UNIVERSIDADE DA BEIRA INTERIOR
Ciências da Saúde

# Epidemiology of injuries in Portuguese senior male rugby union sevens.

## Assessment of injury incidence, severity, impact, type and risk factors in the two top tiers of competition and possible strategies for its mitigation.

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Tese para obtenção do Grau de Doutor em

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(3º ciclo de estudos)

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Co-orientador: Prof. Doutor Luis Taborda Barata

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**António Miguel da Cruz Ferreira**

A thesis submitted for the degree of Doctor of Philosophy in

**Medicine**

Primary Supervisor: Professor Luiz Miguel Santiago, MD, PhD

Associate Supervisor: Professor Luis Taborda Barata, MD, PhD

**Covilhã, January 2019**

# Dedication

To my family, for always being by my side!

# Acknowledgments

The conception, design and conclusion of this project would have not been possible without the help and support of so many friends, partners, rugby agents and academics.

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# Research overview

Sports injuries in rugby sevens have been studied in recent years, but almost exclusively at the highest competitive levels.[1] However, even when compared with the available literature for the fifteens variant at the same level of competition, there is still a significant gap in terms of the volume and quality of data collected.[2,3]

Considering that rugby sevens has a great tradition in Portugal, that it has recently gained Olympic sport status and also has one of the highest injury incidence rates of all sports played worldwide, it becomes crucial, for us, to describe and understand the impact of sports injuries among Portuguese senior male rugby sevens' players and teams. Only with full knowledge of the epidemiology and risk factors for sports injuries at this level of competition will we be able to design, develop and assist with the implementation of effective strategies to mitigate the direct and indirect costs of injuries in rugby sevens, thus promoting players' safety and welfare.

Therefore, it is extremely relevant, in our opinion, to: a) conduct a solid review of the literature on the epidemiology of injuries in rugby sevens; b) to characterize the Portuguese rugby sevens senior male player; c) to accurately determine the injury incidence rate at this level of competition, as well as the potentially relevant risk factors.

Likewise, it will be crucial to open and maintain direct lines of communication with all the different sport agents (athletes, coaches, directors, doctors, physios and parents) in order to get their feedback and include their perspectives on the recommendations to be made, aiming at the reduction of injury incidence rates, the improvement of the show as well as the reduction of direct and indirect costs of the injuries.

## Thesis overview

This thesis is divided into the following Chapters:

Chapter One: Introduction – where relevant background information is detailed, especially regarding injury definitions, theories of injury causation and explanation models of sports injuries and injury prevention, and also a characterization of rugby sevens physical demands and potential risk factors for injuries, players' physical and anthropometric profile and the epidemiology of injuries in rugby sevens.

Chapter Two: Objectives – research aims, research questions and hypotheses for the present study are systematically presented.

Chapter Three: Methods – an overview of the methodology used is briefly presented, as most of the methodology of this thesis has already been published and is available in the literature (the published articles, which include the methodology, are included in the Appendices).

Chapter Four: Results – according to the structure chosen for this thesis, all relevant published data (using the final format accepted for publication) are presented in this section; in addition, other unpublished data relevant to the study are also presented as "authors' article" in this section.

Chapter Five: Discussion and final conclusion – all the key findings and conclusions of the thesis are critically discussed in this section. Methodology used, contribution to existing knowledge and implications for the future are also discussed in this chapter.

Chapter Six: Future perspectives – based on all the findings and feedbacks, future research possibilities are suggested, as well as the discussion of the practical implications of the findings and the use of this knowledge.

## Publications

This thesis lead to the publication of the following papers in indexed peer-reviewed journals:

- Cruz-Ferreira AM, Cruz-Ferreira EM, Santiago LM, Taborda-Barata L. Epidemiology of injuries in senior male rugby union sevens: a systematic review. Phys Sportsmed. 2017 Feb;45(1):41-48. doi: 10.1080/00913847.2017.1248224. (Appendices A1, B1)

- Cruz-Ferreira AM, Cruz-Ferreira EM, Santiago LM, Taborda-Barata L. Epidemiology of injuries in senior male Portuguese rugby union sevens: a cohort prospective study. Phys Sportsmed. 2018 May;46(2):255-261. doi: 10.1080/00913847.2018.1441581. (Appendices A2, B2)

- Cruz-Ferreira AM, Cruz-Ferreira EM, Santiago LM, Taborda-Barata L. Promoting players' safety and welfare through the sharing of scientific knowledge with sports agents: the new reality of Portuguese rugby sevens. Phys Sportsmed. 2017 Oct 5:1-2. doi: 10.1080/00913847.2017.1386067. (Appendices A3, B3)

- Cruz-Ferreira AM, Cruz-Ferreira EM, Ribeiro P, Santiago LM, Taborda-Barata L. Epidemiology of time-loss injuries in senior and under-18 Portuguese male rugby players. Journal of Human Kinetics. 2018; 2: 73-80. doi: 10.1515/hukin-2017-0159 (Appendices A4, B4)

## Conference presentations

This thesis lead to the following oral presentations made at scientific events:

- Cruz-Ferreira AM, Cruz-Ferreira EM, Taborda-Barata L, Santiago LM. Epidemiology of injuries in Portuguese senior male rugby union sevens. 5th ECOSEP Congress and FIFA Update. Dubai, 9-10 Dec 2017 (Appendices A5, B5)

- Cruz-Ferreira AM, Cruz-Ferreira EM, Taborda-Barata L, Santiago LM. Time-loss injuries in senior and under-18 Portuguese male rugby union players. 5th ECOSEP Congress and FIFA Update. Dubai, 9-10 Dec 2017 (Appendices A5, B5)

- Cruz-Ferreira AM, Cruz-Ferreira EM, Taborda-Barata L, Santiago LM. The relationship between precompetitive somatic anxiety, worry and concentration disruption and the occurrence of sports injuries in Portuguese senior male rugby sevens players. 5th ECOSEP Congress and FIFA Update. Dubai, 9-10 Dec 2017 (Appendices A5, B5)

# Resumo alargado

**Introdução:** O rugby de sete (popularmente conhecido como *Sevens*) é uma modalidade desportiva, variante de *rugby union*, disputada por duas equipas de sete elementos cada, num campo com as dimensões habituais da variante de quinze (100 metros de comprimento por 70 de largura), em partidas com duração total de 14 minutos (duas partes de sete minutos com um intervalo de dois entre cada uma). Apesar de ter mais de um século de história, nas últimas duas décadas, após a criação dos Campeonatos Mundiais de Sevens (em 1993) e do Circuito Mundial de rugby de sete (em 1999), esta variante ganhou um especial destaque e mediatismo global, que culminou na sua introdução no programa dos Jogos Olímpicos de Verão, em 2016.

Como se verifica na maioria dos fenómenos sociais de destaque, especialmente nos emergentes, também o rugby de sete passou a beneficiar de uma maior atenção prestada pelos académicos e investigadores nas áreas das Ciências do Desporto e da Medicina Desportiva, tendo as décadas de 2000 e 2010 assistido à realização e publicação de numerosos estudos procurando, em particular, caracterizar o perfil do atleta de rugby de sete, as exigências físicas e as dinâmicas do jogo, mas também aspectos relativos à epidemiologia das lesões desportivas nesta variante. No entanto, apesar deste maior interesse, quando comparada com a variante de rugby de quinze, a literatura disponível sobre o rugby de sete continua a ser escassa e essencialmente centrada nos níveis competitivos mais elevados, em particular nas competições de seleções de elite, como são os casos do Circuito Mundial de rugby de sete, do Campeonato do Mundo e do Torneio Olímpico.

Dessa mesma literatura, é possível apurar que o rugby de sete é uma variante desportiva extremamente exigente do ponto de vista físico, favorecendo os atletas que possuem um conjunto alargado de atributos físicos como a velocidade, a capacidade de suportar um significativo número de contatos com o adversário e de realizar esforços estáticos de alta intensidade. Neste contexto, tratando-se de uma modalidade de conquista territorial e sendo disputada numa campo com as dimensões anteriormente referidas, ao permitir a realização de movimentos de corrida livre a alta intensidade e o contacto direto com oponente procurando interromper esse movimento e recuperar a bola, é aceitável a evidência de literatura científica relatando uma maior incidência de lesões desportivas nesta variante, comparando com o rugby de quinze (para o mesmo nível de competição – elite).

Em Portugal, apesar de o momento de indiscutível maior visibilidade do rugby nacional ter sido a presença da seleção nacional sénior masculina no Campeonato Mundial de rugby de quinze em 2007, a verdade é que é precisamente na variante de rugby de sete que as seleções nacionais têm alcançado os seus maiores sucessos internacionais. Nos Sevens, a seleção sénior masculina de Portugal conta com oito títulos de Campeão Europeu (2002, 2003, 2004, 2005, 2006, 2008, 2010 e 2011) e um segundo lugar (2012), uma medalha de prata nos Jogos Mundiais (2009),

cinco presenças em Campeonatos do Mundo de *Sevens* (melhor resultado o 10º lugar em 2010) e ainda com o estatuto de '*core team*' (equipa residente) do Circuito Mundial de rugby de sete entre as épocas de 2012/13 e 2015/16. Tratam-se, sem dúvida, de feitos que merecem ser destacados, particularmente quando não existe no nosso país nenhuma estrutura de rugby exclusivamente profissional e os jogadores que se dedicam em exclusivo à prática da modalidade são poucos e na sua maioria estrangeiros. É, ainda, importante destacar que os atletas que habitualmente representam a seleção de rugby de sete portuguesa jogam em clubes portugueses e competem, com regularidade, tanto no Campeonato Nacional de rugby de quinze, como no Circuito Nacional de rugby de sete que se disputa no final da época desportiva.

Conhecendo esta realidade e tendo em conta a ausência de um volume significativo de literatura científica relativa à epidemiologia das lesões em rugby de sete, particularmente nos níveis competitivos que não o de elite internacional, torna-se pertinente a realização de uma revisão sistemática da literatura. Da mesma forma, sendo o rugby de sete uma variante com tão significativa tradição no nosso país, e sendo expectável uma elevada incidência de lesões, torna-se pertinente a realização de um estudo epidemiológico que permita caracterizar a ocorrência de lesões desportivas no rugby de sete senior masculino em Portugal. Da mesma forma, será importante procurar identificar factores eventualmente associados com essas lesões, assim como caracterizar o atleta nacional do ponto de vista antropométrico e da sua experiência na modalidade. Seguidamente, tendo em conta o Modelo de Van Mechelen, após o estudo epidemiológico a realizar, procurar-se-á apresentar os resultados obtidos aos agentes da modalidade, discutindo eventuais vias de mitigação do impacto das lesões desportivas no rugby de sete e procurar obter os seus comentários a eventuais sugestões propostas no âmbito da investigação realizada. Por fim, fazendo uma reflexão crítica de toda a informação obtida nos três passos anteriores, elaborar um documento de recomendações à comunidade desportiva e aos orgãos responsáveis pela gestão e organização da modalidade, procurando apresentar possíveis soluções e vias alternativas para a correção de eventuais riscos associados à ocorrência ou ao impacto das lesões desportivas no rugby nacional.

**Metodologia:** O desenho do presente estudo preconiza quatro fases distintas, que adiante se apresentam em detalhe.

Na primeira destas fases, que decorreu entre setembro de 2015 e março de 2016, foi realizada uma revisão sistemática da literatura sobre a epidemiologia das lesões desportivas no rugby de sete senior masculino. Para o efeito, foi utilizada a chave ('Football' [Mesh]) AND ('Athletic Injuries' [Mesh]) OR 'Rugby') no motor de busca eletrónico Pubmed. Foram incluídos todos os artigos originais, de revisão e meta-análise em competições de rugby de sete de seniores masculinos, publicados entre 1995 e setembro de 2015, na língua inglesa, portuguesa, espanhola, italiana ou francesa. A mesma pesquisa foi adaptada e alargada às bases de dados Google Scholar, SCOPUS, Scielo e IndexRMP. As listas de referências dos artigos incluídos, assim

como a literatura cinzenta disponível foi adicionalmente pesquisada para identificação de artigos com interesse potencial que poderiam não estar incluídos nas pesquisas originais.

Na segunda fase do estudo, que decorreu entre maio de 2016 e junho de 2017, procedeu-se à realização de um estudo de coorte prospetivo incluíndo todos os atletas participantes no Circuito Nacional de rugby de sete do primeiro e segundo escalão competitivos. No total, foram incluídas as oito equipas do primeiro nível competitivo, que competiram em três torneios de um só dia (quatro jogos por dia), disputados em três sábados consecutivos. Relativamente ao segundo escalão, foram incluídos os atletas das sete equipas que disputaram o torneio único de um dia de acesso ao patamar superior na época seguinte (disputando três a quatro jogos por dia). Foram identificadas no campo todas as situações de lesão desportiva e os atletas nessas condições foram prospetivamente acompanhados até terem alta médica por parte dos departamentos médicos de cada um dos clubes. As datas das recuperações foram comunicadas aos grupos de investigadores. Este período de seguimento durou 12 meses após o final da última etapa do circuito, ou seja, até junho de 2017.

As principais variáveis em análise incluíram: a taxa de incidência de lesões desportivas (apresentadas em lesões por 1000 horas de jogo-jogador), a sua localização anatómica, tipo, incidente e gravidade (apresentadas em dias de ausência de treino e/ou competição). Foram, igualmente, colhidos dados relativos aos volumes de treino (na época de quinze e de sete), à experiência individual dos atletas, rotinas de aquecimento e solicitado o preenchimento do questionário "*Sport Anxiety Scale*" para avaliação do traço de ansiedade pré-competitiva.

Os testes de Kolmogorov-Smirnoff e de Shapiro-Wilk foram utilizados para avaliar a normalidade das variáveis em análise. Foram assumidas como significativas as diferenças nos valores de incidência e severidade das lesões se os intervalos de confiança a 95% não se encontrassem sobrepostos. Os testes *t de student* e teste *U de Mann-Withney,* quando adequados, foram utilizados para identificar eventuais diferenças relativamente aos dados individuais e antropométricos dos atletas de diferentes patamares competitivos. Para cada patamar competitivo, eventuais diferenças entre jogadores lesionados e não lesionados foram igualmente avaliadas com recurso aos mesmos testes. O coeficiente de correlação de Spearman foi usado para avaliar a relação entre o volume de treino reportado e a gravidade das lesões para cada um dos níveis de competição. O teste exato de Fisher foi usado para estimar o risco relativo de um atleta sofrer uma lesão durante a temporada de sevens se realizou treino específico de sevens durante a temporada de quinze, para cada nível de competição. O nível de significância foi definido em $p < 0,05$. A análise estatística foi realizada com recurso ao programa informático SPSS (version 22.0 for Windows, IBM Corp, Armonk, New York, USA).

Numa terceira fase, já na posse dos dados obtidos durante o estudo de coorte prospetivo, realizou-se em 10 de junho de 2017, na cidade de Coimbra, uma conferência médico-desportiva para apresentação e discussão desses mesmos resultados, tendo para o efeito sido convidados todos os clubes registados na Federação Portuguesa de Rugby, assim como a própria estrutura federativa. A divulgação do evento foi feita com recurso não apenas aos meios mais

convencionais (carta, telefonema e divulgação na comunicação social), mas também com recurso às redes sociais (facebook e twitter) e correio electrónico. Após a apresentação dos resultados do estudo e de um conjunto de sugestões com vista à mitigação do impacto das lesões desportivas no rugby de sete, com base nos dados obtidos na fase anterior do estudo, foi solicitada a avaliação da aplicabilidade e da concordância relativamente a essas propostas por parte dos agentes presentes na conferência. Esta avaliação foi feita com recurso a um questionário contendo 24 questões. As primeiras 23 podiam ser respondidas utilizando uma escala de concordância com a afirmação realizada: 1- nada de acordo; 2- apenas parcialmente de acordo; 3- de acordo; 4- muito de acordo. A última questão compreendia três possibilidades de resposta e era relativa ao período em que deveria decorrer a época de rugby de sete: 1- no final da época de quinze; 2- antes da época de quinze; 3- ao longo de toda a época. Uma análise crítica e descritiva dos resultados obtidos foi realizada, com vista à inclusão das conclusões mais relevantes num documento de "recomendações" a elaborar.

A quarta e última fase do estudo correspondeu à elaboração de um documento de resumo geral do estudo e de recomendações gerais e específicas com vista à mitigação do peso que as lesões desportivas no rugby de sete senior masculino têm no contexto desportivo nacional. Esse documento foi enviado à Federação Portuguesa de Rugby, contendo o resumo da conferência médica realizada na terceira fase do estudo e as sugestões a implementar, mas foi também divulgada publicamente através da publicação de um editorial contendo os aspectos e recomendações mais relevantes em revista científica internacional da área da Ortopedia e das Ciências do Desporto indexada na Pubmed.

**Resultados:** Da revisão sistemática da literatura, foi possível identificar e incluir na análise sete artigos originais (coorte prospetivos) sobre a epidemiologia das lesões desportivas no rugby de sete sénior masculino. A maioria destes estudos (seis) eram relativos a atletas de elite internacional e apenas um a atletas amadores. Na sua maioria (seis) os artigos identificados pertenciam ao mesmo autor (ou grupo de autores) que são, simultaneamente, responsáveis pela área médica da *World Rugby* (entidade reguladora do rugby mundial). Em todo o caso, as taxas globais de incidência de lesões em torneios de rugby de sete de elite variaram de 101,5 a 119,8 lesões por 1000 horas de jogo-jogador. O único estudo sobre jogadores amadores revelou uma menor taxa de incidência de lesões (74,7 por 1000 horas de jogo-jogador). A maioria das lesões ocorreu após contacto com o adversário (72,8 a 83,7%) e a gravidade média das lesões foi superior a 34,1 dias. O membro inferior foi a localização anatómica mais frequente das lesões desportivas nos atletas de elite (56,3 a 70,4%). No grupo amador, as lesões da cabeça/pescoço e do membro superior foram mais frequentes que as das restantes localizações anatómicas. Quanto ao tipo de lesão, as lesões articulares/ligamentares foram as mais frequentes em atletas de elite (34,3 a 51,5%), mas no único estudo em amadores as mais frequentes foram as lesões musculares/tendinosas (37,5%).

Quando realizado o estudo de coorte prospetivo na população portuguesa, identificaram-se 27 lesões desportivas correspondendo a uma taxa de incidência de 133,9 lesões por 1000 horas de jogo-jogador. A gravidade média das lesões foi de 22,22 dias e os eventos com contato precederam 81,5% de todas as lesões registadas. Na sua maioria, o membro inferior foi o principal local da lesão (66,7%) e as lesões articulares/ligamentares e musculares/tendinosas as mais frequentes, correspondendo a 85,1% de todos os casos. Uma associação entre a ocorrência de lesão desportiva e um menor volume de treino durante a temporada rugby de sete foi identificada para o segundo patamar competitivo ($p = 0,021$). Para o mesmo patamar, foi igualmente identificada uma relação inversa entre o número de horas de treino durante a época de rugby de sete e a gravidade das lesões identificadas neste grupo de atletas ($p = 0,008$). Para os atletas a competir no nível superior, aqueles que habitualmente realizaram treino específico de *sevens* em simultâneo com o treino de quinze durante a época de rugby de quinze, apresentaram um aumento significativo do risco de lesão (risco relativo = 3.2; $p = 0,011$). Nenhum dado relevante foi identificado relativamente à associação entre rotinas de aquecimento e a ocorrência de lesões desportivas. Quanto ao nível de ansiedade pré-competitiva, apenas no grupo de atletas de topo e para a sub-categoria "disrupção da concentração" foi identificada uma associação entre valores mais elevados e a ocorrência de lesão.

Na terceira fase do estudo foram apresentados resultados do trabalho de campo realizado entre maio de 2016 e junho de 2017, numa sessão em que estiveram presentes 63 delegados (entre atletas, dirigentes, árbitros, treinadores, médicos, fisioterapeutas, enfermeiros e investigadores). Destes, 36 acederam a participar no preenchimento do questionário entregue para avaliação do nível de aceitação das propostas apresentadas com vista à mitigação do impacte das lesões desportivas no rugby de sete nacional (*estas propostas encontram-se apresentadas em detalhe na discussão deste resumo alargado*). A maioria dos respondentes considerou o conhecimento sobre o peso das lesões desportivas na modalidade um dado de extremo relevo, com 42% a afirmarem concordarem e 58% concordarem muito com essa afirmação, identificando também todos os agentes não profissionais de saúde como elementos de relevo nesse processo (atletas, dirigentes, árbitros, treinadores). A maioria dos respondentes concordou, também, com a necessidade de separação clara das épocas de rugby de sete e de quinze, mas ao mesmo tempo consideraram a relação entre ambas incorreta. Na maioria dos casos os respondentes concordaram com a necessidade de aumentar a duração da época de sevens e de a realizar, como aconteceu na época de 2015/16, no final da de rugby de quinze. No mesmo sentido, 91% dos participantes concordaram com a existência de um número superior de torneios ao longo da época de rugby de sete, com uma ligeira maioria (51%) a concordarem ou a concordarem muito com a necessidade de reduzir o número de jogos por dia. Por outro lado, 77% concordaram ou concordaram muito com a possibilidade de os torneios serem disputados em dois dias e não em apenas um e 71% tinham a mesma opinião sobre a realização de torneios emparelhados em semanas consecutivas com pelo menos uma de intervalo. No que respeita à possibilidade teórica de se propor uma redução das dimensões do recinto de jogo

como medida de redução da incidência de lesões desportivas, a proposta não mereceu a concordância de 80% dos participantes. No final do questionário, foram ainda colocadas quatro questões relativas às medidas apresentadas nas jornadas e à necessidade de serem monitorizadas de forma programada as lesões desportivas no rugby português. Concordaram com a adequação dessas medidas 95% dos respondentes, mas apenas 81% afirmaram concordar ou concordar muito com a sua aplicação nos próprios clubes. Quanto à necessidade de um programa institucional destinado à prevenção de lesões desportivas, 97% dos participantes concordaram ou concordaram muito com o mesmo. Já sobre a necessidade de implementar um programa de vigilância epidemiológica das lesões desportivas no rugby de sete, 94% dos participantes referiram concordar ou concordar muito.

