U.PORTO

MESTRADO INTEGRADO EM MEDICINA
MEDICINA DESPORTIVA

Temporal Analysis of the Frequency and Severity of Sports-Related Injuries in Soccer among Secondary School Students in Portugal

Tomás Osório de Castro Ferreira de Azevedo

M

2026

Temporal Analysis of the Frequency and Severity of Sports-Related Injuries in Soccer among Secondary School Students in Portugal

Dissertação de candidatura ao grau de Mestre em Medicina, submetida ao Instituto de Ciências Biomédicas Abel Salazar – Universidade do Porto

Tomás Osório de Castro Ferreira de Azevedo
Aluno do 6º ano do Mestrado Integrado em Medicina
Instituto de Ciências Biomédicas Abel Salazar – Universidade do Porto
Endereço eletrónico: tomasosorioazevedo@gmail.com

Orientador: Doutora Marta Maria Teixeira de Oliveira Massada
Grau académico: Licenciatura
Especialista em Medicina Desportiva e em Ortopedia e Traumatologia.
Assistente Convidada na Faculdade de Desporto, Universidade do Porto
Endereço eletrónico: martamassada@gmail.com

Coorientador: Professor Doutor Daniel Moreira Gonçalves
Grau académico: Doutoramento
Professor Auxiliar da Faculdade de Desporto, Universidade do Porto
Endereço eletrónico: danielmgon@fade.up.pt

Estudante:

Assinado por: **Tomás Osório de Castro Ferreira de Azevedo**
Num. de Identificação: 14733491
Data: 2026.06.02 20:32:25+01'00'

CHAVE MÓVEL

(Tomás Osório de Castro Ferreira De Azevedo)

Orientador:

Assinado por: **Marta Maria Teixeira de Oliveira Massada**
Data: 2026.06.03 12:07:46+01'00'

CHAVE MÓVEL

(Marta Maria Teixeira de Oliveira Massada)

Coorientador:

Assinado por: **Daniel Moreira Gonçalves**
Num. de Identificação: 12331172
Data: 2026.06.03 15:43:40 +0100

(Daniel Moreira Gonçalves)

DEDICATÓRIA

Aos meus pais e ao meu irmão, que me acompanharam em todos os momentos da minha vida, nos bons e nos menos bons, e que, cada um à sua maneira, contribuíram para moldar quem sou hoje.

Aos meus amigos, que me ouviram, vezes sem conta, dizer que ia chumbar, mesmo quando sabiam que não era verdade. Obrigado por tornarem esta jornada de seis anos mais leve, mais divertida e memorável.

AGRADECIMENTOS

À Doutora Marta Massada, agradeço muito mais do que a orientação na escrita desta tese. Para mim tudo começou quando recorri ao seu consultório por causa de uma fratura de stress na asa do sacro, determinado a competir no apuramento para o Campeonato da Europa de corta-mato. Lembro-me de você me perguntar se eu era maluco, e talvez tenha sentido alguma pena de mim, porque acabou por me convidar a passar um dia no bloco operatório consigo. Um dia viraram vários dias e não está escrito o quanto aprendi nessas manhãs de bloco. Vários dos ensinamentos acabaram mesmo por encontrar lugar nesta tese.

Gostava ainda de reconhecer algo que nunca lhe disse diretamente. Nunca desisti do desporto muito por sua causa e foi a melhor decisão que tomei na minha vida. Alguém que desempenhou um papel muito importante a este nível foi também o meu treinador **Nogueira da Costa**, conhecido pelos atletas como Tozé, a quem agradeço do fundo do meu coração, uma vez que mesmo estando lesionado (foram várias as vezes) me obrigava a ajudá-lo na cronometragem dos treinos, ensinando-me muitas coisas.

Ao **Professor Daniel Gonçalves**, agradeço profundamente pela disponibilidade imediata com que aceitou orientar esta tese. Obrigado pelas inúmeras vezes em que me disse que algo podia ser melhorado e por me motivar, lembrando-me, repetidamente, que ninguém nasce ensinado.

À **Professora Sara Pereira**, agradeço pela ajuda incansável na estatística e pela rapidez quase inacreditável com que respondia às minhas dúvidas. Confesso que, na maioria das vezes, ficava com a cabeça à roda sem perceber grande coisa sobre variáveis dependentes e independentes, valores de resíduos e tudo o resto que parecia um idioma à parte.

PREFÁCIO

Desde que entrei para a faculdade de medicina sempre disse que queria estar relacionado com o desporto. Posso admitir que sou viciado em todos os desportos e mais alguns. Desde que me lembro, estive sempre ligado ao desporto direta ou indiretamente. Joguei futebol até aos 15 anos, depois descobri o atletismo, e hoje sou também um espectador incansável dos jogos de andebol do meu irmão. Toda a gente que convive comigo sabe que organizo a minha vida em função de dar a minha corrida ao final de cada dia.

Ao longo da minha vida enquanto atleta já tive 1001 lesões, pelo que para além da ligação emocional ao desporto, sempre senti curiosidade em compreender os mecanismos que levam às mesmas, a forma como surgem e como se podem prevenir.

A ideia desta tese surge mais uma vez com um pedido de ajuda à Doutora Marta, que me sugeriu aproveitar uma base de dados existente e desenvolver este tema como dissertação de mestrado.

RESUMO

Introdução: O desporto desempenha um papel central na educação dos jovens. No entanto, a prática desportiva, especialmente em modalidades de alta intensidade e contacto físico, acarreta riscos inerentes, incluindo lesões desportivas. Muitos atletas conciliam a participação no desporto federado com as exigências académicas inerentes ao contexto escolar, acumulando simultaneamente cargas físicas, psicológicas e cognitivas. Esta conjugação de exigências tem motivado a comunidade científica a aprofundar o estudo das lesões que ocorrem neste contexto. Em Portugal, o futebol é a modalidade mais praticada, sobretudo entre adolescentes. A sua popularidade incentiva a participação massiva, mas também levanta preocupações quanto à incidência de lesões, à sua gravidade e ao impacto que podem ter na continuidade da prática desportiva.

Objetivos: O objetivo deste estudo é analisar a frequência, a distribuição temporal e a gravidade de lesões desportivas, registadas entre 1 de agosto de 2019 e 30 de junho de 2024, em jogadores de futebol federado do ensino secundário, com idades entre 15 e 18 anos, em Portugal. Especificamente, o estudo procurou caracterizar as lesões por tipo, sexo e região anatómica, determinar a sua frequência global e padrões temporais, examinar a associação entre o contexto de ocorrência e a posição em campo com o tipo de lesão, e avaliar se a gravidade da lesão influencia a continuidade dos atletas na prática desportiva federada.

Métodos: Este estudo recorreu a um desenho de coorte retrospetivo, de natureza descritiva e quantitativa, para caracterizar a frequência e a gravidade das lesões desportivas em atletas portugueses de 15 a 18 anos integrados no ensino secundário. A investigação foi realizada no âmbito competitivo da Associação de Futebol do Porto (AFP), analisando registos clínicos de lesões entre 1 de agosto de 2019 e 30 de junho de 2024. Considerando o ano letivo e a época desportiva, definiu-se o período de 1 de agosto a 30 de junho como um ano completo. A recolha de dados foi retrospetiva e baseada em registos clínicos preenchidos rotineiramente por médicos, após os jogadores federados se apresentarem, por iniciativa própria, numa clínica afiliada à AFP após sofrerem uma lesão. Da população inicial de 3677 atletas federados, foram incluídos aqueles com idades entre 15 e 18 anos, matriculados no ensino secundário português e com um registo clínico completo contendo informação sobre o sexo, escalão competitivo, data da lesão, tipo e localização anatómica, contexto de ocorrência, duração até ao retorno da prática desportiva e posição em campo. Atletas que não cumpriam estes critérios ou que apresentavam registos incompletos ou inconsistentes foram excluídos. Cada lesão foi analisada de forma independente e nenhum atleta contribuiu com mais do que uma lesão para a análise estatística. Para definir a gravidade da lesão, concussões e lesões com tempo de paragem superiores a 28 dias foram classificadas como lesões severas, enquanto que lesões com tempo de ausência igual ou inferior a 28 dias foram consideradas não severas

Resultados: Um total de 828 lesões de atletas com 15 a 18 anos do ensino secundário foram analisados entre 3677 jogadores de futebol federados. A ocorrência de lesões apresentou um

padrão temporal evidente, com janeiro, outubro, novembro e fevereiro a registarem as frequências mais elevadas. As épocas 2022/23 e 2023/24 concentraram mais de metade de todas as lesões, enquanto 2020/21 apresentou um número substancialmente reduzido. Verificou-se uma associação significativa entre época desportiva e gravidade da lesão, com maior proporção de lesões graves em 2021/22. A maioria das lesões ocorreu em atletas do sexo masculino (92.6%), sendo as lesões ligamentares o tipo mais frequente em ambos os sexos. O joelho foi a região anatómica mais afetada. As sessões de treino representaram 55.1% das lesões, e identificou-se uma associação significativa entre o contexto de ocorrência e o tipo de lesão. Embora os médios tenham registado a maior proporção de lesões, a posição em campo não evidenciou uma associação significativa ao tipo de lesão. Lesões severas representaram 81.2% de todos os casos. Porém, a severidade não influenciou significativamente a continuidade dos atletas na prática de desporto federado.

