Universidade de Aveiro Escola Superior de Saúde de Aveiro
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Francisco da Rocha Martins

INCIDÊNCIA E SEVERIDADE DE LESÕES EM JOGADORES DE FUTSAL

INCIDENCE AND SEVERITY OF INJURIES IN ELITE FUTSAL PLAYERS

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Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Fisioterapia, realizada sob a orientação científica do Doutor Mário Alexandre Gonçalves Lopes, Professor da Escola Superior de Saúde da Universidade de Aveiro e coorientação científica do Doutor Fernando Ribeiro, Professor da Escola Superior de Saúde da Aveiro

Dissertation presented to the University of Aveiro to fulfill the requirements to obtain the Master's degree in Physiotherapy, carried out under the scientific guidance of Doctor Mário Alexandre Gonçalves Lopes, Professor at School of Health Sciences at the University of Aveiro and scientific co-supervision by Doctor Fernando Ribeiro, Professor at School of Health Sciences at the University of Aveiro.

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palavras-chave Desporto profissional, epidemiologia, sobrecarga das lesões, classificação de lesões, prevalência de lesões, desporto coletivo, masculino.

resumo

Introdução: O futsal é uma modalidade coletiva com cinco jogadores, que teve um crescimento significativo a nível mundial, assim como em Portugal. Portugal conta atualmente com cerca de 57000 praticantes federados de futsal. Com o aumento da competitividade do futsal e o crescente número de jogadores, o impacto das lesões nestes atletas tornou-se mais relevante. No entanto, existe pouca investigação sobre a tipologia das lesões no futsal de elite em Portugal.

Objetivo: O objetivo deste estudo foi descrever a epidemiologia das lesões sofridas em jogadores de futsal de elite na temporada 2019-2020.

Metodologia: Este é um estudo epidemiológico descritivo e prospectivo de lesões sofridas por jogadores de elite na temporada 2019-2020 da liga de futsal de Portugal (Liga Placard) antes do confinamento por COVID-19. Ao longo da temporada foram acompanhados 167 jogadores de futsal masculino, pertencentes a 9 equipas de elite do campeonato português. As diretrizes do consenso internacional para vigilância de lesões no futebol foram usadas como parte do estudo para recolha de dados, procedimentos e terminologia.

Resultados: Foram registadas um total de 136 lesões durante a época 2019-2020. A incidência geral de lesões foi de 4,57 lesões por 1000h de exposição total (treino e jogo). As lesões com severidade moderada foram as mais frequentes. As lesões mais observadas foram as que envolviam os membros inferiores (83,8%), seguido da cabeça e tronco (8,8%) e dos membros superiores (7,4%). A região inguinal (18,4%), a coxa (16,9%), o joelho (18,4%) e a tibio-társica (15,4%) foram as localizações corporais mais acometidas. Os alas foram os jogadores que mais sofreram lesões com um total de 43 lesões (46,7%), seguidos dos fixos com 15 lesões (16,3%) e dos guarda-redes com 14 lesões (15,2%).

Conclusão: Os resultados deste estudo mostraram que o índice de lesões no futsal é elevado e as lesões ocorrem principalmente por traumas sem contato direto e durante as sessões de treino. A taxa de lesões verificada durante os jogos foi superior a taxa de lesões que ocorre durante as sessões de treino. Neste estudo em particular, os alas foram os jogadores com maior índice de lesões. As localizações corporais mais afetadas foram virilha, coxa, joelho e tibiotársica. Os entorses da tibiotársica e as lesões musculares são o tipo de lesão mais comuns entre os jogadores de futsal de elite portugueses.

keywords

Professional sport, epidemiology, injury burden, injury classification, injury prevalence, team sport, male.

abstract

Introduction: Futsal, is a five-a-side team sport, which has experienced a significant global growth, as well as in Portugal. Portugal currently has about 57000 federated futsal players. Due to the increase in the competitiveness in futsal and the increasing number of players, injury burden sustained by these players has become more relevant. However, there has been little research on the typology of injuries in elite futsal in Portugal.

Aim: To describe and characterize injuries sustained by elite Portuguese futsal players**.**

Methodology: This is a prospective and descriptive epidemiological study of injuries sustained by elite players in the 2019-2020 season of the Portuguese futsal league (Liga Placard), before COVID-19 confinement. A total of 167 players from 9 elite male futsal teams from the Portuguese championship were monitored during the season. The international consensus guidelines for injury surveillance in football was used as part of the study for data collection, procedures, and terminology.

Results: A total of 136 injuries were recorded. The overall injury incidence was 4,57 injuries per 1000h of total exposure (training and match). Moderate injuries were the most frequent. Injuries often involved the lower extremity (83,8%) followed by the head and trunk (8,8%) and the upper limb (7,4%). The groin (18,4%), thigh (16,9%), knee (18,4%) and ankle (15,4%) were the most affected body locations. Wingers were the players that registered the most injuries with a total of 43 injuries (46,7%) followed by lastmen with 15 injuries (16,3%) and keepers with 14 injuries (15,2%).

Conclusion: The results of this study showed that the injury rate in futsal is high, and athletes are more prone to be injured by non-contact trauma and during training sessions. Injury rate during games was higher than during training sessions. In this study, wingers were the players with a highest injury rate. The most affected body locations were groin, thigh, knee and ankle. Additionally, sprains and muscle injuries are the most common type of injuries amongst Portuguese elite futsal players.

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CHAPTER 1 – INTRODUCTION

Framework

Futsal is a team sport and a relatively recent modality. The first record of an organized five-a-side kind of football dates back to 1930 in Montevideo, Uruguay where an Argentine-born coach by the name of Juan Carlos Ceriani, so tired of rain-soaked pitches, cancelled training sessions and brought the game indoors for the first time. Curiously, this was the same year that the pioneering football nation (Uruguay) hosted the first FIFA World Cup in its brand-new Estadio Centenario.

The sport we know today has only been called futsal quite recently and was originally known in Spanish as *futbol sala* or *fútbol de salon* and in Portuguese as *futebol de salão* and *futebol 5*, which all can be translated as indoor football. Futsal is an abbreviation of these phrases (Reed, 2015). In fact, this sport modality has especially developed not only in Portugal and Spain, but also in other countries of the South and Eastern Europe, as Italy, Russia, Ukraine and naturally in countries of South America (Serrano et al., 2013).

This sport is played in a field of smaller dimensions compared to football and with its own set of rules. Each team consists of five players which take up various playing positions as goalkeeper, lastman, left winger, right winger and pivot. Futsal is characterized by intermittent and short duration actions that vary in duration and periodicity that demand high intensity efforts from athletes, these characteristics separate this modality from others. This sport modality also requires a high level of agility, requiring the player to react to the most diverse stimuli in a quick and efficient way (Costa et al., 2014; Kurata et al., 2007; Naser et al., 2017).

Futsal is a dynamic modality with high technical demands that incites creativity, making the athlete acquire greater skill when compared to football (Barbero-Alvarez et al., 2008). These characteristics and the increased level of competitiveness has made futsal a sport of increasing popularity (Lago-Fuentes et al., 2020). However, this sport seems to present a higher risk of injury when compared to football (Junge & Dvorak, 2010). At the highest levels of competition, the combination of repeated high-intensity movements that are performed during training and matches, as well as the requirement for competitive calendars and

exposure to repeated physical contact can put futsal players at high risk of injury (Ruiz-Pérez et al., 2019).

Despite being one of the most practiced sports in some countries, a limited number of prospective epidemiological studies have been published investigating injuries sustained by elite futsal players (Ruiz-Pérez et al., 2019). Most studies demonstrate that injuries in Futsal happen predominantly in the lower limbs, which may be justified by the characteristics of the modality itself (Serrano et al., 2013). Other published studies have reported incidence rates ranging from 3,5 to 89,9 injuries per 1000 hours of play in male players, most of them affecting the lower extremity, such as contusions, ankle sprains and groin injuries (Hamid et al., 2014; Ribeiro & Costa, 2006; Angoorani et al., 2014; Junge et al., 2010).

The lack of epidemiological studies on futsal motivates this study, with elite players within the Portuguese futsal championship. The intention of the study is to generate data on futsal injuries, aiming to find incidence rates and patterns of injuries during futsal practice (futsal training and matches). This study may help coaches, physical trainers and physiotherapists prioritize the application of specific measures to prevent or reduce the risk of the most common injuries.

Purpose

The aim of this study was to describe the epidemiology of injuries sustained in elite futsal players in the 2019-2020 season.

CHAPTER 2 - LITERATURE REVIEW

Futsal - Game Characteristics and Description

Futsal began in the South American countries of Uruguay and Brazil in the 1930s as a solution to the lack of available football fields (The Football Association, 2008). In the 1930's, two versions of small-sided football were being played in the cities of Montevideo and Sao Paulo respectively. In Montevideo, the Argentinean coach Juan Carlos Ceriani developed an indoor version of the 11 a side game that could be played by youth in the local Young Men's Christian Association (YMCA). Meanwhile in Brazil, a version began to develop on the streets of Sao Paulo, leading to the publishing of the first rules of the game in 1936, from the country that would soon become the masters of the game (The Football Association, 2008). Furthermore, futsal is considered the world's fastest growing indoor sport with an impressive increase at amateur, semi-professional and professional levels (Berdejo-del-Fresno, 2014; Naser et al., 2017).

The name *Futsal* simply combines the Spanish words for *Hall – Sala* and *Football – Futbol* into *futsal* (Berdejo-del-Fresno, 2014). Futsal is a 2 × 20min game of high-intensity and intermittent actions requiring high physical, tactical, and technical effort from the players. The court measures approximately 40 × 20m with 3 x 2m goals. Futsal is played within both professional and amateur leagues and uses a smaller (size 3 or 4) low-bounce ball, compared to the usual, outdoor soccer ball (size 5) (Naser et al., 2017; The Football Association, 2008) and each team consists of five players which engage in various positions from goalkeeper, lastman, left winger, right winger and pivot. Futsal is played within touchlines and all players are free to enter the penalty area and can play the ball over head height. As a small-sided game, players are constantly placed under pressure, where they must receive or play the ball in confined spaces. As a game, it places considerable demand on technique, movement, tactical awareness and fitness (The Football Association, 2008).

During FIFA-organized competitions, teams are made up from a squad of 12 players (2 goalkeepers and 10 outfield players) and unlimited substitutions are allowed. Futsal was designed to maintain the rhythm and intensity of play throughout the match, achieved via 'rolling' substitutions. The time is stopped when the ball is out of play and for any events that

may take up time, meaning that the game usually lasts 70-85% longer than the scheduled total of 40 minutes (Barbero-Alvarez et al., 2008). As Futsal is a format of small sided football that is recognized and supported by FIFA and UEFA, it is played within the World and African, Asian, American (North and Central and South), Oceanian and European Championships for Club and National Teams (Berdejo-del-Fresno, 2014). Particularly very popular in South America, Portugal, Spain and Italy, in the last decade, futsal has increased a lot in Asian countries such as Iran, Japan, Kuwait (Berdejo-del-Fresno, 2014).

In Portugal, futsal is a popular sport played by individuals across all ages and genders, all around the country. Futsal emerged in Portugal at the end of the 80s and took on great attention in the early 90s when the three variants (*futebol de salão*, *futebol 5* and futsal) that existed in Portugal at the time came together in just one. In 1985, the first Association of Indoor Soccer was established in Lisbon, and in 1986, in Porto. Subsequently, on the 8th of April, 1988, the Portuguese Indoor Football Federation was created (FPFS) and adopted the rules of FIFA and in 1991, the Portuguese Futsal Federation was created (Braz, 2006). However, currently, the governing body of futsal in Portugal is the Portuguese Football Federation (FPF) (Portugal Football Observatory, 2021).

The past decade clearly registered the nationwide popularity of futsal, in amateur, semi-professional and professional levels. Currently, Portugal has about 57000 federated futsal players (Figure 1 - Portugal Football Observatory, 2021). Futsal is also the most practiced sport indoor in Portugal (FPF, 2018).

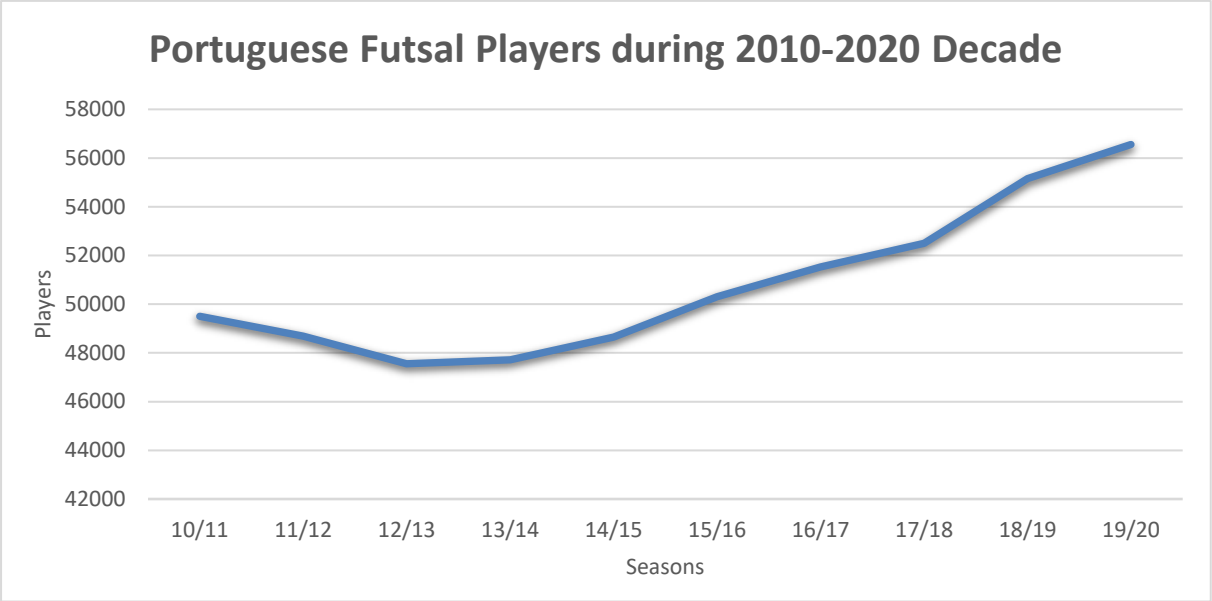

Figure 1 – Futsal players in Portugal (data retrieved online from (Portugal Football Observatory (2021) - 25/05/2021).