Na última fase do estudo, com base nos dados obtidos nas três etapas anteriores, foi publicado um editorial na revista *The Physician and Sportsmedicine* contendo as recomendações do grupo de trabalho e a receção às mesmas por parte dos agentes da modalidade e da Federação Portuguesa de Rugby.

**Discussão:** Da análise global de todas as etapas deste estudo, resulta claro que a taxa de incidência de lesões desportivas no rugby de sete é muito elevada, sendo ainda superior às reportadas para a variante tradicional de rugby de quinze, para o mesmo nível de competição. Estas lesões são, também, mais graves, resultando em períodos de ausência do treino e da competição mais longos. As explicações apresentadas para estes números são variadas, mas parecem assentar no facto de o rugby de sete ser praticado por atletas com condições antropométricas muito semelhantes às dos atletas da variante de quinze mas, pelas características próprias dos Sevens, o jogo é disputado com maior velocidade, levando à produção de maiores momentos lineares e, necessariamente, a transferências de energia mais elevadas durante as placagens. Da mesma forma, pela especificidade da variante, com a necessidade de os atletas procurarem espaços livres num terreno com as mesmas dimensões do campo de rugby de quinze, mas menos densamente ocupado, podem ocorrer mais movimentos rápidos de rotação e mudanças de direção que se associem à ocorrência de lesões mais graves.

Por outro lado, na população de atletas nacionais avaliados neste estudo, verificámos que a taxa de incidência de lesões desportivas no Circuito português na época de 2015/16 foi semelhante à relatada para os torneios de rugby de sete internacionais, apesar da menor gravidade das lesões registadas. Acreditamos que, pelo menos em parte, esses números podem ser justificados pelo fato de que alguns jogadores que competem no Circuito Nacional de rugby de sete também competirem a nível internacional (na *Rugby Europe Grand Prix Series* e/ou na *World Rugby Sevens Series*). Assim, o nível de preparação e a intensidade do jogo poderiam ser considerados semelhantes. Por outro lado, há uma pequena mas relevante diferença metodológica entre o nosso e os estudos prévios. Ao contrário do presente, onde uma equipa de investigadores identificou diretamente possíveis situações de lesão desportiva no campo, abordando a equipa médica de cada clube no final da partida e seguindo cada jogador lesionado

até o último dia da sua recuperação, nos estudos de vigilância de lesões em rugby de sete conduzidos por Fuller et al. a nível internacional, os dados foram obtidos por auto-relato das equipas médicas de cada seleção, após o final de cada torneio. A nossa metodologia, por ser mais pró-ativa, talvez tenha conduzido à identificação de um maior número de lesões, quando comparamos com os estudos ao nível da elite internacional. Da mesma forma, reconhecemos que algumas das lesões identificadas no Circuito Nacional, especialmente as menos severas (menos de 7 dias de ausência ao treino e/ou à competição), poderiam não ter sido identificadas se a metodologia previsse o auto-relato das lesões pelas equipas médicas dos clubes, após os torneios. Assim, a maior taxa de incidência e a menor gravidade das lesões podem estar enviesadas pelo maior número de lesões de baixa gravidade identificadas e reportadas. Neste estudo, foi igualmente identificada uma associação entre volumes de treino e ocorrência de lesões em ambos os níveis de competição em análise, apesar de apresentarem sentidos diferentes. Estes dados parecem reforçar a necessidade de personalizar a preparação dos atletas e das equipas.

Com base nestes dados e durante o evento científico onde os mesmos foram apresentados, sugerimos um conjunto de mudanças no formato da competição e no destaque a dar à variante de sete por todos os agentes que incluiam: 1 - evitar a diminuição do volume de treino durante a temporada de rugby de sete e aumentar o foco na preparação individual dos atletas; 2 - destacar a relevância do rugby de sete para o rugby nacional e a sua promoção, através do aumento da duração da temporada e do número de torneios; 3 - implementar semanas de descanso entre torneios, durante a temporada de sevens, para permitir a recuperação dos atletas; 4 - aumentar a duração dos torneios de 1 para 2 dias, como ocorre em todos os principais eventos internacionais; 5 - diminuir o número de jogos disputados no mesmo dia; 6 - implementar um programa de vigilância de lesões desportivas nas competições portuguesas de rugby de sete.

Como já referido, estas propostas foram apresentadas e avaliadas pelos agentes da modalidade presentes no evento científico organizado para o efeito, através de um questionário anónimo. Ultrapassando as expectativas, 95% dos participantes concordaram com a maioria das recomendações e 81% declararam mesmo que as iriam implementar nos seus próprios clubes. Na sequência desta reunião, os autores do estudo foram convidados pelo Sr. Vice-Presidente da Federação Portuguesa de Rugby, Dr. Gonçalo Neto, presente no evento em representação do Sr. Presidente, a apresentar um breve relatório da conferência e um resumo das recomendações à Direção da Federação Portuguesa de Rugby, para análise do mesmo. Posteriormente, os autores receberam, também, a autorização e o apoio oficial da Federação para implementar um programa de vigilância de lesões no rugby português na temporada de 2017/18.

A possibilidade de estabelecer fortes e eficazes pontes de comunicação com todos os agentes e com o órgão nacional de governação da modalidade permitiu difundir a nossa mensagem e torná-la efetiva no público alvo que, por sua vez, é capaz de relacionar os dados apresentados com sua própria realidade.

Acreditamos firmemente que, para implementar mudanças no mundo real, os académicos devem deixar as universidade e centros de investigação e procurar discutir com os agentes no terreno e com os objetos dos seus próprios estudos as melhores estratégias para resolução dos problemas identificados.

Embora concordemos que o impacto real de nossas recomendações só poderá ser avaliado por estudos futuros, o primeiro objetivo foi já alcançado: utilizou-se a evidência científica para promover a discussão séria sobre a necessidade de se promover a segurança e o bem-estar dos jogadores de rugby de sete portugueses.

Da mesma forma, tendo em conta a escassez de dados de relevo sobre a epidemiologia das lesões no rugby amador a nível internacional, esperamos que o presente estudo possa contribuir para a sua replicação em outras latitudes e ajude novos investigadores a acreditar no impacto e a implementar este tipo de intervenções.

**Conclusões:** Apresentamos o primeiro estudo de revisão sistemática da literatura relativamente à epidemiologia das lesões no rugby de sete e, também, o primeiro estudo apresentando padrões de referência para a incidência, gravidade e fatores de risco associados a lesões desportivas no rugby de sete senior masculino amador. As taxas de incidência de lesões desportivas identificadas foram semelhantes às registadas nas competições internacionais, mas a gravidade das lesões no Circuito Nacional foi inferior.

Como foram identificadas associações estatisticamente significativas entre o volume de treino e a ocorrência de lesões desportivas nos diferentes níveis da competição, apesar de em sentidos opostos para cada um, reforça-se a noção de que os volumes coletivos e individuais de treino, assim como a preparação para a competição devem ser personalizadas. Adicionalmente, devem as equipas médicas e os treinadores ter presente que a taxa de incidência de lesões desportivas no rugby de sete nacional é elevada, reveste-se de custos para atletas e equipas, existindo fatores de risco bem identificados para esta ocorrência.

Esperamos, com este trabalho, contribuir para o desenvolvimento e implementação de novos estudos epidemiológicos no rugby de sete senior masculino amador em Portugal e noutros países. A metodologia utilizada pode ser generalizada para contextos diferentes e mais amplos, por ter sido criada com base no documento de consenso para estudos epidemiológicos em rugby que serviu de base à maioria dos estudos semelhantes previamente publicados. Será crucial, todavia, reunir uma maior evidência sobre um assunto tão relevante, para podermos alcançar um nível de conhecimento mais aprofundado e, com ele, formular com maior precisão estratégias de prevenção de lesões ou recomendar modificações às leis do jogo e aos formatos das competições, visando a promoção da segurança e do bem-estar dos atletas.

# Palavras-chave

Epidemiologia; *football*; lesões desportivas; medicina desportiva; medicina preventiva; *rugby union*; rugby de sete.

# Abstract

**Objectives:** To conduct a systematic review of the literature regarding the epidemiology of injuries in rugby sevens. To determine the incidence rate of injuries in the Portuguese senior male sevens circuit, to characterize them and identify associated factors. To present the results of the study to relevant rugby agents, make suggestions aiming at the mitigation of the problem and collect their feedback.

**Methodology:** A systematic review of the literature was performed. Most relevant electronic databases were searched, complemented by manual searches of bibliographies and "grey literature". A prospective cohort study recording time-loss injuries was then conducted, during the 2015/16 Portuguese circuit (two top divisions). Main outcome measures included: incidence rate, location, type and severity of injuries. Data were also collected regarding players' training loads. Later, in June 2017, suggestions to mitigate the burden of injuries in Portuguese sevens were presented during a scientific meeting and feedback was requested. Data were then compiled, analyzed and used to make recommendations to the Board of the Portuguese Rugby Union.

**Results:** Overall injury incidence rates in elite senior male rugby sevens tournaments ranged between 101.5 and 119.8 per 1000 player-match-hours. Mean severity was greater than 34.1 days. Lower limb and joint/ligament injuries were the most frequent injuries in elite players. The only study in amateur players revealed a lower incidence rate, and a higher proportion of muscle/tendon injuries. During our cohort study, 27 injuries were recorded (incidence rate of 133.9 injuries per 1000 player match-hours). Average severity was 22.22 days. Most injuries occurred in the lower limb and were joint/ligament or muscle/tendon types. Association between injury and lower training loads during the sevens season was identified for the second-tier ($p=0.021$). For the same level, an inverse relation between training hours and injury severity was also found ($p=0.008$). Top-tier players training sevens and fifteens simultaneously during the year presented a significant increase of injury risk (relative risk=3.2; $p=0.011$). Based on these findings several recommendations were presented to independent rugby agents, with 95% agreeing and 81% stating that they would implement them at their own clubs.

**Conclusions:** We conducted the first ever systematic review of the literature on the epidemiology of injuries in rugby sevens. Data obtained confirmed their high incidence rate and severity. We also presented the first study providing benchmark values for the incidence, severity and risk factors associated with injuries in senior male Portuguese rugby sevens. Incidence rates were similar to those at elite tournaments, but severity was lower. Considering the associations between training loads and injuries in both levels of the competition, we suggest the need to customize sevens preparation. The level of acceptance of our recommendations by independent rugby agents was surprisingly high. A summary of the

recommendations was submitted to the Portuguese Rugby Union, for their consideration. Authorization and official support to implement a injury surveillance program for the 2017/18 rugby season were subsequently granted. Although we agree that the real impact of our effort will only be assessed by future studies, our main goal has already been achieved: scientific evidence was used aiming at the promotion of player's safety and welfare in Portuguese rugby sevens.

# Keywords

Athletic injuries; epidemiology; football; preventive medicine; rugby union; rugby sevens; sports medicine.

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**a.m.** Ante meridiem (before noon)

**AAC.** Associação Académica de Coimbra

**ACSM.** American College of Sports Medicine

**CDUL.** Centro Desportivo e Universitário de Lisboa

**CDUP.** Centro de Desporto da Universidade do Porto

**CI.** Confidence interval

**cm.** Centimetres

**CNS/PNS.** Central nervous system/ Peripheral nervous system

**COP.** *Comité Olímpico Português* (Portuguese Olympic Committee)

**CRAV.** Clube de Rugby de Arcos de Valdevez

**FPR.** Federação Potuguesa de Rugby (Portuguese Rugby Union)

**GPS.** Global Positioning System

**HIS.** Heat Stress Index

**IBM corp.** International Business Machines corporation

**IOC.** International Olympic Committee

**kg.** Kilograms

**m.** Metres

**m.s-1.** Metres per second

**Mesh.** Medical Subject Headings

**min.** Minutes

**mlO2/min/kg.** Millilitres of oxygen per minute per kilogram

**mm.** Milimetres

**mmol.L-1.** Millimol per litre

**NY.** New York

**p.m.** Post meridiem (after noon)

**PORDATA.** Portugal database (available online)

**PRISMA.** Preferred Reporting Items for Systematic Reviews and Meta-Analyses

**RBSWS.** Rugby Board Sevens World Series

**RM.** Repetitions maximum

**RSWC.** Rugby Sevens World Cup

**s.** Seconds

**SAS.** Sport Anxiety Scale

**SD.** Standard deviation

**SPSS.** Statistical Package for the Social Sciences (originally, now outdated)

**STROBE.** The strengthening the reporting of observational studies in epidemiology

**TRIPP.** Translational research framework for practice in the prevention of injuries

**USA.** United States of America

**VO2 max.** Maximal aerobic capacity

**WBGT.** Wet Bulb Globe Temperature

# Chapter One: Introduction

# 1. Background

Rugby is a collective sport with almost two centuries of history. According to legend, its origins date back to 1823, when in an act of rebellion, William Web Ellis, a pupil at Rugby School, in the United Kingdom, with total disregard for the rules of football, picked the ball up with his hands and started running forward, overtaking the opponents.[4]

With such a long history, there have been significant changes and progress witnessed by the sport.

According to the chronicles at the time, one of these changes took place in 1883, at the Scottish village of Melrose, where a rugby union tournament was played, for the first time, by teams with only 7 elements instead of the usual 15.[5] This is believed to be the true origin of a variant that, after a few years of lesser visibility, grew dramatically in 1999, with the beginning of one of the current world's most notorious sporting events: the World Rugby Sevens Series.[6]

But the stories and mutations of rugby, from its origins, did not stop with the creation of the sevens variant. In 1895, rugby was split into two different codes: rugby league and rugby union.[4] Although in a first and raw analysis they seem very similar sports, the truth is that the differences between these two codes are significant. The most recognizable one is the fact that rugby league is played by teams of 13 athletes, while in rugby union teams are composed of 15 players. Another specificity of rugby league, only eliminated in 1995, was that until that date, professionalism was prohibited in rugby union, but allowed in rugby league.[7]

However, the development and changes in rugby union and its variants was not an exclusive of the nineteenth century, especially regarding the growth and global dissemination of the sport that allowed its entry into the "Olympic family". Still in the nineteenth century, at the Paris Olympics in 1900, rugby made its debut at the Olympic stage (in the fifteens variant), with an event involving three countries: Germany, France and the United Kingdom. This tournament culminated with the organizing country winning the first ever Olympic gold medal in rugby. The inclusion of rugby, always in the fifteens variant, was repeated at the 1908, 1920 and 1924 Olympics, with the United States of America wining the last gold in the rugby fifteens history.[8] The wait to watch rugby again in the Olympics lasted until the XXI century when, in 2016, following an absence of 92 years, rugby returned to the programme, but this time with the sevens variant of the game.[9]

All the changes witnessed throughout the years, especially the advent of professionalism in 1995, led the players (and therefore the game) to become faster, taller and stronger.[7,10] In

2012, Sedeaud et al. proved what empirically already seemed clear: that for the teams participating in the World Cups from 1987 to 2007, success was directly associated with the greater body mass, stature and experience of their athletes.[11]

The game itself underwent significant changes, not only as a result of the changes in the players' anthropometric and physical profiles, but also due to the evolution of the laws of the game. Several authors have identified a significant increase in the game speed, in the "*ball-in-play*" times, but also in the number of tackles and static phases during each match.[12,13]

All these transformations in a sport that, by its nature, already involved a high number of contacts with the opponent, high speed running and high intensity static efforts, are probably the reason why rugby union fifteens has one of the highest average injury incidence rates of all collective sports: 69 per 1000 player-match-hours, which compares with 28 and 53 injuries per 1000 player-match-hours in football (soccer) and ice hockey, respectively.[14] For rugby sevens, previous reports also point to a high injury incidence rate and severity which, for the same level of competition, can even be greater than for rugby fifteens.[3]

The growing attention given by the media, as well as the increasing number of players in a sport with such a high injury incidence rate and severity, have drawn the attention of academics and institutions throughout the world.[15,16] Sports injuries represent a significant burden for the players, the teams but also for the sport. The burden of injuries is not only associated with the direct economic cost[17,18] but, increasingly, sport agents acknowledge that injuries represent a severe threat and might compromise the pursuit of individual and collective success in sports.[19]

A basic search, in 2015, on the electronic PubMed, Google Scholar, SCOPUS, Scielo and IndexRMP databases, limited to the period between 1995 and 2015, using the search key ("Football"[Mesh]) AND "Athletic Injuries"[Mesh] OR "Rugby Sevens") returned a total of 648 articles.[3] Most of these articles are studies of the epidemiology of injuries in rugby or the design and assessment of injury prevention strategies in the sports. The findings of several of these papers have been used by researchers to make suggestions of rule changes in the sport.[9]

In fact, many of the recent changes implemented by World Rugby (the sport governing body) and several other National Rugby Unions followed the recommendations made by researchers considering their epidemiological studies. As clear examples of this dynamic relation between World Rugby and Science aiming at the promotion of safety and welfare of players', we may highlight the changes made in scrum times,[10,20] the mandatory use of mouthguards in New Zealand,[21] the 2017 law that made any contact above the line of the shoulders of the opponent during the tackle illegal,[22] or even the reduction of the duration of the final match in sevens' tournaments from 20 to 14 minutes.[23]

Beyond the changes (made and/or suggested) to the game laws, many other initiatives by researchers and academic institutions have been proposed and/or implemented by World Rugby and national Unions, aiming at the reduction of injury incidence and the promotion of a safe environment in the sports worldwide.[10,24,25] These projects include training and education of

the distinct sport agents (coaches, physicians, physiotherapists, parents and athletes), such as: a) First Aid or Immediate Care courses in sport,[10] injury prevention protocols,[24,25] injury assessment protocols (e.g. for concussion);[4] b) the publication of guidelines regarding the pre-competitive medical screening, the management of the athlete with a neurologic disorder or single organ; b) the publication of recommendations and educational flyers on infection control and doping.[4]

As happens with all relevant social phenomena, the scientific community has not only an interest, but above all an imperative need or an *obligation* to understand and describe the burden of sports injuries in rugby and contribute to its mitigation, thereby promoting the quality of life, safety and welfare of the athletes, but also reducing all the associated costs. To pursuit that aim, support for scientific research in sports medicine, especially in Olympic sports, has been granted by various institutions, such as the International Olympic Committee (IOC) or the Portuguese Olympic Committee (COP).[9,26] Available literature clearly points to a broad consensus regarding the need to conduct these studies. Only large and robust data for each sport will allow the academics to: a) accurately assess the consequences of sports injuries and complications directly related to sport; b) identify risk factors, mechanisms of injury and their pathophysiology; c) collect relevant epidemiological data and establish effective programmes for the prevention of sports injuries.[16]

Rugby union is a relatively popular sport in Portugal, with records showing that the first game ever played in national soil happened in 1903, when a group of military officers from a British squadron stationed in Lisbon played against a group of local boys from the Lisbon Football Club.[27]

However, although this was the first game ever played in national territory, we had to wait 19 years to witness the first game ever played by two Portuguese teams, again in Lisbon, when, on the 22nd of March 1922, the Royal Football Club played against Sporting.[27] Another long wait, and on the 13th of April 1935, once again in Lisbon, a Portuguese national team played its first international match (and lost 5-6) against Spain.[28]

The beginning of the XXI century witnessed the highlights of the Portuguese national team in terms of international records and achievements, which made rugby more visible to the media and the general public. The successes of the Portuguese teams were seen in both sevens and fifteens variants. In the classic version of the sport, Portugal won the European Nations Cup in 2003-2004 and had its highest moment ever when, in 2007, qualified for the first time for the Rugby World Cup.[29,30] Despite the achievements in rugby fifteens, the truth is that Portugal made an impact in the international stages mainly in the sevens variant. The National Sevens team was crowned European Champion on eight occasions (2002, 2003, 2004, 2005, 2006, 2008, 2010 and 2011), ranked 10th place in the 2005 Rugby Sevens World Cup, won the silver medal at the 2009 World Games and was one of the fifteen World Rugby Sevens Circuit core teams from 2012-2013 to 2015-2016. [6,29,31]

The more visible results in international competitions in the sevens variant, in a sport where anthropometric and physical characteristics of the athletes play such a relevant role, certainly have multiple reasons. However, a hypothetical lesser anthropometric difference of the Portuguese sevens players, comparing with the international elite athletes of the same variant, seems a plausible reason.[11,32–35]

According to the PORDATA website, around seven thousand rugby players were registered in the Portuguese Rugby Union and played the sport on a regular basis, in 2014.[36] These players are the main source of recruitment for the Portuguese national teams, despite the existence of a significant number of Portuguese professional players that play rugby abroad and who may be selected, on certain occasions, to play for the "Lobos" or the "Linces" (the nicknames of the national fifteens and sevens senior male rugby teams).[37]

It is also important to understand how the national competitions are organized. Regarding the senior male fifteens variant, there is a pyramidal structure involving three competitive levels. In the 2015-2016 and 2016-2017 seasons, the competition had the following format: a top division named "Divisão de Honra" (with the top 10 teams); a second tier named "Primeira Divisão" (also with 10 teams); and the last competitive tier named "Segunda Divisão" (with 15 teams grouped by regions: Centre/North and Lisbon/South).[38]

Regarding the sevens senior male competition, in the 2015-2016 season, and similarly to what happens in the World Rugby Sevens Circuit, the first tier of the national championship was played by eight teams in a series of three one-day tournaments, played in consecutive weeks, starting on the 21st of May 2016. The second and third tiers contested the promotion to the next years' first and second tier, respectively, in single day events.[39] For the 2016-17 season an additional change was implemented for the top-tier, by terminating the series format and creating a single-day event, similar to the second and third tier, to decide the national title.