Conclusão: Este estudo fornece uma visão epidemiológica abrangente das lesões desportivas entre jogadores de futebol federado do ensino secundário em Portugal, evidenciando uma carga substancial de lesões e a necessidade de estratégias de prevenção estruturadas e baseadas em evidência. A ausência de um sistema unificado de vigilância epidemiológica nas associações regionais de futebol constitui uma limitação importante para a monitorização eficaz e implementação de intervenções. Investigações futuras devem-se focar no estabelecimento de sistemas contínuos de vigilância epidemiológica, na integração de métricas de carga de treino e indicadores de bem-estar, e na análise de fatores contextuais, psicológicos e de maturação que influenciam o risco de lesão. A avaliação da implementação e eficácia de programas de prevenção em contexto pediátrico será igualmente essencial para traduzir a evidência científica em estratégias práticas de redução de lesões.

Palavras-chave: Lesões desportivas; Futebol; Frequência; Gravidade da lesão; Adolescente; Epidemiologia; Portugal.

ABSTRACT

Introduction: Sport plays a central role in the education of young people. However, playing sport, especially high-intensity and physical contact sports, carries inherent risks, including sports injuries. Many athletes balance participation in federated sport with academic demands, simultaneously accumulating physical, psychological, and cognitive loads. This combination of stressors has prompted the scientific community to deepen its investigation into the injuries that emerge within this context. In Portugal, soccer is the most widely practised sport, especially among adolescents. Its popularity encourages mass participation, but also raises concerns about the incidence of injuries, their severity and the impact they may have on the continuity of sports practice.

Objectives: The aim of this study was to analyse the frequency, temporal distribution and severity of sports-related injuries in secondary school federated soccer players aged 15 to 18 years in Portugal from 1 August of 2019 to 30 June of 2024. Specifically, the study sought to characterize injuries by type, sex and anatomical region, determine their overall frequency and temporal patterns, examine the association between context of occurrence and playing position with the type of injury sustained, and assess whether injury severity influenced athletes' continuation in federated soccer.

Methods: This study employed a descriptive, quantitative, retrospective cohort design to characterize the frequency and severity of sports injuries among Portuguese youth athletes aged 15 to 18 years enrolled in secondary education. The investigation was conducted within the competitive structure of the Porto Football Association (AFP), analyzing clinical injury records from 1 August 2019 to 30 June 2024. Considering the academic year and the sporting season, a year is considered to run from 1 of August to 30 of June. Data collection was retrospective and based on clinical records routinely completed by doctors, as federated soccer players registered in the AFP presented to the clinic after sustaining an injury, by their own initiative. From an initial population of 3677 federated athletes, the study included those aged 15 to 18 years who were enrolled in the Portuguese secondary education system and had a complete clinical injury record containing information on sex, competitive age category, date of injury, type and anatomical location, context of occurrence, return to sport duration and playing position. Athletes not meeting these criteria or presenting incomplete or inconsistent records were excluded. Each injury episode was analysed independently and no athlete contributed more than one injury to the analysis. To define the severity of an injury concussions were classified as severe injuries, while time-loss injuries were considered non-severe when the absence from sports was 28 days or less and severe when the absence exceeded 28 days.

Results: A total of 828 injuries of secondary school athletes aged 15 to 18 were analysed among 3677 federated soccer players. Injury occurrence showed clear temporal clustering, with January, October, November and February representing the months with the highest frequency. The 2022/23 and 2023/24 seasons accounted for more than half of all injuries, while 2020/21 showed a markedly reduced number of cases. A significant association was found between season and injury severity,

with a higher proportion of severe injuries observed in 2021/22. Most injuries occurred in male athletes (92.6%), and ligament injuries were the most frequent type in both sexes. The knee was the predominant anatomical region affected. Training sessions accounted for 55.1% of injuries, and a significant association was identified between context of occurrence and injury type. Although midfielders sustained the highest proportion of injuries, playing position was not associated with injury type. Severe injuries represented 81.2% of all cases, however, injury severity did not influence athletes' continuation in federated soccer.

Conclusion: This study provides a comprehensive epidemiological overview of sports-related injuries among federated secondary school soccer players in Portugal, highlighting a substantial injury burden and the need for structured, evidence-based prevention strategies. The absence of a unified injury surveillance system within regional soccer associations remains a major limitation for effective monitoring and intervention. Future research should focus on establishing continuous epidemiological surveillance, integrating training load and wellness metrics, and examining contextual, psychological and maturational factors influencing injury risk. Evaluating the implementation and effectiveness of prevention programmes in youth athletes will also be essential to translate scientific evidence into practical injury reduction strategies.

Keywords: Sports injuries; Soccer; Frequency; Injury severity; Adolescent; Epidemiology; Portugal.

Abbreviations

USA	United States of America
ACL	Anterior Cruciate Ligament
AFP	Porto Football Association
UEFA	Union of European Football Associations
FIFA	Fédération Internationale de Football Association
WHO	World Health Organization
OSTRC-H	Oslo Sports Trauma Research Center Questionnaire on Health Problems
PHV	Peak Height Velocity

Index

List of Tables

List of Figures

1. Introduction

Soccer, known globally as football, is the most widely played sport in the world, with over 250 million active participants across more than 200 countries. Beyond its cultural and economic importance, it is a sport defined by its fast pace, unpredictability, and high physical demands, all of which expose players to a considerable risk of injury. During match play, athletes are repeatedly required to sprint, accelerate and decelerate, change direction abruptly, jump, and engage in frequent physical contact. While many injuries occur during these high-intensity moments, the risk of injury in soccer is complex and multifactorial, arising from the interaction between intrinsic and extrinsic factors. Importantly, this injury burden is present at every level of the game, from youth and amateur players to elite professionals.

A wide range of intrinsic and extrinsic factors has been associated with injury risk in children and adolescents. As highlighted in a systematic review [1], intrinsic factors include non-modifiable characteristics such as age, sex, and previous injury, as well as modifiable elements like physical fitness, muscle strength, joint stability, biomechanics, and proprioception. Extrinsic factors include aspects such as training and match load, playing position, climate conditions, time of the season, and playing surface [2,3,4]. Overall, research consistently shows that injuries occur more frequently during matches than during training, largely due to the higher intensity, competitiveness, and physical contact involved in match situations [5].

Sex-related differences in injury patterns have also been widely reported in soccer. Female players appear to be at higher risk of certain injury types, particularly non-contact injuries [6]. Among these, anterior cruciate ligament (ACL) injuries are especially relevant, with female soccer players showing a two- to eight-fold higher risk compared with male players [7]. In general, lower limb injuries dominate the injury profile in soccer, especially affecting the knee and ankle. ACL ruptures and ankle sprains are consistently highlighted due to their frequency, long recovery periods, and high recurrence rates [8,9].

The relationship between playing position and injury risk remains unclear. Some studies, such as those involving South Korean youth national teams, have reported a higher incidence of injuries among midfielders compared with other positions [10]. However, other research in adolescent elite populations has found no clear association between playing position and either injury type or anatomical location [11]. In addition, studies in youth soccer have shown that injuries tend to occur more often during the competitive season, with the knee and ankle being the most commonly affected areas [12].

Although injury risk has been extensively studied from a physical and sporting perspective, adolescent athletes face an additional layer of demands linked to their academic lives. Young players in secondary education must balance the demands of competitive sport with school responsibilities, including long study hours, homework, examinations, and preparation for national entrance exams required for higher education. In Portugal, this stage of education is often associated with

substantial academic workload and psychological pressure, with students reporting on average around 25 hours of weekly school-related activity in addition to individual study time [13].

These academic demands can contribute to higher levels of stress, fatigue, sleep disruption, and reduced recovery time, all of which may increase vulnerability to injury. Psychological stress has also been linked to reduced concentration, impaired attention, increased muscle tension, and poorer decision-making, potentially increasing injury risk during training and competition [14]. Supporting this, research conducted in Portugal among secondary school students found that 19.9% reported mental health problems and nearly half had received psychological or psychiatric support [15], highlighting the relevance of mental health in this age group.

The impact of sports injuries goes well beyond physical limitations. Injuries can disrupt training and competition, affect performance, and also influence social and emotional well-being [16]. For many young athletes, sport is closely tied to identity and social belonging, meaning that injury can be a particularly challenging experience. Studies have shown that injured athletes often report higher levels of stress, anxiety, and depressive symptoms compared with their uninjured peers [17], while psychological factors such as optimism and lower stress levels appear to support better recovery outcomes [18].

Understanding injury severity is essential to fully capture the burden of sports injuries [19]. Severity can be assessed through several approaches, including time loss from sport, need for medical attention, self-reported impact, clinical assessment, and economic consequences [20]. However, the most commonly used indicator in sports medicine remains time loss, defined as the number of days an athlete is unable to fully participate in training or competition [21]. According to the Union of European Football Associations (UEFA) consensus statement [8], injuries resulting in more than 28 days of absence are classified as severe. To complement this approach, tools such as the Oslo Sports Trauma Research Center Questionnaire on Health Problems (OSTRC-H) have been developed to capture ongoing symptoms and functional limitations that may not necessarily lead to time loss [22].

Concussion has also become an increasingly important concern in modern soccer. The Fédération Internationale de Football Association (FIFA) and the World Health Organization (WHO) have emphasized that concussion should be treated as a serious brain injury, requiring immediate recognition and structured return-to-play protocols [23]. In addition, repetitive head impacts have been associated with long-term neurodegenerative consequences, including chronic traumatic encephalopathy [24].