Futsal requires planning of specific measures to protect the health of the increasing number of players, as literature has shown the lack of scientific research on injury incidence in futsal players (Baroni et al., 2008; Lopes et al., 2020; Varkiani et al., 2013). Acknowledging the injury and prevalence of injuries in different levels of competition can guide the development of specific injury prevention strategies for futsal players.

Injury, Sport Injuries and Epidemiology

The incidence and prevalence of sports injuries is directly related to the type of sport, with each athlete and the environmental characteristics of the sport (Alozza & Ingham, 2003). For this reason, it's important to have knowledge about the sport, what is the pattern of the most common injuries, what preventive programs can be developed to reduce the incidence of injuries, improve the athlete's performance and, consequently, the team's performance (Santos et al., 2010).

WHO defines injury as the physical damage that results when a human body is suddenly or briefly subjected to intolerable levels of energy (States et al., 2013). It can be a bodily injury resulting from acute exposure to energy in amounts that exceed the threshold of physiological tolerance, or it can be an impairment of function resulting from a lack of one or more vital elements (i.e. air, water, warmth), as in drowning, strangulation or freezing. The time between

exposure to the energy and the appearance of an injury is short (Krug, 1999). However, some authors referred that a clearer definition was needed (Langley & Brenner, 2004). These authors also stated that the definition of injury is fraught with challenges and complexities. Importantly, injuries unlike most diseases must be defined simultaneously by the causative event and by the resulting pathology (Langley & Brenner, 2004). Furthermore, according to Holder et al. (2001), injuries may be categorized according to whether or not they were deliberately inflicted and by whom.

Specifically related to sport, the term "sports injury" is used to refer to a variety of musculoskeletal damage caused by sports participation (van Mechelen et al., 1992). In sports research, many definitions have been employed (Clarsen & Bahr, 2014; Kenny et al., 2018) and many consensus recommendations have been made for several sports, including cricket, football (soccer), rugby union, tennis, and for athletics. The most accepted injury definition in football was declared by the Injury Consensus Group which was established under the auspices of Federation Internationale de Football Association Medical Assessment and Research Centre – the Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries (Fuller et al., 2006). According to Clarsen & Bahr (2014) this statement suggests that there is no, single 'one-size-fits-all' injury definition but there are three alternative definitions that can be used to identify incidents: (1) all complaints, (2) medical attention and (3) time-loss. The consensus statement developed by Fuller et al. (2006) establishes definitions and methodologies, implementation standards and reports that should be adopted for studies of injuries in football and provides support for studies in other team sports. For these authors, an injury is defined as any physical complaint sustained by a player that results from a football match or football training, irrespective of the need for medical attention or time-loss from football activities. An injury that results in a player receiving medical attention is referred as a "medical-attention" injury and an injury that results in a player being unable to take a full part in future football training or match play as a "time-loss" injury (Fuller et al., 2006). Time-loss injuries are also characterized as an anatomic tissue-level impairment that results in an athlete not being able to complete a training session or specific sports related activities one or more days beyond the day of onset (Fuller et al., 2006). Likewise, a recurrent injury is defined as: "an injury of the same type and at the same

site as an index injury and which occurs after a player's return to full participation from the index injury. A recurrent injury occurring within two months of a player's return to full participation is referred to as an "early recurrence", one occurring 2–12 months after a player's return to full participation as a "late recurrence", and one occurring more than 12 months after a player's return to full participation as a "delayed recurrence". With regards to match and training exposure, match exposure is defined as a "play between teams from different clubs" while training exposure is defined as a "team based and individual physical activities under the control or guidance of the team's coaching or fitness staff that are aimed at maintaining or improving players' football skills or physical condition." The same document offers guidance for classifying injuries in terms of location, type, diagnosis, and causation are proposed (Fuller et al., 2006).

Kenny et al. (2018) stated that time-loss and medical attention definitions are well suited to capture acute injuries, which often lead to missed sport participation and/or to seek medical care. In contrast, recurrent and overuse injuries are more appropriately captured with an "all complaints" definition, which encompasses any physical or psychological complaint resulting from relevant sports participation, regardless of its consequences. The same authors conclude that there are strengths and limitations to each definition and that it is important that the appropriate definition for the injury outcome of interest be chosen for injury surveillance research.

To encourage consistency in the definitions and methodology used, and to enable data across sports studies to be compared, Bahr et al. (2020) recently updated a set of recommendations for sports injury and illness studies. This statement was developed by a diversified expert panel invited by the International Olympic Committee (IOC) to try to close some of the previous gaps included in former statements. The most recent consensus statement provides general guidance for researchers on how to plan and conduct data collection and how to report this data. However In football studies, Fuller et al. (2006) referred that variations in definitions and methodologies have created differences in the results and conclusions obtained from studies of football injuries, making interstudy comparisons difficult. Thus, most studies in football and football variations (futsal, etc.) should follow the

terminology recommended by the *consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries developed by* Fuller et al., (2006).

In sport, it is generally accepted that time-loss and medical-attention injury definitions are the most reliable and accurate (Orchard & Hoskins, 2007). Also, almost every injury surveillance systems register these injuries via a third party (this is: coaching staff, medical practitioner, physiotherapist). Clarsen & Bahr (2014) refer that use of multiple personnel for injury registration, however, may introduce systematic bias, depending on the availability and qualifications of the personnel and the interpretation and completeness of data collection.

Injuries in Futsal

Participation in sports has beneficial effects on health. Unfortunately, there are also negative effects due to sports injuries (van Hespen et al., 2011). Injuries in team sports have been extensively studied (Florit et al., 2019; Gabbett, 2004; Myklebust, 2014) and as a team sport, futsal bears a resemblance to outdoor football (Nemcic et al., 2016; van Hespen et al., 2011). While injuries in football have been the subject of numerous publications (Ekstrand, 2008; Ekstrand et al., 2011; Ekstrand et al., 2020; Merron et al., 2006; Peterson et al., 2000) in the case of futsal, studies assessing the incidence of injuries and the risk factors are scarce (Gayardo & Matana, 2012; Junge & Dvorak, 2010; Lopes, et al., 2020; López-Segovia et al., 2019; Ruiz-Pérez et al., 2019; Serrano et al., 2013). Nevertheless, the increasing interest surrounding futsal has also increased the demand for futsal-related literature to allow a better understanding of this sport regarding its assets as well as its intricacies (Tomsovsky et al., 2020). A few studies developed in futsal have shown the relationship between time played in match, injury incidence, training sessions, burden and time-loss recovery from injury in futsal (Gayardo & Matana, 2012; Junge & Dvorak, 2010; López-Segovia et al., 2019; Ruiz-Pérez et al., 2019; Serrano et al., 2013). Since futsal is treated as a variation of football, the injury rate in futsal has been compared with football (Ahmad-Shushami & Abdul-Karim, 2020; Junge & Dvorak, 2010). However, injury rate in futsal has been considered slightly higher than the rate in football when data was collected throughout the season (Ahmad-Shushami & Abdul-Karim, 2020; Junge & Dvorak, 2010). Junge & Dvorak (2010) studied prospectively, the incidence and characteristics of injuries sustained by futsal players during top-level international

tournaments. The authors analyzed player injuries during 3 consecutives Futsal World Cups (2000, 2004, 2008) using “an established injury report system”. Physicians of the participating teams reported all injuries after each match on a standardized injury report form. The average response rate was 93%. A total of 165 injuries were reported from 127 matches, with an incidence rate of 195,6 injuries per 1000 player-hours or 130,4 injuries per 1000 matches. Most injuries were caused by contact with another player and involved the lower extremity (70%), with most the frequent diagnosis being contusion of the lower leg (11%), ankle sprain (10%) and groin strain (8%). In relation to injury type, Junge & Dvorak (2010) identified contusions (44,2%) and sprains (19,4%) as the most common injuries sustained by the participating futsal players in the world cups. The most affected body region and part, where the lower extremity (69,7%), followed by head & neck (12,7%), the upper extremity (10,3%) and trunk (7,3%). The body parts predominantly injured were knee (15,8%), thigh (13,9%), ankle and lower leg (both 12,1%). Regarding the severity of the injuries, it was observed that about half of the injuries were expected to prevent players from participating in matches or training. The incidence of time-loss injuries was 79,5 per 1000 player-hours or about one in every two matches (Junge & Dvorak, 2010).

Ahmad-Shushami & Abdul-Karim (2020) during the Malaysian Games in 2018 analyzed the incidence, conditions and characteristics of football and futsal injuries. The authors during the tournament studied: 14 teams of male football, 12 teams of male futsal and 11 teams of female futsal. The event involved players aged under 21 years. A medical report form used by the FIFA Medical Assessment and Research Centre (F-Marc), was provided to the physiotherapists and team medical doctors of all the teams to report all injuries after each match. As results, a total of 48 injuries were reported from 26 football matches, equivalent to 64,64 injuries per 1000 match hours (95%CI-46,35 to 82,93) while in futsal, a total of 48 injuries from 41 matches were reported, equivalent to 292,42 injuries per 1000 match hours (95% CI-209,7 to 375,14). From the study the author concluded that the rate of injury in female futsal players was higher compared to male: 358,21 versus 247,04 injuries per 1000 match hours ($p=0,224$). Still, futsal recorded higher injuries rates per 1000 match hours than football ($p<0,001$).

Angoorani et al. (2014) recorded and analyzed the incidence and characteristics of injuries in Iran futsal national teams from March 2011 to September 2012. The authors during the study period, observed that 32 of the 55 national players (58,2%) sustained 54 injuries (incidence rate =2,22 injuries per 1000 players-hours). Most injuries (85,2%) were located on the lower limbs. The ankle was the most frequent injury location (40,7%) and the sprain was the most frequent type of injury. These authors also observed that the incidence rate of injury in female players was significantly higher than male players (P=0,001).

Gayardo & Matana (2012) studied the prevalence of injuries in female athletes in the Brazilian National league of futsal reported during the 2010 season. Out of 135 athletes, 73 (54,1%) presented some form of injury, with lower limb injuries accounting for 86,5% of the total number of injuries, of which, 28,9% on the ankle, 24% on the thigh and 23,1% on the knee. Regarding the kind of injury, 54 (51,9%) occurred without contact and 48 (46,1%) by direct contact. Curiously, 62 (59,6%) of injuries occurred during technical/tactical or physical training and 42 (40,4%) occurred during matches. With regards to the severity of injuries, the most prevalent where moderate injuries (time-loss between 7 and 28 days) followed by severe injuries (> 28 days) and, lastly, the mild injuries (time-loss up to 6 days).

Hamid et al. (2014) during the Federal Land Development Authority/Football Association of Malaysia National Futsal League 2010 observed a total of 86 injuries were reported from 141 matches, equivalent to an incidence of 91,5 injuries per 1000 player-hours (95% CI 72,2 to 110,8), or 61,0 injuries per 1000 player matches (95% CI 48,1 to 73,9). These authors refer that most injuries were minor and resulted from contact with another player. Injuries often involved the lower extremity (44%) followed by the trunk (14%) and the upper limb (13%). Ankle (n=7; 39%) and knee (n=6; 33%) sprains were the most prevalent diagnoses of the time-loss injuries. A significant association between time-loss and type of injury was found $\chi 2$ (1,N=86) =3,99, p=0,04. In addition, time-loss injury was significantly associated with playing surface $\chi 2$ (1,N =86) =10,11, p=0,018. With respect to these latter results, although the number of injuries that occurred between the vinyl and wood surfaces were comparable (44 vs. 42), time-loss injuries often occurred when matches were held in vinyl surface (68%) compared to wooden surfaces (32%).

Ribeiro & Costa (2006) during the 15th Brazilian Sub20 Futsal Championship investigated the incidence, circumstances, and characteristics of injuries recorded during the 15th Brazilian Sub20 Futsal Championship, demonstrating similar results to the previous research. The study found that contact injuries were predominant in 65,62% (21 out of 32 injuries) and injury incidence during the Futsal Championship was higher than those found in outdoor soccer tournaments. However, a study by Broman et al. (2013) at the European Maccabi Games 2011, found that the majority of injuries sustained at multi-sport tournaments were muscle and tendon injuries, with 52 injuries (59%) of the 88 total medical encounters. The study also found that the sport with the highest risk of muscle or tendon injury was football, with 45% of the total injuries compared to 27% in futsal. Demonstrating, futsal had a moderate risk of injuries occurring in this sport. Moore et al. (2014) mentioned that the study by Broman et al. (2013) demonstrates futsal's similarity with football, in terms of the location of injuries, but also the differences, as a lower injury risk, suggesting that futsal provides an environment where injuries are less likely to occur, compared with football.

Serrano et al. (2013) studied the potential causes for injuries in Portuguese futsal players. The sample was composed by 411 Portuguese male and female futsal players, of different competitive levels. The results confirm the ankle sprain as the injury with the highest incidence (48,8% of total). Injuries with a recovery period between 8 and 28 days, were the most prevalent (52,7% of total). This study did not show association between gender or the position of the player on the field and the incidence of injuries. However, there were significant differences in training and matches, with greater occurrence of sprains and contractures in training sessions and higher incidence of muscle tears and fractures during matches. Bolling et al. (2011) in a transversal observational study during the 2009 season in seven competitive categories under 12, 13, 14, 15, 17, 20 years, found similar results. The authors observed a higher level of injury incidence in adults, suggesting that the older the player, the higher the injury risk. Also, most injuries occurred in non-contact situations and during training. Muscle injuries were mainly non-contact, while bone and ligament injuries were predominantly by contact. However, it was not possible to establish a cause-and-effect relationship between these two factors due to the study design.