Despite being frequent in countries with greater tradition in the sport, sparse data are available regarding Portuguese players, the epidemiology of injuries or any other relevant medical aspect of rugby.[33–35,40] Thus, we are not able to thoroughly characterize some of the most relevant dimensions of Portuguese rugby, such as: the anthropometric profile and experience of the players; training and competitive loads; injury incidence, its impact and burden.

## 1.1. Injury definition

Injury was defined, as suggested by Fuller et al. in the '*Consensus statement on injury definitions and data collection procedures for studies of injuries in rugby union'* as:

*"Any physical complaint, which was caused by a transfer of energy that exceeded the body's ability to maintain its structural and/or functional integrity, that was sustained by a player during a rugby match or rugby training, irrespective of the need for medical attention or time-loss from rugby activities. An injury that results in a player receiving medical attention is referred to as a 'medical-attention' injury and an injury that results in a player being unable to take a full part in future rugby training or match play as a 'time-loss' injury."* [41]

The same definition was also accepted and considered in our study, with slight differences in its formulation, to avoid excluding some of the data under analysis. Therefore, the definition used by Fuller et al. in the World Rugby Sevens World Series (Men) Surveillance[32,42] studies was also accepted: *'any injury sustained during Sevens World Series Tournament match or training activity that prevents a player from taking a full part in normal training activities and/or match play for more than one day following the day of injury.'*

Finally, and again to broaden the pool of articles to include in our analysis, the definition used by López et al. in their study of the "Profile of an American amateur rugby union sevens series" was also accepted: *'any physical complaint caused by transfer of energy that exceeded the body's ability to maintain its structural and/or functional integrity, sustained by a player during a rugby match.'*[43]

## 1.2. Theories of injury causation in sport

One of the most consensual theories considers that injuries "*typically result from a transfer of energy to tissues that exceeds the body's ability to maintain its structural and / or functional integrity*".[41]

In a relevant article published in *Ergonomics*, Kumar described the four main theories proposed to explain the causes of injuries in non-sports environments. However, despite not being initially considered for sport injuries, such theories may have a direct application in the latter: a) *multivariate interaction theory of musculoskeletal injury precipitation*; b) *differential fatigue theory*; c) *cumulative load theory*; d) overexertion theory. [44]

Briefly, the central point of these theories is the assumption that musculoskeletal injuries have a biomechanical nature. The disruption of a biological system is dependent on its individual components and their mechanical properties. These will be determined by the individual's genetics, the morphological characteristics, the psychosocial structure as well as the occupational biomechanical risks to which he/she is exposed. That is the theoretical basis upon which the multivariate interaction theory lays.[44]

On the other hand, the *differential fatigue theory* considers that performing unbalanced and asymmetric occupational activities will cause a differential fatigue leading to a kinetic and kinematic imbalance, which results in the occurrence of an injury.[44]

The *cumulative load theory*, in turn, suggests a load limit beyond which an injury can be precipitated, with the premise that all material substances have a finitude. [44]

Finally, the overexertion theory clearly states that an effort exceeding the limit of the absolute tolerance of the structure precipitates the occurrence of a musculoskeletal injury.[44]

Although clearly distinct, the literature suggests that all these theories interact and concurrently contribute, in different degrees and in different situations, to the possible explanation of the precipitating mechanism of sport and non-sport injuries.[44,45]

## 1.3. Explanation models of sports injuries and preventive strategies

For sports medicine and sports injuries, we can find some explanatory models/theories for sports injuries in the literature that can help to understand the interaction of the different factors leading to injury. Simultaneously, these theories also allow the development and planning of strategies aiming at injury prevention.

In 1987, Van Mechelen presented a model (the *Sequence of prevention model)* that to date remains the cornerstone for most of the sports injuries prevention programmes. [24,46]

This model is based on four steps. The first one involves the identification and description of the extent of the problem (sports injuries). The second one implies the identification of the factors and mechanisms that contribute to the occurrence of injuries. The third one corresponds to the introduction of strategies with potential to mitigate the risk and/or severity of injuries, based on the etiological factors and mechanisms identified during the second phase. Finally, the last step involves assessing the impact of the implemented measures, by repeating the first step.[46]

One of the major limitations in the implementation of this model, widely identified by academics actively engaged in the study of injuries in different sports, is the sparsity of robust epidemiological studies allowing the conclusion of the first phase of the model proposed by Van Mechelen.[45] However, in the last two decades, with the growing interest in this field, a significant increase in the number of studies in all the phases of the model has been noticed, making it even more important to accurately assess the impact of modifications in various areas of sports (e.g. rule changes; injury prevention programmes; changes in the competition formats).[47]

Based on the van Mechelen model, in 2006, Finch added two more steps and proposed a new model entitled "translational research framework for practice in the prevention of injuries" (TRIPP).[48] The fifth step included the assessment and discussion of how the outcomes of the previous four steps of the model can actually be implemented in the sport. The sixth step involved implementing the intervention in the real-world context and then assessing its effectiveness. The author considered that these two steps are necessary to ensure that the suggested measures for the prevention of sports injuries are accepted, adopted and implemented by the cohort for which they are intended.[48]

Prior to the changes proposed by Finch, in 1994, Meeuwisse also suggested a modification to the Van Mechelen model: the "*multifactorial model of the aetiology of sports injuries*". In this model, the author changes the four-step sequence of the van Mechelen's approach, seeking to account for the interaction of internal and external risk factors in the occurrence of sports injuries. This suggestion essentially contributed to the discussion about the need to detail the

second stage of the sequence of the prevention of sports injuries, and to consider and assess multiple risk factors for injury causation. This model, however, is extremely similar to the "*multivariate interaction theory of musculoskeletal injury precipitation*" already discussed in the "theories of injury causation".[41,49]

Gissane et al. considered the linear sequence of the explanatory model presented by Meeuwisse inadequate, since a clear onset (with a healthy athlete) and an end point (a sports injury) could be excessively simplistic to describe the occurrence of sports injuries, and therefore suggested the "*cyclical operational model to investigate contact sports injuries*".[50] This model attempts to overcome the limitations identified by the authors regarding the "*multifactorial model of the aetiology of sports injuries*" since it does not take into account the changing nature of the intrinsic risk factors over time, the possibility of recurrence of the injury and the consequences of an injury. In this model, a healthy/fit athlete is considered but the authors acknowledge that he might have a number of intrinsic risk factors for injury. A timely assessment of both intrinsic and extrinsic risk factors should be undertaken to better understand and reduce the risk of injury. Regarding extrinsic risk factors, and prior to the athlete's exposure, there is the possibility of implementing preventive strategies that include, but are not limited to, pre-competitive warm-up and adequate hydration, use of personal protective equipment, orthoses or functional taping.[50]

Conceptually, this model includes the possibility that athletes resume their activity without limitations, when healthy (or completely recovered), but also to return to a lower level of play and participation, if they are only able to do it at that level. The same authors suggest that the application of this model leads to a better understanding of the multifactorial nature of sports injuries and, additionally, helps to minimize the risk of injury (and recurrence of injury) by supporting the rehabilitation of athletes, and by allowing them to return at lower levels of participation.[50]

However, in 2007, Meeuwisse et al. argued that the model presented by Gissane et al. did not consider the consequences of repeated participation in sports, with and without injury, and so they suggested a new model to explain sports injuries: the *"dynamic, recursive model of aetiology in sport injury"*.[51] This model emphasizes that adaptations occur within the sporting context (both in the presence and absence of injury), which may alter the risk and affect the etiology in a dynamic and recursive way. They considered that sports injuries are often preceded by a chain of events and circumstances that, when present, are sufficient cause to result in injury. Thus, this model acknowledges the implications of repeated exposure, possible adaptation or maladaptation to such exposure, as well as the possible existence of an injury or the complete (or incomplete) recovery from a previous injury.[51]

As Williams concluded, the explanatory models of injuries in a sports context are complex and each contribute with relevant elements of analysis to a better understanding of the phenomena and implementation of effective preventive strategies. Increasingly, explanatory models of sports injuries emphasize the need for further studies that consider the changing nature of the

risk within individuals, as well as the importance of operationalizing theoretical knowledge through the design and application of practical measures, achievable and accepted by the agents on the field.[45]

## 1.4. Physical demands, patterns of movement and contact in rugby sevens

Rugby sevens variant witnessed an exponential growth both in popularity and visibility in the world of sport. [16] This growing visibility of sevens, confirmed by the growth of the *World Rugby Sevens Series* and inclusion of sevens in the Olympic programme, led to greater attention of the scientific community with regard to some specific aspects of the variant, which acted as a catalyst for research.[52]

Due to the specificity of the variant, which involves matches in a field with the same dimensions of the fifteens rugby and the same basic set of rules, but only with seven players competing for each team, several authors sought to characterize with greater accuracy the specificities of rugby sevens, regarding its physical requirements, movement patterns and contact events.[53–65]

Most of the studies available conclude that sevens is played at a considerably higher intensity than at fifteens rugby, with players covering a distance of approximately 100 to 120 metres per minute of play, which compare with 70 to 80 metres per minute in the classic variant.[55,66–68] Regarding the distances covered during a full tournament, Ross et al.[66] concluded that sevens' players cover an additional 51 to 82% (backs and forwards, respectively) compared to a player of the same position at the same level of competition. Considering each unit of time, in a sevens match, a player experiences a greater number of contact events with the opponent (40% more),[69] when compared to a fifteens back of the same level of competition.[55,66–68] Naturally, these contact events include open-field plays such as tackles, rucks or scrum, and might lead to higher levels of fatigue at the end of a sevens tournament, compared to the end of a fifteens match for the same level of competition.[66]

It should also be noted that blood lactate levels sampled from rugby sevens' players at the end of a tournament, by Granatelli et al., were higher than those recorded for players of the same level of competition after a fifteens match. These data confirm the specificity and higher physical demands of rugby sevens.[53]

Suarez-Arrones et al.[57] further studied the physical demands of rugby sevens and compared them with the fifteens variant. These authors concluded that sevens demanded a higher number of sprints, had fewer and shorter breaks during the match and also had faster defense-offense and offense-defense transitions.[57] The same authors also suggested that during a sevens match a player is expected to run at a speed greater than 20.1km.h$^{-1}$ for an average distance of 18 metres, but in many occasions he will be expected to run distances longer than 40 metres, however at lower average speed.

Considering the significant demands of sevens, such as the high speed running, the numerous high impact contact with the opponents, as well as the small rest periods (during the match and between matches) and the multiple games played on the same day and/or on consecutive

days (depending on the tournament), it is necessary that these players possess a broad set of physical characteristics and aptitudes such as strength, speed, power as well as a higher aerobic capacity comparing to the fifteens' variant.[53,55,66,70]

Methodologies used in previous studies assessing the movement patterns, physical requirements and game moments in the sevens' variant were different and included game video analysis, use of Global Positioning System (GPS) or heart rate monitors during matches, as well as direct measurements of blood lactate.[53,55,69]

These studies allowed the authors to reach some conclusions that could contribute to a better understanding of the relationship between the characteristics and requirements of the sport and the risk of sports injuries during its practice. In the next topic "*1.5. Risk factors for sport injuries*", the most relevant variables considered as intrinsic or extrinsic risk factors for sports injuries in rugby sevens will be individually addressed in detail.

# 1.5. Risk factors for sport injuries in rugby sevens

## 1.5.1. Nature of the sport and specific movements of the game

As already mentioned, rugby sevens is an intermittent contact sport played in a fifteens rugby field (100 metres long and 70 metres wide), between two teams of seven elements, during two halves of seven-minutes.[1,71] Until 2016, the finals of the tournaments lasted 10-minutes each half, but from the beginning of the 2016-2017 season, at the initiative of World Rugby, the duration of the finals became the same as that of the remaining matches, aiming at the potential reduction of the incidence of accumulated fatigue injuries.[23]

Several researchers in the field of sports science have been publishing on the physical requirements and specificities of rugby sevens although almost all research refers to elite international competitive level players,[53–55,59,72] despite the existence of some studies with athletes at national level.[56,57]

Ross et al. concluded that, at elite level, there were no statistically significant differences between the performance and performance patterns during the game for forwards or backs in rugby sevens, nor between group-stage or play-off matches.[69]

During the 14 minutes of a rugby sevens match (for group stage and play-offs), Ross et al. reported between 58 and 78 running movements per player, with a total distance ranging between 1423 (±299) and 1446 (±299) metres with a maximum speed of 8.11 $m.s^{-1}$(± 0.70) and 8.22 $m.s^{-1}$(±0.80), respectively.[59] These data, multiplied by the average number of games during an international elite tournament (n = 6) allowed the author to conclude that in sevens the player covers a greater distance (and at a higher average speed) than in rugby fifteens.[69] Similar studies previously published by Suarez-Arrones et al. [56,57] and Higham[55] were consistent with the conclusions by Ross et al, regarding the total distance covered by the players and average speed.

Ross et al. also concluded that at elite international level the game has an average total duration ranging from 15 minutes (min) and 10 seconds (s) to 15min and 41s. However, the ball-in-play time (or useful time) was only between 6 min and 38s and 7min and 31s.[69] These data translate to a mean activity cycle of play ranging between 27.8s (± 20.1) and 33.4s (± 25.1), and a mean recovery cycle ranging between 38.0s (± 21.6) and 45.2s (± 23.0). Maximum duration of a single play ranged between 1min and 56s and 2min and 21s.[69] During these periods of play, there are about 200 game activities (e.g. passes, rucks, tackles, lineouts or scrums). Suarez-Arrones et al., analyzing the performance of ten Spanish elite sevens players' found in a group of forwards an average of 45.1 (± 24.5) high impact collisions with the opponent (greater than 7g), 7.4 (± 1.8) tackles and 1.0 (± 1.1) rucks during each game.[56] These data are consistent with the reports by Ross et al.[69] that suggested the existence of a greater number of contact events (specially high impact events) with the associated transfer of energy, per unit of time, in rugby

sevens, when comparing with the fifteens variant. This allowed the author to infer that the nature of sevens may lead to a relative higher number of injuries per unit of time played. Assessing the individual performance of 27 elite international players competing in the World Rugby Sevens Series, Ross et al. recorded from 1.78 (± 1.89) to 1.83 (± 2.41) scrums, 1.01 (± 1.83) to 1.12 (± 1.8) rucks, as well as 0.93 (± 0.85) to 0.98 (± 0.89) lineouts per game during the group-stage and the play-offs phase, respectively.[69] Substantial differences between the Suarez-Arrones et al. and the Ross et al. studies were only found regarding the number of tackles reported for the elite international level. For this group, a much lower number of movements were recorded: 2.41 (± 2.29) to 2.72 (± 2.48) tackles per game at international level, during the group stage and play-off matches, respectively.[56,69] These data seem to indicate a more fluid game at the elite level, with fewer stops, comparing with the national level of competition.

### 1.5.2. Age

Age is undoubtedly a well-identified, non-modifiable risk factor for sports injuries which has been recognized by several authors with interest in the epidemiological study of sports injuries.[73]

Specifically regarding rugby sevens, it was not possible to identify any studies correlating age with the risk of occurrence and/or type, or severity of sports injuries. In the fifteens variant, several studies comparing the incidence of sports injuries between senior and junior male athletes (under 18 years of age) from the same country, confirmed a much higher incidence in the first group.[74-76] The same was identified by a previous epidemiological study in Portuguese senior male and under-18 rugby fifteens players, by our group of researchers.[77]

However, for the same level of competition and for the same age group, the influence of the players' age with the occurrence of a sports injuries, even for rugby fifteens, is still unclear.[78]

### 1.5.3. Position

As previously described, rugby sevens is played in the same field as the fifteens variant, in games lasting 14 minutes (two halves of 7 minute) between two teams of seven players. Although three of these players are designated as forwards and four as backs (as in the fifteens variant), the roles of these players are not as clear as in the classic version of the sport, as all of them are engaged in the same movements during the game, with the exception of the lineouts and the scrums (only disputed by the forwards).[1]

Since even the physical demands and performance requirements for both groups on the field do not differ significantly,[69] no significant differences regarding the incidence of sports injuries between sevens forwards and backs would be expected.

Nevertheless, it is important to acknowledge, as described by Renzi et al. in 1999, that there are clear anthropometric differences between forwards and backs, not only in rugby fifteens but also in rugby sevens.[79] These data have been confirmed by several studies assessing the anthropometry of sevens players at different competitive levels.[70,80] Theoretically, considering the suggestion made by Fuller et al. that a sports injury "typically results from a transfer of energy to tissues that exceeds the body's ability to maintain its structural and/or functional integrity",[41] the differences between players' anthropometric characteristics could lead to different injury incidences for both groups. However, until now, data from all previous studies do not support that theory.[3]

### 1.5.4. Level of competition

The introduction of professionalism in rugby union, in 1995, led to some significant changes both in the individual preparation and physical condition of the athletes as well as in the game itself.[81] These changes made the differentiation between the levels of competition clearer both at international level (high performance tier 1, high performance tier 2, and development) and club level (professional, semi-professional, and amateur). Naturally, these differences were associated with the level of commitment to the game and, consequently, with the acquisition of a broader set of skills (physical, technical and tactical) that allowed players to compete with greater success.[2,81,82]

Epidemiological studies assessing the injury incidence in rugby sevens are sparse and, from the available literature, only two included data from athletes not competing at elite level.[43,83] Therefore, it is difficult to clearly understand the existence (or not) of differences in the risk of occurrence of injuries between levels of competition in senior male rugby sevens.

However, if we consider the larger study on amateur rugby sevens players, published by López et al.,[43] assessing a group of American players, we were able to identify a lower injury incidence rate in this group, comparing with the reports from the World Rugby Sevens Series and the Olympic games.[1,80]

This lower injury incidence identified in the lower competitive levels is consistent with previous data published for the fifteens variant,[2,75,84] thus highlighting the probable higher physical demands (and its association with the increased risk of injury) at the top-tiers of competition.

### 1.5.5. Recurrence of a previous injury

The definition of recurrent injury is extremely relevant to understand its importance in the context of the epidemiology of sports injuries. Naturally, as previously stressed, all the definitions used in this thesis are compliant with the *Consensus statement on injury definitions and data collection procedures for studies of injuries in rugby union*, presented by Fuller et al.,[41] that considers as a recurrent injury: "*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 2 months of a player's return to full participation is referred to as an 'early recurrence'; one occurring 2 to 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'.* [41]

The meta-analysis published by William et al.[85] included seven studies assessing the incidence of sports injuries in rugby fifteens distinguishing first from recurrent injuries.[81,84,86-90] Injury incidence rate for recurrent injuries (11 per 1000 player match-hours; 95% confidence interval 10-12) was much lower than for new injuries (78 per 1000 1000 player match-hours; 95% confidence interval 74-83). However, in the four studies where the severity of injuries was individually assessed, recurrent injuries presented a higher mean severity (30 days, 95% confidence interval 26-35), when compared with new injuries (20 days, 95% confidence interval 15-24).[85,90]

It must be noted, however, that no data comparing the severity of the recurrent injury and of the preceding index injury were available. As Williams reported, it is possible that severe injuries tend to recur more regularly, thus influencing the mean time of absence for each type of injuries. Future studies comparing the severity of a recurrent injury and of the preceding index injury may contribute to the clarification of this topic.[45]

In the review of the literature performed, no relevant study with regard to the injury incidence of recurrent and first injuries in rugby sevens was identified.

### 1.5.6. Fatigue

The specificity of rugby sevens, which results from the need to play several games on the same day, for only 14 minutes, on a playing field identical to the fifteens variant, as previously explained (see *1.4. Physical demands, patterns of movement and contact in rugby sevens*), results in a specific fatigue pattern of the variant, already studied by several authors, at different levels of competition and locations.[53,55,64]

These studies reached the conclusion that, at international elite level, athletes are required to possess higher aerobic and anaerobic capacities, comparing to the fifteens athletes of the same level, as they are more frequently requested to run at higher speed and for longer distances.[55]

As expected, and in agreement with the previous reports for other sports, during the sevens match, there is a reduction in the intensity and in the volume of physical work performed by each athlete that remains on the field during both halves of the game.[55,91,92] For example, Higham et al. showed that between the first and the second half of the match, there is a reduction in the relative distance covered by athletes at a speed greater than 2m.s-1, as well as in the number of speed changes during the match.[55]

Higham et al.[55] suggested that the cause for this decrease in the athlete's performance would be multifactorial, including central and peripheral fatigue,[93,94] but also due to technical and tactical aspects. However, the inability to maintain the same levels of physical performance between the first and the second half of the games, especially regarding the faster and more intense runs, seems to reinforce the likely impact of fatigue on the deterioration of the athlete's level of participation in the game. These higher levels of fatigue might also be responsible for the increased incidence of sports injuries identified in rugby sevens, during the second half, particularly at the elite level.[1,55]

In contrast, what was observed regarding the athletes' performances between the first and second halves of the same match, throughout the tournament, from game to game, was that the patterns of movement remained, basically, similar and no significant deterioration in the performance was noted.[55] However, we must clarify that these data relate to tournaments where a maximum of three games per day are played, on two or three consecutive days.

These data seem to point towards the ephemerality of cumulative fatigue at the end of each game, at the elite international level, where the competition formats seem to help minimizing the impact of one match in the athlete's performance in the subsequent match. As clear examples of this cautious approach, we can identify the recovery time between each game at international and elite level (between three and four hours in the World Rugby Sevens Series[6] and five hours during the Olympic tournament in Rio de Janeiro[95]), the duration of the tournaments (two to three days in the Sevens Series and three days during the Summer Olympics), thereby allowing the match load to be divided into multiple days,[6] but also the implementation of effective strategies that allow athletes to recover more efficiently, such as a combination of active and passive recovery strategies, cryotherapy, and accurate hydration and nutrition.