Given the significant burden of injuries in soccer, prevention has become a central focus in sports medicine research. Prevention programs such as FIFA 11+ have shown strong effectiveness, with studies reporting reductions in injury rates of up to 50% [5]. However, real-world implementation remains inconsistent, particularly in youth and amateur settings. Coaches often prioritize short-term performance outcomes over long-term injury prevention strategies, which limits the adoption of evidence-based practices [25].

Despite the growing international literature on soccer injuries, the Portuguese context remains underexplored, especially at regional and youth levels. There is still no comprehensive epidemiological framework dedicated to associations such as the Associação de Futebol do Porto (AFP), and regional injury incidence data remain scarce. In addition, adolescent athletes represent a particularly important but understudied population, given the combined physical, psychological, and academic demands they face. This lack of structured epidemiological data limits the development of targeted prevention strategies and constrains evidence-based decision-making within clubs, federations, and healthcare systems.

The aim of this study is to analyze the frequency, temporal distribution, and severity of sports injuries in federated soccer athletes aged 15 to 18 years who are simultaneously enrolled in secondary education in Portugal. Using a retrospective five-season database of clinically recorded injuries, the study will characterize injuries according to type, sex, anatomical location, playing position, and context of occurrence, as well as examine injury severity and its impact on sports participation. Additionally, it will explore the potential influence of the dual academic and sporting demands experienced during adolescence.

2. Methods

This investigation used a descriptive, quantitative, retrospective cohort design to characterize the frequency and severity of sports injuries among young federated soccer players in Portugal, aged 15 to 18 years and enrolled in the Portuguese secondary education system. The study was conducted within the competitive structure of the Porto Football Association (Associação de Futebol do Porto, AFP). The observation window extended from 1 August 2019 to 30 June 2024, corresponding to five competitive seasons. For the purposes of this study, one season/year was defined a priori as the period between 1 August and 30 June, aligning the academic year with the soccer calendar.

The source population comprised 3677 federated soccer players registered in the AFP database during the study period. Inclusion criteria were: (1) age between 15 and 18 years at the time of injury, (2) enrolment in the Portuguese secondary education system, and (3) one complete clinical injury record containing information on sex, competitive age category, season and month of injury, type (articular, bone, ligament or muscular) and anatomical location, context of occurrence (practice or match), return to sport date, and playing position (goalkeeper, defender, midfielder or forward). Athletes not meeting these criteria or presenting incomplete or internally inconsistent records were excluded. (**Figure 1**) Each injury episode was analysed independently and no athlete contributed more than one injury to the analysis. Follow-up was inherent to the routine clinical documentation process. Each injury record included the date of return to full training and match selection, which allowed calculation of return to play in days. No additional active follow-up mechanisms were implemented. Athletes who did not return to competition after the injury were not excluded, as eligibility was based solely on the availability of a complete clinical injury record documenting an injury sustained during active federated participation.

The exposure period for each athlete corresponded to their active participation in training sessions and official competitions under AFP jurisdiction. The primary outcomes were the frequency of sports injuries and the injury severity from 1 August 2019 to 30 June 2024. According to the UEFA consensus [8], injury is defined as any physical damage that occurs during soccer activities which results in the player being unable to participate fully in future training sessions or matches. Frequency variables included sex, age, season, playing position, context of occurrence, month of injury, return to play duration, anatomical location and type of injury. Injury severity was defined in accordance with the UEFA consensus [8] and constrained by the available data. Time-loss injuries were classified as non-severe when absence from sport was ≤28 days and severe when absence exceeded 28 days. Days missed were calculated as the difference (in calendar days) between the date of injury and the date of return to full training and selection availability. Concussions were classified a priori as severe injuries due to their potential neurological implications and in accordance with contemporary FIFA and WHO recommendations [23], independently of time-loss duration.

All variables were extracted from official clinical records routinely completed by AFP affiliated medical teams when federated players presented to the clinic, on their own initiative, after sustaining an injury. These records followed standardized documentation procedures, ensuring

comparability of measurements across seasons and teams. Injury type, anatomical location and return to play duration were recorded using consistent medical terminology and classification systems adopted by the AFP medical department. Because all participants were affiliated with a single regional federation and adhered to a standardized medical reporting framework, assessment methods remained uniform throughout the cohort.

Several measures were taken to minimize bias. Selection bias was reduced by including only athletes with complete clinical records, thereby limiting misclassification of key variables. Information bias was mitigated through the use of standardized injury reporting forms and uniform clinical procedures, which minimized variability in measurement and recording. To address confounding, descriptive and comparative analyses were stratified by sex, playing position, context of occurrence and injury type, allowing exploration of potential confounding patterns. Records with implausible or inconsistent dates were checked and, when unresolved, excluded from analysis.

The study size was determined by the total number of eligible athletes in the AFP database during the study period. No a priori sample size calculation was performed, as the goal was to include the entire accessible population meeting the inclusion criteria and to describe injury patterns in this real world cohort.

Data were summarized using absolute and relative frequency distributions and cross-tabulations. Where appropriate, frequency measures were expressed as counts and proportions of injuries, stratified by sex, playing position, context and injury characteristics. Associations between categorical variables were examined using inferential tests (e.g. chi-square tests), with statistical significance set at $P<.05$. All analyses were conducted using IBM SPSS Statistics, version 25.0 (IBM Corp., Armonk, NY, USA).

3. Results

Given the methodological framework described in the Methods section, the following segment presents the results obtained from a retrospective cohort comprising a total of 3677 federated soccer players in AFP. The analysis reflects the pattern of injuries recorded from 1 August 2019 to 30 June 2024, considering the attributes of the athletes and the circumstances in which injuries occurred. Injury patterns are described according to type, sex, anatomical region, and temporal distribution, alongside the frequency and severity of injuries as defined by criteria. The results also explore the relationship between type of injury characteristics and contextual factors such as training versus competition and playing position. All findings are reported using absolute and relative frequencies and cross-tabulations, in accordance with the descriptive analytical approach adopted.

3.1 Determine the temporal distribution of injuries and analyse the association between their severity and season in which they occur

From the initial population of 3677 federated athletes, a total of 828 athletes (767 males and 61 females) enrolled in the Portuguese secondary education system, with a mean age of 16.5 years and a standard deviation of 1.1, as we can see in **Table I**, were analysed. As shown in **Table II**, the months with the highest frequency of injuries were January and October, each accounting for 12.9% (n = 107) of all recorded cases. November followed closely with 12.8% (n = 106), while February represented 12.4% (n = 103) of the total.

When examining the distribution of injuries across sporting seasons, **Figure 2** shows that the 2022/23 and 2023/24 seasons were the most affected, representing 28.4% (n = 235) and 26.8% (n = 222) of all injuries respectively. The 2019/20 season accounted for 18.8% (n = 156) of cases, while 2021/22 represented 17.4% (n = 144). In contrast, the 2020/21 season recorded only 8.6% (n = 71) of all injuries, reflecting the lowest frequency within the study period from 1 August 2019 to 30 June 2024.

A statistically significant association between the season and injury severity was identified, as presented in **Table III** (χ^2 (4) = 28.274; $p < 0.001$). In the 2019/20 season, the proportion of non-severe injuries was significantly higher than the overall average, whereas the 2021/22 season showed a disproportionately elevated number of severe injuries.

3.2 Characterization of injuries by sex, type and anatomical region affected

Of the 828 injuries included in the analysis, as we can observe in **Table IV**, most of these injuries occurred in male soccer players, who accounted for 92.6% (n = 767) of all recorded cases, while 7.4% (n = 61) affected female players.

Regarding the type of injury, **Table V** shows that among the 767 injured male athletes, ligament injuries represented the largest proportion (47.3%, n = 363), followed by bone injuries (24.0%, n = 184), articular injuries (17.7%, n = 136), contusions (8.3%, n = 64) and muscle injuries (2.6%, n = 20). A similar pattern was observed in female athletes, as presented in **Table VI**, where 67.2% (n = 41) of injuries were ligamentous, followed by bone injuries (11.5%, n = 7), articular injuries (9.8%, n = 6), contusions (8.2%, n = 5) and muscle injuries (3.3%, n = 2).

In terms of anatomical region, **Table VII** indicates that injuries in male players predominantly involved the knee (60.0%, n = 460), with the ankle accounting for 10.3% (n = 79) of cases. As shown in **Table VIII**, the distribution among female athletes was comparable, with 68.9% (n = 42) of injuries affecting the knee and 9.8% (n = 6) the ankle.

3.3 Association between injury context, playing position and injury type

The association between injury context and playing position with injury type was analysed to identify potential patterns in injury distribution.

As shown in **Figure 3**, 44.9% (n = 372) of all injuries took place during matches, while 55.1% (n = 456) occurred in training sessions, indicating that practice environments accounted for a slightly higher proportion of injury events within this cohort.

A more detailed examination of the relationship between the context of occurrence and the type of injury demonstrated a statistically highly significant association, as presented in **Table IX** (χ^2 (4) = 23.847; $p < 0.001$). Injuries sustained during matches displayed a markedly different profile from those occurring in training. In competitive settings, bone injuries were significantly more frequent than expected, whereas in training sessions they occurred at a significantly lower rate, as indicated by the adjusted residuals (4.7; -4.7). Ligament injuries showed an opposite descriptive pattern, being more common in training and less common in matches. Although these deviations did not reach statistical significance, the adjusted residuals were near the significance cutoff (1.9; -1.9).

