a plan that will ease learning before and during exercise intervention. When showing the exercises first, it's important to pick an environment with little distractions. The correct way of doing the exercise should be shown first and right after the incorrect way. After demonstrating the movement, the players should perform the movement so that the coach can supervise and provide feedback. If the exercise program con-

sists of several exercises, the coach can show them in small increments to allow time for the player to practice and assimilate the different exercises. (Kisner & Colby 2012, 27.)

Effective instruction for functionally driven exercise program must include adherence. The factors influencing on athletes adherence can be grouped into few categories: athlete's characteristics, athlete's health related factors and program related variables. What a coach must do, is to use strategies that foster adherence. (Kisner & Colby 2012, 37.)

## 9 THE PROCESS OF THE THESIS

The idea for the thesis started in the spring 2015. The selection for choosing this topic was a combination of few different reasons. Firstly, I've played football almost my whole life. Within my future career I would like to work as a physiotherapist in a professional football club. The second reason is, during my time I've played football, I've suffered numerous injuries mainly in the ankle area. Apart from myself, I've witnessed football injuries on many occasions that could've been prevented by better warm up or by implementing a few therapeutic exercises in the training schedule.

The initial idea in the spring 2015 was to do a literature review of ankle injuries suffered by football players or an exercise package for football players in preventing ankle injuries. I began reading articles and books with these topics in my mind in the early days of summer 2015. After having a meeting with the mentor of the thesis, I decided to pick an exercise package for football players in preventing ankle injuries as the topic. Right along the same time, I contacted Musan Salama RY and agreed to do this thesis in collaboration with them.

During the 3 months in the summer of 2015 I wrote most of the theory part for the thesis. In the process of writing the theory and further reading the literature, I narrowed my topic down to only concern ankle sprains instead of all ankle injuries.

I'm happy with the topic I chose and I feel like the process has been enjoyable and interesting. Furthermore, I really believe these kinds of exercise packages including therapeutic exercises should be implemented in the training schedules for football players from early age. Figure 9. depicts the journey my thesis has taken during these months I've done it.