Suarez-Arrones, assessing the impact of three consecutive games in the physical performance of national level competition officials confirmed the existence of a significant reduction in running performance, particularly in high intensity running, during the third match on the same day. In this study, the mean lapse of time between the first and second match was 178 (± 85) minutes and between the second and the third was 173 (± 48) minutes.[64] However, it is important to make some distinctions between Arrones' and Higham' studies: a) in the first study, the object of analysis was the physical performance of referees at a national competition level and not athletes; b) all matches of the tournament were held on the same day; c) no recovery strategies other than rehydration and nutritional supplementation were observed.[64]

More recently, Granatelli et al.,[53] used global positioning systems (GPS), heart rate and blood lactate monitoring throughout a set of sevens rugby matches, to study a group of Italian international rugby athletes. These authors confirmed the gradual decline of athletes' physical performance from the first to the second half of the same match (from 643 ± 70 to 578 ± 77 metres covered, respectively), a decrease in the average percentage of maximal heart rate achieved (from 88.3 ± 4.2 to 87.7 ± 3.4%, respectively) and an increase in blood lactate (from

3.9 ± 0.9 to 11.2 ± 1.4 mmol.L-1, respectively). According to these authors, the decrease in the athletes' performance occurred consistently in the last 3 minutes of the match, with a reduction of 40.5% per minute in the distance traveled.[53]

These data reinforce the demanding nature of rugby sevens, from both aerobic and anaerobic aspects of the variant, and the need to implement strategies allowing a proper recovery following each match and reduction of fatigue. This way it might be possible to mitigate the deleterious effects of accumulated fatigue which, as previously identified, are associated with a greater risk of sports injury (see *1.2. Theories of injury causation in sport*).[45,53,55]

## 1.5.7. Match and training load

The relationship between the risk of sports injuries and athletes' exposure to training and competition (particularly since the introduction of professional in sports), has been the subject of particular interest by different agents of the sporting community (e.g. athletes, coaches, researchers) but also by the International Olympic Committee itself.[96] This organization invited a panel of academics with sports medicine and sports sciences backgrounds to consolidate the available evidence on the subject and to promote the development of guidelines and research trends for the future. They acknowledged the role of training loads management and competition formants/calendars at the onset of sports injuries, but also highlighted the lack of clear evidence and robust studies. However, the individuality of the response to exposure and the increased risk of injury associated with the outliers of training and competitive loads appear as two consensual factors.[96]

In 2013, Rogalski et al.,[97] assessed the effects of training and match loads on the occurrence of sports injuries in Australian football (a distinct code of football). These authors had already identified a higher risk of injuries for athletes with higher relative loads of training and play in the two weeks before a sporting event/match, or with a significant increment of load in the week preceding an event, comparing to the former.[97]

Elloumi et al.[98] published a study that monitored training loads with perceived fatigue in 16 rugby sevens elite players. In this study the authors confirmed the hypothesis that athletes perceive greater fatigue at the end of intense periods of training as opposed to periods of greater rest, but a clear association between the risk of injury and perceived fatigue was not established.[98]

As previously mentioned, in the chapter dedicated to the presentation of theories of injury causation, the cumulative load and overuse of structures, among other causes, might lead to the occurrence of sports injuries. [44] Thus, it is possible to understand the need to maintain athletes' exposure to an optimal level of training and competition that allows the reduction of sports injuries risk in rugby, as stated by Quarrie et al., at the World Rugby Medical Commission Conference in 2016.[99] Regarding the individual preparation of athletes, neither an excessive load, that increases fatigue and promotes the overload of the structures, putting them at

greater risk of injury, nor the absence of an adequate preparation for a contact sport as rugby sevens, are acceptable.[99]

Recently, some of the authors responsible for the abovementioned communication, published a cohort prospective study of seven seasons (from 2006/7 to 2012/13) in *Sports Medicine*, in which they monitored the game load (exposure to match-play) and the incidence of sports injuries among athletes of the professional teams of the English rugby Premiership.[100] Considering a period of 12 months, a higher risk of injury was reported for athletes who participated in at least 35 matches, as well as for those who took part in 15 or fewer matches. At every given period, a higher risk of injury was also identified for the group of athletes with the highest absolute match load accumulated over the period of one month.[100] These data match those reported by Orchard,[101] Gabbet,[102] Soligard et al.[96] and Quarrie et al.[99] and reinforce the need to identify, for each sport and for each athlete, an optimal load of training and match-play that allows the reduction of the risk of injury.

However, it was not possible to identify a single study evaluating the relationship between training and/or match load and the risk of sports injury in rugby seven.

### 1.5.8. Precompetitive anxiety

Anxiety in the competitive sport context, has been identified as a relevant predictor of sports injuries by several prominent authors.[103–108] With the exception of one study from Lavallée and Flint, in 1996, that sought to identify the association between various psychological factors and sports injuries in rugby fifteens athletes, there are no robust data available on the association between anxiety and the occurrence of sports injuries in rugby union fifteens, or in sevens.[109] The most relevant data to be drawn from this small work, which only included 13 rugby players, was the identification of an increase in the frequency of sports injuries in athletes with higher levels of anxiety, assessed using the Sport Competition Anxiety Test.[110]

It is important, in this analysis, to distinguish two sides of anxiety: a) anxiety as a trait of personality; b) anxiety as a state (associated or not with competition).[111,112] Regarding the former, it does not seem to have a clear effect on the occurrence/predisposition to the occurrence of sports injuries, while the opposite has been reported for the latter.[111,112] In recent years, however, several authors have sought to assess the hypothetical relationship between competitive trait anxiety and sports injuries in athletes of different sports, and indeed many have been able to demonstrate it.[111–114] As an example, Ivarsson et al.[103] suggest that "trait anxiety may augment the likelihood that an individual will appraise a situation as threatening, thereby increasing the physiological stress response and the subsequent likelihood of injury.[103]

The assessment of player's precompetitive trait anxiety can be performed using validated tools such as the *Sport Anxiety Scale*,[105] which is a multidimensional measure of anxiety and was designed to measure individual differences in cognitive anxiety (worry and concentration disruption) as well as somatic anxiety experienced by athletes. This scale has already been

adapted and validated for the Portuguese language and culture.[105] *Sport Anxiety Scale* is an easy-to-apply tool, a self-administered questionnaire with 21 points that athletes must answer by weighing from 1 (none) to 4 (very) their level of agreement regarding each statement. These 21 questions assess three distinct areas of anxiety: "concentration disruption" (5 questions); “worry" (7 questions); and "somatic anxiety" (9 questions). The sum of all the answers gives a total result for the test (ranges from 21 to 84) and also a result for each of the subscales (which ranges from 5 to 20 for "concentration disruption"; 7 to 28 for "worry"; 9 to 36 for "somatic anxiety"). The higher the score, the greater the level of anxiety of the athlete in that area.[105]

## 1.5.9. Field conditions

In a wide range of "outdoor" sports played on grass (natural and/or artificial), clay or sand, field conditions have been classically postulated as possible risk factors for sports injuries.[115-117]

However, despite the efforts of several researchers that attempted to establish a relationship between field conditions and sports injuries, most of the information obtained is heterogeneous and difficult to systematize, taking into account, for example, the use of subjective criteria in the characterization of field conditions.[118]

In 2013, Petrass and Twomey,[118] conducted a systematic review of the evidence available regarding the relationship between ground conditions and the occurrence of injuries concluding that it is very limited, of poor quality and that further research is needed to establish a robust relationship between playing field conditions and sports injuries.[118]

In the sub-analyses of rugby studies, it was possible to identify that, with the exception of one, the vast majority of authors used subjective criteria/methods to assess field conditions.[116,119,120] In general, when subjective methodology was used, fields were classified heterogeneously with categories such as "hard" or "slippery". Takamura et al.,[121] on the other hand, used a penetrometer applied two hours prior to the beginning of the match to assess the field condition. Interestingly, only in the studies where a subjective assessment of the field conditions was performed, were some associations found regarding the risk of injury. In the single study using objective methodology, no association was found.[118]

Thus, it seems clear that in order to accept a relationship between field conditions and the risk of sports injury in rugby (sevens and fifteens) as valid, more studies, with consensual methodologies and a robust set of evidence will be necessary. Something that has not yet been achieved.

## 1.5.10. Weather conditions

Despite rugby union being generally considered a winter sport, the case of sevens is slightly different. Both at national and European levels, rugby sevens tournaments are preferably held at the end of the fifteens season which, in both cases, occurs from May to July (the end of

spring and beginning of summer in the northern hemisphere).[115] Under these circumstances, athletes can expect high temperatures, as well as high relative humidity, which represent an additional source of stress and hazard.[122]

Acknowledging this reality, despite the absence of robust evidence regarding the real influence of extreme weather conditions on the risk of injury in rugby (fifteens and/or sevens), World Rugby presented a guideline for rugby agents to use during events where temperature and/or relative humidity might not be considered ideal for sport, namely temperatures above 30 degrees Celsius, and/or relative humidity above 60%[123]

According to World Rugby Heat Guidelines,[123] and despite the fact that the American College of Sports Medicine (ACSM) recommends the use of an on-site Wet Bulb Globe Temperature (WBGT) as well as the cancellation of events when the WBGT raises above 28, for rugby union, the analysis of weather conditions is based on the Heat Stress Index (HSI), measured using a hygrometer at the site of the game. The same guidelines mention that prior studies have confirmed that a Heat Stress Index percentage under 150, puts athletes at minimal risk, and that some studies suggest that players are able to cope with an Index as high as 250. However, World Rugby Heat Guidelines are recommend to be applied as long as if the Index is above 150.[123]

These include the following game day interventions:

"*a) Provision of dressing room fans if air conditioning not available.*

*b) Provision of sideline shade if game played during the day when radiant heat (direct sunlight) is a contributing factor.*

*c) Strategic positioning of towels immersed in ice water around the ground – behind goal posts and at junction of each quarter line and sideline.*

*d) 2 minute break at the 20 minute mark of each half. The focus of this break should be triple: a medical assessment of each athlete for signs of heat stress, cooling of athletes and re-hydration. It is suggested that cooling would be best achieved by immediately removing jersey and shoulder pads, application of ICE water to head ± body. Utilizing sideline fans and shade (if game during day) would also be ideal. It should be noted that a 2 minute break has been recommended (as opposed to a 1 minute break) because the focus during this break is primarily medical assessment and cooling.*

*e) It should be noted that increasing access of water carriers to the field has not been recommended as it is felt that there is adequate breaks in the course of a game to allow water carrier access and player re-hydration.*"[123]

## 1.6. Physical and anthropometric profile of rugby sevens players

Being widely recognized as a high-intensity contact sport, rugby sevens athletes are expected to possess a strong physical condition and, as in many other sports, it has been possible for researchers to accurately characterize the physical and anthropometric profile of these players.

As happens with the fifteens variant, in sevens, players are grouped as forwards or backs, depending on their position on the field.[66] However, in contrast to what usually happens in rugby fifteens, there are fewer differences in the roles assigned to athletes of each group in the sevens variant.[1,56,57,72] Thus, a tendency for greater anthropometric and physical homogeneity between forwards and backs is expected in sevens, compared with rugby fifteens.[1,66,72]

If, on one hand, the absence of major anthropometric and physical differences between forwards and backs in rugby sevens is expected and accepted, the opposite can be said regarding the profiles of players competing in different levels of performance. In a recent study, Ross A. et al.[66] compared the profiles of international and provincial rugby sevens athletes in New Zealand and concluded for the existence of significant differences between them.[66] In this study, unique in the available literature, international athletes were older, taller, heavier, and had lower body fat mass than provincial level players. They also performed better in all the physical tests conducted (acceleration 5 and 10 metres; 40 metres speed; horizontal jumping; bench press; repeated sprints test; and multi-stage fitness test).[66]

Despite the relevance of these data, helping to get a better understanding of the sevens player physical profile, the sample of this study was small (n = 65) and only considered athletes from one country.[66,70,124,125]

As expected, most data available reports the physical and anthropometric profiles of elite athletes. Ross et al,[66,124] Higham et al.,[70,125] and Fuller et al.[32] presented relevant data on the anthropometric and physical profile of sevens players, summarized in tables 1 and 2.

**Table 1.** Physical and anthropometric profile of sevens players (mean ± standard deviation)

| | Higham D. et al[70] | Ross A. et al[66] | | Ross A. et al | Fuller C. et al.[80] | |
|---|---|---|---|---|---|---|
| Year | 2013 | 2015 | | 2015 | 2015-16 | 2016 |
| Country | Australia | New Zealand | | Australia | Multiple | Multiple |
| Level of competition | Elite | Provincial | Elite | Elite & Provincial | Elite | Elite |
| Age (years) | 21.9 (±2.00) | 21.2 (±3.36) | 24.0 (±3.71) | n.a. | 24.2 (±3.6) | 25.9 (±3.5) |
| Height (cm) | 183.0 (±6.00) | 182 (±4.86) | 186 (±5.74) | n.a. | 183.6 (±7.0) | 182.6 (±7.5) |
| Body mass (kg) | 89.7 (±7.60) | 89.1 (±9.45) | 95.7 (±7.06) | n.a. | 92.0 (±9.2) | 90.5 (±9.4) |
| Skinfolds sum (mm)* | 52.2 (±11.5) | 73.8(±15.50) | 61.6 (±10.50) | n.a. | n.a. | n.a. |
| Acceleration 5m (s) | n.a. | 1.02 (±0.06) | 0.99(±0.03) | 1.00 (±0.05) | n.a. | n.a. |
| Acceleration 10m (s) | 1.74 (±0.06) | 1.73 (±0.08) | 1.68 (±0.05) | 1.70 (±0.08) | n.a. | n.a. |
| Speed 40m (s) | 5.11 (±0.15) | 5.23 (±0.18) | 4.99 (±0.11) | 5.11 (±0.20) | n.a. | n.a. |
| Bench press 1RM (kg) | n.a. | 108 (±21.20) | 127 (±11.20) | 122 (±14) | n.a. | n.a. |
| Vertical jump (cm) | 66.3 (±7.20) | n.a. | n.a. | n.a. | n.a. | n.a. |
| Horizontal jump (cm) | n.a. | 252 (±18.00) | 266 (±11.00) | 264 (±13.3) | n.a. | n.a. |
| Multistage fitness test (m) | 2256 (±268) | 2164 (±288) | 2563 (±197) | 2418 (±287) | n.a. | n.a. |

**Legend:** cm – centimetres; kg- kilograms; mm- milimetres; NA- not aplicable; n.a.- not available; RM- repetitions maximum; s- seconds; *-sum of seven skinflods[70]

**Table 2.** Physical and anthropometric profile of sevens players by position (mean ± standard deviation)

| | Rienzi E. et al[79] | | Higham D. et al[70] | | Fuller &Taylor[32] | |
|---|---|---|---|---|---|---|
| Year | 1999 | | 2014 | | 2008-2015 | |
| Country | Multiple | | Australia | | Multiple | |
| Level of competition | Elite | | Elite | | Elite | |
| Position | Forwards | Backs | Forwards | Backs | Forwards | Backs |
| Age (years) | n.a. | n.a. | 22.4 (±2.3) | 21.5 (±2.0) | 22.4 (±2.3) | 21.5 (±2.0) |
| Height (cm) | 184.6 (±4.6) | 175 (±5.1) | n.a. | n.a. | 187 (±5.6) | 183.1 (±6.9) |
| Body mass (kg) | 93.5 (±5.1) | 78.6 (±7.1) | 95.0 (±5.1) | 87.4 (±7.3) | 95.0 (±5.1) | 87.4 (±7.3) |

**Legend:** cm – centimetres; kg- kilograms; n.a.- not available.

Given the specific requirements of sevens, high performance athletes usually present a distinct profile from that seen in players who are more frequently engaged in the fifteens variant.[70,79] On average, the former have higher aerobic capacities and lower body mass and body fat

mass.[70] According to Fuller C. et al., for the same level of competition (international elite), sevens backs presented, on average, less 2cm of height and 6kg of body mass than the fifteens players of the same positional group, while forwards were 1cm shorter and 13kg lighter. Both groups also presented lower percentages of body fat mass (1 to 14%). According to Higham D. et al., comparing the sevens players physical tests scores with the fifteens players of the same level (international elite), the former were faster, but no significant differences were found regarding their aerobic capacity. [70,126]

In conclusion, it is safe to say that a greater homogeneity is expected between forwards and backs in rugby sevens. A relatively high height-to-weight ratio associated with greater speed and agility in sevens players seems to constitute a competitive advantage, considering the specific needs of the sport.[70] These characteristics, which can be maximized by training, seem to reflect a greater balance in the preparation of athletes, taking into account the need to perform more running movements, changes in direction, but also tackles and contacts with the opponent per unit of time in rugby sevens.[55,69,70]

### 1.6.1. Profile of the Portuguese rugby sevens player

No studies with reliable reports of the anthropometric and physical profile of Portuguese rugby sevens players were available in the literature. However, some data regarding the fifteens variant were found. Three papers that resulted from the only two studies assessing Portuguese rugby players. The first two reporting data from amateur and semi-professional players of national club level (one presenting data regarding the players' competitive level and the other regarding the players' position) and one reporting data from Portuguese international players.[33–35]

Comparing with similar studies at international level, the results reported for the Portuguese players are clearly inferior: athletes are shorter, lighter and have worse performances in all the physical tests.[33–35] The analysis of results from both studies revealed that in Portugal the classic differences between forwards and backs in rugby fifteens, as well as between athletes from different levels of competition exist and are in accordance with those previously identified in studies conducted in other countries. Forwards were taller and heavier than backs, with worse performances in the physical tests. Same position players from higher competitive levels were taller and heavier, and also had better results in the physical tests.[7,70]

Data from the previous studies are summarized in table 3.

**Table 3.** Physical and anthropometric profile of Portuguese rugby players (mean ± standard deviation)

| | Cruz-Ferreira & Ribeiro[34] | | Cruz-Ferreira & Ribeiro[33] | | Vaz et al[35] | |
|---|---|---|---|---|---|---|
| Year | 2013 | | 2013 | | 2014 | |
| Level/Positional group | Semi-professional | Amateur | Forwards | Backs | Forwards (Int.) | Backs (Int.) |
| Age (anos) | 23.5 (±5.0) | 27.5 (±9.0) | n.a. | n.a. | 26.7 (±2.9) | 26.2 (±2.8) |
| Height (cm) | 178 (±6) | 175 (±7) | 180 (±6) | 175 (±7) | 184.4 (±6.3) | 180.6 (±7.1) |
| Body mass (kg) | 86.7 (±13.6) | 86.9 (±15.8) | 96.0 (±13.4) | 86.9 (±15.8) | 100.7 (±12.9) | 88.0 (±11.4) |
| Sum of 9 skinfolds (mm)* | 129.8 (±56.7) | 189.1 (±71.7) | 184.9(± 78.9) | 129.1(±45.1) | n.a. | n.a. |
| Acceleration 10m (s) | 2.07 (±0.26) | 2.01 (±0.14) | 2.10 (±0.27) | 1.97 (±0.20) | n.a. | n.a. |
| Speed 30m (s) | 4.66 (±0.46) | 4.71 (±0.34) | 4.86 (±0.39) | 4.50 (±0.32) | n.a. | n.a. |
| Bench press 1RM (kg) | n.a. | n.a. | n.a. | n.a. | 109.5 (±20.56) | 98.3(±19.84) |
| VO2 max (mlO2/min/kg) | 50.10 (±5.06) | 48.69 (±7.02) | 46.60 (±5.64) | 52.33 (±5.41) | n.a. | n.a. |

**Legend:** cm – centimetres; kg- kilograms; mlO2/min/kg- millilitres of oxygen per minute per kilogram; mm- millimeter; n.a.- not available; s- seconds; VO2 max – maximal aerobic capacity.

## 1.7. Epidemiology of injuries in rugby sevens

As previously mentioned, rugby is undoubtedly one of the fastest growing sports today, both in terms of media attention and number of players, especially after the introduction of professionalism in 1995 and the inclusion in the Olympic program of the sevens variant. [1,16,54,55,58]

Both fifteens and rugby sevens are dynamic, intermittent high-intensity contact sports that require a complex combination of physical, psychological, technical and tactical skills for success at national and international levels.[55,69,70,127] As the field dimensions are the same, but fewer players are engaged in each phase of the game, there seems to be a trend towards a higher number of high intensity running, sprints and contacts with the opponent, per unit of time, during sevens matches.[57,69]

Rugby Union has shown in the past years to be one of the sports that more carefully listens to researchers in the field of sports medicine and sports sciences, always looking to promote a safe environment for all agents, but especially for the players.[96,99,128] However, most of the effort from both independent researchers and the World Rugby Medical Commission has focused on the fifteens variant, with a significant body of evidenced being published in recent years, mainly epidemiological surveillance studies.[75,84,87,89,129–131] These data lead to the publication of a meta-analysis authored by Williams et al., in 2013.[2]

Williams reported that at elite or professional level, incidence rates of sports injuries in rugby fifteens ranged between 89.1 and 96 injuries per 1000 match player-hours, with an average severity of 20 days. Also, it was found that the higher the level of competitions the higher the incidence rate and the severity of injuries.[2,132,133] In the fifteens variant, lower limb and muscle/tendon type were the most frequent injuries recorded.[2,75,84,87,89,129–131]

Despite the accumulated evidence for rugby fifteens, it was not possible to identify a systematic review of the literature regarding the epidemiological aspects of sports injuries in senior male rugby sevens. For that reason, a systematic review on the topic must be considered of the utmost importance.