Regarding the player's position on the pitch, **Table X** shows that midfielders accounted for the largest proportion of injuries (39.7%; n=329), followed by defenders (29.0%; n=240) and forwards (22.6%; n=187), while goalkeepers represented only 8.7% (n= 72) of all recorded cases. Despite these positional differences in injury frequency, the analysis presented in **Table XI** indicates that there was no statistically significant association between playing position and the type of injury sustained (χ^2 (12) = 17.370; $p = 0.136$). This means that, although some positions experienced a higher number of injuries overall, the distribution of injury types remained broadly similar across all playing roles.

3.4 Assessment of injury severity and impact on continued participation in federated soccer

This section, using the same 828 secondary school students federated soccer players as in all other analyses, examined the severity of the injuries sustained and their implications for athletes' ability to continue participating in federated soccer. As illustrated in **Figure 4**, the majority of all documented injuries were classified as severe, representing 81.2% (n = 672) of the total, while 18.8% (n = 156) were considered non-severe according to the criteria adopted in this study.

To explore whether injury severity influenced athletes' continuation in federated sport, a chi-square test was conducted. As shown in **Table XII**, no statistically significant association was found between the severity of the injury and the decision or need to discontinue federated participation (χ^2 (1) = 0.021; p = 0.885). The frequency distribution was nearly identical across severity categories, indicating that, within this cohort, severe injuries did not translate into higher rates of sport discontinuation when compared with non-severe injuries.

4. Discussion

This study aimed to characterise the frequency, temporal distribution, and severity of sports injuries in federated soccer players aged 15 to 18 years enrolled in secondary education in Portugal over a five-season period. The main findings demonstrate a high overall burden of injury in this population, with a predominance of severe injuries and a clear predominance of ligament and knee injuries. Injuries occurred slightly more frequently during training sessions than during match play, and no association was observed between injury severity and discontinuation of federated participation.

4.1 Determine the temporal distribution of injuries and analyse the association between their severity and season in which they occur

In this section, the temporal distribution of injuries was determined and the association between injury severity and the season in which injuries occur was analysed, revealing meaningful temporal patterns and seasonal variations in injury severity.

The marked concentration of injuries in specific months like January, October, November and February, representing 51.0% of all injuries, could be explained by some reasons. It is important to mention that young soccer players experience a period of rapid changes in muscle and ligament structures, and a concomitant increase in training volume may lead to a greater predisposition to injury, regardless of the month in which these changes occur [26].

Multiple studies indicate that exposure to a high cumulative training load leads to a higher incidence of sports injuries [27,28,29]. This does not imply that promoting intense training in young soccer players is inappropriate, since, when properly planned, training stimulus enhances physical tolerance and resilience to injury [26]. However, when recovery is not adequate the incidence of injuries increases [30]. Another factor that may explain the higher frequency of injuries is the abrupt increase in weekly workload. In line with this, Gabbett [31] and Piggott et al. [32] reporting that approximately 40% of injuries were associated with abrupt increases (>10%) in weekly training load during the preceding week. This mechanism may help explain the injuries observed in January and February in our cohort, which coincide with the resumption of competitive activity following the Christmas break. In the meantime, October and November, in Portugal, correspond to a period of high academic demands for secondary school students, as they include the first major assessment cycle after the summer holidays. Negative stress factors can increase injury risk [14], and according to Kenttä et all., poor recovery status further elevates this risk [30].

It is also noteworthy that most injuries in this cohort occurred in October, November, January and February raising the possibility that cold environmental conditions may also contribute to a higher injury incidence. Although most evidence linking cold exposure to the incidence and severity of musculoskeletal complaints originates from occupational research, some studies consistently show that workers exposed to cold environments report more than 25% additional complaints compared

with those performing the same tasks in temperate climates. While causal pathways between cold induced alterations in muscle function and injury risk are not fully established, it as been hypothesized that since “force production, velocity, power and manual dexterity” are negatively affected by cold [33], then the likelihood of injury is plausibly greater during cold-weather sports participation [34].

Biological maturation may also contribute to the temporal distribution of injuries observed in this cohort. During adolescence, particularly around peak height velocity (PHV), rapid skeletal growth is not always accompanied by proportional adaptations in muscle-tendon units and neuromuscular control, resulting in temporary reductions in coordination, flexibility, and load tolerance. These maturational changes may increase susceptibility to both acute and overuse injuries [35,36]. Furthermore, substantial inter-individual differences in maturation status exist among players of the same chronological age, meaning that identical training loads may impose very different physiological demands [37]. In this context, periods characterized by abrupt increases in workload, such as the return to competition after the Christmas break, may expose biologically vulnerable athletes to a heightened risk of injury.

Considering the seasonal patterns observed in this cohort, the COVID 19 pandemic had a substantial impact on both the frequency and severity of injuries in young federated soccer players. The unusually low number of injuries recorded in the 2020/21 season aligns with the prolonged suspension of organized sport, and intermittent lockdowns, which markedly limited opportunities for injury occurrence. However, this period of constrained activity was followed by a sharp rebound in injury frequency during the 2022/23 and 2023/24 seasons, which together accounted for more than half of all documented injuries.

The COVID 19 pandemic caused an unprecedented disruption in training, with lockdown measures leading to prolonged inactivity and detraining effects. In a study ran in Croatia in youth soccer players [38] injury incidence dropped during the 2019/20 and 2020/21 seasons due to reduced training and match exposure. However, upon resumption of regular activities, a sharp increase in injuries was observed, probably due to deconditioning and loss of neuromuscular control, which also may contribute to the rise of severe injuries [39]. The significant association between season and injury severity in this cohort reinforces this interpretation. While 2019/20 displayed a higher than expected proportion of non-severe injuries, the 2021/22 season, immediately following the most restrictive pandemic phase, showed a disproportionately elevated number of severe injuries.

4.2 Characterization of injuries by sex, type and anatomical region affected

In our cohort, we identified a marked imbalance in the distribution of injuries between male and female players, with 92.6% of all recorded cases occurring in male athletes. This finding provides an important contextual foundation for the discussion, as it reflects the structural gender asymmetry present across all age groups. According to official registration data from the AFP, across all competitive age categories, there are 33 733 registered male soccer players compared with only 2 352 registered female players. This disproportionate participation naturally results in a higher

absolute number of injuries among male athletes and must therefore be considered when interpreting gender specific injury patterns.

Concerning the type of injury, the pattern observed in male athletes diverges from what is typically described in the epidemiological literature. The systematic review and meta-analysis by Robles-Palazón et al. [40], which includes exclusively male and female soccer players aged ≤19 years, identifies muscle/tendon injuries as the most frequent category among adolescent boys. These results are consistent with evidence from other youth cohorts in which muscle injuries predominate, such as the prospective study by Leão et al. [41], conducted with 180 male youth athletes from Coritiba Foot Ball Club (Curitiba, Paraná), where muscle injuries accounted for 59% of all cases, followed by joint injuries (19.8%), ligament injuries (13%) and a notably low proportion of bone fractures (6%). In contrast, our results reveal a substantially different distribution, with ligament injuries emerging as the most frequent type among male athletes, while muscle injuries represented the least prevalent category in this subgroup.

The distribution of injury types in female athletes is partially aligned with the evidence synthesized by Robles-Palazón et al. [40]. Their meta-analytic findings indicate that joint and ligament injuries constitute the most frequent category in female youth soccer, and our results similarly identified ligament injuries as the predominant type in this subgroup. Exists scientific evidence that anatomical, biomechanical, neuromuscular, and hormonal differences increase the risk of ligament injuries in women [42,43]. However, our results demonstrated a higher proportion of bone injuries, with articular injuries representing the third most frequent category.

These variations in the distribution of injury types in this cohort, when compared with the patterns reported in these studies, are consistent with a combination of methodological factors. First, the nature of our injury database is fundamentally different. The injuries included in our dataset result from athletes seeking medical assistance on their own initiative, which inherently captures clinically relevant cases and may overrepresent injury types that are more symptomatic, painful or functionally limiting, such as ligament and bone injuries. In contrast, Robles-Palazón et al. [40] quantify injury risk using incidence rates per 1000 hours of exposure, derived from prospective studies that record all injuries meeting predefined criteria, regardless of whether athletes seek medical care. A similar methodological distinction applies to the prospective study conducted by Leão et al. [41] with 180 male youth athletes from Coritiba Foot Ball Club. Because their data were collected through continuous, structured monitoring within a single club, all injuries were systematically recorded, which could increase the proportion of mild muscle injuries.

Furthermore, the classification systems in the meta-analysis by Robles-Palazón et al. [40] differ substantially. While the systematic review groups muscle/tendon and joint/ligament injuries into combined categories, our study distinguishes ligament, bone, articular and muscle injuries separately, which naturally alters the distribution of results.

Regarding the anatomical region affected, the distribution observed in our cohort aligns broadly with the patterns described in the American Academy of Pediatrics Clinical Report (2019), which states that most injuries in youth soccer involve the lower extremities, with the ankle and knee being

the most commonly affected regions [44]. According to Kolodziej et al. [45], typical soccer actions such as single-leg landings, cutting maneuvers, rapid decelerations, pivoting and changes of direction could generate high ground reaction forces, multiplanar joint loads, dynamic knee valgus and increased rotational stress at the ankle, which may help explain the higher incidence of knee and ankle injuries observed in youth soccer players.

4.3 Association between injury context, playing position and injury type

The analysis of how injuries relate to both the context in which they occur and the player's position on the pitch provides an important perspective for understanding whether situational demands or positional roles influence the type of injury sustained.