Data collected by Van Hespen et al. (2011) in the Netherlands, studied football and futsal injuries in 1039 male elite soccer players, 118 elite female soccer players, and 77 male elite futsal players. The results were analyzed by incidence, location, type, re-injury, overuse/trauma and severity of injuries. Injury was defined as any physical complaint caused by soccer/futsal and resulting in time-loss from soccer/futsal of at least 1 day. These authors observed a total of 965 injuries in the male soccer group, the mean incidence rate was 5,9 injuries per 1000 player-hours, most injuries were located on the knee (20%) and most frequent type were sprain / ligament injuries (20%). Most injuries were caused by direct trauma (67%), while 15% of the injuries were due to re-injuries and the average of time-loss was 34 days. In women's football the authors reported a total of 125 injuries, most injuries were located in the knee (22%) and the most common type of injury were sprain/ligament injuries (32%). Of the reported injuries, 16% were classified as first injuries and 73% of the 125 injuries were caused by direct trauma, while average time-loss was 21 days. In the male futsal group the authors registered a total of 58 injuries with and incidence rate of 3,1 per 1000 players-hours. Most injuries were in the ankle (38%) and the most registered type of injury were sprain/ligament injuries (38%). Of the 58 injuries, 41% were first injuries and 74% of injuries were induced by direct trauma, average time-loss was over 4 weeks. The authors concluded in these 3 studies that male soccer players sustained an injury incidence almost twice as high as male futsal players, along with a higher time-loss due to injury.

Ribeiro & Costa (2006) studying injuries that occurred during the 15th Brazilian U20 Indoor Football Championship (Futsal) and identified a total of 32 injuries with a 1,39 injury incidence per match. Contact injuries were predominant (65,62%), accounting for 21 of the 32 registered injuries. The rate of injuries resulting in game removal was 0,48 injury/match and 71,7 injuries/1000 match hours. These authors also identified contusions (31,25%) and sprains (28,12%) as the most incident type of injuries. The lower extremity was the primarily affected body part (84,4%).

Ribeiro et al. (2003) carried out a study with 50 male federated athletes of a Brazilian futsal club with ages between 9 and 16 years and registered that the locations of the most common injuries were in the foot and ankle (46%), and in the knee (19%). The authors hypothesized that the postural alterations could increase the incidence of injuries, however

no statistical correlation was established between the groups. Another Brazilian study by Kurata et al. (2007) enrolled 21 athletes aged between 18 and 26 years. The results demonstrated that the body segment mostly injured was the ankle, with 32,35%, followed by the knee, with 17,65% and the foot with 14,71%. The most incident injuries were contusions and sprained ankle with 26,47% each, followed by muscular injury (17,64%) and ligament injury (14,71%).

Lopes, et al. (2020) while studying the effectiveness of the FIFA 11+ in reducing injury in male futsal players in six amateur futsal clubs, observed that the players sustained a total of 58 injuries during a regular futsal season. Of the 58 injuries, 54 (93,1%) were acute injuries and 42 (72,4%) were in the lower limb, with 13 (22,4%) being in the ankle. There were 29 (50%) “hematoma/contusion/bruises” and 13 (22,4%) “sprain/ligament injuries”. More than half of the injuries were due to contact with other players, 35 (60,3%).

Ruiz-Pérez et al. (2019) in a prospective study that analyzed the injury incidence, characteristics, and burden of injuries amongst sub-elite female futsal players, in three consecutive seasons (2015–2018), identified a total of 30 injuries within a total exposure of 4,446.1 hours (310 h of match exposure and 4,136.1h of training exposure). The overall, match and training incidence of injuries were 6,7, 6,4 and 6,8 injuries/1000h of exposure, respectively. Most injuries involved a non-contact mechanism (93%), with the lower extremity being the most frequently injured anatomical region (5,62 injuries/1000h of exposure). The most common type of injury was muscle/tendon (4,9 injuries/1000h of exposure) followed by joint (non-bone) and ligament (1,3 injuries/1000h of exposure). The injuries with the highest injury burden were those that occurred at the knee (31,9 days loss/1000h exposure), followed by quadriceps (15,3 day loss/1000h) and hamstring (14,4 day loss/1000h) strains.

From the studies presented above it has been demonstrated that the lower limbs are the most common site of injuries, followed by the head/neck area and then injuries to the upper limbs. The ankle, knee and thigh are the specific body areas with the highest injury rates in these studies. So, it is of interest to understand the underlining factors behind the specificity of injuries in this sport.

Factors Influencing Futsal Injuries

Cohen and Abdalla (2005) stated that football-art has given way to football-strength, based on strong guarding, physical preparation, and aggressive defending strategies. In futsal, this tendency occurs in a similar way, as the modality is characterized by actions of high intensity and short duration, combined with periods of less intensity and varied duration which can contribute to a higher risk of injury (Naser et al., 2017). In fact, in recent years some studies have been carried out to investigate the type, location, and severity of injuries in futsal (Bolling et al., 2011; Lopes et al., 2020; López-Segovia et al., 2019; Manuel Serrano et al., 2013; Uluöz, 2016). These studies have also tried to analyze selected potential player-related or environment-related risk factors (Arnason et al., 2004). There are several factors and mechanisms that can contribute to a higher incidence of injuries in futsal. Risk factors can be divided into intrinsic and extrinsic risk factors as well as modifiable and non-modifiable factors (Bahr & Krosshaug, 2005). The intrinsic factors are inherent to age, gender, body composition, fitness level, anatomy, skill level, psychological factors. Extrinsic factors are related to teammates, opponents, coaching, sports equipment, conditions of the playing field, type of footwear, physical and health condition, gender, number of matches, training and motivation (Bahr & Krosshaug, 2005).

Junge & Dvorak (2010) considered that futsal´s smaller and harder ball, the hard surface of the pitch and the fast speed of the game may result in a higher risk of collisions and injuries, which may account for the differences in the incidence rates between futsal and football. In fact, the smaller futsal pitch, demands players to perform multiple and quick movements such as sprinting, running, jumping and cutting, which can lead to non-contact injuries which in fact seem to be increasing (Gayardo & Matana, 2012; Ruiz-Pérez et al., 2019). Florit et al. (2019) conducted a retrospective study exploring tendinopathy injuries in athletes of Football Club Barcelona (FCB) in five sports modalities (football, basketball, handball, roller hockey, and indoor football/futsal), over 8 seasons (2008-2009 season to 2015-2016 season). These authors observed a higher incidence of tendinopathies in indoor (54,3%) compared to outdoor sports. The potential underlying mechanism may be due to the performance of jumping actions which characterize volleyball, basketball and handball as well as abrupt stopping and changes of directions, as playing area is lesser compared to outdoor sports. In fact, the smaller

futsal pitch, demands players to perform multiple and quick movements such as sprinting, running, jumping and cutting, which can lead to non-contact injuries which in fact seem to be increasing (Gayardo & Matana, 2012; Ruiz-Pérez et al., 2019). Another factor that can influence these injuries is related to shoe-surface traction. Keshvari & Senner (2015) refer that the interaction between footwear and the pitch surface is an important aspect for successful performance and injury prevention in futsal. Lake (2000) stated that the aspects of traction between the shoe outsole and the playing surface are also important factors related to player's safety and performance, where appropriate traction allows athletes to successfully perform the intended movements without risk.

Some studies have studied injury incidence in male and female futsal. Angoorani et al. (2014), observed that most injuries occurred in female athletes, injury incidence rate was significantly higher in female players than male players and U-23 male players (4,17/1000h and 1,48/1000h respectively). They also, observed that the incidence rate of non-contact injuries was significantly higher in female players compared to the male players. Furthermore, Varkiani et al. (2013) presented the epidemiology of futsal injuries during one year (21st of March 2010 to 20th of March 2011) to the Sport Medicine Federation Injury Surveillance System of Iran, and observed that of the 1145 injuries reported, male athletes sustained most injuries (89,6%) compared to female athletes. However, incidence rate was higher in female (12,6/1000h) compared to male p (7,8/1000h).

Some other factors have shown to be associated with to an increased injury rate in futsal. Bolling et al. (2011), found a higher level of incidence in adults, suggesting that older players, are at higher risk of sustaining an injury. Regarding the somatotype of players, Martinez-Riaza et al. (2017) revealed in a five-season retrospective study, with Spanish futsal teams, that both the endomorphic and mesomorphic players (pivots) were more prone to injury.

Some authors consider training volume, intensity and frequency as key to the prevention of sports injuries. In their study, Medina et al. (2016) assessed the effectiveness of a variety of preventive measures focused on volume, intensity and frequency that were included into the training program of a professional futsal team. They observed that reducing monthly and total training volume, lowering the number of high intensity microcycles and decreasing the number of weekly training sessions were effective in reducing injury occurrence in one season

as compared to the other season, where training intensity was higher in the first quarter of the season and training volume was higher due to differences in competition schedules. Other studies in the area, observed that the volume of training (Almeida et al., 1999) and the high intensity observed in training (Brooks et al., 2008) are significantly correlated with an increased risk of injuries in team sports. Docking et al. (2018) observed that the most widely recognized risk factors for tendinopathy were increased load and high physical demand during training and matches.

Physiotherapy and Injury Prevention in Futsal

The importance of reducing injuries in sports in not new, many programs associated with measures and procedures to reduce the numbers of injuries have been developed in many sports modalities (Footyfirst, Rugbysmart, FIFA 11+) and all have shown results (Donaldson et al., 2016; Lopes et al., 2020; Quarrie et al., 2007).

Junge & Dvorak (2010) have shown that futsal players are prone to a high rate of injuries compared to outdoor football. In Futsal, only one study has applied the FIFA 11+ injury prevention program to analyze the effectiveness in reducing injury in amateur futsal players (Lopes, et al., 2020). This Portuguese study (Lopes et al., 2020) enrolled 71 male futsal players from six amateur futsal clubs (37 intervention group and 34 control group). The 11+ program was executed twice a week for 30 weeks by the intervention group, separated by a 10-week period where both groups executed their regular warm-up. As results, players sustained a total of 58 injuries during the regular futsal season, with 24 injuries in the 11+ group and 34 injuries in the control group; the overall incidence of injuries per 1000 player-hours was significantly higher in the control group (11,6 vs. 6,5; mean difference (95% CI) -5,1 (-9,1 to -1,1), p=0,014). The 11+ group had a significantly lower incidence of acute (11,2 vs. 5,7; -5,5 (-9,4 to -1,6), p=0,007) and lower limb (8,7 vs. 4,4; -4,2 (-8,1 to-0,4), p=0,032) injuries per 1000 player-hours. Players from the control group registered a higher number of days injured (20,4 ± 17,3 vs. 10,5 ± 9,1, p=0,036). With these results, the authors concluded that the FIFA 11+ is an injury prevention program suited for injury reduction in amateur futsal players, as it reduces the incidence of overall, acute and lower limb injuries during the season.

Reis et al. (2013) evaluated the efficacy of FIFA's 11+ injury prevention program in 36 youth futsal players (18 control group and 18 intervention group) where, the intervention group performed the program twice a week for 12 weeks. Intervention group increased (P=0,05) quadriceps concentric (14,7%-27,3%) and hamstrings concentric (9,3%-13,3%) and eccentric (12,7%) peak torque with isokinetic testing. The intervention group also improved functional H:Q ratio by 1,8% to 8,5% (P=0,05), squat jump (13,8%) and counter-movement jump (9,9%), 5-m and 30-m sprint (8,9% and 3,3%, respectively), agility (4,7%), and slalom (4,8%) performances. Intervention group also improved balance, by decreasing the number of falls by 30% in the nondominant limb. The results suggest that FIFA11+ can be used as an effective conditioning means for improving physical fitness and technical performance of youth futsal players which may lead to the reduction of injury risk.

In a literature review, Lopes et al. (2020) studied the application of the FIFA 11+ program across several studies. The researchers concluded that the FIFA 11+ did not only reduce the risk in injuries in football and in futsal players afterwards, but it also revealed positive effects on some physical parameters such as muscle strength in futsal players, suggesting the use of FIFA 11+ to reduce the risk of injuries in futsal players.

It is important for futsal coaches to consider injury prevention programs on their training plans, taking an active role on the awareness and education of the players. Furthermore, multidimensional teams can complement and further accomplish the education of futsal players (Reis et al., 2013). A main element in these multidimensional team is the physiotherapist. Physiotherapy in sports has been proving to be more and more indispensable every day, considering that the degree of competitiveness is greater, taking athletes, through their training, to a level very close to their individual limits (Dhillon et al., 2017). Physiotherapists treat different types of sports injuries, which include muscle, ligament and tendon injuries, muscle fascia abnormalities, back pain, muscle spasm, headache and the rehabilitation after the consolidation of fractures (Sandeep, 2016).

For Sandeep (2016) a sports physiotherapist has the following specific functions:

- **Outreach in Sport**: physiotherapists will advise the sports staff and athletes and take on action to promote injury prevention strategies to enhance sports practice conditions.

- **Prevention:** physiotherapists should be alert to avoid as far as possible all those factors that might bring up injuries by sports in general and of each particular sport, associated injuries and / or consequences of a primary injury, and its possible recurrence.
- **Recovery**: physiotherapists should rehabilitate the functionality of the athlete as quickly as possible, accelerating the biological processes of recovery from injury, limiting the absence from training to ensure a safe and full return to play.
- **Rehabilitation:** physiotherapists, promote and adequate recovery from injury, restoring the athlete's ideal physical condition prior to the injury. The Physiotherapist in Sport must quickly promote the full functionality of the athlete aiding the biological processes of recovery from injury, limiting the deconditioning of the athlete.
- **Learning and Teaching:** physiotherapists should aim to improve all these facets through a continual process of learning and teaching in collaboration with other professionals.
- **Research:** physiotherapists should conduct studies, contributing to expand and develop expertise in Sport Physiotherapy.

For Grant et al. (2014) the essential role of the sports physiotherapist is to provide treatment and rehabilitation of injuries and also to provide support for performance through injury prevention, maintenance and recovery interventions.

CHAPTER 3 - METHODOLOGY

Research Setting and Participants

The study was carried out with futsal players of Portuguese elite teams, of the 1st Division of the Portuguese National Futsal Championship named Liga de Futsal Placard.

Study Design

This prospective, quantitative study following a descriptive design was carried out with futsal players of Portuguese elite teams competing in the 1st Division of the Portuguese National Futsal Championship called Liga de Futsal Placard. A total of ten teams of the Portuguese 1st Division National Futsal Championship participated in the study. One team was excluded due to the absence of registered injury data. Data was prospectively collected over the 2019/20 season and registration was accomplished by the team physician or physical therapist. The international consensus guidelines for injury surveillance in football was used as part of the study for data collection, procedures, and terminology (Fuller et al., 2006).