# Chapter Two: Objectives

# 2. Background

Despite being a sport with a significant presence and history in Portugal, a very limited number of studies centered in Portuguese rugby and its athletes are available.[33–35,40] Recently, a small study conducted by the candidate during the conceptualization of the present study, assessing the burden of sports injuries in senior male and in under-18 Portuguese club level players, identified a higher injury incidence rate than that reported previously for the same level of competition in countries such as England or New Zealand.[75,77,85]

On the other hand, almost all of the studies published regarding the epidemiology of injuries in rugby sevens come from international (or elite) level and still, compared to rugby fifteens, sparse data are available.[3] Also, considering the available literature, it seems that incidence rates and injury severity in rugby sevens, for the same level of competition, might be higher than in the fifteens variant.[3]

As an increase in the number of athletes is expected, following the recent introduction of sevens in the Olympic programme, to deepen the knowledge regarding the epidemiology of injuries in rugby sevens, especially in a non-elite setting, must be considered crucial to increase players' safety.[52]

## 2.1. Aims and research questions

Given the sparse data available and the lack of information on relevant aspects of the epidemiology of injuries in non-elite rugby sevens, we consider that it is important to contribute to deepen that knowledge. Likewise, we consider it necessary to establish an open dialogue between all agents of the sport, seeking to contribute to mitigate the incidence of injuries, improve the sporting experience, lower associated costs and to ensure the safety and welfare of the players.

Therefore, the following aims were defined for the present study:

### 2.1.1. General aims

- To conduct a systematic review of the literature regarding the epidemiology of injuries in rugby sevens.

- To determine the incidence rate of injuries in the two top-tiers of the Portuguese senior male sevens circuit; to characterize them and identify associated factors.

- To present and discuss the results of the study with relevant rugby agents; to make suggestions aiming at the mitigation of the problem and collect their feedback.

- To suggest changes/improvements regarding the individual and/or collective preparation of sevens players for the competition, as well as to the competition formats, based on the findings of the field study and the feedback of the suggestions made to the rugby agents.

### 2.1.2. Specific aims

- To characterize the anthropometric profile of the Portuguese senior male rugby sevens player.

- To assess the Portuguese players' experience, training loads, warm-up routines and specific preparation for the sevens season.

- To measure players' pre-competitive trait anxiety.

- To describe the competition formats (duration, number of matches, schedule) of the Portuguese sevens circuit.

- To determine player's exposure to competition.

- To determine the incidence rate of sports injuries during the competition.

- To determine the severity of injuries.

- To identify the game event, field location, period and number of games played when an injury occurred;

- To assess the relationship between the occurrence of injuries, as well as injury severity and:

    - position;

    - type, location and event;

    - period of the match;

    - number of matches and/or tournaments played;

    - new *versus* recurrent injuries;

    - pre-competitive anxiety levels;

    - warm-up routines;

    - training loads.

- To identify areas of possible intervention and make recommendations aiming at the mitigation of the impact of sports injuries in seven-rugby, if appropriate.

- If any suggestions are made, to assess their acceptability by independent rugby sevens agents, measured by the level of agreement and willingness to implement them.

- To present a summary of the study findings and recommendations to the Portuguese Rugby Union.

### 2.1.3. Research questions

This research aims to answer the following questions:

1- Is the injury incidence rate in Portuguese senior male rugby sevens different from that previously reported for amateur, but also for elite level competitions?

2- Are there risk factors associated with the occurrence of sports injuries in Portuguese senior male rugby sevens?

3- Will the opportunity for a researcher in the field of Sports Medicine to make recommendations and suggestions of improvements in the players preparation and competition formats of Portuguese senior male rugby sevens aiming at the mitigation of the injury burden be given? And if so, how open will the sport agents be to those suggestions?

## 2.2. Hypotheses

Considering the above, a set of hypothesis was formulated:

**Hypothesis 1:** The incidence of injuries in Portuguese rugby sevens is high and even greater than the previously reported for non-elite levels.

**Hypothesis 2:** There are differences regarding the distribution of injuries by type and location in Portuguese rugby sevens. The lower limb is the most frequent site. Joint/ligament and muscle/tendon the most frequent types of injuries.

**Hypothesis 3:** There are differences regarding the distribution of injuries per game halves, number of games and tournaments played. Most injuries occur in the second half.

**Hypothesis 4:** There are differences regarding the event that causes an injury. Most of the injuries occur after contact events and tackle is the single most frequent event preceding and injury.

**Hypothesis 5:** There is an association between training loads and type of training and the occurrence and severity of injuries.

**Hypothesis 6:** Rugby agents are open to discuss and accept changes to the individual and collective preparation of players, as well as to the competition formats of Portuguese rugby sevens.

## 2.3. Variable identification

To allow an accurate approach to the theme in analysis, several variables present in the research hypothesis were identified. Below, we present the independent and dependent variables identified.

### 2.3.1. Independent variables

An independent variable is the one considered as a determinant factor to the occurrence of a certain outcome; as a condition or cause to a certain effect or consequence; as a stimulus that leads to a response; as a variable whose variation does not depend on that of another. In this study, the following independent variables were considered:

- Age;
- Position;
- Level of competition;
- Rugby fifteens player.

### 2.3.2. Dependent variables

As a dependent variable we consider those which are a result, a consequence or a response to a stimulus; one that is an observed effect of the manipulation of the independent variable; a variable whose value depends on that of another.

The following dependent variables were considered:

- Body mass;
- Height;
- Years of experience in rugby;
- Years of experience in rugby sevens;
- Field training load during fifteens season;
- Gym training load during fifteens season;
- Field training load during sevens season;
- Gym training load during sevens season;
- Additional sevens training during fifteens season;
- Warm-up duration prior to the first game of the sevens tournament;
- Warm-up duration in the subsequent games of the sevens tournament;

- Time/period of the match at the moment of the injury event;

- Temperature and humidity at the moment of the injury event;

- Number of games and tournaments already played at the moment of the injury event

- Pre-competitive sports anxiety test scores;

- Sports injury (type of injury; anatomical location of injury; match event preceding injury; injury severity; recurrence of injury);

- Field zone were injury occurred.

# Chapter Three: Methods

# 3. Overview

The design of this study considered four phases:

1) A systematic review of the literature.

2) A prospective study of the epidemiology of injuries in Portuguese rugby sevens.

3) The organization of a conference to present and discuss the results, to make suggestions aiming at the mitigation of the burden of sports injuries in Portuguese rugby sevens and to assess the level of acceptance of these recommendations by independent sport agents.

4) The publication of an "opinion article" and a summary of the relevant findings and suggestions regarding the future sevens competitions in Portugal to be sent to the Portuguese Rugby Union.

## 3.1. First phase

Aiming at gaining full knowledge of the available literature on the epidemiology of injuries in rugby sevens, as explained, and due to the sparse data previously published on the topic, a systematic review of the literature was conducted. This review was based on the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA) statement.[134]

Since this was just a review of already published papers, no ethical approval was requested for this part of the study. As this systematic review lead to the publication of an article, details on the methodology used (research strategy, study selection and quality assessment as well as data collection) will be presented later (*Chapter Four: Results*), to avoid duplication.

## 3.2. Second phase

A cohort prospective study was conducted leading to two articles: one main article with data regarding the epidemiology of injuries in Portuguese rugby sevens; and one other paper only focused in the association of pre-competitive anxiety and the occurrence of sports injuries among the top-tier players. To avoid duplication, we only present in this subchapter general details of the methodology, leaving the more specific aspects to data presented on the articles (*Chapter Four: Results*).

### 3.2.1. Study setting

Senior male Portuguese club rugby sevens players were the target of this intervention, aiming at the determination of the incidence rate and characterization of sports injuries in the top two national tiers, during the 2015/16 season.

The Portuguese rugby sevens championship comprises the "Circuito Nacional de Sevens" and "Primeira Divisão de Sevens", respectively the first and second tiers. One other competition, named "Segunda Divisão de Sevens" and corresponding to the third tier of competition usually also takes place in the sevens season but access is granted to any club interested, so competition formats, players and level of play are excessively heterogeneous.

A total of sixteen teams were registered for both top competitions (Rugby Clube de Loulé, later announced its withdrawal from the competition).

The top eight teams competed in three consecutive tournaments played in May 21st 2016 (in Setúbal), May 28th 2016 (in Lisbon) and June 4th 2016 (in Coimbra). The bottom seven teams competed in a single event held on May 21st 2016, in Lousã. All tournaments were scheduled to take place between 10 a.m. and 6 p.m. of the same day in natural grass fields.

### 3.2.2. Participants

All senior male players (aged 17 or older) engaged in the dispute of any of the tournaments of the first and second tiers were considered. Each team can register up to 12 players for each tournament.

### 3.2.3. Recruitment

All athletes engaged in the four above-mentioned sporting events, were considered in our study and individually recruited. Prior to the first event, informed consent and relevant data was sent to each team competing in the Portuguese sevens championships (Appendix C1). Contacts

were made available, study was explained in detail to each participant and questions were answered. Consenting players were included.

### 3.2.4. Ethics and procedures

1- In March 2016, the study protocol was presented to the Portuguese Rugby union, and approved (Appendix D1).

2- In the same month, an Ethical Approval from the Ethics Committee of the Portuguese Centro Regional Health Administration was requested and granted (Appendix D2).

3- During the following months, team managers from the 16 teams involved in the Sevens events were individually contacted and asked to participate in the project, helping in the recruitment process.

4- Informed consent was provided and, when consenting, players were asked to fill in a questionnaire providing data regarding age, experience in the sport as well as training loads, but also to assess their pre-competitive levels of anxiety (see details in *Chapter Four: Results*).

5- The study design followed the STROBE (*the strengthening the reporting of observational studies in epidemiology*) statement for cohort studies.[135]

6- All procedures were similar to those previously used in comparable study designs for other national and international competitions,[43,71,136] and conformed to the current consensus statement on definitions and data collection procedures in Rugby union.[41]

### 3.2.5. Data collection

1- Anthropometric, individual experience, warm-up routines and training load data was collected for all consenting players, using a self-report questionnaire (details in *Chapter Four: Results*).

2- The assessment of pre-competitive anxiety levels was performed using a validated questionnaire (the Portuguese version of the *Sport Anxiety Scale [Appendix C2]*).[104]

3- Injury data: suspected injuries were identified by researchers present on the field of play. An injury report form, designed in accordance with the current consensus statement on definitions and data collection procedures in Rugby union,[41] was filled by the researcher, for each injury [Appendix C3]. A follow-up period of 12 months was considered for all injured players (between June 2016 and June 2017). Date of their return to training or/match without limitations was collected for all injured athletes.

4- Match exposure: total exposure time was calculated using the formula NmPmDm/60, where "Nm" is the number of games played, "Pm" the number of athletes on the field and "Dm" is the duration of the match in minutes.

5- The Portuguese Rugby union granted full access to the game official sheets (with player's identification, substitutions and scores).

6- An assessment of the field conditions was conducted prior to the start of each tournament, by direct inquiry of two of the referees and one delegate from the Portuguese Union present at the venue. They were asked to score the field in a scale from 1 (not ready for play) to 10 (perfect conditions),

7- Weather conditions: temperature (Celsius) and relative humidity (as a percentage) were determined for every hour of the tournaments, using a thermo-hygrometer placed in the midfield 2 metres apart from the sideline, over the match officials table.

### 3.2.6. Standardization of procedures

Before the field work, the research team (composed of 4 field researchers and 2 supervisors) conducted a series of five meetings aiming at the standardization of procedures, regarding data collection and the identification of injuries.

The recommendations derived from the "Consensus Statement on Injury definitions and data collection procedures for studies in Rugby union" were discussed, especially those related to the definition of injury, "time-loss injury" and "medical attention injury".

Aiming to identify any challenges regarding the proposed methodology, a pilot study was performed during the National Rugby Sevens University Championship, in April 2016.[137]

One other relevant aspect of the present study concerns the assessment of injury incidence in athletes competing in different competitive levels. Aiming to reduce bias, data analysis accounted the competitive level of each athlete.

A small number of researches was considered for this study, thus improving the efficiency of observation and reducing inter-observer differences, limiting biases of observation.

### 3.2.7. Statistical analysis

Professional statistical support from ClinicalLab-Eurotrials project (an organization that helps researchers in the field of Medicine) was granted. Further details regarding the statistical analysis of each paper are provided in '*Chapter Four: Results'*. Statistical analysis was performed using the software SPSS (version 22.0 for Windows, IBM Corp, Armonk, NY, USA).

## 3.3. Third phase

Following the field study and during the subsequent follow-up period, arrangements were made to hold a scientific meeting in a central location, during the 2016/17 sevens season, to present and discuss the findings of the cohort prospective study, make suggestions/recommendations aiming at the mitigation of the burden of sports injuries (based on the previous findings) and collect rugby agents' feedback to those recommendations. The organization committee of this conference included the research team and also the staff from the institutional sponsors (IDEALMED and Associação Académica de Coimbra – Secção de Rugby). The title of the conference was "*I Jornadas Médico-Desportivas do Rugby*".

### 3.3.1. Date and location

The 10th of June 2017 was the selected date, as the 2016/17 Portuguese National Sevens Circuit would start in the following week. Also, because at this point, 12 months of follow-up period from the cohort study were already concluded.

The city of Coimbra, where the Sevens Circuit was planned to take place the following weekend, was selected to host the meeting. Regarding the venue, the institutional support from IDEALMED (a private hospital in Coimbra) was granted, and the authorization to use IDEALMED's Conference Room free of charge received.

### 3.3.2. Institutional and scientific sponsorship

Logistic support from IDEALMED and Associação Académica de Coimbra – Secção de Rugby was received, following direct request by the research team. Both institutions granted their support and helped in the practical aspects of the event organization with staff and media support. Also, the students association of the School of Health Technology of Coimbra granted their support and were responsible for the disclosure of the event on the internet and social media.

The Portuguese Rugby Union was also invited and accepted to be an institutional partner of the event (Appendix D3), sending their representatives to listen our suggestions and to take part in the discussion (see sub-chapter '*3.3.4. Program'*).

The Faculty of Health Sciences of the University of Beira Interior also granted their scientific support and their representatives formed the Scientific Committee of the event (Appendix D4).

### 3.3.3. Divulgation, target population and registration

Acknowledging the new dynamics of communication, the event was disclosed by not only the classical way (direct invitation to relevant agents, formal letters sent to the Portuguese clubs and announcements in the local media),[138] but also using the internet and social media.

The target of our event were all rugby agents (players, coaches, referees, directors, fans, parents, physiotherapists or doctors) of all genres, ages and backgrounds. No registration fee was requested to participate in the event.

Registration to the event was made by sending an email to the conference email (displayed on the website and on the incitation letters), by accessing the conference website and sending a message to register their interest (http://jornadas-medico-desportivas-rugby.webnode.pt) or by confirming their presence on the facebook event page (https://www.facebook.com/events/458776497799182/?active_tab=discussion).

### 3.3.4. Programme

The event took place in the morning of 10th June 2017, and included three rounds of presentations and discussion. The full programme is presented below:

*9.00 - Registration*

*9.15 - Opening Ceremony*

*9.30 - Rugby Sevens: challenges of an expanding variant*

*Moderator: Professor Luis Taborda Barata, MD, PhD*

*- Technical and tactical specificities of sevens (Prof. Rui Carvoeira)*

*- Preparation for the competition - coach's point of view (Coach João Pinto)*

*- Preparation for competition - athlete's point of view (Dr. Ricardo Dias)*

*10.30 - Epidemiology of sports injuries in rugby sevens*

*Moderator: Professor Luiz Miguel Santiago, MD, PhD*

*- Review of the literature and our reality (Dr. António Cruz-Ferreira, MD)*

*- Medical assistance during a sevens tournament (Pt. Ricardo Ferreira)*

*11.30 - Coffee-break*

*12.00 – Competition formats: reconciling the athlete's well-being, sustainability and the show*

*Moderator: Dr. Pedro Henriques*

*13.00 - Closing Ceremony*

### 3.3.5. Assessment of agents' feedback

At the end of the event an anonymous questionnaire was handed out to all participants, requesting their feedback and perspectives on several points. In this questionnaire, relevant suggestions were included aiming at the mitigation of sports injuries in rugby sevens derived from the study findings. All these data were presented during the event, prior to the request to answer the questionnaire.

At the end of the event, rugby agents were invited to express their level of agreement with the sentences/suggestions made, using a scale from 1 to 4 (where 1: "disagree"; 2: "partially agree"; 3: "agree"; 4: "strongly agree"). To simplify the interpretation of results, if the respondent answered "1" or "2" it was considered to disagree with the statement/recommendation, while answering "3" or "4" it was considered to agree.

Full questionnaire is available in its original Portuguese version (Appendix C4); a translated version in English is presented below:

*"Following this meeting, several statements are presented in order to understand their impact. Read each statement and express your level of agreement. There are no right or wrong answers. We want to understand your degree of agreement with the statements made. Do you agree that ("1 Disagree"; "2 Partially agree"; "3 Agree"; "4 Strongly Agree"):*

*1. Coaches' knowledge regarding injury prevention in sevens is appropriate.*

*2. Players' knowledge regarding injury prevention in sevens is appropriate.*

*3. Managers' knowledge regarding injury prevention in sevens is appropriate.*

*4. Referees' knowledge regarding injury prevention in sevens is appropriate.*

*5. Sports injuries in rugby are a relevant problem for all.*

*6. Coaches have a role to play in reducing the incidence of sports injuries (e.g. changes in training type and duration)*

*7. Physicians and physiotherapists have a role to play in reducing the incidence of sports injuries (e.g. implementation of injury prevention programs)*

*8. Directors have a role to play in reducing the incidence of sports injuries (e.g. changes in competitive models)*

*9. In the current conditions of Portuguese rugby, there must be a clear distinction between the sevens and the fifteens competitive periods.*

*10. A decrease in the number of training hours (field and gym) during the sevens season in Portugal is acceptable*

*11. The Sevens Season in Portugal currently has the appropriate duration*

*12. The duration of the Sevens season in Portugal should be longer*

*13. The number of annual Sevens tournaments organized by Portuguese Union is adequate*

*14. The number of annual Sevens tournaments organized by Portuguese Union must be higher*

*15. The number of matches during each day of the tournament is adequate*

*16. The number of matches during each day of the tournament should be smaller*

*17. Each Sevens tournament should be played in two days and not just one day*

*18. If it is not possible to hold tournaments on consecutive days, group stage and play-offs should be played in different weeks, thus reducing the number of daily matches (e.g. as in the English Sevens Championship).*

*19. Field dimensions should be rethought to reduce injuries and increase attractiveness*

*20. Suggestions for the reduction of injuries presented today are suitable.*

*21. I will be implement these suggestions in my club.*

*22. It is essential to implement a formal Sevens injury prevention program for coaches, players, directors and referees.*

*23. It is important to implement a national injury surveillance study in Portuguese rugby.*

*Regarding Portuguese rugby sevens, when should competition take place (select one):*

*a) at the end of fifteens season (April to June); b) before the fifteens season; c) during the whole season.*

*Please provide your role in rugby:*

*a) player; b) director; c) researchers; d) physio; e) doctor; f) coach; g) other: _____"*

### 3.3.6. Statistical analysis

Only a descriptive analysis of data was conducted. Data are presented as absolute values or as percentages. Statistical analysis was performed using the software SPSS (version 22.0 for Windows, IBM Corp, Armonk, NY, USA).

## 3.4. Fourth phase

Following the conclusion of the previous phases of the study, data were systematized and a set of recommendations aiming at the promotion of player's safety and welfare, as well as the mitigation of injury burden in national rugby was sent to the Portuguese Rugby Union.

The final phase of this study consisted in the draft and publication of an opinion article summarizing the findings and making suggestions for the future (see *Chapter Four Results*).

# Chapter Four: Results

# 4. Results

## 4.1. Systematic review of the literature

Following the identification of the sparsity of relevant literature available regarding the epidemiology of injuries in rugby sevens, the first phase of this thesis consisted of the design, writing and publication of the first systematic review on the epidemiology of injuries in senior male rugby union sevens. Seven prospective cohort original articles addressing injuries in senior male rugby sevens players were included. An overall injury incidence rate in elite rugby sevens tournaments was reported to range from 101.5 to 119.8 per 1000 player-match-hours, with a mean severity greater than 34.1 days. Lower limb and joint/ligament injuries were the most frequent injuries in elite players. The only study in amateur players revealed a lower injury incidence rate (74.7 per 1000 player-match-hours), and a higher proportion of muscle/tendon (37.5 %) injuries. In conclusion, injury incidence rates in rugby sevens seem to be higher than those reported for the 15-a-side variant, for the same level of competition. Injuries also seem to be more severe, resulting in longer absence periods. That might be a result of greater speed at which sevens is played, leading to a possible increase in energy transfers during tackles, more running and turning manoeuvers which can lead to more injuries and which are also more severe.

### 4.1.1. Epidemiology of injuries in senior male rugby union sevens: a systematic review

Citation: Cruz-Ferreira AM, Cruz-Ferreira EM, Santiago LM, Taborda-Barata L. Epidemiology of injuries in senior male rugby union sevens: a systematic review. Phys Sportsmed. 2017 Feb;45(1):41-48. doi: 10.1080/00913847.2017.1248224. (Permission to reproduce granted from the Journal [http://www.tandfonline.com]. This is the authors accepted manuscript of an article published as the version of record in The Physician and Sportsmedicine © 26 Oct 2016 - https://www.tandfonline.com/10.1080/00913847.2017.1248224 [Appendix B1])

**Introduction**

Rugby Union is definitely one of the fastest growing sports in the world, especially after the introduction of professionalism in 1995. In 2009, Rugby Union was accepted as one of the new summer Olympic sports,[9] making its return to the Olympic family in the 7-a-side variant. Recent numbers released by the Rugby Union governing body (World Rugby) claim that the sport is played in 120 countries by more than 7 million players, with 102 member unions and 18 associated unions being responsible for developing the sport and organizing competitions within their borders.[139]

Although most rugby players in the world play 15-a-side Rugby Union, it is also undeniable that rugby sevens has become an increasingly popular format.[54,55,58] It is played in the same field, and with almost the same rules, but over two 7-minute halves (finals with 10-minute halves *[accurate at the date of publication]*) by teams of seven players, three designated as forwards and four as backs, although their roles are not as clear as in 15-a-side rugby.[54,55,58,69] Currently, World Rugby holds a Rugby Sevens World Series played in a multistage tournament for 7 months, from December to May, in cities from five continents. Tournaments are scheduled as rounds of 2 tournaments with each round separated by 6–8 weeks.[58] Each tournament takes place in 2 days (sometimes 3 days), with teams playing up to three matches each day.[58,69]

In the same way as the original 15-a-side variant, rugby sevens is also a dynamic, high intensity, intermittent full contact sport, [124] requiring a combination of physical, psychological, technical, and tactical skills for success at national and international levels.[55,70,127] As no differences in the dimensions of the field are found between Rugby sevens and 15-a-side Rugby, and fewer players are engaged in each phase of the game in the sevens variant, a tendency toward a higher number of sprints[57] and contacts with the opponents[69] during competitive matches is expected.