Jones et al. [46] reported that although the incidence of injury per 1000 hours is consistently higher in match play, the substantially greater volume of training exposure results in a higher absolute number of injuries occurring during training sessions. This pattern mirrors the distribution observed in our cohort, in which 55.1% of all injuries occurred in training.

The contrasting injury patterns observed between training and match play reflect the fundamentally different biomechanical and situational demands inherent to each context. Match environments expose players to higher intensity actions, greater situational unpredictability and more frequent physical contact [47,48], all of which increase the likelihood of acute traumatic injuries [48]. This information could explain the significantly higher than expected proportion of bone injuries recorded during matches in our study.

In contrast, training sessions typically involve repetitive technical drills, controlled tactical tasks and the progressive accumulation of mechanical load, conditions under which non-contact injury mechanisms are more likely to emerge. A non-contact injury such as an ACL rupture during a change of direction in training is often attributable to a complex interaction of internal risk factors [49]. This contextual profile aligns with the descriptive pattern observed in our cohort, where ligament injuries occurred more frequently during training, although these deviations did not reach statistical significance.

Attending to the position on the field, midfielders sustained the highest proportion of injuries (39.7%), followed by defenders (29.0%) and forwards (22.6%), whereas goalkeepers accounted for only 8.7% of all recorded cases. This positional distribution is broadly consistent with previous research. Hwang-Bo et al. [10] in a study, conducted in South Korea, with the purpose to identify the frequency and characteristics of injuries that occurred during the training camps and matches of the national soccer team's under-20 and under-23 for 2 years, reported that midfielders and defenders typically exhibit the greatest injury burden, a pattern partly attributed to the larger number of players occupying these positions. Even if the number of players in the playing position varies, depending on the tactics of the soccer matches, generally, the numbers of players in the midfielder and defenders´ positions are higher than those in the forward and goalkeepers´ positions [10]. In the meantime, Martins et al. observed that defensive and forward sectorial positions were the most

affected by injuries across multiple seasons, while goalkeepers consistently presented the lowest injury incidence due to their lower physical demands and limited exposure to direct contact situations [50].

Reis et al. [51] reported a significant association between position and injury type, with midfielders disproportionately affected by joint and ligament injuries, likely reflecting the high frequency of turning, pivoting and change of direction actions inherent to their role. However, our results are consistent with those of Hall et al. [11] who prospectively monitored 369 male academy players and similarly found no association between playing position and any injury type or location, indicating that positional role does not fundamentally determine the nature of injuries sustained.

4.4 Assessment of injury severity and impact on continued participation in federated soccer

Understanding the severity of injuries is essential for interpreting their functional consequences and their potential influence on young athletes' ability to maintain participation in federated soccer.

Although injuries are common in youth soccer, international epidemiological evidence consistently shows that most events are of minimal severity, typically resulting in only 1 to 3 days of time loss. Robles-Palazón et al. [40], for example, reported that minimal injuries predominate in adolescent players, while moderate and severe injuries occur at substantially lower rates. Their meta-analysis identified incidence rates of 1.7 injuries/1000 h for moderate injuries and 0.8–1.3 injuries/1000 h for severe injuries, values considered problematic due to their high burden. In practical terms, these authors estimate that a typical youth squad of 20 players may expect approximately two severe injuries per season. In contrast, the present study documented a markedly different pattern. In our cohort, 81.2% of all injuries were classified as severe. This discrepancy is likely explained by the nature of the data source, as injuries were recorded only when athletes voluntarily sought medical care, a process that naturally favours the registration of more serious conditions. Consequently, the high proportion of severe injuries observed in this cohort should be interpreted not as an indication of unusually high injury severity in this population, but rather as a reflection of the clinical based reporting pathway inherent to the study design.

Despite the high proportion of severe injuries identified in this cohort, the present study found no statistically significant association between injury severity and the decision or need to discontinue federated soccer participation. This finding aligns with emerging evidence suggesting that the relationship between injury severity and long term sport continuation is far from linear. Ortega et al. [52] demonstrated that, although athletes sustaining moderate or severe injuries typically recover functional capacity (≈90%), only 63% return to their pre-injury performance level and just 44% resume competitive participation. These results highlight that return to sport outcomes depend not only on the clinical severity of the injury but also on psychological factors such as anxiety, stress, and perceived readiness.

Similarly, another article on return to play after serious injury indicates that athletes' motivations are often shaped by external pressures, such as expectations from coaches, fear of disappointing others, or need for scholarships in secondary students to enter in a university, rather than intrinsic desire alone. Individuals driven by intrinsic motivation tend to experience greater confidence and well-being upon returning, whereas externally controlled motivations may compromise psychological adjustment [53]. Taken together, this literature supports the interpretation that injury severity alone does not dictate sport discontinuation. In the context of the present study, the absence of an association between severity and dropout likely reflects the multifactorial nature of return to play decisions, where psychological readiness, social environment, and personal motivation play a decisive role too.

5. Limitations

This study has several limitations that should be acknowledged. The retrospective design and reliance on clinical records, generated only when athletes voluntarily sought medical care, may have led to under reporting of minor injuries and limited control over the standardization of data collection. For that reason, the database likely overrepresents clinically significant injuries, as athletes with minor complaints may not have sought medical evaluation.

The absence of individual exposure data for all federated athletes in AFP prevented the calculation of incidence rates per 1000 hours, restricting the analysis to absolute frequencies. Also, important individual characteristics, such as biological maturation, were not available, limiting the ability to explore more detailed risk profiles.

Additionally, no detailed contextual information was collected regarding training and match conditions, including practice intensity, type of exercise, weekly load, competitive schedule, or environmental factors, which constrains mechanistic interpretations of injury occurrence. The reduced number of female athletes limits the generalizability of sex specific findings, and the simplified categorization of playing positions, without distinguishing fullbacks or wingers as commonly done in other epidemiological studies, may have reduced comparability with existing literature.

6. Conclusion

This retrospective cohort study provides a comprehensive epidemiological characterization of sports-related injuries among federated secondary school soccer players in Portugal, offering one of the most detailed regional analyses conducted to date within the AFP.

Overall, the study highlights the substantial injury burden faced by adolescent soccer players and underscores the need for structured, evidence-based prevention strategies within Portuguese youth football. The absence of a unified epidemiological surveillance system within soccer associations, such as the AFP, remains a critical gap, limiting the capacity of clubs, federations and healthcare providers to implement targeted interventions.

Future research should prioritize the development of a structured and continuous epidemiological surveillance system within Portuguese youth football, enabling the calculation of exposure adjusted incidence rates and more accurate comparisons with international data. Prospective studies integrating training load metrics, wellness indicators and contextual factors, such as academic stress, weather conditions and playing surfaces, would allow a deeper understanding of the mechanisms underlying injury occurrence. Expanding research to include biological maturation, psychological determinants of injury and return to sport outcomes is also essential, particularly in adolescent populations. Finally, evaluating the implementation, adherence and effectiveness of injury-prevention programmes, such as FIFA 11+, in real world youth settings will be crucial to bridging the gap between scientific evidence and practical application.

7. References

1. Emery C. Risk factors for injury in child and adolescent sport: A systematic review of the literature. Clin J Sport Med. 2003;13(4):256-268.
2. Lysens R, Steverlynck, Ostyn M et al. The predictability of sports injuries. Sports Med. 1984;1(1):6-10.
3. Bahr R, Holme I. Risk factors for sports injuries—A methodological approach. Br J Sports Med. 2003;37(5):384-392.
4. Bahr R, Krosshaug T. Understanding injury mechanisms: a key component of preventing injuries in sport. Br J Sports Med. 2005;39(6):324-329.
5. Ekstrand J, Waldén M, Hägglund M. Hamstring injuries have increased by 4% annually in men's professional football, since 2001: a 13-year longitudinal analysis of the UEFA Elite Club Injury Study. Br J Sports Med. 2016;56(5):259-266.
6. Parsons JL, Coen SE, Bekker S. Anterior cruciate ligament injury: towards a gendered environmental approach. Br J Sports Med. 2021;55(17):984-990.
7. Gupta AS, Pierpoint LA, Comstock RD, Saper MG. Sex-Based Differences in Anterior Cruciate Ligament Injuries Among United States High School Soccer Players: An Epidemiological Study. *Orthop J Sports Med.* 2020
8. Fuller CW, Ekstrand J, Junge A, et al. Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. Clin J Sport Med. 2006;16(2):97-106.
9. Gokeler A, Bisschop M, Benjaminse A, et al. Quadriceps function following ACL reconstruction and rehabilitation: Implications for optimisation of current practices. Sports Med. 2014;51(4):769-790.
10. Hwang-Bo K, Joo CH. Analysis of injury incidences in the Korea national men's soccer teams. J Exerc Rehabil. 2019;15(2):268-273.
11. Hall EC, Larruskain J, Gil SM, et al. Playing position and injury incidence rate in male academy soccer players. J Athl Train. 2022;57(7):656-663.
12. Wilkerson GB, Marshall SW, Kerr ZY, et al. The First Decade of Web-Based Sports Injury Surveillance: Descriptive Epidemiology of Injuries in US High School Girls' Soccer (2005–2006 Through 2013–2014) and National Collegiate Athletic Association Women's Soccer (2004–2005 Through 2013–2014). J Athl Train. 2018;53(9):880-892.
13. Direção-Geral da Educação. Matriz dos Cursos Científico-Humanísticos. Lisboa: DGE; 2012.
14. Andersen MB, Williams JM. A model of stress and athletic injury: prediction and prevention. J Sport Exerc Psychol. 1988;10(3):294-306.
15. Ribeiro I, Pires R, Oliveira P et al. Fatores protetores e de vulnerabilidade de estudantes do Ensino Secundário. RevSALUS. 2023.
16. Covassin T, Beidler E, Ostrowski J et al. *Psychosocial Aspects of Rehabilitation in Sports*. Clinics in Sports Medicine. 2015;34(2):199-212.
17. Gulliver A, Griffiths KM, Mackinnon A et al. The mental health of Australian elite athletes. J Sci Med Sport. 2015;18(3):255-261.
18. Hammond T, Gialloreto C, Kubas H et al. The prevalence of failure-based depression among elite athletes. Clin J Sport Med. 2013;23(5):421-425.
19. van Mechelen W, Kemper HC, Hlobil H. Incidence, severity, aetiology and prevention of sports injuries: A review of concepts. A review of concepts. Sports Med. 1992;14(2):82-99.