Procedures

The international consensus guidelines for injury surveillance in football was used as part of the study for data collection, procedures, and terminology (Fuller et al., 2006). The inclusion and exclusion criteria were as follows: 1) all players on the main team (i.e. players with a contract to play on the main team) were included in the study; 2) any player which joined the team throughout the season was included from the date he joined the team; 3) any player who already had an injury at the start of the study was included, but the injury was not included in the injury statistics; 4) any player who left the club permanently during the study period was excluded from that date, but the players loaned to another club, were included again when they returned to the club and 5) any player that had an injury when he left the club, was followed so that the date of full recovery was registered.

Player's baseline characteristics were recorded with a pre-designed questionnaire. The registered information was player´s position, age, height, weight, dominant leg. Body mass was calculated from the ratio of weight (kg) to squared height (m^2). All injuries were registered

using the injury report developed by Fuller et al. (2006). Following the recommendation of Fuller et al. (2006), all injuries were categorized according to location, type, body side, body part, mechanism of injury (traumatic or overuse), severity, whether the injury was a recurrence or not and if it was during training or match. An injury was defined as any physical complaint sustained by a player that results from a match or training, irrespective of the need for medical attention or time-loss from sports practice, while a time-loss injury was defined as an injury that inhibits the player from full participation in forthcoming training or match play. The day on which an injury occurred was day 0 and was not counted when determining the severity of an injury. If a player had to stop training or participating in a match because of injury on a day but could participate the next day, the time-loss was recorded as 0 days (Ruiz-Pérez et al., 2019). Injury severity was based on the player's period of absence from team training as for availability for match selection, and was here classified in five of the six existing classes, slight (0 days), minimal (1-3 days), mild (4-7 days), moderate (8-28 days) and severe (more than 28 days) (Fuller et al., 2006). Total player exposure was defined as the sum of training and match exposure (hours). Registered matches were characterized as friendly matches and official matches, however friendly matches were considered as training (Bahr et al., 2020), thus being included in the training exposure. Match exposure contemplated official matches played by the players during the season (official league match, league cup match, Portuguese cup match, UEFA champions league match). Illnesses and any physical or mental complaint that did not result from a futsal match or training were excluded. The incidence of injuries is reported as the number of injuries per 1000 player-hours (Fuller et al., 2006).

Injury burden was calculated as player-days absence/1000 player-hours (Bahr et al., 2020). A risk matrix was built according to Fuller (2018) and Ruiz-Pérez et al. (2019) where injury severity was plotted against injury incidence with criteria incorporated into the graph for evaluating the level of risk of main injuries sustained in this study.

Ethical Considerations

This study was previously approved by the Ethics Committee of University of Beira Interior, Portugal under code number CE-UBI-Pj-2019-042. All participants were informed

about the study procedures and written consent was obtained. All procedures were carried out in accordance with the Declaration of Helsinki**.**

Data Analysis

For the statistical analysis, descriptive statistic was used for descriptive and analytic epidemiology respectively. All statistical analysis was completed with SPSS software (version 25) and Excel 2019.

Descriptive statistics such as: mean and/or median; described the outcome measures (number of reported injuries, incidence rate, body region injured, age and gender). Dispersion of these variables were expressed by standard deviation (SD) and/or maximum and minimum values.

Qualitative variables were expressed as absolute frequency and percentage. When needed, qualitative variables were analyzed using contingency tables and their statistical significance using Pearson’s X2 test if the assumptions are met, or Fisher's test otherwise, and rate ratios were reported with 95% confidence intervals (CIs).

CHAPTER 4 - RESULTS

The studied sample consisted of 167 male futsal players, belonging to 9 teams of the Portuguese national futsal league (*Liga Placard*) during the 2019-2020 season until COVID-19 shutdown. Baseline characteristics of the participants are shown in table 1. The players presented an average age of 27,84±5,44 years, and mean weight and height of 73,68±9,51kg and 174,79±7,57cm, respectively. Considering BMI, these players presented an average index of 24,02±2,27kg/m^2.

Table 1 - Players and team characteristics and exposure time.

	N	Mean±SD	Range
Age	130	27,84±5,44	19-40
Weight	104	73,68±9,51	43-96
Height	104	174,79±7,57	150-191
BMI	104	24,02±2,27	19,11-31,74
Training Exposure	28389,91	170,00±74,10	6-309,40
Match Exposure	1349,79	8,08±7,71	0-32,97
Total Exposure	29739,77	178,08±77,24	6-318,13
Total Matches	202	22,44±5,61	13-32
Total Friendly Matches	61	6,78±4,63	0-16
Total Training Sessions	1289	143,22±31,78	92-192

During the 2019-2020 season the total time exposure of all players was 29739,77 hours (28389,91 hours of training exposure and 1349,79 hours of match exposure). The average official matches (national official matches and UEFA Futsal champions league) played by the participating teams were 22,44±5,61 matches. During this season, 1289 training sessions were held with an average of 143,22±31,78 training sessions per participating team.

With regards to the playing position, of all 167 participants only 130 players were identified with their field position (figure 2). Amongst the 130 players, 16,9% were keepers, 14,6% lastman, 46,9% wingers, 13,1% pivots and 8,5% were universal players wing-pivots. Regarding lower limb dominance, only 111 players identified this characteristic, thus 77,5% (86 players) of all cases showed to be dominant on their right side and 20,7% (23 players) on their left side and 1,1% (2 players) were ambidextrous.

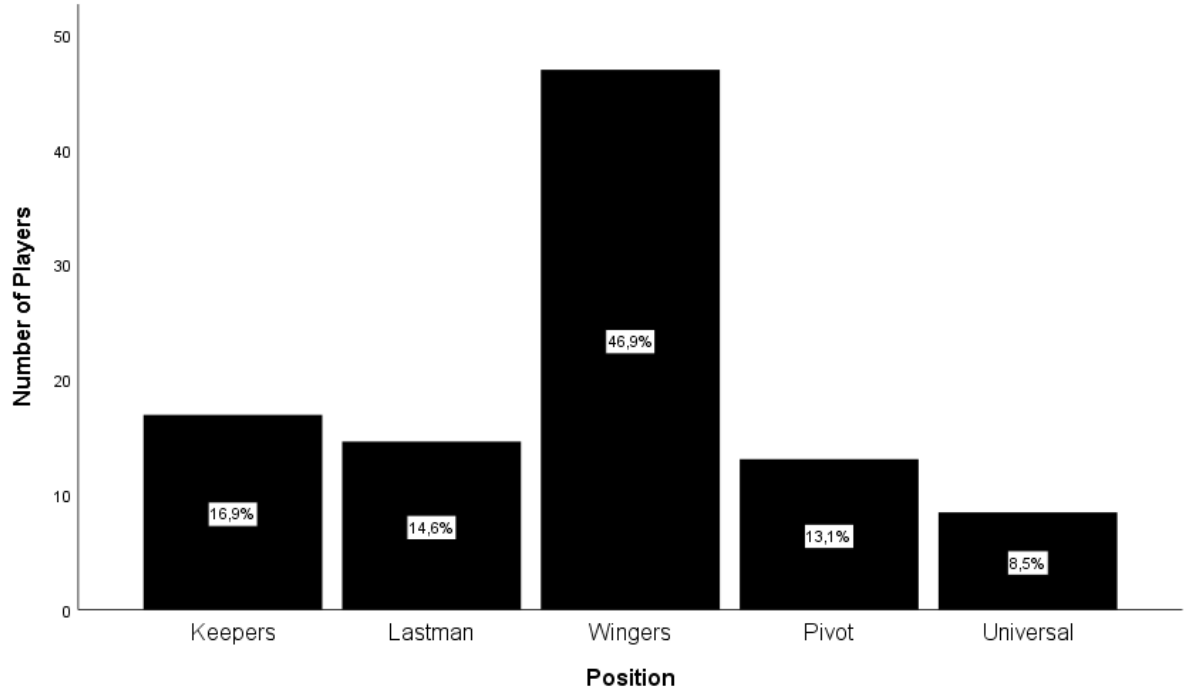

Figure 2 - Athlete's position on pitch.

Table 2 shows the total training sessions and matches played during season 2019-2020. August was the month with the most training sessions. Training sessions and friendly matches in this month accumulated a total of 247 athletic exposures. November was the month with the most training sessions and official matches summing up a total 230 athletic exposures.

Table 2 - Total training sessions and matches played during season 2019-2020.

	Training Sessions			Friendly Matches			Official Matches		
	Range	Sum	Mean±SD	Range	Sum	Mean±SD	Range	Sum	Mean±SD
August	5-33	199	22,11±7,90	0-9	48	5,33±2,55	0-0	0	0,00±0,00
September	17-26	174	21,75±3,24	0-1	2	0,25±0,46	4-4	32	4,00+0,00
October	15-30	176	22,00±5,81	0-1	1	0,13±0,35	3-6	30	3,75+1,39
November	12-28	180	20,00±4,90	0-1	1	0,11±0,33	4-8	49	5,44±1,24
December	15-23	174	19,33±2,60	0-1	1	0,11±0,33	1-4	26	2,89±0,78
January	17-30	177	22,13±4,49	0-4	7	0,88±1,64	2-5	26	3,25+1,28
February	16-27	168	21,00±3,89	0-1	1	0,13±0,35	3-4	29	3,63±0,52
March	7-9	41	8,20±1,09				0-3	10	1,25±1,16
Total		***1289***			***61***			***202***	

A total of 136 injuries were sustained by the 167 players that participated in the study (table 3). A total of 87 (63,9%) injuries occurred during training, 37 (27,2%) during match and 12 (8,8%) were not identified. Injury rate was 4,57 injuries per 1000 player-hours. Of the 63,9%

training injuries observed, most occurred during futsal training sessions (46,3%), 2,2% of the injuries occurred in futsal complementary training meetings (sessions designed for technical/tactical reviews and strategy improvement), while 8,8% of the injuries occurred in complementary training sessions, designed for development of physical preparation (endurance, strength, speed, flexibility and agility). When it comes to injuries during games, most injuries occurred during league games (19,9%). Of the 136 injuries reported, 8,8% of were classified as not identified (time, moment or event were not known).

Table 3 - Descriptive data of injuries by side and occurrence (%, mean, SD, 95% CI and IR).

Injuries	N	%	Mean±SD	95% CI	IR
Total	136		0,81±0,95	0,67 to 0,96	4,57
Injury Side	**N**	**%**	**Mean±SD**	**95% CI**	**IR**
N/A	2	1,5	0,01±0,10	0,00 to 0,03	0,07
Right Side	66	48,5	0,39±0,60	0,30 to 0,48	2,22
Left side	57	41,9	0,34±0,69	0,24 to 0,45	1,92
Bilateral/central	11	8,1	0,06±0,29	0,02 to 0,11	0,37
Injury occurrence	**N**	**%**	**Mean±SD**	**95% CI**	**IR**
Training	**87**	**63,9**	**0,52±0,84**	**0,39 to 0,65**	**3,06**
Futsal Training	63	46,3	0,37±0,66	0,28 to 0,48	2,22
Futsal Complementary Training	3	2,2	0,02±0,13	0,00 to 0,03	0,11
Complementary Training	12	8,8	0,00±0,07	0,00 to 0,02	0,42
Friendly Match*	1	0,7	0,07±0,26	0,03 to 0,11	0,04
Other type of training	8	5,9	0,05±0,41	-0,01 to 0,11	0,28
Match	**37**	**27,2**	**0,22±0,48**	**0,15 to 0,30**	**27,41**
League Match	27	19,9	0,16±0,40	0,10 to 0,22	20,00
UEFA Champions League Match	2	1,5	0,12±0,11	0,00 to 0,02	1,48
League Cup Match	3	2,2	0,01±0,13	0,00 to 0,29	2,22
Portuguese Cup Match	5	3,7	0,03±0,17	0,00 to 0,05	3,70
Not Identified	**12**	**8,8**	**0,07±0,26**	**0,03 to 0,11**	**0,40**

Included as training.

IR – number of injuries per 1000 player-hours.

Considering the type of injury (table 4) 42 (31%) were muscle rupture/tear/strains and 41 (30,2%) sprains/ligament injuries. Table 4 also shows that 114 injuries (83,8%) were located in the lower limb. Groin, thigh, knee and the ankle were the most affected body parts with 25 (18,4%), 23 (16,9%), 25 (18,4%) and 21 (15,4%) injuries reported respectively.

Table 4 - Classification of injuries by type and location (%, mean, SD, 95% CI and IR).

Type of injury	N	%	Mean±SD	95% CI	IR
Concussion	3	2,2	0,01±0,13	0,00 to 0,03	0,10
Fracture	5	3,7	0,03±0,17	0,00 to 0,05	0,17
Other bone injury	1	0,7	0,01±0,08	-0,01 to 0,02	0,03
Dislocation / subluxation	3	2,2	0,02±0,13	0,00 to 0,04	0,10
Sprain/ligament injury	41	30,2	0,24±0,48	0,16 to 0,31	1,38
Other injuries	15	11,0	0,09±0,34	0,03 to 0,14	0,50
Meniscus or cartilage	3	2,2	0,02±0,15	0,00 to 0,48	0,10
Muscle rupture/tear/strain	42	31,0	0,25±0,53	0,16 to 0,33	1,41
Tendon rupture	8	5,8	0,48±0,21	0,01 to 0,08	0,27
Synovitis	1	0,7	0,01±0,08	-0,01 to 0,08	0,03
Contusion, hematoma, bruise	7	5,2	0,04±0,20	0,01 to 0,07	0,24
Laceration	4	2,9	0,02±0,19	0,00 to 0,05	0,13
Nerve injury	3	2,2	0,01±0,23	-0,02 to 0,05	0,10
Total	***136***	***100,0***			
Injury Location	**N**	**%**	Mean±SD	95% CI	**IR**
Head and Trunk	**12**	**8,8**	**0,07±0,26**	**0,32 to 0,11**	**0,40**
Head and Face	2	1,5	0,01±0,11	0,00 to 0,02	0,07
Sternum/dorsal region	1	0,7	0,01±0,08	-0,01 to 0,02	0,03
Abdomen	2	1,5	0,01±0,11	0,00 to 0,03	0,07
Lumbar region/waist area	7	5,1	0,04±0,20	0,01 to 0,07	0,24
Upper Limb	**10**	**7,4**	**0,06±0,30**	**0,01 to 0,11**	**0,34**
Shoulder/clavicle	3	2,2	0,01±0,13	0,00 to 0,04	0,10
Elbow	2	1,5	0,01±0,11	0,00 to 0,03	0,07
Forearm	3	2,2	0,02±0,23	-0,02 to 0,05	0,10
Hand/Finger	2	1,5	0,01±0,11	0,00 to 0,03	0,07
Lower Limb	**114**	**83,8**	**0,68±0,86**	**0,55 to 0,81**	**3,83**
Groin	25	18,4	0,15±0,47	0,07 to 0,22	0,84
Thigh	23	16,9	0,14±0,41	0,08 to 0,20	0,77
Thigh Region (anterior)	18	13,2	0,11±0,38	0,05 to 0,16	0,61
Thigh Region (posterior)	5	3,7	0,02±0,17	0,00 to 0,06	0,17
Knee Region	25	18,4	0,15±0,39	0,09 to 0,21	0,84
Lower Leg and Achilles Tendon	5	3,7	0,02±0,17	0,00 to 0,06	0,17
Ankle	21	15,4	0,12±0,37	0,07 to 0,18	0,71
Foot	15	11,0	0,09±0,31	0,04 to 0,14	0,50
Total	***136***	***100,0***			

IR – number of injuries per 1000 player-hours.