Although it is known that rugby union has had a good sports medicine service over the years, and that player welfare is a main concern for World Rugby,[9] injury surveillance studies in rugby union are essentially focused on the 15-a- side variant, with a significant body of evidence being published in recent years.[2,75,84,88,89,129–131] At elite or professional level, injury incidence rates in rugby union 15-a-side reaches 89.1–96 injuries per 1000 player match-hours, with an average severity of 20 days of absence from competition and training.[2,89,128] The most frequent location of injuries is the lower limb, while muscle/tendon is the most common type of injury.[2,89,128] The aim of our study was to systematically review the available literature regarding the epidemiological aspects of injuries in senior male rugby sevens, especially those regarding the incidence, type, location, period of match, and severity of injuries. We chose to include data from all levels of play and playing positions.

**Methods**

The present study was conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[134] No ethical approval was requested, since this was just a review of already published studies.

***Search strategy***

We conducted a search on PubMed databases from 1995 to September 2015, using the following search strategy: ('Football' [Mesh]) AND ('Athletic Injuries' [Mesh]) OR 'Rugby Sevens.' The same strategy was then adapted to perform a similar search on Google Scholar, SCOPUS, Scielo, and IndexRMP. We also searched the reference lists of included studies and 'grey literature' to identify other potentially relevant studies. Inclusion criteria for retrieved studies were: (i) Original articles (prospective or retrospective cohort and randomized controlled design), review articles, and meta-analyses; (ii) study population comprising 7-a-side senior male rugby teams; (iii) studies clearly defining athletic injuries; (iv) studies providing relevant epidemiological data, such as injury incidence for match or tournament, incidence of new and recurrent injuries, incidence of injuries by playing position, type and site of injury, severity of injury or injury mechanism. Studies with all types of design including longitudinal (prospective and retrospective), cross-sectional, observational, and ecological, were included. Studies were excluded from our analysis if: they were focused on under-18 or female players only; focused on 15-a-side Rugby Union only; concerned other football codes (Rugby League, Australian Football, American Football, Gaelic sports, or similar); did not report Rugby Sevens injury surveillance studies or data.

***Study selection and quality assessment***

Following the literature search, two reviewers (ACF and ECF) conducted a screening of the title and abstract of the retrieved articles. Whenever necessary, full texts were also analyzed. The relevant studies, according to the eligibility criteria, were selected and underwent a qualitative analysis of the data included, using the 22-item checklist provided by the 'Strengthening the reporting of Observational Studies in Epidemiology' statement for cohort, case–control, and cross-sectional studies (combined),[140] aiming to make the evaluation and interpretation of results more objective. Using a previously accepted methodology,[2,141] studies were categorized as of poor, moderate, or good reporting quality.

***Data collection***

From all the selected articles, relevant data were extracted and compiled (see table 4), which included: level of the competition; number of athletes; length of the competition; relevant epidemiological data as considered before. Our aim was to determine the level of play, playing

position, type and site of injury, injury incident and severity of injuries reported in the relevant selected studies. When available, data were collected using the items of the international consensus statement on injury definitions and data collection procedures in studies of injuries in rugby union,[41] to ease further analysis and interpretation. Determination of time at risk for injuries is reported as player match-hours; incidence rate is reported as number of injuries per 1000 player match-hours; injury severity is given in days of absence from competition and training.

It is also important to define the variable not contemplated in the consensus statement: level of competition. For the present study, we opted to use the traditional division into tiers according to playing strength and potential usually used by World Rugby and authors engaged in injury surveillance studies in rugby union.[2] Thus, taking into consideration the World Rugby ranking of Rugby Unions (male),[142] competitions were considered of 'level one' if disputed by top clubs or national teams of at least one tier-1 nation (including England, France, Ireland, Wales, Scotland, Italy, New Zealand, Australia, South Africa, and Argentina); 'level two' if disputed by teams of the second division of tier-1 nations or by top clubs or national teams of at least one tier-2 nation (other Rugby Unions ranked until the 20th position of World Rugby rankings); 'level three' if disputed only by teams or nations in none of the previous circumstances.

**Results**

A summary of the study process can be seen in figure 1, which shows a flow diagram of the article selection process. The initial electronic database search returned a total of 1372 articles, and an additional manual search yielded 5 more relevant articles. By removing duplicates, the nonrelevant articles and those related to different football codes, to women or youth rugby only, 209 potentially relevant papers were assessed for inclusion in the review, based on the previously determined inclusion criteria. As expected, most of the studies involved 15-a-side rugby union, and those were explicitly presented separately from other reasons for non-inclusion. Seven cohort prospective studies were included in this review (see table 4). The quality of the studies ranged from poor to moderate. Of the seven included articles, five collected data prospectively from the injury incidence from the men's World Rugby Sevens World Series tournaments over the course of one or several seasons.[1,32,42,143,144] These studies were conducted by the World Rugby Medical and Research Staff.[42] One study reported data prospectively collected from injury incidence in a series of amateur rugby tournaments in the USA,[43] while one last study prospectively reported data regarding the incidence of concussion in three World Rugby Sevens World Series tournaments (2008/2009, 2010/2011, and 2012/2013).[71] Regarding the study by Lopez et al.,[43] included in this systematic review, only data on male players were considered.

### *Level of play*

Most (six) of the studies selected for this review[1,32,42,71,143,144] were conducted by the Rugby Union Governing Body's (World Rugby) Medical and Research Staff[145] in World Rugby Sevens World Series or World Cup, focusing upon a population of level one (elite) rugby players, while only one study[43] was conducted at a nonprofessional level, in 4 amateur 1-day tournaments in a USA local Rugby Union (level three). All of the studies were conducted between 2008 and 2015.

### *Total match exposure*

The reported total exposure for players ranged between 866.3 player match-hours for the amateur tournament series reported and 6480.6 player match-hours for the largest collection of data of the injury surveillance studies of the Sevens World Series and World Cup compiled by Fuller and Taylor[32] between 2008 and 2015. When taking into consideration each annual World Rugby Sevens Series, we can identify a growth in the total match exposure between the initial series considered (2008/2009) with a total of 979.1 player match-hours and the last one (2014/2015) with 1253.9 player match-hours.

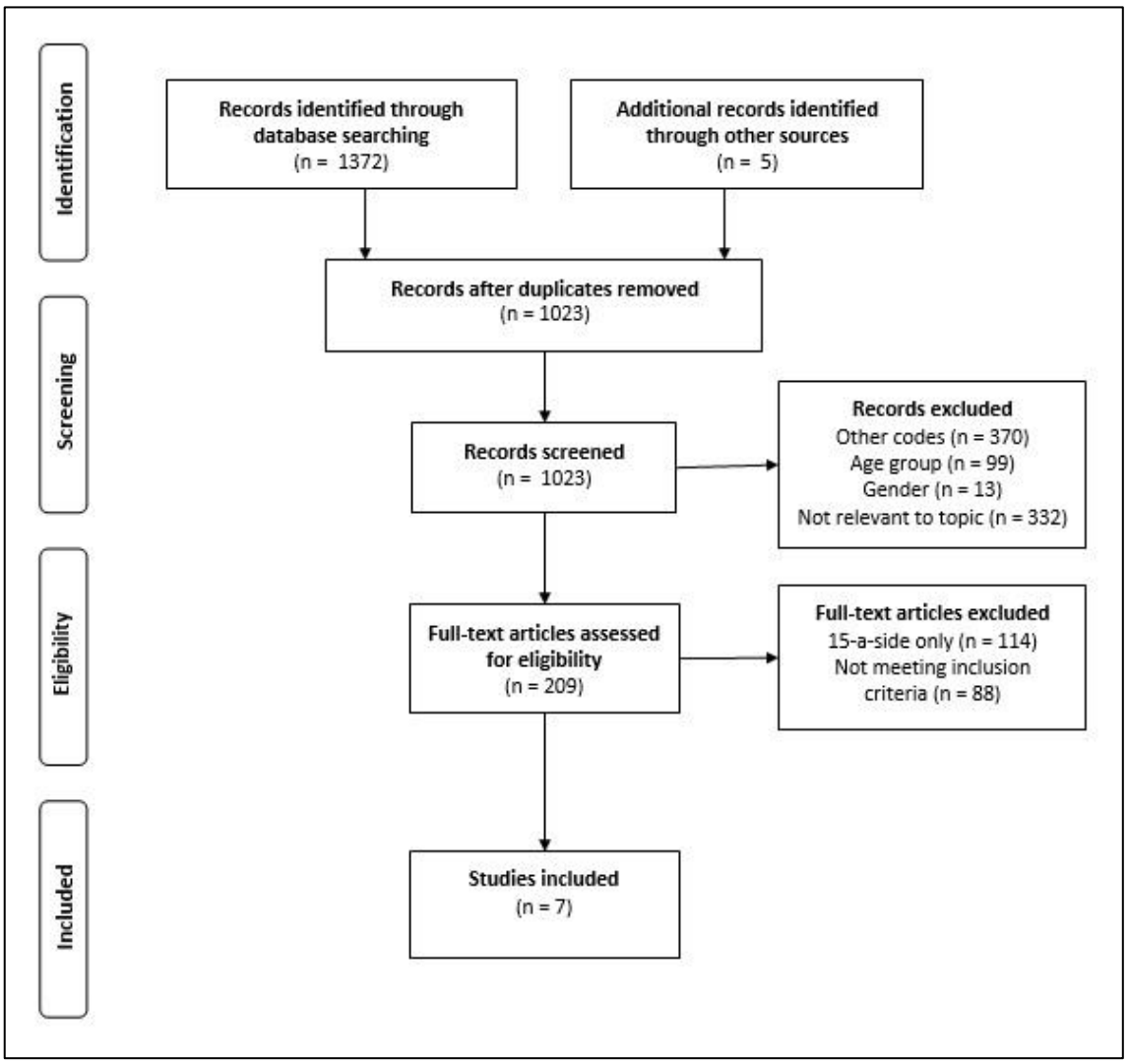
### *Injury definition*

All articles selected for this systematic review provided clear definitions of injuries, essentially in line with the international consensus statement on injury definitions and data collection procedures in studies of injuries in Rugby Union,[41] but with slight differences. Injury was defined by Fuller et al.[1] as *'any physical complaint sustained by a player during a Rugby Sevens match that prevented the player from taking a full part in training and/or match play for more than one day following the day of injury,'* while the same author in the World Rugby Sevens World Series (Men) Surveillance studies[32,42,143,144] defined injury as *'any injury sustained during Sevens World Series Tournament match or training activity that prevents a player from taking a full part in normal training activities and/or match play for more than one day following the day of injury.'*

Lopez et al.[43] chose to define injury as *'any physical complaint caused by transfer of energy that exceeded the body's ability to maintain its structural and/or functional integrity, sustained by a player during a rugby match.'*

The other study included in our review, that only reported the incidence of concussions in World Rugby Sevens World Series,[71] defined injury as *'any concussion sustained by a player during a match that prevented the player from taking a full part in all* training activities or match play for more than 1 day following the day of injury, irrespective of whether match or training sessions were actually scheduled.'

**Figure 1.** Search strategy flow diagram (reproduced with permission from the Journal [Appendix B1])




### *Overall injury incidence rate*

Five studies provided overall match injury incidence for level one rugby sevens tournaments,[1,32,42,143,144] one only provided the match injury incidence of concussion in level one rugby sevens tournaments,[71] and one the overall match injury incidence of an Amateur (level three) tournament.[43] The overall injury incidence rate amongst level one players ranged from 101.5 per 1000 player match-hours[143] to 119.8 per 1000 player match-hours (95% CI, 101.5–141.4),[144] respectively, in the Rugby Sevens World Series of 2010/2011 and 2012/2013. For all seasons between 2008/2009 and 2014/2015, the reported overall match injury incidence was 108.3 per 1000 player match-hours (95% CI, 100.6–116.6).[32] For amateur players (level three), the reported injury incidence of the only available study was 55.4 per 1000 player match-hours (95% CI, 42.3– 68.5), including both male and female athletes. For male athletes only, the reported injury incidence of the same study was 74.7 per 1000 player match-hours.[43]

### *Severity of injuries*

All studies with level one players provided injury severity data.[1,32,42,143,144] The mean severity of injuries ranged between 34.1 days in 2010/2011[143] and 51.5 days (95% CI, 40.3– 62.7) in 2013/2014, while the overall mean severity for injuries sustained at the level one tournaments considered in this analysis was 44.2 (95% CI, 40.6–48.1).[32] No data were available for the mean severity of injuries in amateur players.[43] Using the international consensus statement on injury definitions and data collection procedures in studies of injuries in Rugby Union[41] definition of injury severity, most of the injuries reported at international level were considered severe (28 days or more),[1] while at amateur level most were moderate (8–28 days).[43]

### *Type of injuries*

All studies with level one players provided information on the type of injures.[1,32,42,143,144] The most frequent type of injuries sustained by elite players, taking into consideration the definition of the international consensus statement on injury definitions and data collection procedures in studies of injuries in Rugby Union,[41] was joint/ligament injuries, ranging from 34.3% (95% CI, 26.4–42.1) in 2012/2013 to 51.5% (95% CI, 41.8–61.1) in 2008/2009,[1] and an overall 44.5% (95% CI, 40.8–48.2) for all tournaments between 2008/2009 and 2014/ 2015.[43] Muscle/tendon was the second most frequent site of injury, being responsible for 32.4% of all injuries (95% CI, 28.9–35.8), followed by central nervous system/peripheral nervous system in 11.6% (95% CI, 9.2–13.9) and bone injuries in 8.4% (95% CI, 6.4–10.5) of cases.[43] Both skin and other injuries accounted for less than 2% of cases each.[43] At amateur level, muscle/tendon accounted for 37.5% (23.0–54.0) of all injuries, followed by joint/ligament in 22.9% (95% CI, 12.0–37.0), central nervous system/peripheral nervous system in 16.7% (95% CI, 7.0–29.0), and skin in 14.6% (95% CI, 5.0–26.0) of cases.

### *Location of injuries*

All studies included in our review provided clear information on the location of injuries reported.[1,32,42,43,71,143,144] Lower limb injuries occurred more often than injuries to all other body regions together, as reported in all level one tournaments, with its proportion ranging from 56.3% (95% CI, 47.9–64.7) in 2014/2015[43] to 70.4% in 2010/2011.[143] Upper limb and head/neck were the locations, respectively, in 17.0% (95% CI, 14.2–19.8) and 15.8% (95% 13.1–18.5) of all injuries reported between 2008/2009 and 2015/2015 at World Rugby sevens World Series and Rugby sevens World Cup,[32] and trunk was the site for only 6.1% (95% 4.4–7.9) of cases. However, at amateur level, lower limb injuries were the least frequent site for reported injuries (14.6%) and head/neck the first (33.3%), followed by the upper limb (31.3%) and trunk (18.8%).[43]

### *Injury incident*

All studies reported that the ratio between contact and non-contact events leading to injuries was 3:1, with overall percentages ranging from 72.8% to 83.7% (95% CI, 77.4–90.1).[1,32,42,43,71,143,144] The tackle is the event of the game where more injuries occur at both amateur (74.5%; 95% CI 60.0–85.0)[43] and international rugby (51.9%).[32] Being tackled, however, at level one rugby tournaments, is usually more frequently associated with injuries (33.6%; 95% CI, 30.1–37.2) than tackling (21.3%; 95% CI, 18.2–24.4).[32] While running and collision with the opponent, respectively, accounted for 19.3% (95% CI, 16.3–22.2) and 12.0% (95% CI, 9.5–14.5) of the all injuries at elite level.[32]

### *Period of match*

Six of the seven articles reported the period of match when injury occurred.[1,32,42,43,71,144] Injuries were more frequent in the second half of the games for both backs and forwards. Data regarding all elite tournaments from 2008/2009 to 2014/ 2015 show an incidence, in the first half, of 37.7 (95% CI: 33.1–42.3) to 40.5 (95% CI: 34.4–46.5) injuries per 1000 player match-hours, respectively, for backs and forwards. During the second half, backs sustained an average of 62.3 (95% CI: 57.7– 66.9) injuries per 1000 player match-hours, while forwards suffered 59.5 (95% CI: 53.5–65.6) injuries per 1000 player match-hours. According to Fuller and Taylor,[32] a significant statistical difference is reached ($p < 0.001$) in terms of injury incidence between halves at elite rugby. No data were available for amateur players.

### *Playing position*

Six studies included in our systematic review provided information on the incidence of injuries according to playing position in male rugby sevens.[1,32,42,71,143,144] At elite level tournaments, injury incidence for backs ranged from 101.5 to 129.1 (95% CI: 105.0–158.8) injuries per 1000 player match-hours.[42,143] For the same level of competition, injury incidence among forwards ranged between 81.9 (95% CI: 60.9–110.0) and 119.8 (95% CI: 93.0–154.3) injuries per 1000 player match-hours. Data regarding all World Rugby Sevens World Series from 2008/ 2009 to 2014/2015 confirmed an overall incidence rate of 91.5 (95% CI: 80.9–103.4) injuries per 1000 player match-hours for forwards and 121.0 (95% CI: 110.3–132.7) injuries per 1000 player match-hours for backs, revealing a significant difference between them ($p < 0.001$).[32] For amateur players, it is reported that backs also sustained more injuries, with no significant differences regarding mean severity, type, location, or cause of injuries between players of different positional groups; however, no data regarding male players only are reported.[43]

**Table 4.** Data extracted from the studies included in this review (reproduced with permission from the Journal [Appendix B1])

| **Author** | Lopez et al[43] | Fuller et al[1] | Fuller and Taylor[143] | Fuller and Taylor [144] | Fuller and Taylor [42] | Fuller and Taylor [71] | Fuller and Taylor [32] | Fuller and Taylor [32] |
|---|---|---|---|---|---|---|---|---|
| **Level** | Amateur | Elite | Elite | Elite | Elite | Elite | Elite | Elite |
| **Tournament** | USA Rugby | RBSWS, RSWC | RBSWS | RBSWS, RSWC | RBSWS | RBSWS | RBSWS | RBSWS |
| **Year** | 2010 | 2008-9 | 2010-11 | 2012-13 | 2013-14 | 2008-13 | 2014-15 | 2008-15 |
| **Quality** | Moderate | Moderate | Poor | Poor | Poor | Moderate | Poor | Poor |
| **Players (n)** | 1536 | 290 | Not given | 312 | 357 | Not given | 331 | 1824 |
| **Total exposure** | 866.3 | 979.1 | 965.8 | 1168.3 | 1219.6 | 4086 | 1253.9 | 6480.6 |
| **Incidence rate** (95% CI) | 55.4 (42.3-68.5)* | 106.2 (87.8-128.9) | 101.5 | 119.8 (101.5-141.4) | 109.9 (92.8-130.1) | 8.3 (5.9-11.6)** | 107.7 (90.9-127.4) | 108.3 (100.6-116.6) |
| **Severity** (mean days) | NA | 45.0 | 34.1 | 42.7 (35.2-50.3) | 51.5 (40.3-62.7) | 19.3 (14.8-23.6) | 41.3 (36.2-48.15) | 44.2 (40.6-48.1) |
| **Injury incidence as function of injury severity** (per 1000 player/hours, 95% CI) | | | | | | | | |
| Slight (0-1 days) | 25.0 (0.0-37.0) | NA | NA | NA | NA | NA | NA | NA |
| Minimal (2-3 days) | 6.3 (0.0-13.0) | 8.2 (4.1-16.4) | NA | NA | NA | NA | NA | NA |
| Mild (4-7 days) | 22.9 (11.0-35.0) | 16.3 (10.0-26.7) | NA | NA | NA | NA | NA | NA |
| Moderate (8-28 days) | 33.3 (20.0-47.0) | 31.7 (22.3-45.1) | NA | NA | NA | NA | NA | NA |
| Severe (>28 days) | 12.5 (3.0-22.0) | 49.0 (37.0-65.2) | NA | NA | NA | NA | NA | NA |
| **Type** (%, 95% CI) | | | | | | | | |
| Bone | 6.3 (0.0-14.0) | 8.7 (3.3-14.2) | 8.2 | 10.7 (5.6-15.8) | 9.7 (4.7-14.7) | - | 8.1 (3.5-12.8) | 8.4 (6.4-10.5) |
| CNS/PNS | 16.7 (7.0-29.0) | 4.9 (0.7-9.0) | 6.1 | 14.3 (8.5-20.1) | 13.4 (7.7-19.2) | 100 | 17.0 (10.7-23.4) | 11.6 (9.2-13.9) |
| Joint/ligament | 22.9 (12.0-37.0) | 51.5 (41.8-61.1) | 49.6 | 34.3 (26.4-42.1) | 49.3 (40.8-57.7) | - | 40.0 (31.7-48.3) | 44.5 (40.8-48.2) |
| Muscle/tendon | 37.5 (23.0-54.0) | 33.0 (23.9-42.1) | 35.7 | 36.4 (28.5-44.4) | 24.6 (17.3-31.9) | - | 31.1 (23.3-38.9) | 32.4 (28.9-35.8) |
| Skin | 14.6 (5.0-26.0) | | 2.0 | 2.1 (0.0-4.5) | 2.2 (0.0-4.7) | - | 3.0 (0.1-5.8) | 1.9 (0.9-2.9) |
| Other injuries | 2.1 (0.0-7.0) | 1.9 (0-4.6) | 1.0 | 2.1 (0.0-4.5) | 0.7 (0.0-2.2) | - | 0.7 (0.0-2.2) | 1.3 (0.5-2.1) |
| **Location** (%, 95% CI) | | | | | | | | |
| Head/neck | 33.3 | 4.9 (0.7-9.0) | 12.2 | 18.6 (12.1-25.0) | 19.4 (12.7-26.1) | 100 | 21.5 (14.6-28.4) | 15.8 (13.1-18.5) |
| Upper Limb | 31.3 | 17.5 (10.1-24.8) | 9.2 | 15.0 (9.1-20.9) | 17.2 (10.8-23.5) | - | 17.8 (11.3-24.2) | 17.0 (14.2-19.8) |
| Trunk | 18.8 | 7.8 (2.6-12.9) | 8.2 | 5.7 (1.9-9.6) | 4.5 (1.0-8.0) | - | 4.4 (1.0-7.9) | 6.1 (4.4-7.9) |
| Lower Limb | 14.6 | 69.9 (61.0-78.8) | 70.4 | 60.7 (52.6-68.8 | 59.0 (50.6-67.3) | - | 56.3 (47.9-64.7) | 61.1 (57.4-64.7) |
| **Cause** (%, 95% CI) | | | | | | | | |
| Contact | 72.9 (59.0-83.0) | 77.8 (69.7-85.8) | 72.8 | 76.8 (69.8-83.9) | 83.7 (77.4-90.1) | 100 | 77.7 (70.5-84.8) | 78.5 (75.4-81.6) |
| No-contact | 27.1 (15.0-39.0) | 22.2 (14.2-30.3) | 27.2 | 23.2 (16.1-30.2) | 21.3 (17.8-24.7) | - | 22.3 (15.2-29.5) | 21.5 (18.4-24.6) |

**Legend:** *Refers to overall rate (males injury incidence was of 74.7); **Injury incidence related to concussion only; CI- confidence interval; CNS/PNS- Central nervous system/ Peripheral nervous system; NA- not available; RBSWS- Rugby Board Sevens World Series; RSWC- Rugby Sevens World Cup.