20. Waldén M, Mountjoy M, McCall A, et al. Football-specific extension of the IOC consensus statement: methods for recording and reporting of epidemiological data on injury and illness in sport. Br J Sports Med. 2020;54(7):372-389.
21. Mountjoy M, Junge A, Alonso JM, et al. Consensus statement on the methodology of injury and illness surveillance in FINA (aquatic sports). Br J Sports Med. 2016;50(10):590-596.
22. Leppänen M, Pasanen K, Clarsen B, et al. Overuse injuries are prevalent in children's competitive football: a prospective study using the OSTRC overuse injury questionnaire. Br J Sports Med. 2019;53(3):165-171.
23. FIFA; WHO. Concussion is a serious brain injury (Internet). Geneva: FIFA; 2024.
24. Hänni S, Tegner Y, Vedung F et al. Soccer-related concussions among Swedish elite soccer players: A descriptive study of 1,030 players. Scand J Med Sci Sports. 2020;30(1):168-175.
25. Benjaminse A, Verhagen E. Implementing ACL injury prevention in daily sports practice- it's not just the program: Let's build together, involve the context, and improve the content. Sports Med. 2021;51(8):1547-1555.
26. Mandorino M, Figueiredo AJ, Gjaka M et al. Injury incidence and risk factors in youth soccer players: a systematic literature review. Part II: Intrinsic and extrinsic risk factors. *Biology of Sport*. 2022;40(1):27–49.
27. Bowen L, Gross AS, Gimpel M, et al. Accumulated workloads and the acute: chronic workload ratio relate to injury risk in elite youth football players. Br J Sports Med. 2017;51(5):452-459.
28. Bacon CS, Mauger AR. Prediction of overuse injuries in professional U18–U21 footballers using metrics of training distance and intensity. *Journal of Strength and Conditioning Research*. 2017;31(10):2808–2815.
29. Bell DR, Lang PJ, McLeod T.V et al. SM. Sport specialization is associated with Injury History in Youth Soccer Athletes. Sports Health. 2018;10(3):258-263.
30. Kenttä G, Hassmén P. Overtraining and recovery. Sports Med. 1998;26(1):1-16.
31. Gabbett TJ. The training—injury prevention paradox: should athletes be training smarter and harder? Sports Med. 2016;46(6):751-754.
32. Piggott B, Newton M, McGuigan M. The relationship between training load and incidence of injury and illness over a pre-season at an Australian Football League Club. J Aust Strength Cond. 2009;17(3):4-17.
33. Wakabayashi H, Oksa J, Tipton M. Exercise performance in acute and chronic cold exposure. J Physiol Anthropol. 2015.
34. Gatterer H, Faulhaber M, Burtscher M. et al. Practicing Sport in Cold Environments: Practical Recommendations to Improve Sport Performance and Reduce Negative Health Outcomes. Int J Environ Res Public Health. 2021.
35. Bult HJ, Barendrecht M, Tak IJR. Injury risk and injury burden are related to age group and peak height velocity among talented male youth soccer players. Orthop J Sports Med. 2018;6(12):1–10.
36. Towlson C, Salter J, Ade JD et al. Maturity-associated considerations for training load, injury risk, and physical performance in youth soccer: One size does not fit all. Sports Med. 2021;51(6):1039–1051.
37. Hall ECR, Erskine RM et al. The association of growth and maturation with injury in academy soccer players: a narrative review. Sports Med. 2026;56(1):35–79.
38. Skomrlj J, Modric T, Sekulic D, et al. Understanding Longitudinal Muscle Injury Trends in Youth Football: Insights from U9 to U13 Players. *Sports*. 2025;13(6):163.

39. Bittencourt NFN, Meeuwisse WH, Mendonça LD, et al. Complex systems approach for sports injuries: moving from risk factor identification to injury pattern recognition—narrative review and new concept. Sports Med. 2016;46(6):743-752.
40. Robles-Palazón FJ, López-Valenciano A, Ayala F, et al. Epidemiology of injuries in male and female youth football players: A systematic review and meta-analysis. Sports Med. 2021;51(4):845-875.
41. Leão TM, Borek RS, Basso RO, et al. Characteristics of musculoskeletal injuries in youth football: a prospective study. *BMC Sports Science, Medicine and Rehabilitation*. 2025;17(1):45.
42. Dos'Santos T, Stebbings GK, Morse C et al. Effects of the menstrual cycle phase on anterior cruciate ligament neuromuscular and biomechanical injury risk surrogates in eumenorrheic and naturally menstruating women: A systematic review. Sports Med. 2023.
43. Cırdı YU, Günay A, Akgün U. Characteristics and prevention of ACL injuries in females. *Acta Orthopaedica et Traumatologica Turcica*. 2025;59(1):1–10.
44. Watson A, Mjaanes JM. LaBella CR, et al. Soccer injuries in children and adolescents. Pediatrics. 2019;18(6):215-220.
45. Kolodziej M, Willwacher S, Nolte K et al. Biomechanical Risk Factors of Injury-Related Single-Leg Movements in Male Elite Youth Soccer Players. Sports Biomech. 2022.
46. Jones S, Almousa S, Gibb A et al. Injury Incidence, Prevalence and Severity in High-Level Male Youth Football: A Systematic Review. Sports Med. 2019;49(12):1879-1899.
47. Morgans R, Ju W, Radnor JM, et al. The positional demands of explosive actions in elite soccer: Comparison of English Premier League and French Ligue 1. Int J Sports Physiol Perform. 2024.
48. López-Valenciano A, Ruiz-Pérez I, Ayala F, et al. Epidemiology of injuries in professional football: a systematic review and meta-analysis. Br J Sports Med. 2020;53(12):726-732.
49. Windt J, Gabbett TJ. How do training and competition workloads relate to injury? The workload-injury aetiology model. Sports Med. 2017;47(3):449-462.
50. Martins F, França C, Marques A et al. Sports injuries of a Portuguese professional football team during three consecutive seasons. Acta Med Port. 2022;35(5):357-364.
51. Reis GF, Santos TRT, Lasmar RCP et al. Sports injuries profile of a first division Brazilian soccer team: a descriptive cohort study. Brazil Journal of Physical Therapy (BJPT). 2015;50(5):567-574.
52. Ortega E, Garcia-Mas A, Gómez-Espejo V. Psychological readiness to return to sports practice and risk of recurrence: Case studies. *Cuadernos de Psicología del Deporte*. 2022;22(1):1–12.
53. Podlog LW, Eklund R. Return to Sport After Serious Injury: A Retrospective Examination of Motivation and Psychological Outcomes. J Sport Rehabil. 2005;14(1):20-34.

Table I- Baseline Demographic Profile of the Sample

	TOTAL (N = 828)	MALE (N = 767)	FEMALE (N = 61)
Age, mean ± SD	16.5 ± 1.1	16.5 ± 1.1	16.4 ± 1.0
Competitive Age Categories			
Under 15	32 (3.9%)	28 (3.7%)	4 (6.6%)
Under 17	523 (63.2%)	493 (64.3%)	30 (49.2%)
Under 19	224 (27.1%)	201 (26.2%)	23 (37.8%)
Senior	49 (5.9%)	45 (5.9%)	4 (6.6%)
Position on the field			
Goalkeeper	72 (8.7%)	68 (8.9%)	4 (6.6%)
Defender	240 (29.0%)	226 (29.5%)	14 (23.0%)
Midfielder	329 (39.7%)	305 (39.8%)	24 (39.3%)
Forward	187 (22.6%)	168 (21.9%)	19 (31.1%)

Table II- Temporal distribution of injuries by month of occurrence

MONTH OF OCCURRENCE	NUMBER OF ATHLETES	PERCENTAGE (%)
JANUARY	107	12.9%
FEBRUARY	103	12.4%
MARCH	72	8.7%
APRIL	72	8.7%
MAY	64	7.7%
JUNE	65	7.9%
AUGUST	19	2.3%
SEPTEMBER	53	6.4%
OCTOBER	107	12.9%
NOVEMBER	106	12.8%
DECEMBER	60	7.2%

Table III- Association between season and severity

		SEVERITY		
SEASON		**SEVERE**	**NON-SEVERE**	**TOTAL**
19/20	Count	112	44	156
	Expected Count	126.6	29.4	156.0
	% within season	71.8%	28.2%	100.0%
	Adjusted Residual	-3.3	3.3	
20/21	Count	61	10	71
	Expected Count	57.6	13.4	71.0
	% within season	85.9%	14.1%	100.0%
	Adjusted Residual	1.1	-1.1	
21/22	Count	135	9	144
	Expected Count	116.9	27.1	144.0
	% within season	93.8%	6.3%	100.0%
	Adjusted Residual	4.3	-4.3	
22/23	Count	194	41	235
	Expected Count	190.7	44.3	235.0
	% within season	82.6%	17.4%	100.0%
	Adjusted Residual	0.6	-0.6	
23/24	Count	170	52	222
	Expected Count	180.2	41.8	222.0
	% within season	76.6%	23.4%	100.0%
	Adjusted Residual	-2.0	2.0	
TOTAL	Count	672	156	828
	Expected Count	672.0	156.0	828.0
	% within season	81.2%	18.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
PEARSON CHI-SQUARE	28.274[a]	4	<.001
LIKELIHOOD RATIO	31.435	4	<.001
N OF VALID CASES	828		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 13.38.