With reference to the mechanism of injury, most of the registered injuries occurred by trauma 83 (61%) while 32 (23,5%) were registered as overuse injuries (table 5). Considering the mechanism of contact of registered injuries, 86 (63,2%) were cause by non-contact, 42

(30,9%) were incited directly and indirectly by contact with a player and 4 (2,9%) with an object.

Table 5 - Classification of injuries by mechanism and cause of injury (%, mean, SD, 95% CI and IR).

Mechanism	N	%	Mean ± SD	95% CI	IR
Overuse / repetitive micro trauma	32	23,5	0,19±0,49	0,12 to 0,27	1,08
Trauma / acute	83	61,0	0,50±0,77	0,38 to 0,61	2,79
Not identified	21	15,5	1,24±0,56	0,95 to 1,52	0,71
Total	***136***	***100,0***			
Contact as mechanism of injury	**N**	**%**	**Mean ± Sd**	**95% CI**	**IR**
Non-contact	86	63,2	0,51±0,78	0,40 to 0,63	2,89
Contact with a player	42	30,9	0,25±0,54	0,17 to 0,33	1,41
Contact with an object	4	2,9	0,02±0,15	0,00 to 0,05	0,13
Not identified	4	2,9	0,02±0,15	0,00 to 0,05	0,13
Total	***136***	***100,0***			

IR – number of injuries per 1000 player-hours.

Figure 3 shows the different injury mechanisms. The most frequent mechanisms of injury onset were overstretching (11,3%), kicking the ball (9,6%) and collision (9,6%).

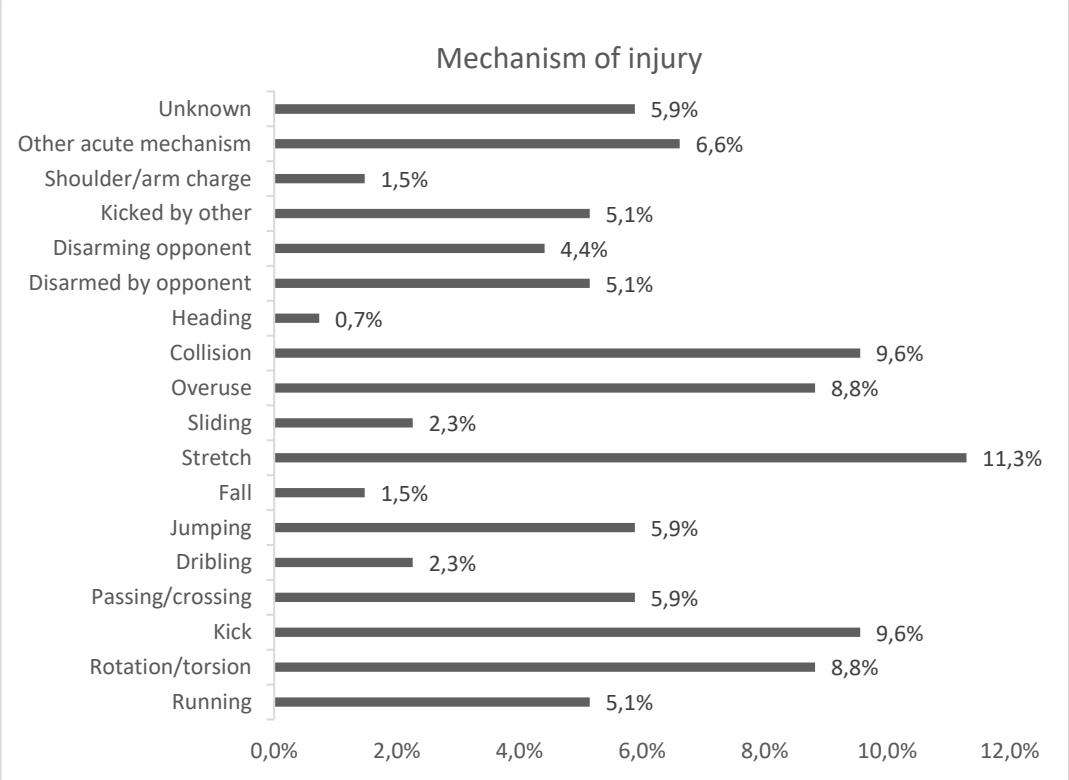

Figure 3 - Mechanism that caused injury.

Injury severity is represented in figure 4. The most common were moderate injuries, lasting between 8 to 28 days, with a total of 58 (43%) injuries, followed by mild injuries where players were withheld from training or playing official matches for 4 to 7 days, with a total of 32 (24%) injuries. Minimal and severe injuries represented 22 (16%) and 21 (15%) respectively of total injuries. Only 3 (2%) injuries were registered without time-loss.

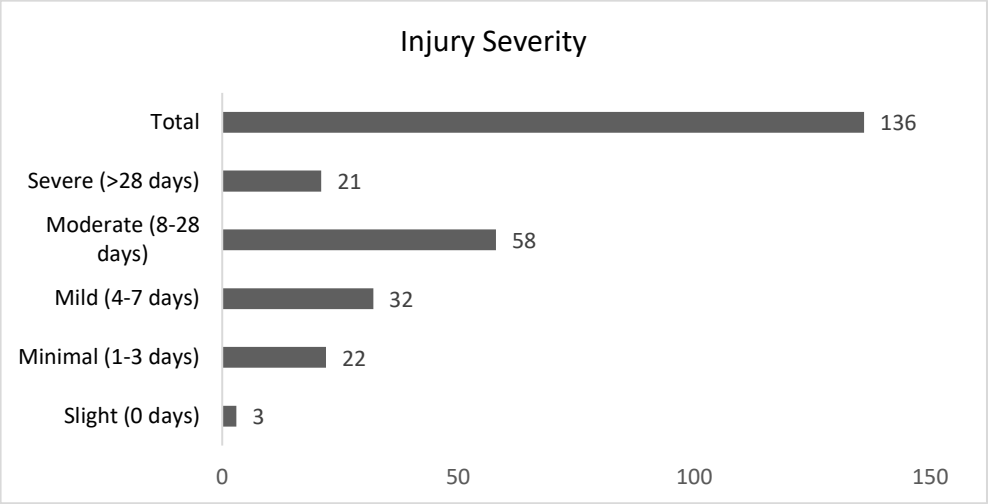

Figure 4 - Injury severity.

When analyzing severity by body location (figure 5), the knee (8,1%), the thigh (7,4%), ankle (6,6%) and groin (5,9%) are the body locations with higher percentage of moderate and severe injuries.

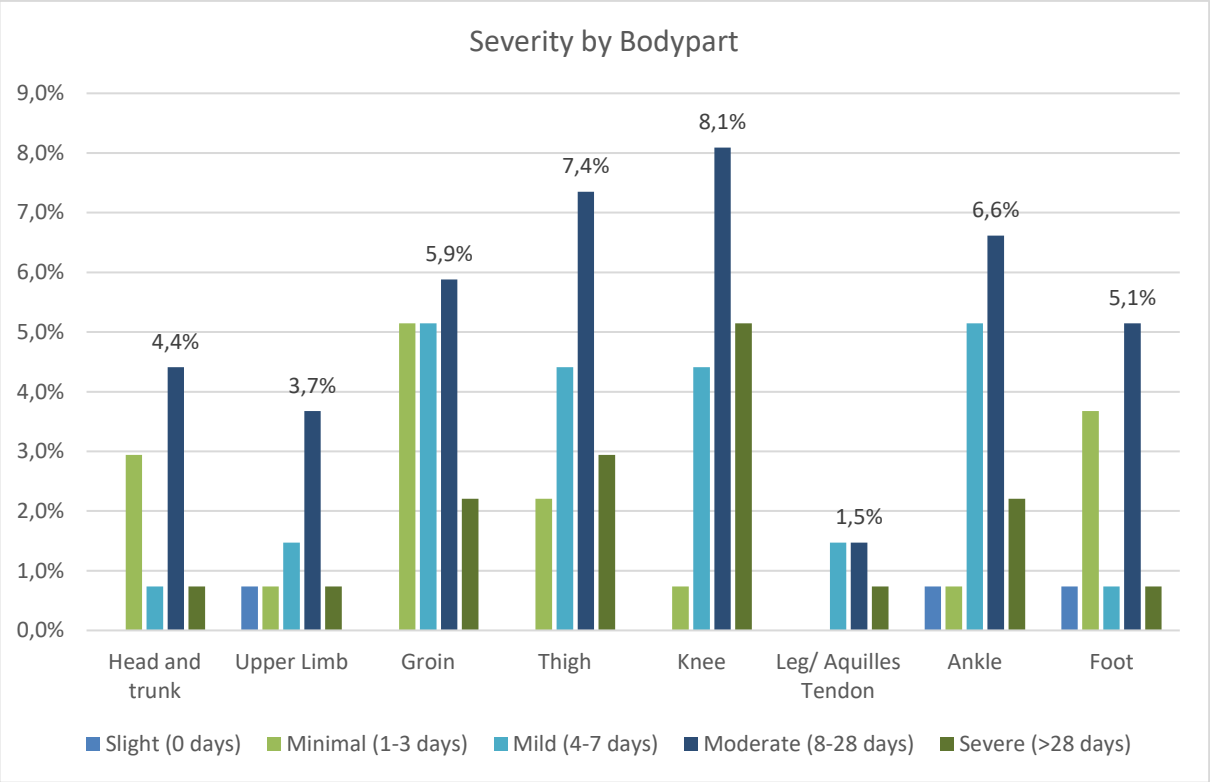

Figure 5 - Injury severity by body location.

Of the 130 participants with registered position, wingers were the players that registered most injuries 43 (46,7%) out of 92 injuries reported, followed by lastmen 15 (16,3%) and keepers 14 (15,2%) (table 6).

Table 6 – Injuries by player position (%, mean, SD, 95% CI and IR).

Injury by player position		N	%	Mean±SD	95% CI	IR
Keepers	N. º injuries	14	15,2	0,95±1,29	0,38 to 1,53	0,47
	Lower limb injuries	12	14,5	0,82±1,30	0,24 to 1,39	0,40
Lastmen	N. º injuries	15	16,3	1,37±1,12	0,83 to 1,91	0,50
	Lower limb injuries	13	15,7	1,00±0,94	0,55 to 1,45	0,44
Winger	N. º injuries	43	46,7	1,00±0,80	0,80 to 1,20	1,45
	Lower limb injuries	40	48,2	0,89±0,76	0,69 to 1,08	1,35
Pivot	N. º injuries	12	13,0	1,06±1,03	0,53 to 1,59	0,40
	Lower limb injuries	11	13,3	0,88±0,86	0,44 to 1,32	0,37
Universal	N. º injuries	8	8,7	0,91±0,70	0,44 to 1,38	0,27
	Lower limb injuries	7	8,4	0,73±0,65	0,29 to 1,16	0,24
Total	***Total N. º athlete[1]***	***92 of 130****				
	N.º athletes with LL injuries[2]	***83 of 130****				

[1] total n. º athlete with position identified*
[2] total athletes with lower limb injuries and position identified*

In table 7, it's possible to observe that of the 136 injuries, 118 (86,8%) were primary injuries and 18 (13,2%) were recurrences. The average time-loss due to injury was 23,87±25,54 days, with a total loss of 2196 days across all 9 participating clubs during the 2019-2020 season until COVID-19 confinement. Of the 136 injuries described, 133 induced time-loss. In this study, the calculated injury burden was of 73,84 days lost per 1000h of total player exposure.

Table 7 - Injury recurrence and time-loss injuries (%, mean, SD, 95% CI and IR).

Injury Recurrence	N	Mean±SD	95%IC	IR
Primary injury	118 (86,8%)	0,71±0,87	0,57 to 0,84	3,97
Recurrence injury	18 (13,2%)	0,11±0,33	0, 06 to 0,16	0,61
Total	***136***			

Days of absence due to injury	Range	Sum	Mean ± SD	95%IC	Injury Burden
	0-137	2196	23,87±25,54	18,58 to 29,16	73,84

Total Injuries with time-loss =133	Time-Loss IR = 4,47	Total Athletes with time-loss injuries = 92

IR – number of injuries per 1000 player-hours.

Injury Burden - number of days lost to injury per 1000 hours of total player exposure.

Lower limb injuries were the most reported both in training and in match. Lower limb injuries characteristics and incidence are shown on table 8. Lower limb injury incidence rate in match was higher than in training, presenting 24,45 injuries per 1000h of match exposure compared to 2,54 lower limb injuries 1000h of training exposure. Of the 114 lower limb injuries, the groin (14,91%), thigh (14,91%), knee (13,16%) and ankle regions (10,53%), represent the most injured areas during training, while the knee and ankle (7,89%) are the body parts most affected during matches followed by the foot and thigh regions (4,39%).

Table 8 – Occurrence and number of injuries of the Lower Limb.