**Discussion**

The present study reports the first systematic review of injury incidence rate in elite and amateur rugby sevens. We collected a relevant amount of epidemiological data related to injury incidence, type, location, period of match, and severity in senior male rugby sevens players from all levels of play and playing positions.

It is clear that injury surveillance studies in rugby sevens, when compared to the 15-a-side variant, are scarce and that most of the available data rely on grey literature and the work of the World Rugby Medical and Research Staff.[145] We chose to discuss the results of the present review while simultaneously comparing them with the available literature on injury surveillance and epidemiology of injuries in the 15-a-side variant of rugby union. Both types of rugby formats involve players of the same football code, the same field dimensions, basic rules, match events and moments of the game, as well as the definitions and methodologies recommended by the international rugby consensus statement.[41]

The largest collection of data, as mentioned before, relates to the World Rugby Sevens World Series,[1,32,42,143,144] and shows some interesting aspects. First, a constant growth in the number of games (player match-hours) that athletes are exposed to is clear: from 979.1 player match-hours in 2008/2009[1] to 1253.9 player match-hours in 2014/2015,[32] showing an increase of almost 30% in match exposure over a period of 6 years. Despite this relevant increase in the number of hours that athletes had to be on the field, the overall injury incidence rate at level one tournaments remained stable, with 106.2 injuries per 1000 player match-hours in 2008/2009 and 107.7 in 2014/2015. In fact, between each annual Series, not much difference is seen in the injury incidence rate at the World Rugby Sevens World Series tournaments, with numbers ranging from 101.5[143] to 119.8[144] injuries per 1000 player match-hours, with an average of 108.3 per 1000 player match-hours for all tournaments held between 2008 and 2015.[32] At amateur level, the only available study revealed an injury incidence rate of 74.7 per 1000 player match-hours in an American local sevens series of tournaments.[43] At both levels, the reported injury incidence rates are higher than those reported for 15-a-side rugby union, where injury incidence rates were 89.1–96 per 1000 player match-hours, at professional/elite level[2,89] 21.7–25 per 1000 player match-hours, at amateur level.[75,130]

One other aspect that becomes clear after analysis of the collected data is that injuries in rugby sevens are more severe than in the 15-a-side variant. From our review, we concluded that injuries lead, on average, to 34.1–51.5 days of absence in rugby sevens level one players whereas in the 15-a-side variant, at the same level of competition, the mean severity of match injuries was 20 days of absence from competition and training.[2] However, the under-reporting of minor injuries in rugby sevens might influence the average level of severity recorded.[71] Rugby sevens is played with greater speed, thereby leading to an increase in energy transfers during tackles and other contact events. In addition, it also involves more running,[59] cutting, and turning manoeuvers possibly causing more severe knee and ankle ligament injuries associated with longer absences from practice.[1] It is also important to remember that rugby sevens

tournaments consist of several matches played during the same day, or on two days. Recent data seem to confirm that match demands remain consistent across tournament rounds, and that players are involved in up to 40% more contact events in a rugby sevens tournament than in a 15-a-side match, which could lead to a higher degree of fatigue.[59,60,69]

In 15-a-side rugby, the most frequent type of injury at level one competitions are muscle/tendon[129] and, at amateur level, joint/ligament.[85] The opposite was seen in rugby sevens. At level one sevens tournaments, joint/ligament injuries were more frequent, while muscle/tendon injuries were of higher frequency in the only level three tournament considered. This might also be used to advocate that at elite level, rugby sevens is played with greater speed and with more open field running and turning movements that can lead to this type of injuries. However, larger and more detailed studies should be taken in order to make such statements.

Despite these differences, both at rugby sevens or 15-a-side and amateur or elite level, joint/ligament and muscle/tendon are responsible for over two-thirds[129] of all injuries and should be the main focus of future interventions designed to reduce injury incidence rates in rugby union. Nevertheless, due to the risk associated with severe/catastrophic injuries, head/neck injuries should remain an important field of intervention by World Rugby Medical Research Group, as it currently happens.[143]

Regarding the location of injuries, no differences were found between rugby sevens and 15-a-side. Lower limb injuries were more frequent at level one competitions, and accounted for about half of the reported injuries.[85] At amateur level, the largest meta-analysis of injury surveillance studies in rugby 15-a-side reported that injuries at this level were also most frequent in the lower limbs. However, in our review, the only study available with non-elite players does not support that conclusion. It is important to notice, in any case, that in order to draw any significant conclusions, more data would have to be available. Injuries sustained on the head/neck and upper limb were less frequent, with the former ranging from 4.9 to 21.5% and the latter from 9.2 to 17.8%, at international level. However, at level three competitions, a significant number of head and neck injuries were reported, being the single most frequent site of injuries. These data are ambiguous and are not in agreement with the available literature for amateur rugby 15-a-side, in which head/neck injuries are of a lesser frequency.[75] For this fact, health professionals providing medical care at rugby sevens tournaments should be familiar with the guidelines and protocols on the management of head and neck injuries in rugby union.[71]

In agreement with all literature,[2,32,43,75] at level one and level three competitions, most injuries result from contact events, particularly tackle (tackling and especially being tackled),[2,32] but also with collision resulting from high speed running. This highlights the nature and demands of rugby union, and might account for the high injury incidence rate of the sport. The rugby sevens variant, due to its specificities, might be associated with even greater incidence rates. With this paper, we aimed to contribute towards establishing the extent of the problem, which

had yet not been done, but also towards highlighting some reasons that could explain the relevant numbers of injuries found. The high number of matches played on the same day and in subsequent days by Sevens' players, possibly leading to higher levels of fatigue, as suggested by recent studies,[69] should be taken into consideration by all agents. Changing the competition models, aiming to reduce the number of matches played on a single day and increasing the time between each game in order to reduce the number of injuries, seems a reasonable hypothesis to test in future studies.

In order to allow an effective intervention, further research at all levels of competition and capable of providing consistent evidence is needed. The authors believe that future focus of research in rugby sevens should include larger, high-quality injury surveillance studies in level two and level three competitions held at national and international levels.

At international level, Sevens Series are played throughout the year, with tournaments taking place in two consecutive weeks, with players involved in 3 games per day for two consecutive days.[1] At amateur level, competitions take place with 1-day tournaments played in consecutive weeks during 1 month, at the end of the season.[43] A question that should be raised in future research is whether the competition format in rugby sevens is appropriate or if it might be responsible for the high level of injuries and severity reported. Changes in the tournament formats must be considered and tested, aiming to assess strategies to reduce injury incidence rates and severity.

Rugby sevens has the same basic set of rules as rugby union 15-a-side, which allows players to move from one to the other variant during the same season. Whether lack of specific training and players' mobility between variants is or not a cause for the high injury rates and severity, should also be a question raised in future investigations.

### *Limitations*

It is important to report that, despite being of the knowledge of the authors, our systematic review did not include a search in EMBASE and SPORTDISCUS databases due to their inaccessibility at the authors' institutions.

Regarding the selected articles, although a significant homogeneity in the methodology was found, since the consensus statement on injury definitions and data collection procedures in studies of injuries in Rugby Union was followed by all authors in their study design, and injury definitions were very similar, there are some limitations to report.

First, most of available data have not yet been published and are available only at the World Rugby website. Second, the data represent the effort of the same group of investigators, who are also members of the World Rugby Medical and Research Staff. And third, even from the published data, only one article is not from the same main author. Therefore, we have to consider that there could be a bias in the reported data.

Results regarding non-elite players reported in our systematic review are naturally biased, since only one study[43] reported data for non-elite players and included mixed data from male and female athletes, while results from elite players were reported by six of the selected articles.

**Conclusion**

Rugby sevens, being a high-speed, high-intensity variant of rugby union, holds a significantly high injury risk for players. Injuries sustained by rugby sevens players are severe, leading to higher average absences from training and playing, when compared to the 15-a-side variant. Joint or ligament injuries on the lower limb, and injuries following contact events are the most common among elite athletes.

Taking into consideration the recent growth of rugby sevens, and the acceptance of this sport into the Olympic Family, a growing interest of the medical and scientific community in the topic of injury surveillance and injury prevention is expected, as occurred after the introduction of professionalism in the most popular variant of Rugby Union (15-a-side). The relevant numbers identified for injury incidence and its severity in rugby sevens should drive all rugby agents to consider the discussion of rule changes or tournament organizational changes in this variant of the sport, as has previously happened with 15-a-side rugby.

## 4.2. Epidemiology of injuries in senior male Portuguese rugby union sevens

This cohort prospective study led to the publication of one article entitled "Epidemiology of injuries in senior male Portuguese rugby union sevens: a cohort prospective study". Additionally, to help in the contextualization of this paper, a brief unpublished article containing mostly descriptive data collected during the cohort prospective study, and not considered for publication is presented: "Competition, field conditions, weather and the occurrence of injuries". Likewise, we also present one other short unpublished article focused on the association between trait anxiety and the occurrence of sports injuries in the top-tier sub-cohort, entitled "The relationship between trait anxiety and sports injuries in senior male Portuguese rugby sevens players".

### 4.2.1. Competition, field conditions, weather, and the occurrence of injuries

In this subchapter details regarding the competition, the weather and field conditions, as well as the occurrence of injuries are presented to assist the interpretation of the results of the study. Results are presented in a descriptive fashion.

**Competition details: matches, scores and classification**

As previously presented, the Portuguese rugby sevens championship in 2015/16 comprised the "Circuito Nacional de Sevens" and "Primeira Divisão de Sevens", respectively the first and second tiers. A total of sixteen teams registered for both top competitions, however Rugby Clube de Loulé expected to play in the "Primeira Divisão de Sevens" announced its withdrawal on the same day of the tournament.

Top eight teams (Académica, Belenenses, Benfica, Cascais, CDUL, CDUP, Direito and Técnico) competed in three consecutive tournaments played in May 21st 2016 (in Setúbal), May 28th 2016 (in Lisbon) and June 4th 2016 (in Coimbra). The bottom seven teams (Agrária, Bairrada, CRAV, Guimarães, Lousã, Santarém and Vila da Moita) competed in a single event held on May 21st 2016, in Lousã. All tournaments took place between 10 a.m. and 6 p.m. of the same day in natural grass fields.

Portuguese Rugby Union granted the researchers access to all the details of the competition (scores, schedule and classification) here presented in tables 5 to 10 to assist the interpretation of the study.

**Table 5**. First Stage schedule of the "Circuito Nacional de Sevens"

| | Time | Team 1 | Score | | | Team 2 | Venue |
|---|---|---|---|---|---|---|---|
| Match 1 | *10h00* | Direito | 26 | - | 7 | CDUL | Setúbal |
| Match 2 | *10h20* | Belenenses | 36 | - | 7 | Benfica | Setúbal |
| Match 3 | *10h40* | Cascais | 14 | - | 10 | Académica | Setúbal |
| Match 4 | *11h00* | CDUP | 0 | - | 27 | Técnico | Setúbal |
| Match 5 | *11h20* | CDUL | 21 | - | 17 | Académica | Setúbal |
| Match 6 | *11h40* | Direito | 45 | - | 12 | Cascais | Setúbal |
| Match 7 | *12h00* | Benfica | 14 | - | 22 | Técnico | Setúbal |
| Match 8 | *12h20* | Belenenses | 17 | - | 5 | CDUP | Setúbal |
| Match 9 | *12h40* | Cascais | 17 | - | 5 | CDUL | Setúbal |
| Match 10 | *13h00* | Académica | 0 | - | 56 | Direito | Setúbal |
| Match 11 | *13h20* | CDUP | 24 | - | 21 | Benfica | Setúbal |
| Match 12 | *13h40* | Técnico | 0 | - | 21 | Belenenses | Setúbal |
| ***Break - 20 Minutes*** | | | | | | | |
| Match 13 | *14h20* | Académica | 27 | - | 7 | Benfica | Setúbal |
| Match 14 | *14h40* | CDUL | 35 | - | 0 | CDUP | Setúbal |
| Match 15 | *15h00* | Cascais | 21 | - | 14 | Técnico | Setúbal |
| Match 16 | *15h20* | Direito | 38 | - | 5 | Belenenses | Setúbal |

**Table 6**. Second Stage schedule of the "Circuito Nacional de Sevens"

| | Time | Team 1 | Score | | | Team 2 | Venue |
|---|---|---|---|---|---|---|---|
| Match 1 | 12H00 | CDUL | 50 | - | 0 | Técnico | Lisbon |
| Match 2 | 12H20 | CDUP | 0 | - | 43 | Cascais | Lisbon |
| Match 3 | 12H40 | Direito | 55 | - | 0 | Benfica | Lisbon |
| Match 4 | 13H00 | Belenenses | 47 | - | 0 | Académica | Lisbon |
| Match 5 | 13H20 | Benfica | 7 | - | 0 | Técnico | Lisbon |
| Match 6 | 13H40 | Direito | 48 | - | 0 | CDUL | Lisbon |
| Match 7 | 14H00 | Académica | 19 | - | 17 | Cascais | Lisbon |
| Match 8 | 14H20 | Belenenses | 31 | - | 5 | CDUP | Lisbon |
| Match 9 | 14H40 | CDUL | 24 | - | 0 | Benfica | Lisbon |
| Match 10 | 15H00 | Técnico | 0 | - | 57 | Direito | Lisbon |
| Match 11 | 15H20 | CDUP | 12 | - | 19 | Académica | Lisbon |
| Match 12 | 15H40 | Cascais | 10 | - | 29 | Belenenses | Lisbon |
| ***Break - 30 Minutes*** | | | | | | | |
| Match 13 | 16H30 | Técnico | 5 | - | 40 | CDUP | Lisbon |
| Match 14 | 16H50 | Benfica | 5 | - | 19 | Cascais | Lisbon |
| ***Break- 30 Minutes*** | | | | | | | |
| Match 15 | *17h40* | CDUL | 21 | - | 14 | Académica | Lisbon |
| Match 16 | *18h00* | Direito | 38 | - | 5 | Belenenses | Lisbon |

**Table 7**. Third Stage schedule of the "Circuito Nacional de Sevens"

| | Time | Team 1 | Score | | | Team 2 | Venue |
|---|---|---|---|---|---|---|---|
| Match 1 | 11h00 | Cascais | 5 | - | 29 | Académica | Coimbra |
| Match 2 | 11h20 | Direito | 55 | - | 0 | Técnico | Coimbra |
| Match 3 | 11h40 | Belenenses | 31 | - | 14 | CDUP | Coimbra |
| Match 4 | 12h00 | Benfica | 19 | - | 12 | CDUL | Coimbra |
| Match 5 | 12h20 | Técnico | 0 | - | 57 | Académica | Coimbra |
| Match 6 | 12h40 | Direito | 47 | - | 5 | Cascais | Coimbra |
| Match 7 | 13h00 | CDUP | 33 | - | 10 | CDUL | Coimbra |
| Match 8 | 13h20 | Belenenses | 24 | - | 7 | Benfica | Coimbra |
| Match 9 | 13h40 | Cascais | 19 | - | 22 | Técnico | Coimbra |
| Match 10 | 14h00 | Académica | 0 | - | 21 | Direito | Coimbra |
| Match 11 | 14h20 | Bendica | 5 | - | 17 | CDUP | Coimbra |
| Match 12 | 14h40 | CDUL | 12 | - | 17 | Belenenses | Coimbra |
| ***Break - 20 Minutes*** | | | | | | | |
| Match 13 | 15h20 | Cascais | 12 | - | 17 | CDUL | Coimbra |
| Match 14 | 15h40 | Técnico | 24 | - | 12 | Benfica | Coimbra |
| Match 15 | 16h00 | Académica | 38 | - | 19 | CDUP | Coimbra |
| Match 16 | 16h20 | Direito | 31 | - | 29 | Belenenses | Coimbra |

**Table 8**. Final classification after the three stages of the "Circuito Nacional de Sevens"

| Classification | Team | First stage points | Second stage points | Third stage points | Total Points |
|---|---|---|---|---|---|
| 1st | Direito | 22 | 22 | 22 | 66 |
| 2nd | Belenenses | 19 | 19 | 19 | 57 |
| 3rd | Académica | 10 | 15 | 17 | 42 |
| 4th | CDUL | 13 | 17 | 10 | 40 |
| 5th | Cascais | 17 | 13 | 9 | 39 |
| 6th | CDUP | 12 | 10 | 15 | 37 |
| 7th | Técnico | 15 | 9 | 13 | 37 |
| 8th | Benfica | 9 | 12 | 12 | 33 |

**Table 9**. Schedule of the "Primeira Divisao de Sevens"

| | Time | Team 1 | Score | | | Team 2 | Venue |
|---|---|---|---|---|---|---|---|
| Match 1 | 11h30 | Lousã | 36 | - | 0 | Agrária | Lousã |
| Match 2 | 11h50 | Moita | 22 | - | 0 | Santarém | Lousã |
| Match 3 | 12h10 | Guimarães | 21 | - | 12 | Bairrada | Lousã |
| Match 4 | 12h30 | Loulé | NS | - | W | CRAV | Lousã |
| Match 5 | 12h50 | Moita | 10 | - | 19 | Lousã | Lousã |
| Match 6 | 13h10 | Santarém | 17 | - | 7 | Agrária | Lousã |
| Match 7 | 13h30 | Bairrada | 26 | - | 17 | CRAV | Lousã |
| Match 8 | 13h50 | Guimarães | W | - | NS | Loulé | Lousã |
| Match 9 | 14h10 | Santarém | 15 | - | 19 | Lousã | Lousã |
| Match 10 | 14h30 | Agrária | 7 | - | 43 | Moita | Lousã |
| Match 11 | 14h50 | Loulé | NS | - | W | Bairrada | Lousã |
| Match 12 | 15h10 | CRAV | 14 | - | 12 | Guimarães | Lousã |
| ***Break - 20 Minutes*** | | | | | | | |
| Match 13 | 15h50 | Agrária | W | - | NS | Loulé | Lousã |
| Match 14 | 16h10 | Santarém | 5 | - | 29 | CRAV | Lousã |
| Match 15 | 16h30 | Moita | 14 | - | 12 | Bairrada | Lousã |
| Match 16 | 16h50 | Lousã | 36 | - | 17 | Guimarães | Lousã |

**Legend:** NS – no show; W – winner.

**Table 10**. Classification of the "Primeira Divisao de Sevens"

| Classification | Team |
|---|---|
| 1st | Lousã |
| 2nd | Guimarães |
| 3rd | Moita |
| 4th | Bairrada |
| 5th | CRAV |
| 6th | Santarém |
| 7th | Agrária |
| 8th | Loulé |

**Field conditions**

Quality of the field was assessed using a questionnaire presented to two of the referees and one of the delegates of the Portuguese Rugby Union present at each venue. Agents were asked to rate the field condition between 1 (not ready for play) and 10 (perfect conditions), prior to the beginning of the matches. Table 11 presents the results of this questionnaire.