Table IV- Frequency of injuries by sex

		NUMBER OF ATHLETES	PERCENTAGE (%)
SEX	**Male**	767	92.6%
	Female	61	7.4%

Table V- Frequency of injuries by type in male soccer players

INJURY TYPE	NUMBER OF ATHLETES	PERCENTAGE (%)
LIGAMENT	363	47.3%
ARTICULAR	136	17.7%
BONE	184	24.0%
MUSCULAR	20	2.6%
CONTUSIONS	64	8.3%

Sex = Male

Table VI- Frequency of injuries by type in female soccer players

INJURY TYPE	NUMBER OF ATHLETES	PERCENTAGE (%)
LIGAMENT	41	67.2%
ARTICULAR	6	9.8%
BONE	7	11.5%
MUSCULAR	2	3.3%
CONTUSIONS	5	8.2%

Sex = Female

Table VII- Frequency of injuries by anatomical region in male soccer players

ANATOMICAL REGION OF THE INJURY	NUMBER OF ATHLETES	PERCENTAGE (%)
SKULL	6	0.8%
FACE	19	2.5%
TEETH	9	1.2%
SHOULDER	19	2.5%
ARM	2	0.3%
FOREARM	3	0.4%
WRIST	39	5.1%
HAND	24	3.1%
ELBOW	8	1.0%
SPINAL COLUMN	4	0.5%
THORAX	28	3.7%
HIP	19	2.5%
THIGH	21	2.7%
KNEE	460	60.0%
LEG	15	2.0%
ANKLE	79	10.3%
FOOT	12	1.6%

Sex = Male

Table VIII- Frequency of injuries by anatomical region in female soccer players

ANATOMICAL REGION OF THE INJURY	NUMBER OF ATHLETES	PERCENTAGE (%)
SKULL	0	0.0%
FACE	1	1.6%
TEETH	1	1.6%
SHOULDER	1	1.6%
ARM	0	0.0%
FOREARM	0	0.0%
WRIST	3	4.9%
HAND	2	3.3%
ELBOW	0	0.0%
SPINAL COLUMN	1	1.6%
THORAX	1	1.6%
HIP	0	0.0%
THIGH	2	3.3%
KNEE	42	68.9%
LEG	1	1.6%
ANKLE	6	9.8%
FOOT	0	0.0%

Sex = Female

Table IX- Association between injury type and context of occurrence

CONTEXT OF OCCURRENCE		TYPE OF INJURY					
		Ligament	Articular	Bone	Muscular	Contusions	Total
Match	Count	168	55	114	6	29	372
	Expected Count	181.5	63.8	85.8	9.9	31.0	372.0
	% within context of occurrence	45.2%	14.8%	30.6%	1.6%	7.8%	100.0%
	Adjusted Residual	-1.9	-1.6	4.7	-1.7	-0.5	
Practice	Count	236	87	77	16	40	456
	Expected Count	222.5	78.2	105.2	12.1	38.0	456.0
	% within context of occurrence	51.8%	19.1%	16.9%	3.5%	8.8%	100.0%
	Adjusted Residual	1.9	1.6	-4.7	1.7	0.5	
Total	Count	404	142	191	22	69	828
	Expected Count	404.0	142.0	191.0	22.0	69.0	828.0
	% within context of occurrence	48.8%	17.1%	23.1%	2.7%	8.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
PEARSON CHI-SQUARE	23.847[a]	4	<.001
LIKELIHOOD RATIO	23.928	4	<.001
LINEAR-BY-LINEAR ASSOCIATION	2.418	1	.120
N OF VALID CASES	828		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.88.

Table X- Frequency of injuries by position on the field

POSITION ON THE FIELD	NUMBER OF ATHLETES	PERCENTAGE (%)
GOALKEEPER	72	8.7%
DEFENDER	240	29.0%
MIDFIELDER	329	39.7%
FORWARD	187	22.6%

Table XI- Association between injury type and playing position

		TYPE OF INJURY					
POSITION ON THE FIELD		**LIGAMENT**	**ARTICULAR**	**BONE**	**MUSCULAR**	**CONTUSIONS**	**TOTAL**
Goalkeeper	Count	26	14	21	0	11	72
	Expected Count	35.1	12.3	16.6	1.9	6.0	72.0
	% within position on the field	36.1%	19.4%	29.2%	0.0%	15.3%	100.0%
	Adjusted Residual	-2.3	.5	1.3	-1.5	2.2	
Defender	Count	132	36	50	7	15	240
	Expected Count	117.1	41.2	55.4	6.4	20.0	240.0
	% within position on the field	55.0%	15.0%	20.8%	2.9%	6.3%	100.0%
	Adjusted Residual	2.3	-1.0	-1.0	.3	-1.4	
Midfielder	Count	163	61	70	9	26	329
	Expected Count	160.5	56.4	75.9	8.7	27.4	329.0
	% within position on the field	49.5%	18.5%	21.3%	2.7%	7.9%	100.0%
	Adjusted Residual	.4	.9	-1.0	.1	-.4	
Forward	Count	83	31	50	6	17	187
	Expected Count	91.2	32.1	43.1	5.0	15.6	187.0
	% within position on the field	44.4%	16.6%	26.7%	3.2%	9.1%	100.0%
	Adjusted Residual	-1.4	-.2	1.4	.5	.4	
TOTAL	Count	404	142	191	22	69	828
	Expected Count	404.0	142.0	191.0	22.0	69.0	828.0%
	% within position on the field	48.8%	17.1%	23.1%	2.7%	8.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
PEARSON CHI-SQUARE	17.370 [a]	12	.136
LIKELIHOOD RATIO	18.634	12	.098
LINEAR-BY-LINEAR ASSOCIATION	.071	1	.790
N OF VALID CASES	828		

a. 2 cells (10.0%) have expected count less than 5. The minimum expected count is 1.91.

Table XII- Impact of injury severity on the continuation of federated soccer participation

WITHDRAWAL FROM FEDERATED SOCCER		SEVERITY		
		Severe	Non-Severe	Total
Withdrawal	Count	405	95	500
	Expected Count	405.8	94.2	500.0
	% within withdrawal from federated soccer	81.0%	19.0%	100.0%
	Adjusted Residual	-.1	.1	
Not Withdrawal	Count	267	61	328
	Expected Count	266.2	61.8	328.0
	% within withdrawal from federated soccer	81.4%	18.6%	100.0%
	Adjusted Residual	.1	-.1	
Total	Count	672	156	828
	Expected Count	672.0	156.0	828.0
	% within withdrawal from federated soccer	81.2%	18.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
PEARSON CHI-SQUARE	.021[a]	1	.885		
CONTINUITY CORRECTION	.003	1	.957		
LIKELIHOOD RATIO	.021	1	.885		
FISHER'S EXACT TEST				.928	.480
LINEAR-BY-LINEAR ASSOCIATION	.021	1	.885		
N OF VALID CASES	828				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 61.8