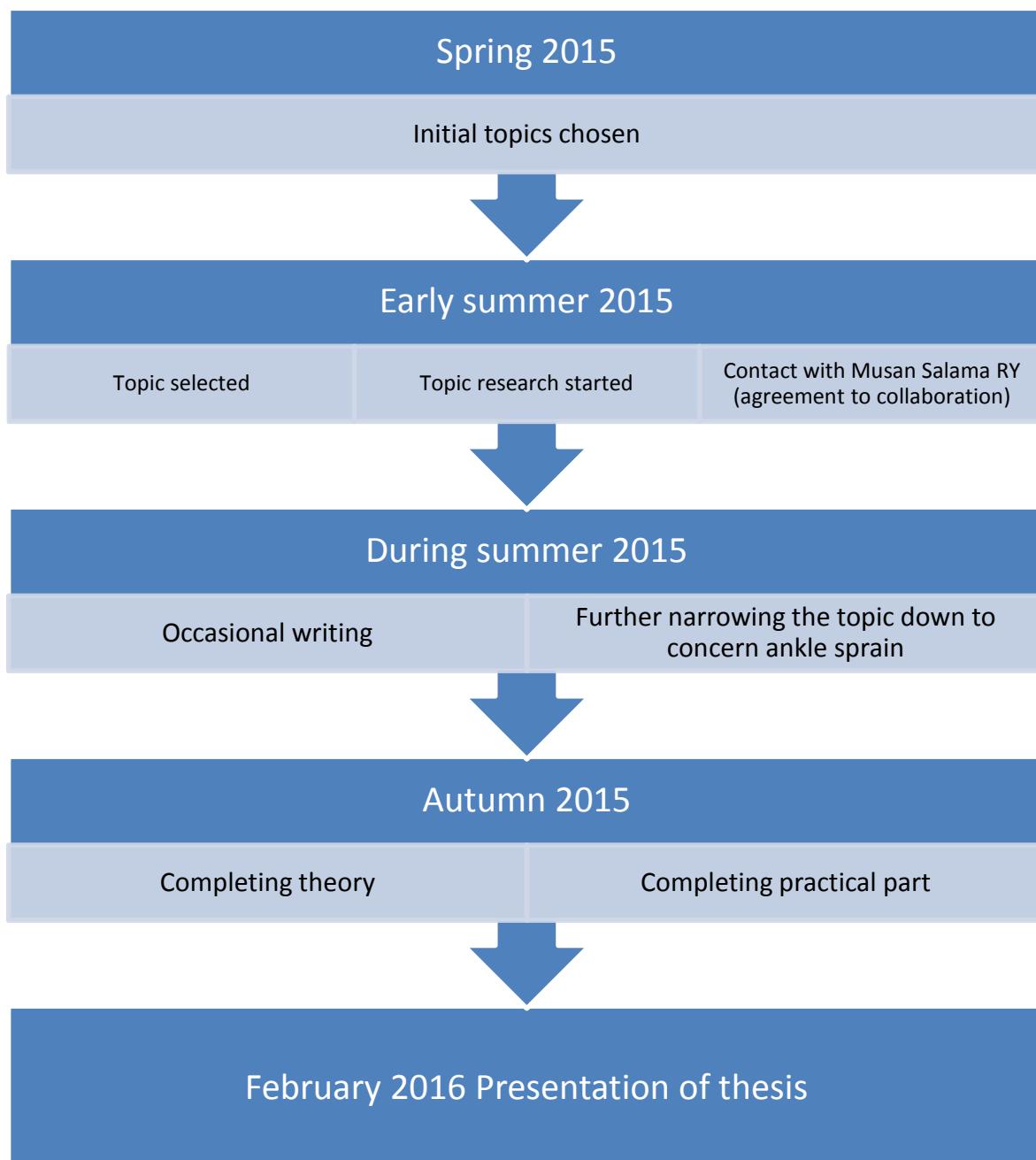


Figure 9. The process of the thesis.

## 10 DISCUSSION

Football as a sport is played by both males and females from the very young age to elderly. It can be played on multiple different kinds of pitches e.g. grass, artificial turf and sand. Most teams from amateur to professional do 15-30 minutes of warming up before training sessions. In that time, few minutes should be sacrificed to do a specific ankle and knee prevention exercises. Although, most coaches prefer drills that lead up to the actual training sessions with the ball, strengthening the specific muscles is very important as well.

The main idea of this thesis was to provide football players and coaches a selection of evidence based proven therapeutic exercises in prevention of ankle sprains. The literature used for this thesis shows how effective a successful injury prevention program is. The program can help reduce the amount of injuries, the economical costs of injuries and educate both the players and coaches of what an individual football player demands to stay healthy.

The most time consuming parts of this thesis was to find and separate good and reliable articles from the bad ones. The theoretical part took most time to write as every sentence must be reference based. Luckily there were a number of good studies and articles made about football and ankle injuries. It should be noted that some relevant articles and studies were excluded for the lack of permissions or the lack of memberships to websites. Even though most literature concerned the rehabilitation process, few articles had some sort of referencing to prevention of ankle injuries also. Initially I was going to do a literature review of ankle injuries but after doing a lot of reading on the subject I noticed how scarce any kind of injury prevention programs for footballers are. In addition, since I play football myself and witness the amount of ankle sprains, I knew there was a need for this kind of exercise package. Narrowing down the topic came very naturally as I proceeded to write the theoretical part. Injury prevention program for all ankle injuries at some point turned out to be way too vast of a topic for this thesis.

This thesis was made with the intention to provide a proper guideline for players and coaches to be implemented in their training sessions or warm-ups before matches. I



read as many articles as possible for the best results of this thesis. The lack of literature of this specific topic showed out to be problematic. Most of the literature concerned rehabilitation of the ankle. I had to take bits and pieces of many different articles to gather the information that I felt would be the most important. With that being said, further research is required with the purpose of making even stronger conclusions and an exercise package with broader in-depth knowledge of the ankle and it's biomechanics.

Many articles that I've read throughout this process, all state how injury prevention still lacks evidence based research. For example when to start the program; how many reps and sets to do; how long should the program last and how long should a warm-up be are all questions that need future research.

This thesis topic could also be expanded further. I feel like there is a need for proper evidence based prevention and rehabilitation guidelines for physiotherapists and coaches to use with their athletes. The guideline would start all the way from diagnostics until the return to full fitness and play in rehabilitation for example. Since bachelor's thesis is suppose to be quite narrow, this type of research couldn't be done but it could be a good topic in the future for master's thesis.

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