Body part	Training		Match		Not Identified*		Total	
Groin	17	14,91%	3	2,63%	5	4,39%	25	21,93%
Thigh Region	17	14,91%	5	4,39%	1	0,88%	23	20,18%
Knee Region	15	13,16%	9	7,89%	1	0,88%	25	21,93%
Lower Leg and Achilles Tendon	2	1,75%	2	1,75%	1	0,88%	5	4,39%
Ankle	12	10,53%	9	7,89%	0	0,00%	21	18,42%
Foot	9	7,89%	5	4,39%	1	0,88%	15	13,16%
Total	***72***	***63,16%***	***33***	***28,95%***	***9***	***7,89%***	***114***	***100,00%***
Lower limb injury incidence	IR= 2,54**		IR=24,45***					

*Not Identified – Not identified when injury occurred.

** - Lower Limb Injury Incidence Rate in Training Exposure.

*** - Lower Limb Injury Incidence Rate in Match Exposure

Figure 6 represents a graphical view of injury distribution during the 2019-2020 season along with monthly training sessions and matches. The pre-season (August) registered 29 (21,3%) injuries of the 136 reported during the season, being as well the month with the most training sessions. Furthermore, most injuries 69 (50,7%) were sustained during the 1st half of the season (September to December), along with the highest number of matches. The 2nd half of the season (January to March), incomplete due to COVID-19 shutdown, registered 38 (27,9%) injuries.

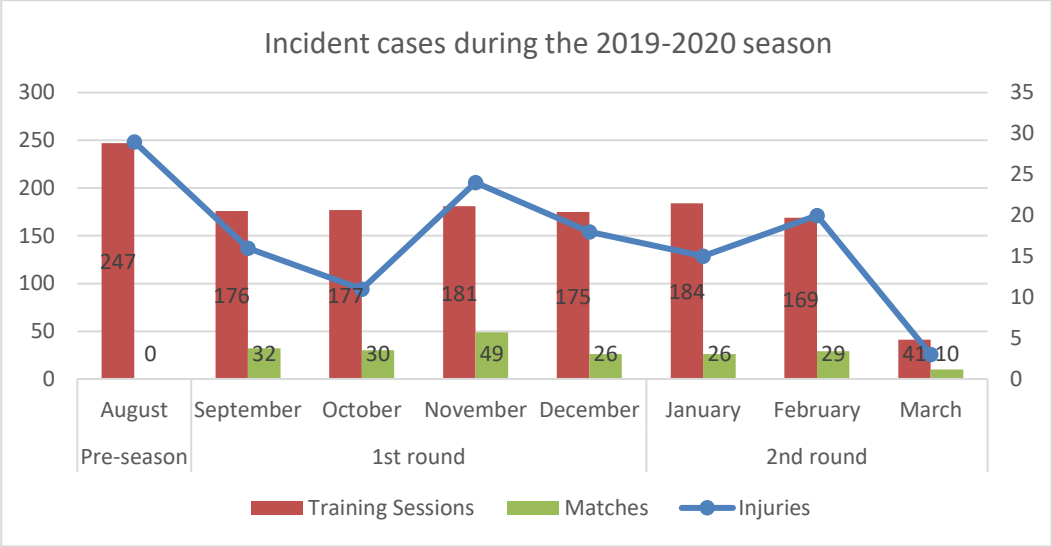

Figure 6 – Incident cases during the season.

Injury burden and injury rate was higher during the preseason; however, the 1st half of the season registered the highest number of injuries (figure 7).

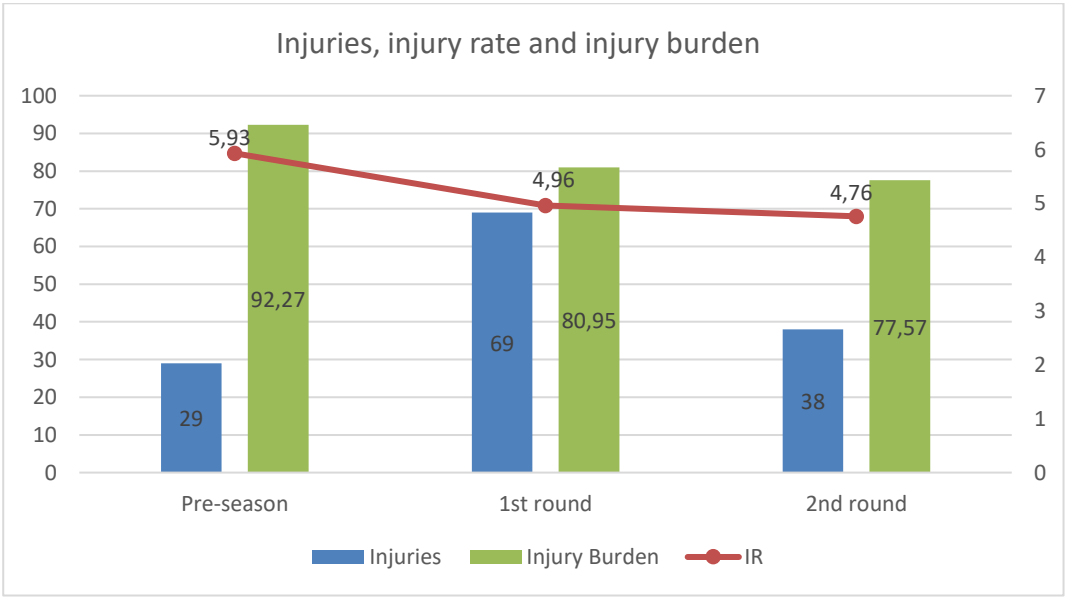

Figure 7 - Injuries, injury rate and injury burden thru the 2019-20 season.

Figure 8 represents the monthly injury rate and injury burden. In August (pre-season), the injury rate reached 5,93 injuries/1000 hours of exposure and injury burden presented 92,27 days loss/1000 hours of exposure. Furthermore, in December (1st round) the incidence rate of injuries was 5,60 injuries/1000 hours exposure with an injury burden of 99,60 days loss/1000 hours exposure. February (2nd round) registered the highest incidence rate of 6,00 injuries/1000 hours exposure along with the highest injury burden of 105, 52 days loss/1000 hours exposure.

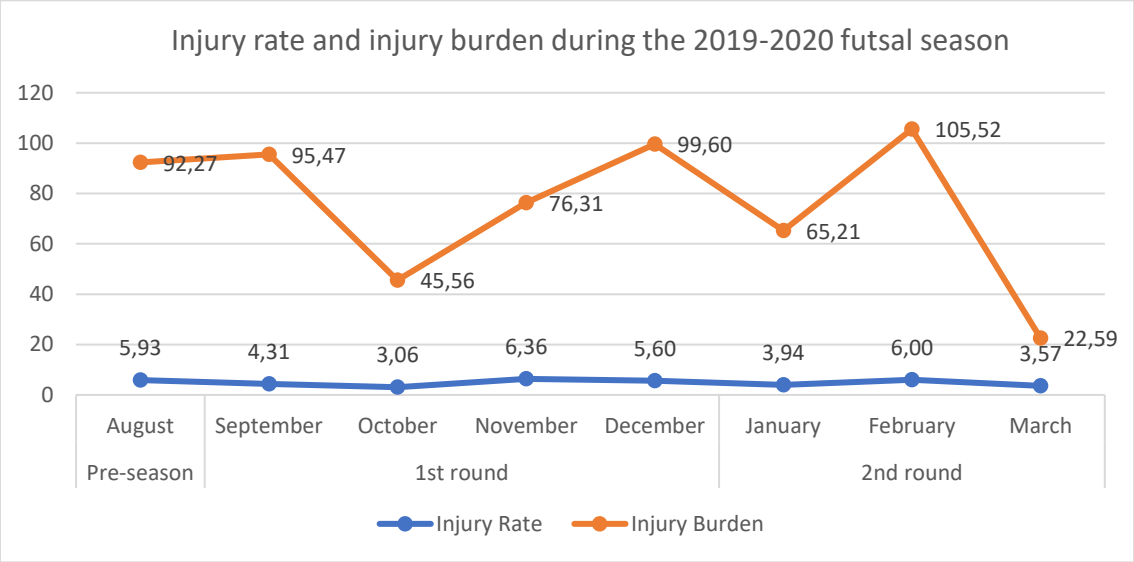

Figure 8 – Monthly injury burden and injury rate thru the season.

The quantitative risk matrix of injuries created for this study (figure 9), displays the relationship between incidence and severity for each of the most common types of time-loss injuries reported thru the 2019-2020 Portuguese futsal season. For each type of injury, severity is shown as the average number of days lost from training and competition, while incidence is shown as the number of injuries per 1000 hours of total exposure for each injury type (Bahr et al., 2018, 2020).

The shading illustrates the relative importance of each of the injury types; the darker the color, represents greater injury severity and burden, meaning that greater priority should be given to the prevention of that injury (Ruiz-Pérez et al., 2019). The risk matrix suggests that injury reduction in the body regions of the thigh, ankle and knee should be prioritized and be strongly dealt with.

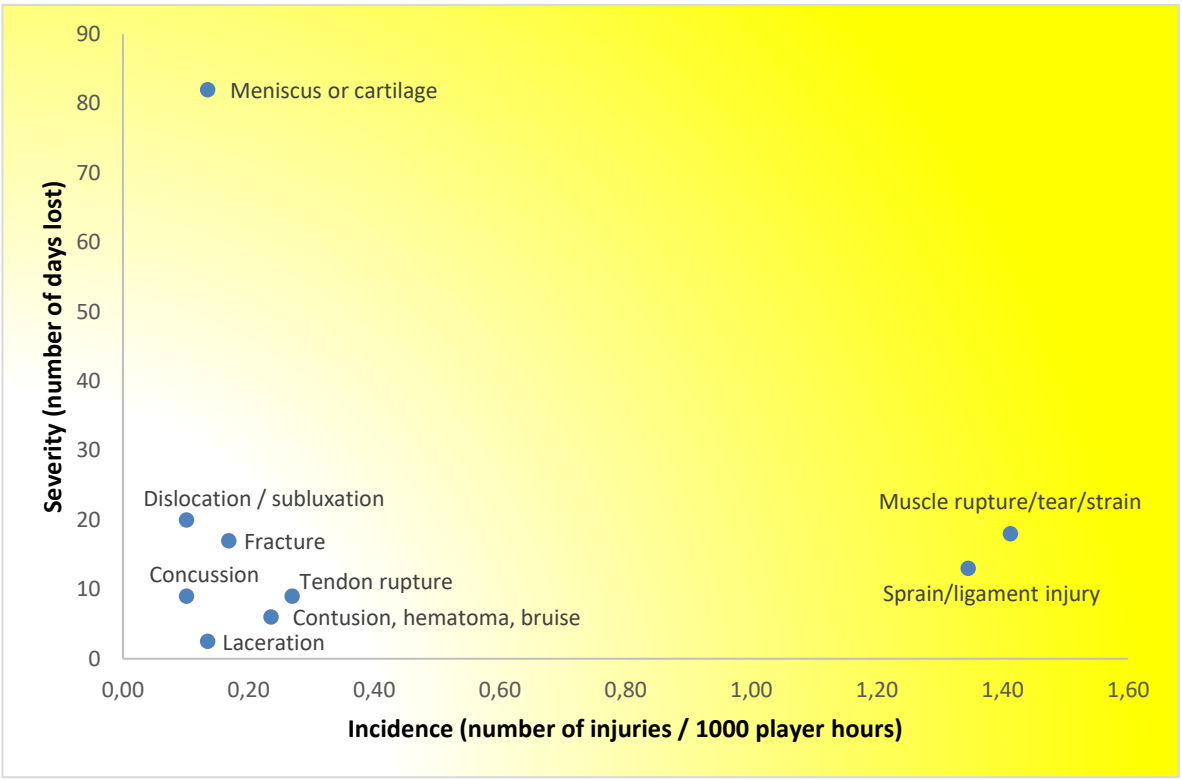

Figure 9 - Quantitative risk matrix of injuries. Relationship between time-loss days and injury rate

Figure 10 exposes in graphical form new injuries (incidence) and the number of injured players (prevalence) during each of the 32 weeks of the season. The chart shows peaks of new injuries that follow weeks of higher accumulated number of injured players.

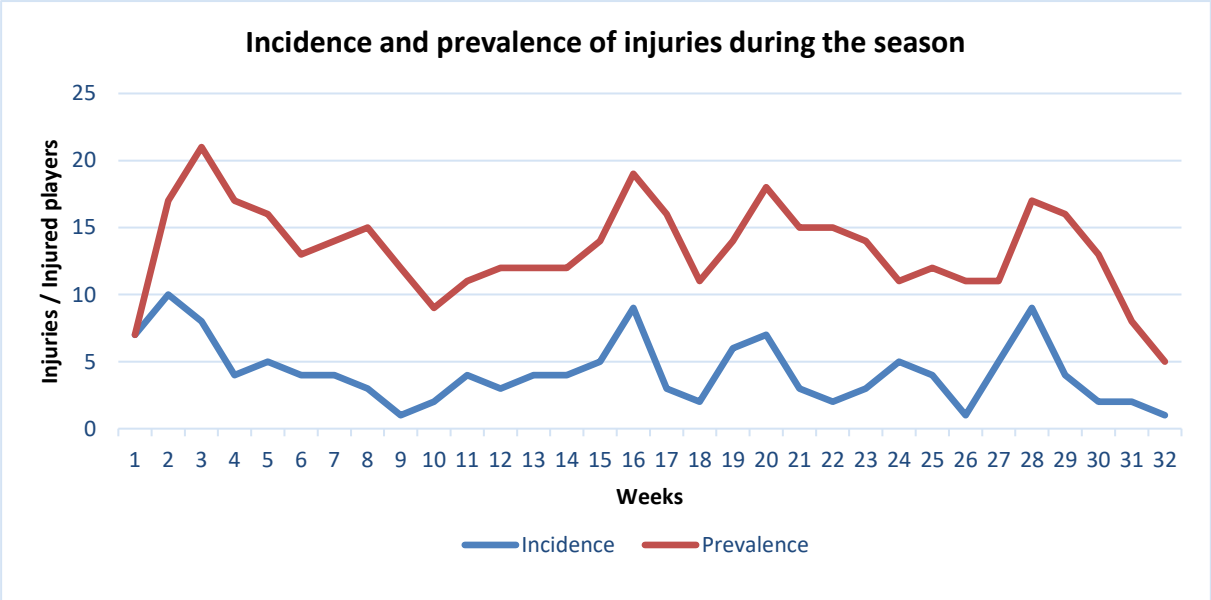

Figure 10 - Incidence and prevalence of injuries during the 2019-2020 season.