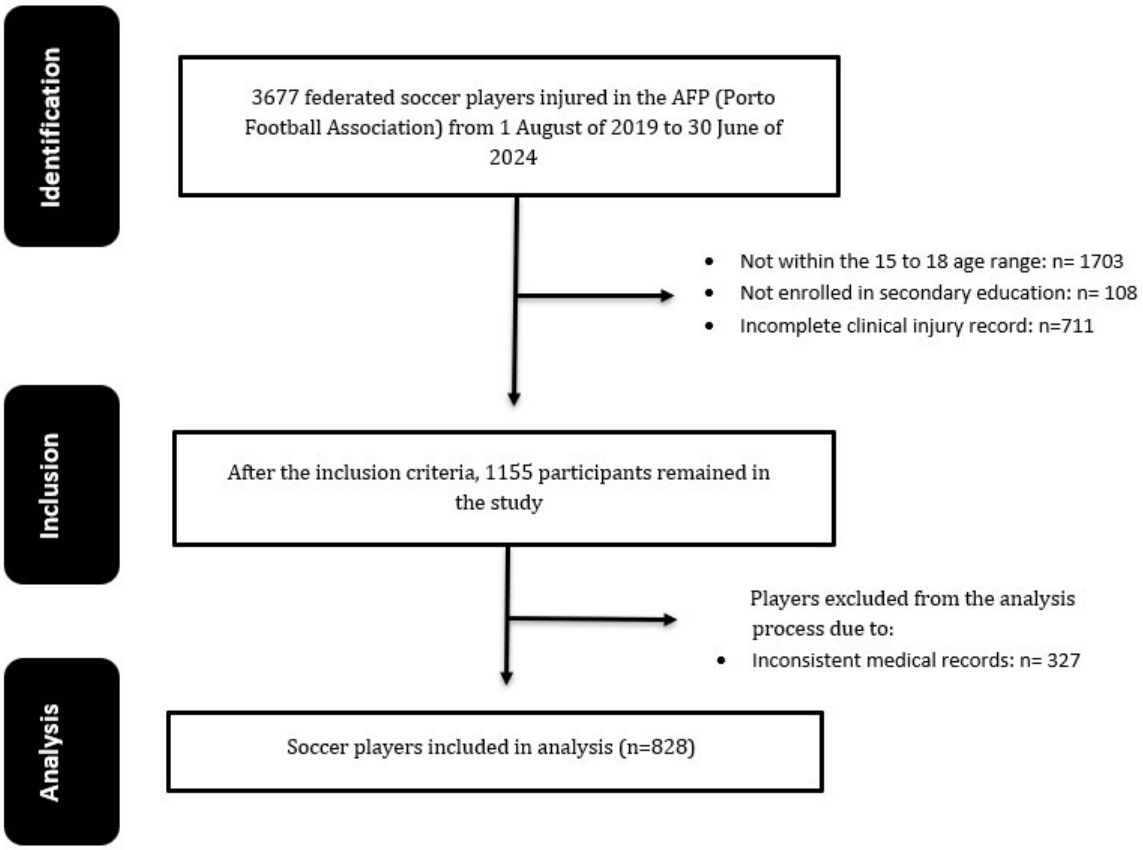

Figure 1- Inclusion/exclusion flow chart of federated youth soccer players included in the study

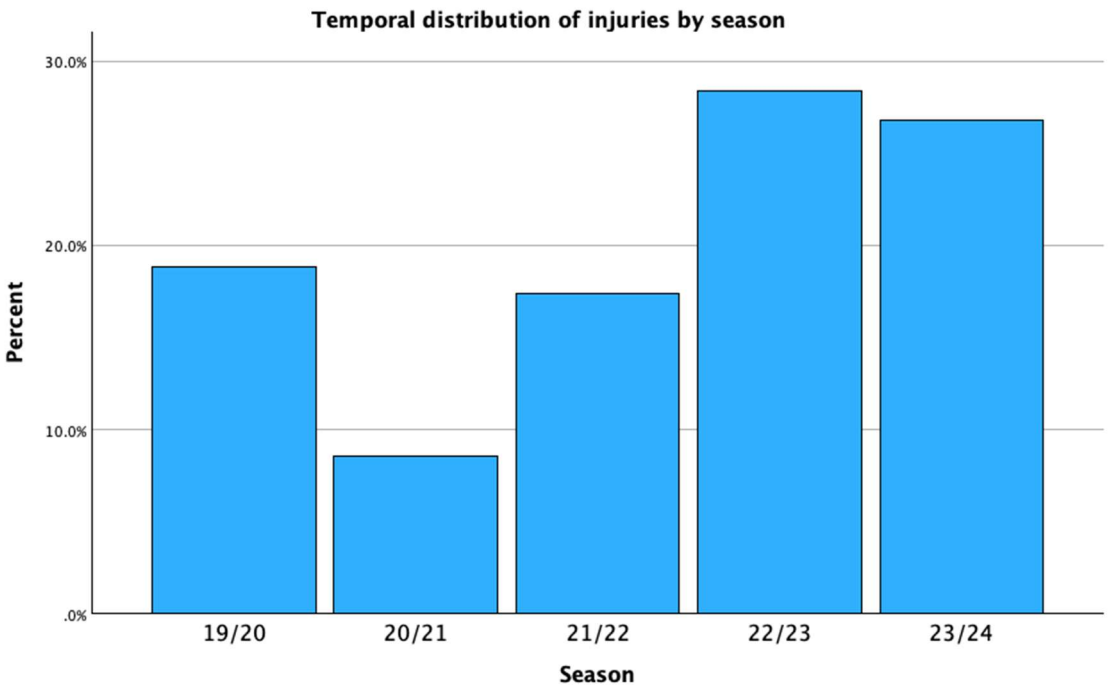

Figure 2- Temporal distribution of injuries by season

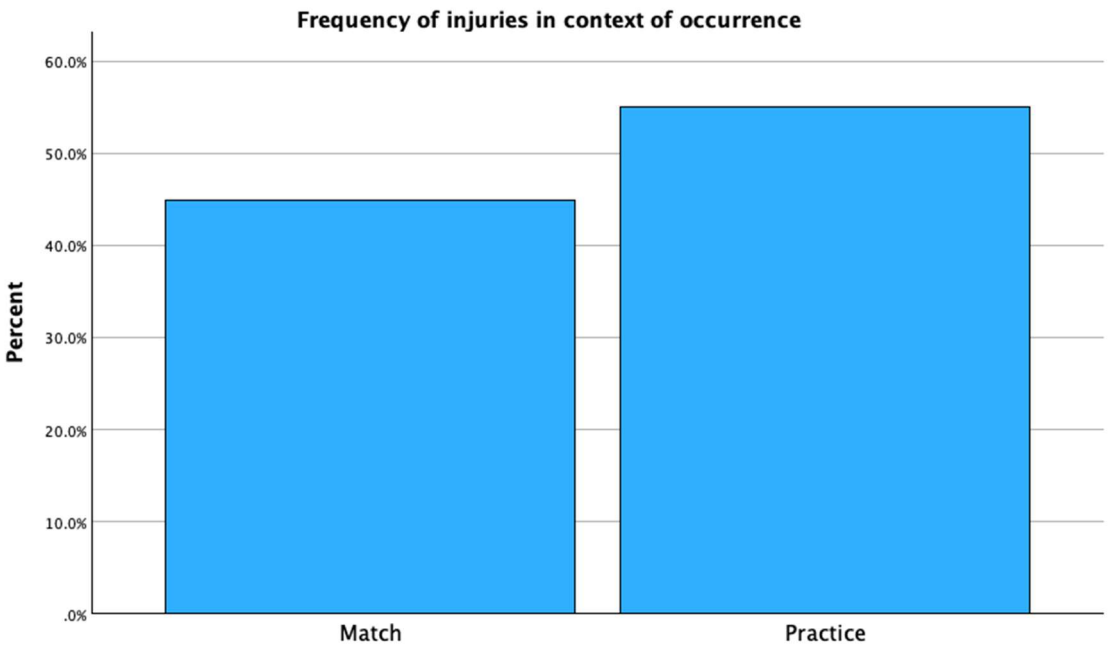

Figure 3- Frequency of injuries in context of occurrence

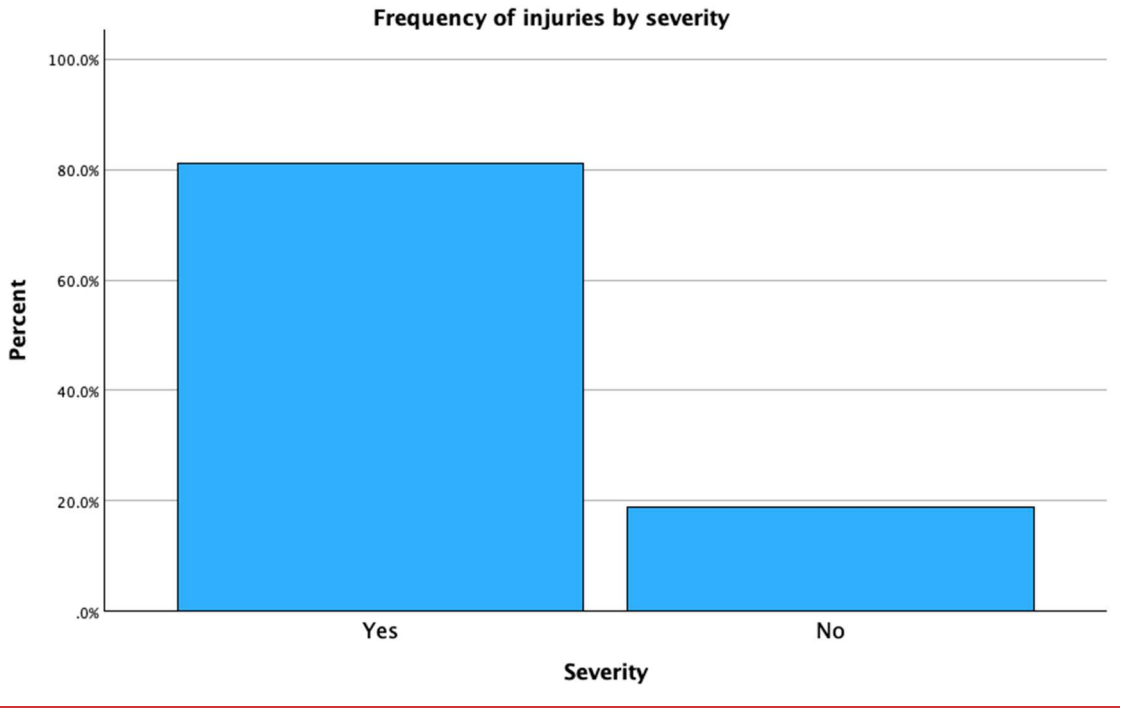

Figure 4- Frequency of injuries by severity

INSTITUTO DE **CIÊNCIAS BIOMÉDICAS ABEL SALAZAR**