Table 9 shows the distribution of injuries along with the BMI classification. Of the 167 players only 104 had their BMI measures reported. Most injuries (47 – 36,2%) were sustained by players with normal BMI classification, while overweight and obese players had a total of 19 (14,6%) injuries. No significant differences were observed between both groups regarding the number of injuries sustained.

Table 9 - BMI sample classification and number of injuries / Pearson Chi-Square

BMI	Athletes with injury						*χ2*	*P*
	NO		*YES*		*TOTAL*			
Normal	26	20,0%	47	36,2%	73		2,969	0,981
Overweight	11	8,5%	18	13,8%	29			
Obese	1	0,8%	1	0,8%	2			
Total	38		66		104			

Table 10 represents a crosstab analysis of the relationship between age groups and injuries sustained. Of the 167 participants only 130 had their age reported. Over 50% of players were above 25 years of age. It´s possible to observe that most injuries were sustained by older athletes above 26 years of age (45,4%) compared to lower age groups – 25 or less (25,4%). Furthermore, 36,9% of athletes between 26 and 35 years of age and 8,5% of athletes above 36 years of age sustained injuries. No significant differences were observed between groups with regards to the number of injuries sustained.

Table 10 - age intervals and number of injuries / Pearson Chi-Square

Age Intervals	Athletes with injury						*χ2*	*P*
	NO		*YES*		*TOTAL*			
25 or less	15	11,5%	33	25,4%	48	36,9%	2,969	0,610
26 to 35	21	16,2%	48	36,9%	69	53,1%		
36 or above	2	1,5%	11	8,5%	13	10,0%		
Total	38		92		130			

CHAPTER 5 – DISCUSSION

The purpose of this study was to analyze sport injuries sustained by Portuguese elite futsal players during the 2019-2020 season before COVID-19 confinement. Futsal is a unique sport with speed and intensity features that differentiates this sport from others. Additionally, futsal players need to know how to act in different sectors of the court (Baroni et al., 2008) turning this sport physically more demanding and exposing players to injury risk. Our results demonstrated an injury rate of 4,57 injuries per 1000 hours of total exposure. This value is in accordance with other studies that displayed a range between 2,22 to 5,30 injuries per 1000 hours of player-hours (Angoorani et al., 2014; Lopes et al., 2020; Rahnama et al., 2010; Ruiz-Pérez et al., 2019; van Hespen et al., 2011). Specifically, our study presents a lower incidence rate in training exposure (3,06), however match incidence rate is surprisingly higher (27,41), when compared to the training and match incidence rates reported in the study by Angoorani et al. (2014) which showed an injury rate of 3,1 and 10,7 injuries per 1000 hours of training and match exposure and the study by Ruiz-Pérez et al. (2019) which revealed an injury rate of 6,77 and 6,45 injuries per 1000 hours of training and match exposure. The reason for a lower training incidence of injuries can be associated to training sessions with less contact between teammates, due to player awareness or lower level of aggressiveness and competitiveness during training sessions. Yet, the reason for a higher incidence in match injury incidence in our study can be linked with a high level of performance and competitiveness in which players engage in match day. Tomsovsky et al. (2020) states that the higher competitiveness, commonly associated to matches, can result in a higher risk of injury, which could justify the differences in these injury rates. Considering the most injured body regions, the lower limbs were the most affected, totalizing 83,8% of all injuries, corroborating the findings in the literature concerning the high incidence of injuries in the lower limbs (Angoorani et al., 2014; Ferreira et al., 2017; López-Segovia et al., 2019; Pinheiro & Rocha, 2017; Ruiz-Pérez et al., 2019). Naturally, the disproportion of injury incidence between the body extremities can be attributed to the higher demand of the lower extremity in this sport (Merron et al., 2006). In our study, of the 114 registered lower limb injuries groin and knee (21,9% and 21,9%) were the most affected body areas, followed by the thigh and the ankle (20,1% and 18,4%) - (Table

8). These results are similar to other findings that mentioned that of all the injuries of the lower limb, the ankle, knee, thigh and groin are the sites most commonly injured (Angoorani et al., 2014; Hamid et al., 2014; Junge et al., 2010; Serrano et al., 2013; Varkiani et al., 2013). Additionally, regarding lower limb injuries, training was responsible for more injuries (63,16%) than match (28,95%). However, when adjusting the number of injuries to the number of hours of exposure to training and matches, the lower limb incidence rate was of 2,54 and 24,45 per 1000 hours of player hours, respectively. Furthermore, the high incidence of ankle and knee injuries can be explained by the characteristics of the playing surface (Luciano & Lara, 2012) and the specificities of futsal itself (Wu et al., 2019). The constant accelerations and decelerations, tackles, jumps and direction changes on the typical hard surface of a futsal pitch can cause great stress on the ankle, knee and the groin (Nemcic et al., 2016).

The most reported type of injuries in this study were sprain/ligament injury, with 41 injuries (30,2%) and muscle rupture/tear/strain with 42 injuries (31%). These numbers agree with other studies. Hamid (2014) and Lago-Fuentes et al. (2020) observed that 32,6% and 34,5% of the injuries registered in their studies were sprains. In the study by Serrano et al. (2013) 48,8% of the 512 injuries reported were sprains and Angoorani et al. (2014) observed that 51,8% of the total 54 injuries registered were also sprains. As observed in these studies, sprains can represent up to 51,8% of all injuries. Respecting muscle injuries (rupture/tear/strain), studies have shown that these injuries can represent up to 75% of all injuries (Ruiz-Pérez et al., 2019). Lopes et al. (2020) referred that 30,1% of the 58 injuries sustained by the players in their study were muscular injuries. Lago-Fuentes et al. (2020) observed that 44,5% of the total injuries in their study were also muscle related.

As stated by Junge & Dvorak (2010), in their study in Futsal World Cups (2000, 2004, 2008), the majority of injuries in futsal seem to be associated to injury mechanisms by contact trauma, as stated by Junge & Dvorak (2010) in their study in Futsal World Cups (2000, 2004, 2008), where 60,6% of registered injuries were contact injuries and 34,5% were non-contact injuries. In a prospective study during the 2010 FELDA (Federal Land Development Authority)/FAM (Football Association of Malaysia) National Futsal League, Hamid et al. (2014) observed that the incidence of contact injuries (63%), was significantly higher than non-contact injuries (37%). Ribeiro & Costa (2006), also in a prospective study identified that 65,6%

of the registered injuries were caused by contact. Furthermore, Uluöz (2016) in his retrospective study also found that 58,1% of the injuries were derived by contact. However, in our study we registered that 63,2% of the injuries were of non-contact type, contradicting the numbers of the previous authors. Tomsovsky et al. (2020) in their narrative review, referred that non-contact injuries have also been shown to be one of the most frequent injuries in futsal. In a retrospective study by Gayardo & Matana (2012) it was observed that 51,9% of all injuries were caused without contact. In the prospective study of Angoorani et al. (2014), 70,4% of all injuries in the Iran Futsal National Teams were triggered by non-contact trauma. López-Segovia et al. (2019) while studying preseason injury characteristics in Spanish professional futsal players of the National Futsal League, reported that most injuries were caused without contact with another player (58,5%). Lago-Fuentes et al. (2020) in a prospective study with elite female futsal players, verified that 74,4% (67 of the 90 injuries reported) were non-contact injuries. Differences in injury mechanisms may be associated to variability of injury definitions, diversification of the methods of injury data registration or simple insufficient injury data, may justify the differences between the mechanisms of injury incidence in the referred studies.

According to Fuller et al. (2006), another element that characterizes injuries, is whether if they occur during one specific, identifiable event (acute/trauma injury) or if they are caused by repeated micro-trauma without a single, identifiable event (overuse injury). In our case, most injuries described were related to a specific acute event (61%) while overuse injuries represented 23,5% of total injuries. Similar results have been observed in various studies. Lopes et al. (2020) presented 54 of the 58 injuries identified (93,1%), as acute injuries. Uluöz (2016) observed that the proportion of acute/traumatic injuries was 73 (78,50%) and overuse was 20 (21,50%). Ruiz-Perez (2019) in a 3-season follow-up also observed that the proportion of traumatic injuries in futsal were higher (66,7%) than overuse injuries (33,3%). The onset of overuse injuries can be related to overtraining (Brukner et al., 2012). Tomsovsky et al., (2020) in their narrative review, claim that these injuries are very hard to determine for two reasons; firstly, due to the gradual onset of symptoms resulting in an overuse injury and: secondly, because of the definition of injury, which is mostly associated to time-loss, and players might often play with an overuse injury. Although overuse injuries are a common phenomenon in

futsal and are challenging to assess and manage, acute injuries represented the highest percentage of injury incidence in futsal.

In our study, of the total 136 injuries registered only 2% (3 of the 136 injuries) had 0 days of time-loss, considered as non-time-loss injuries (NTL). This number is extremely low considering other studies. Dvorak and Junge (2010) and Ribeiro et al. (2006) registered high numbers of NTL injuries (51,4% and 65,6%). Lopes et al. (2020) which also presented a low number of NTL injuries, below 30%, stated that the lack of constant medical assistance during training sessions and matches in most of the amateur clubs that participated in their study may have led to a lower rate of registration of minor injuries. However, this argument may not apply to this study as it contemplates elite futsal teams, that have higher economic capacities and more appropriate medical assistance. In our study, we acknowledge that the absence of a significant number of injuries without time-loss may be due inconsideration of their significance as relevant injuries to register. Nevertheless, NTL injuries are also important. Powell & Dompier (2004), consider that these 2 categories, must be adequately considered. Time-loss injuries are more severe compared to NTL injuries as they affect the player's ability to perform in the following days after injury. However, the fact that an injury did not lead to absence from training or match participation, can place similar need of medical attention (Kerr et al., 2017). Whereas NTL injuries do not directly result in a period of missed sports participation, they often require diligent management by the athletic trainer and medical staff to allow the athlete to continue their training and match participation. Therefore, protective measures pointed at NTL injuries may also need to be contemplated.

Our research showed that 86,8% (118) of injuries sustained by athletes were primary and only 13,2% (18) were recurrent. Such results are compatible with literature (Pinheiro & Rocha, 2017; Ruiz-Pérez et al., 2019; López-Segovia et al., 2019) which reports that the number of recurrent injuries are also lower than the primary injuries. Injury rates of primary injuries in our study were also higher than recurrent injury rates (3,97 vs. 0,61 injuries per 1000 hours) and similar results have been described in other studies. Ruiz-Pérez et al. (2019) reported that the incidence rate of new injuries (5,62 per 1000 hours of exposure) was higher than recurrent injury incidence rate (1,12 per 1000 hours of exposure). Ahmad-Shushami & Abdul-Karim (2020) found a higher percentage of recurrence injuries in futsal (24% for men's futsal and

25,92% for women's futsal) compared to men's football (14,58%). Lopes et al. (2020) also showed that recurrent injuries accounted for 35% of overall injuries of the 3 amateur teams integrated in the control group of their study. Higher recurrent injury rates may be related to premature return to training/play and incomplete or inadequate rehabilitation (Ruiz-Pérez et al., 2019). Eliakim et al. (2018) consider that insufficient rehabilitation from prior injury, high levels of team pressure that can lead to premature return to play and the player's willingness for early return to play prior to complete recovery, are possible risk factors for recurrences amongst players. The lower rate of recurrence injuries verified in our study, can be associated to the fact that top-level clubs in Europe have greater medical support, providing for more personalized rehabilitation of injured players (Ekstrand et al., 2011).

Sustained injuries can furtherly be classified considering their moment of occurrence, during a match or training session (Fuller et al., 2006). Various studies (Angoorani et al., 2014; Ruiz-Pérez et al., 2019) have shown that the frequency of training injuries can represent up to 93% of all injuries in futsal. In fact, one of the reasons is due to the greater number of training hours compared to match time. Likewise, our study shows similar results, where training injuries represent almost 64% of all injuries reported. In fact Gabbett (2016) considers that there is a relationship between high training loads and injury, referring that excessive and rapid increases in training loads are likely responsible for a large proportion of non-contact, soft-tissue injuries, which can occur in the pre-season. However, Gabbett (2016) argues that physically hard (and appropriate) training develops physical qualities, which in turn protects against injury. The author considers that, training sessions design (workload, intensity, duration), when possible, should mimic match demands so that players are prepared for match days. Training loads must be physiologically and psychologically appropriate to offer a protective effect against injury, to allow players to cope with the demands of competition (Gabbett, 2016).

When analyzing the severity of injuries, Tomsovsky et al. (2020) in their literature review, refer that studies have shown that the results may be influenced by the study design. Retrospective studies (Ahmad-Shushami & Abdul-Karim, 2020; Gayardo & Matana, 2012; Serrano et al., 2013; Uluöz, 2016) have shown that moderate (8-28 days lost) and severe injuries (>28 days lost) are more incident than minor (0-3 days lost) or mild injuries (4-7 days

lost), as minor injuries tend to be forgotten, whilst other prospective studies have shown that most injuries in futsal are mild (Angoorani et al., 2014; Hamid et al., 2014; Junge & Dvorak, 2010; Ribeiro & Costa, 2006). However, our study presents a mixture of the existing literature, where moderate injuries represent 43% (58) of the reported injuries and mild injuries represent 24% (32). We can suggest that the difference between our results and those observed in other studies may be related to the high level of competitiveness of the Portuguese championship placing pressure on players to attain maximum performance to compete in this highly competitive environment. Yet, minimal and severe injuries represented 16% (22) and 15% (21) respectively. Regarding minimal severity injuries, our study showed a lower percentage than the study by Junge et al. (2010) which registered a proportion of 26,1% of all injuries and Angoorani et al. (2014) a proportion of 33,3%. As for severe injuries, our results are higher comparing the same authors 1,2% (Junge & Dvorak, 2010) and 13% (Angoorani et al, 2014). Contrarily, other studies have shown higher incidence of severe injuries. Pinheiro & Rocha (2017) while studying injury prevalence in recreational futsal athletes in 2015 found that 50,8% of the injuries were severe. Likewise Ahmad-Shushami & Abdul-Karim (2020) while studying incidence, circumstances and characteristics of injuries during the Malaysian Games of 2018 observed that in futsal 35,4% of injuries were reported as moderate to severe. Also, Serrano et al. (2013) while studying Portuguese male and female futsal players of diverse competitive levels, observed that 160 injuries (31,3%) of 512 total injuries were considered severe injuries. Nevertheless it is extremely important not to ignore minimal injuries since they may predispose players to re-injury, other new injuries and possibly injuries with added severity (Eliakim et al., 2018). Furthermore, we can speculate that the low number of severe injuries observed in our study may be the result from high standards of team management and medical assistance within these elite teams.

Portuguese futsal elite teams tend to play a long competition season, divided into 2 rounds (first half from September to December and the 2nd half from January to May). Before starting the regular season, each team prepares a pre-season period that usually lasts approximately 4 weeks. The participating teams in our study, selected August as a common month to accomplish the pre-season camp. The purpose of the futsal pre-season is to prepare players mentally and physically for the competitive season. However, pre-season can be

physically demanding in terms of training sessions and friendly matches. In this study, August is considered the pre-season and revealed a high percentage of injuries and injury rate compared to other months. Our study revealed that August, November, December and February were the months of the season that registered the highest number of injuries. Nevertheless, August also registered the highest number of athletic exposures with the highest number of training sessions and friendly matches. The average number of training sessions was 22,11±7,90, ranging from a minimum of 5 to a maximum of 33 training sessions. The average number of friendly matches were 5,33±2,55, where some teams did not participate in any friendly match and others registered a total of 9 friendly matches during this month. In fact, some studies have shown that periods with higher training loads can lead to a greater number of injuries in team sports (Jones et al., 2017). Miloski et al. (2011) refered that in the pre-season, training loads are higher than in the competitive period because it's a period characterized by a necessary increase in the level of fitness. Additionally, Killen et al. (2010) reinforces that the pre-season is a period where the incidence of injuries is considerably higher and Malone et al. (2017) shows that there's a positive relationship between the training load accumulated during the mesocycle (sum of 4 weeks) and the probability of injury, that is, the higher the load, the greater the probability of injury. However, there are some studies that have shown that the more training a team performs during the pre-season, the lower the risk of injury (Ekstrand et al., 2020; Eliakim et al., 2018). Since studies related to futsal on this topic are scarce, a recent publication on football has analyzed how the number of training sessions performed by teams during the pre-season influences the incidence of injuries and the player's readiness to compete during the season (Ekstrand et al., 2020). This study analyzed 44 elite teams from 13 different European countries for 15 consecutive seasons (2001/2002-2015/2016). The teams included in the study participated in the UEFA Champions League or the UEFA Europa League. The number of pre-season sessions included the period from the first training session to the first official competition game. The results revealed the average number of training sessions performed by the teams during the pre-season was 30 (ranging from 10 to 51 sessions). For all teams during the season, the average number of days lost was 144,6 for every 1000 hours of total exposure (injury burden) and the injury rate was 7,1 for every 1000 hours of exposure. The authors demonstrated that, teams that undertook a

greater number of pre-season training sessions experienced fewer injury-related problems during their competitive seasons. The authors refer, that a higher number of pre-season training sessions may help elite soccer teams to remain injury-free during the competitive season. However, the results from this study should be interpreted with caution. It was not controlled whether the players who accomplished the greatest number of training sessions sustained less injuries during the season. Assuming the results presented by Ekstrand et al. (2020), it is important that technical teams and medical staff control the training procedures, implementing adequate recovery plans and introducing prevention strategies to minimize the incidence of injuries in the pre-season. In summary and relating the information from previous authors to our study, we found that August had a greater number of athletic exposures and assuming that more training sessions are carried out in order to prevent the occurrence of injuries, the additional exposure and the accumulated load may lead to a greater number of injuries. Also in our study, November and December registered a high number of injuries (42) and both months registered a high number of athletic exposures (356 training sessions and 75 matches). Although the previous months could lead to some improvement in physical condition, the intensity and stress associated with the competitiveness of the sport, may lead to an increased risk of injuries in the referred months. Ruiz-Pérez et al. (2019) suggested that the accumulated fatigue during previous months may increase the injury risk during the middle of the season. In our study, February was also a month with high injury rate. This high injury incidence may be related to the winter-break (normally registered in the end of December to middle of January). Winter break is characterized with fewer or no matches, however, training sessions and friendly matches continue. Knowing that training during the winter break continues and acknowledging that the first round of the championship was very competitive, we can speculate that the period of densely scheduled matches in the first round may lead players to psychological and physical fatigue which could result in an increased risk for injury and reduced performance during the following period (Ekstrand et al., 2004). Petersen et al. (2010) reported a higher incidence in the 2 months following the winter break which is consistent with the results of the present study. Ruiz-Pérez et al. (2019) registered similar results in their study, recommending precaution after Christmas break as injury incidence rates can increase. Conversely, Ekstrand et al. (2018) observed that the absence of a scheduled

winter break was associated with a higher injury burden. The same authors also revealed that teams without a winter break had a higher incidence of severe injuries compared to teams that had their scheduled break.

When exploring injury incidence in different positions of the field, studies are also not consensual, as one study has shown that outfield players have higher injury rates (Ruiz-Pérez et al., 2019) and another demonstrated that goalkeepers had higher injury incidence compared with players in other positions (defenders and forwards) (Hamid et al., 2014). Our study is in accordance with Ruiz-Perez et al. (2019), where outfield players (wingers and lastman) presented a higher injury rate of overall injuries. Ruiz-Perez et al. (2019) observed that lastman´s incidence rate (3,37 per 1000 hours) was higher than wings (2,02 per 1000 hours). While in our study, winger's incidence rate (1,45 injuries per 1000 hours) was higher than lastman (0,50 injuries per 1000 hours). Our study also showed that these player positions (winger and lastman) presented a higher injury rate in the lower limbs (1,35 and 0,44 lower limb injuries per 1000 hours) compared to other player positions. Furthermore, goalkeepers, in our research study were also amongst the field positions with a high incidence of overall injuries (0,47 injuries per 1000 hours) compared to pivot and universal players (0,40 and 0,27 injuries per 1000 hours respectively). Ruiz-Perez et al. (2019) also verified that goalkeeper's injury rate was higher 0,90 injuries per 1000 hours compared to pivots 0,45 injuries per 1000 hours. Curiously, in our study, goalkeepers presented a higher incidence of lower limb injuries (0,40 injuries per 1000 hours) compared to outfield players that act as pivot (0,37 injuries per 1000 hours) and universal players (0,24 injuries per 1000 hours). Serrano et al. (2013) while studying incidence and injury risk factors in Portuguese futsal players also verified that goalkeepers presented a higher incidence of overall injuries compared to other players (wingers). The authors also demonstrated that goalkeepers had higher incidence of injuries of the lower limbs. The high numbers of injury incidence in futsal goalkeepers can be justified by the increased participation of these players in all phases of the game, be it defensive, offensive and in transitions. These injuries may also be due to the specificity of the role, involving explosive lateral movements, long and repeated internal kicks, vertical jumps and frequent resisted external rotation and abduction positions, to prevent opponents from scoring (Eirale et al., 2014). Conversely, Della Villa et al. (2018) in their study with football players refer that

goalkeepers seem to be at lower general injury risk when compared to outfield players and that there is also a tendency towards strikers (forwards) to be at higher risk of injury during match however not during training. In fact, different playing positions may have different injury rates and patterns due to different physical loads, different movement patterns, and characteristic combinations of anticipated and non-anticipated reactive movements.

When analyzing the BMI values in our studied population, the results obtained were similar to those found in other studies (Angoorani et al, 2014; Martinez-Riaza et al., 2017). In our study most injuries (36,2%) occurred in athletes with normal BMI classification. Although considerable research has attempted to identify the relationship between body composition and injury, the findings have been conflicting (Watson et al., 2017). Some studies have observed that injury severity was higher in players with low BMI (Gastin et al., 2015), while other studies have shown that the odds of injury are higher if the player's BMI is ≥25 kg/m^2, when compared to players with a BMI <25 kg/m^2 (Grant et al., 2015). Furthermore, it should be noted that an excess in body mass involves an extra effort during most actions of training and match, with a consequent, fatigue increase which is an added injury risk (Martinez-Riaza et al., 2017). We agree with other authors who mention that BMI values may not be useful when assessing specific players' body composition as they cannot differentiate whether body weight increases are due to an increase in muscle or fat content (Kweitel, 2007; Lorenzo & Chamoro, 2004). Other authors believe that the interpretation of the BMI may be affected due to the proportionality of sitting height and leg length, as relatively long legs would reduce BMI scores (Garn et al., 1986). Considering the results in our study and the fact that there were no observed differences in the number of injuries and BMI classification of the players included in the study, it may be important to further analyze the prevalence of overweight in futsal players, to assure overweight as a concern for practitioners working with team sports (Nikolaidis et al., 2019).

With regards to age, most injuries in our study occurred in older players, above 25 years of age (26 to 35 years – 36,9% and 36 years and above – 8,5%). Football studies have shown that older players are at higher risk of injury in general, compared to younger athletes (Arnason et al., 2004; Herdy et al., 2017). Futsal studies, have also shown, that older athletes are more prone to injuries than younger players (Lindenfeld et al., 1994; Serrano et al., 2013).

These authors have found a higher incidence of injuries in futsal players aged over 25 years (38,5%) than in players aged between 19 and 24 years (34,6%). It is difficult to compare the findings of these studies since research methods differ in terms of the sport and age range. Further research could analyze these effects in more depth, possibly using samples with broader diversity of age distribution and a larger sample of teams.

When analyzing the results based on incidence and prevalence-based measures, we must bear in mind that incidence and prevalence are terms commonly used to describe the number, proportion and rate of sports injury in epidemiological and clinical literature. The number of incident cases identify when injuries occur, while prevalence refers to the number of athletes with injuries at a certain time point. Having these definitions in mind, the data presented in this study (Figure 10), suggest that injuries in futsal are frequent during the futsal season. We observed, moments during the season characterized by a high injury prevalence, such as pre-season weeks (week 3 and 4), the weeks before the end of the first round and five to six weeks after the winter break. Similar results have been presented by other authors (López-Segovia et al., 2019; Ruiz-Pérez et al., 2019). Regarding the incident cases, the data analyzed showed a greater number of athletes with new injuries (higher incidence) in August, November and February. Some possible justifications for these incidence peaks throughout the season may be related to an increase in the season's workload (greater number of training sessions and matches). Medina et al. (2016) showed that in futsal there is a direct relationship between high training volumes and an increase in the incidence of injuries and that the continuous adaptation of training volumes to the needs of the team and to the specific needs of each player is crucial to reduce the incidence of injuries along various moments of the season. The increase in prevalence, normally follows higher peaks of incident cases. In this study, only week 8 showed an increase in the prevalence of injuries, when in the last 3 weeks, incidence was decreasing. This may be related to the type, location and severity of the injury sustained by players, requiring more time for recovery till return to play, therefore, increasing the number of injured players in that point of the season.

The quantitative risk matrix of injuries created for this study, increases the visibility of the injury incidence and severity of each of the most common types of time-loss injuries reported in our study. The risk matrix created, suggests that injury reduction in the body regions of the

knee, ankle and thigh should be prioritized and be strongly dealt with. Our results are in accordance with the study of Ruiz-Pérez et al. (2019). These authors also observed that the knee and the ankle region and particularly the thigh muscles, were locations with a significantly higher injury burden, which led to longer absence of futsal players from training and matches. According to Bahr et al. (2018) the risk matrix approach has some limitations that should be kept in mind. The authors refer that the risk matrix will usually differ substantially between sports, and may vary between different levels, genders and age groups within the same sport. In fact, while comparing our study to Ruiz-Perez et al. (2019), we can see that, although, the most common types of time-loss injuries and regions reported are similar, however the injury burden is different. These differences can occur, since our study enrolled elite male players and the study by Ruiz-Pérez et al. (2019), recruited female players. Nevertheless, we consider that the use of the risk matrix is a simple method to increase the visibility of injury burden and can assist the planning process of training sessions for the season and the management of injury prevention strategies.

CHAPTER 6 – CONCLUSION

This prospective study provides some understandings into of the epidemiology of injuries in Portuguese elite male futsal players. The specificity and characteristics of futsal, as a collective, fast and quick-decision sport, can instigate a set of sport-specific injuries that sets this sport apart from others. The results of this study reports that the injury incidence in futsal is high and players are more prone to be injured by non-contact trauma and during training sessions as players are exposed to more training hours. Throughout the season, the overall injury rate was 4,57 injuries per 1000 player-hours, and injury rate verified is higher in match (27,41 injuries per 1000 hours) than in training (3,06 injuries per 1000 hours). The most affected body areas were groin, thigh, knee and ankle. Additionally, sprain and muscle injuries are the most common among the Portuguese elite futsal players. In this study, wingers were the players with a higher injury rate.

Our results are generally in agreement with the available literature regarding the rate of injuries and locations of higher injury burden. During the 2019/2020 futsal season, peaks of higher incidence were identified in August (pre-season), November and February (following the winter-break), that were generally followed by the higher peaks of injury prevalence.

Besides these findings, this study presents some limitations. It is highly possible that not all injuries were reported, specifically injuries without time-loss. Additionally, the restriction of a regular end of season, with the abrupt COVID-19 shutdown in March, possibly led to incomplete and missing data. Nevertheless, the strengths of this study are its prospective nature. Nine of the fourteen teams that participated in 2019-2020 season of the Portugal elite futsal championship were followed during the season until COVID-19 shutdown. Another strong point is that an internationally accepted registration method was used for the surveillance of injuries in elite futsal in Portugal.

These results assist the management and decision making of the need of injury prevention strategies in futsal. Specific strategies may be directed for the pre-season, last two/three weeks of first round and after Christmas break. Finally, this data is useful for stakeholders as technical staff, physical trainers and physiotherapists to acknowledge the main injuries and design specific strategies to reduce injury risk, to consequently optimize sports performance in futsal. However, future studies are needed with rigorous registration procedures, higher

number of players and teams in different competitive levels, genders, and age groups to contribute to the identification of risk factors for the development of specific injury preventive programs for futsal.

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