**Table 11.** Assessment of field conditions

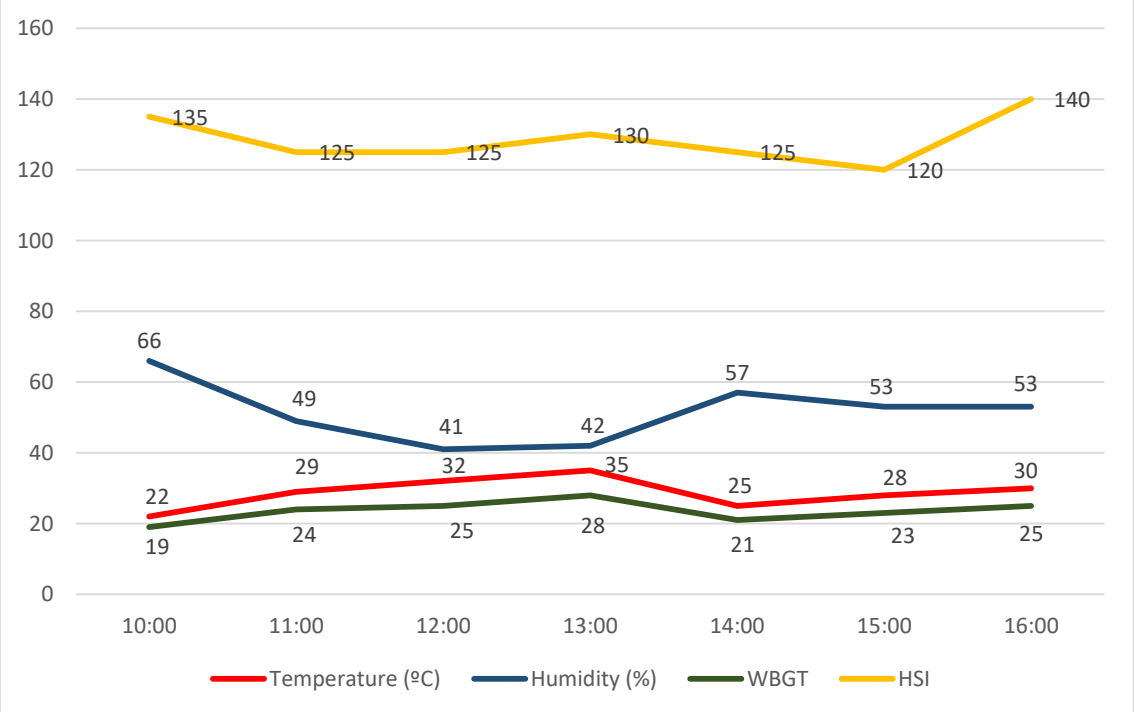
| Venue | Referee 1 | Referee 2 | Union's delegate | Total | Average |
|---|---|---|---|---|---|
| Setúbal (natural turf) | 6 | 7 | 7 | 20 | 6.7/10 |
| Lisbon (natural turf) | 10 | 8 | 10 | 28 | 9.3/10 |
| Coimbra (natural turf) | 9 | 7 | 10 | 26 | 8.7/10 |
| Lousã (natural turf) | 8 | 6 | 8 | 22 | 7.3/10 |

As we can see from table 11, all the scores were positive (higher than 6 out of 10) and, on average, overall assessment of the field conditions ranged from 6.7 to 9.3 (out of 10).

### Weather conditions

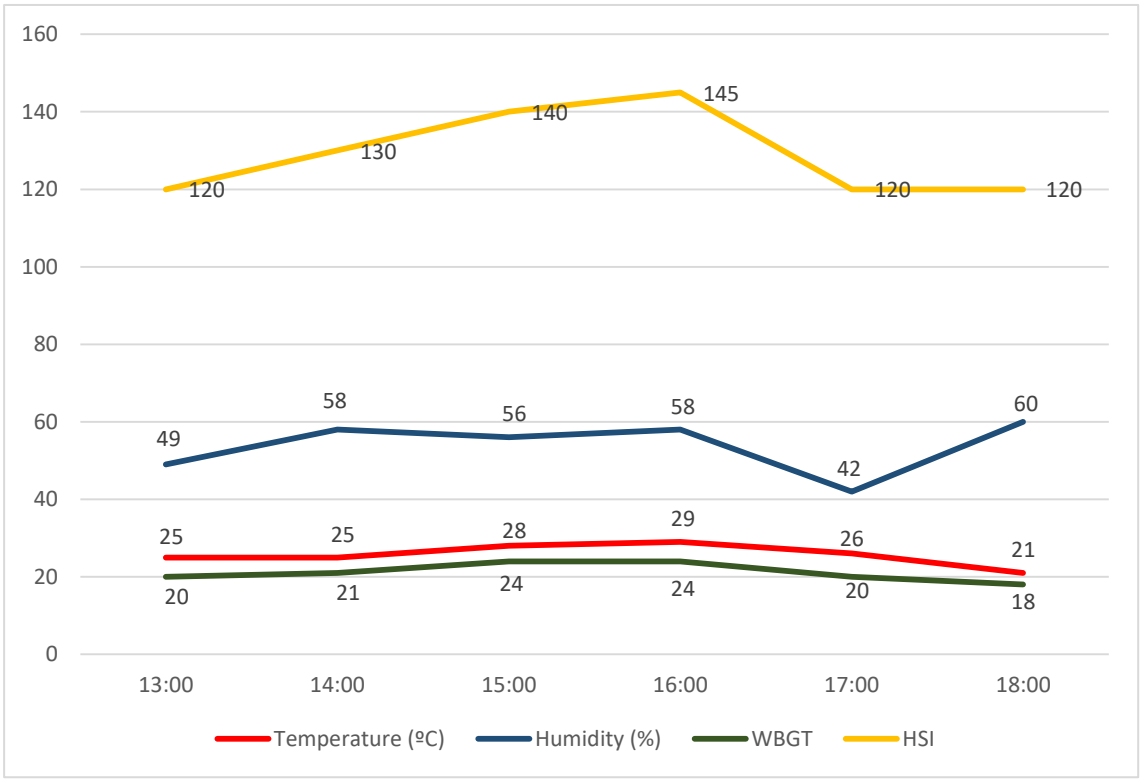
The Portuguese sevens championship usually takes place at the end of spring. Weather conditions during each of the tournaments were assessed using a hygrometer, as described in subchapter *3.2. Second phase*. Graphs 1 (a,b,c) and 2 present data collected (temperature and relative humidity). Calculated WBGT (by the Liljegren method available at http://www.climatechip.org/heat-stress-index-calculation) and estimated HIS (available at World Rugby Heat Guidelines)[123] for each hour of the tournament, are also presented. Temperatures are presented e degrees Celsius (ºC); humidity as relative percentage (%)

**Graph 1a.** Weather conditions during the first stage of the "Circuito Nacional de Sevens"



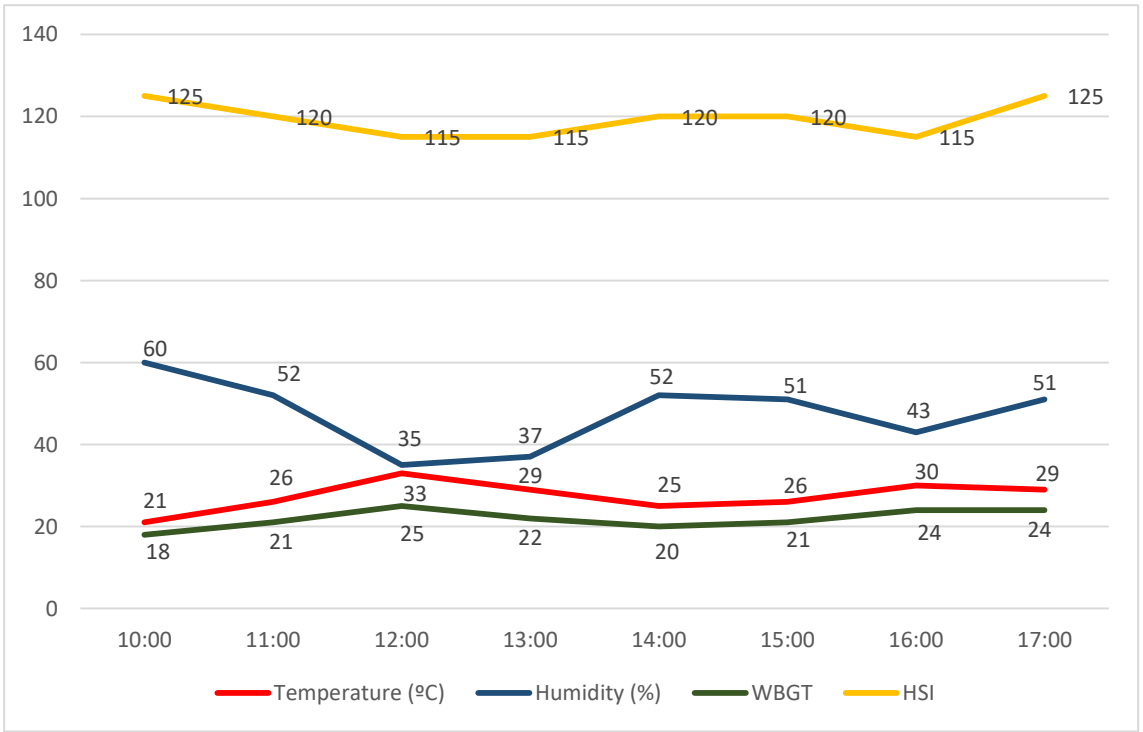

**Legend:** HSI - Heat Stress Index (estimated);[123] WBGT – Wet Bulb Globe Temperature (calculated).

**Graph 1b.** Weather conditions during the second stage of the "Circuito Nacional de Sevens"



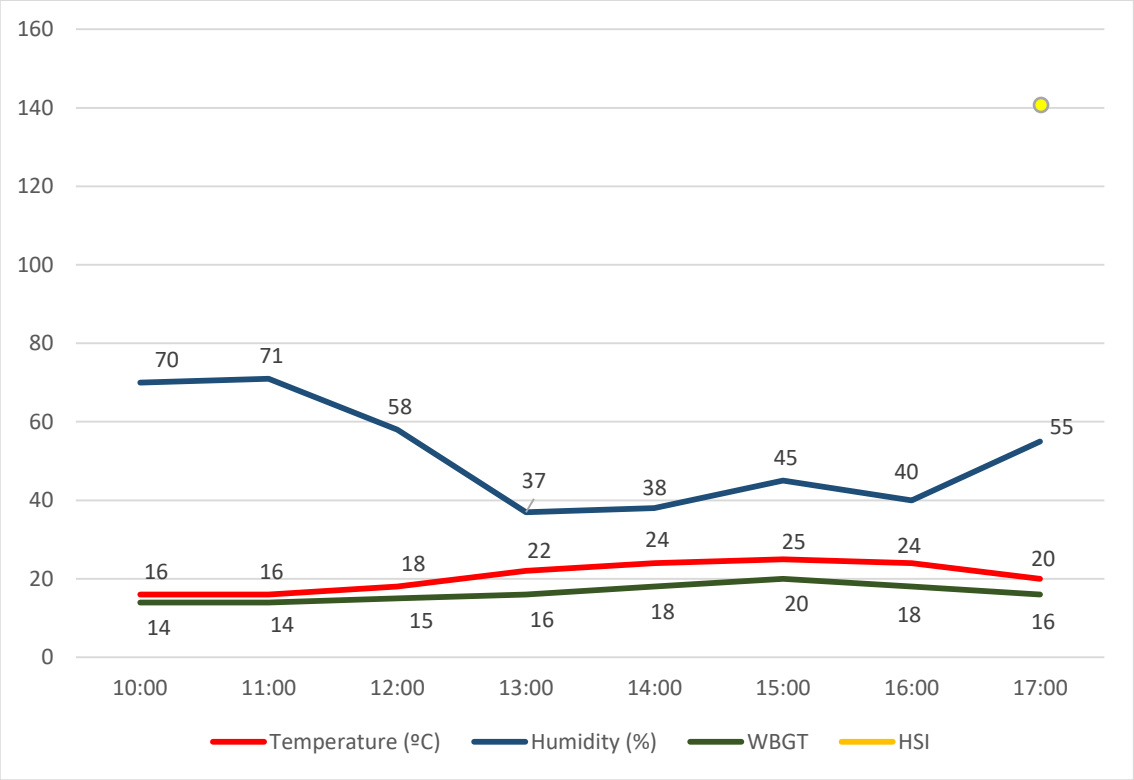

Legend: HSI - Heat Stress Index (estimated);[123] WBGT – Wet Bulb Globe Temperature (calculated).

**Graph 1c.** Weather conditions during the third stage of the "Circuito Nacional de Sevens"




**Legend:** HSI - Heat Stress Index (estimated);[123] WBGT – Wet Bulb Globe Temperature (calculated).

**Graph 2.** Weather conditions during the "Primeira Divisão de Sevens"




**Legend:** HSI - Heat Stress Index (estimated);[123] WBGT – Wet Bulb Globe Temperature (calculated).

For some small periods during the "Circuito Nacional de Sevens" temperatures rose above 30ºC or relative humidity rose above 60% (never both conditions cumulatively). However, WBGT and HSI were never higher than 28 and 150, respectively. Therefore, we can consider that almost all of the games were played under perfect weather conditions and heat was not a concern, according to the World Rugby Heat Guidelines. For the "Primeira Divisão de Sevens", temperature, WBGT and HSI were all under the targets for ideal conditions of play. Humidity was above 70% for the first two hours of the tournament, but temperature was mild (16ºC) and ideal for rugby.

**Occurrence of injuries**

A total of 60 matches were played during the competition. In the top-tier, eight teams played a total of 48 matches (12 each team), while in the second-tier only 12 matches were played (teams played three or four matches each).

During the competition, 27 injuries occurred. Table 12a, 12b presents all data regarding the occurrence of injuries, total exposure and injury rates for each tournament assessed. Ninety-five confidence intervals were calculated for the incidence rates, and differences between them were considered if CI did not overlap.

**Table 12a**. Exposure, injuries and incidence rates for each sevens tournament

| Tournament | Matches (n) | Exposure (player match-hours) | Injuries (n) | Incidence rate (injuries per 1000 player match-hours; 95% CI) |
|---|---|---|---|---|
| Circuito Nacional (all) | 48 | 161 | 27 | 118 (73.1–180.9) |
| Circuito Nacional (1st stage) | 16 | 53.66 | 7 | 130.5 (57-258) |
| Circuito Nacional (2nd stage) | 16 | 53.66 | 5 | 93.2 (34-206) |
| Circuito Nacional (3rd stage) | 16 | 53.66 | 7 | 130.5 (57-258) |
| Primeira Divisão | 12 | 40.6 | 8 | 197 (91.5–374.2) |

**Legend:** CI – confidence interval.

**Table 12b**. Injuries: distribution per game

| | Injuries (n, %) | | | | |
|---|---|---|---|---|---|
| Tournament | Match 1 | Match 2 | Match 3 | Match 4 | Total |
| Circuito Nacional (all) | 6 (31.5%) | 4 (21.1%) | 4 (21.1%) | 5 (26.3%) | 19 (100%) |
| Primeira Divisão | 3 (37.5%) | 2 (25%) | 3 (37.5%) | - | 8 (100%) |

Although incidence rates ranged from 93.2 to 197 per 1000 player match-hours from the second stage of the "Circuito Nacional de Sevens" to the "Primeira Divisão de Sevens", respective 95% CI overlapped, so no statistically significant differences could be identified. Finally, regarding the position, 59% of all injured players were backs.

In summary, regarding the circumstances under which this study was conducted, it becomes clear that all tournaments took place on adequate fields, under good weather and injury incidence rates did not differ significantly between tournaments.

## 4.2.2. Epidemiology of injuries in senior male Portuguese rugby union sevens: a cohort prospective study

In this subchapter we present the main article of our study. It was aimed at assessing the incidence, type and location of injuries sustained during the Portuguese rugby union sevens circuit, and also at investigating the influence of players' training loads on injury risk, using a cohort prospective design. A total of 27 injuries were recorded corresponding to an incidence rate of 133.9 injuries per 1000 player match-hours. The average severity was 22.22 days, and contact events preceded 81.5% of all injuries. Most injuries occurred in the lower limb and were joint/ligament or muscle/tendon injuries type. The association between injuries and lower volume of training during the sevens season was identified for the second-tier ($p = 0.021$). For the same level, an inverse relation between training hours and injury severity was also found ($p = 0.008$). Top-tier players engaged in specific sevens training simultaneously with the fifteens preparation during the year presented a significant increase of injury risk (relative risk = 3.2; $p = 0.011$). In conclusion, injury incidence in this study was similar to that reported for international sevens, although with a lower average severity. An association between training loads and the occurrence of injuries was found for both tiers, although with differential results, thus reinforcing the need to customize players' preparation. Data regarding warm-up routines and the number of games played before the occurrence of injuries was also assessed during the study. However, data were too heterogeneous and their analysis was excluded from this paper. Further studies at non-elite competitions are needed to gather significant data to accurately formulate future injury prevention protocols or recommend modifications to game laws or competition formats, aiming at players' welfare.

Citation: Cruz-Ferreira AM, Cruz-Ferreira EM, Santiago LM, Taborda-Barata L. Epidemiology of injuries in senior male Portuguese rugby union sevens: a cohort prospective study. Phys Sportsmed. 2018 May;46(2):255-261. doi: 10.1080/00913847.2018.1441581. (Permission to reproduce granted from the Journal [http://www.tandfonline.com]. This is the authors accepted manuscript of an article published as the version of record in The Physician and Sportsmedicine © 27th February 2018 https://doi.org/10.1080/00913847.2018.1441581 [Appendix B2])

### Introduction

Rugby Union is played by more than 7.7 million players worldwide[139] and the sevens variant has recently become an Olympic sport.[16] Being a very demanding sport, with a high number of physical contacts per match and frequent high intensity activities such as running, sprinting or tackling, injury incidence rates in rugby union are reported to be very high.[57,66,146] A significant

body of evidence has been published in the past years, reporting the injury incidence rates in Rugby Union 15-a-side.[85]

In contrast, sparse data are available regarding injuries in rugby sevens, although a recent systematic review confirmed the higher injury incidence rate in sevens compared with rugby fifteens.[3] Most of these data concerned elite players and competitions and revealed an injury incidence rate ranging from 101.5 to 119.8 per 1000 player match-hours, and a mean severity higher than 34 days per injury.[3] Injury distribution by type and location did not differ from the fifteens variant, with lower limb being the most frequent site of injury, and muscle/tendon and joint/ligament injuries the most frequent type.[3] One epidemiological study, published after the release of this systematic review, reporting the injuries which occurred during the 2016 rugby sevens Olympic tournament concluded that the incidence, severity and nature of the injuries sustained during the men's tournaments fell within the normal range of values for international rugby sevens tournaments.[80]

If at elite level one must acknowledge the shortage of available data in the literature regarding rugby sevens injuries, for amateur and national levels, data are even sparser.[3] Besides the research published by López et al. in 2012,[43] only one other study in non-elite college rugby sevens players is available. This study was published in 2017 and also suggests a lower injury incidence rate among amateur players (59.3–74.7 injuries per 1000 player match-hours in senior male competitions).[83] Injury type and location do not seem to differ significantly from amateur to elite level.[3] The only minor detail reported by Cruz-Ferreira et al.,[3] based on the single study assessing amateur players was that unlike at elite level, muscle/tendon injuries were of relative higher frequency at that level of competition.[3]

It is also important to understand the exposure of players to training and match load and its association with sports injuries. All the major international competitions, such as the World Rugby Sevens Series, the Rugby Sevens World Cup, or the Olympic Tournament are played during multiple days (two or three), with teams competing in two or three matches a day.[71,80] The Rugby World Cup and the Olympic Tournament are played in a single week however, the Sevens Series is played throughout the year, in 10 stages around the world.[71] Amateur competitions usually involve players competing in one or multiple one-day tournaments contested during summer or at the end of the fifteens season.[39,43]

Regarding risk factors associated with the occurrence of injuries in rugby sevens, evidence is not abundant.[100] A recent paper authored by Williams et al.[100] while agreeing with the lack of evidence in the literature, presented the accumulated and recent match load (both high and low) as targets for rugby players and coaches assessment as it substantially influences the risk of injury.[100]

The Portuguese national rugby sevens team has been one of the most successful teams in Europe and one of the few that have been able to compete regularly in the major rugby sevens competitions, and its roster is mainly composed of home-based players. Portugal has been a core team at the World Rugby Sevens Series from 2012 to 2016 and won the European Rugby

Sevens Grand Prix (top European nations competition) eight times between 2002 and 2012. They have also been present in five Rugby Sevens World Cups, finishing in 10th place in 2005; and won the Silver Medal at the 2009 World Games.[147]

Considering the four-step 'sequence of prevention model' suggested by Van Mechelen in 1992,[46] which remains the gold-standard for all injury prevention interventions in sports, to be able to work aiming at the reduction of the burden of injuries in rugby sevens, the extent of the problem must be identified and described. As little evidence is available regarding non-elite rugby sevens injuries, the aim of this study was to determine the injury incidence rate, type, location and severity of injuries which occurred during the Portuguese national senior male rugby sevens circuit. It was also our objective to investigate the influence of players' experience in the sport and training load on the occurrence of sports injuries.

**Methods**

The study followed a prospective cohort design and included data collected during the 2015/16 Portuguese national rugby sevens circuit. All definitions and procedures used in this study were compliant with the international consensus statement on injury surveillance studies for rugby,[41] and the methodology used is similar to that in previously published studies.[1,71,80] The reporting of this study conforms to the STROBE statement.[148]

All players taking part in the top two levels of the Portuguese national senior male rugby sevens circuit were included in the study. This is an annual competition contested by the top senior male rugby sevens teams in Portugal, played nationwide after the end of the fifteens season from May to June.[39] In the 2015/16 season, the top-tier included the eight highest ranked teams in the country that competed in three one-day tournaments, contested in three consecutive weekends, with each team playing four games per day. The remaining seven teams competed in a single one-day tournament, aiming at promotion to the top level for the following year, playing three–four games each.[39]

A group of researchers was present at each tournament, identifying every injury occurring during the tournaments. Injury was defined as 'any physical complaint sustained by a player during a rugby sevens match that prevented the player from taking a full part in training and/or match play for more than one day following the day of injury'.[1] Data were collected using a specific report instrument modeled after the consensus statement on injury definitions and data collection procedures in studies of injuries in rugby union.[41]

The researchers were responsible for recording details of each injury: date of injury, playing position (forward, back), number of games played, period of game (first half, second half, or extra time), activity at the time of injury (tackling, being tackled, collision, scrum, line-out, ruck, maul, or other), location of injury (head/neck, upper limb, trunk, or lower limb), type of injury (bone, joint/ligament, muscle/tendon, skin, brain/spine/ peripheral nervous system, or

other).[41] A description of the various types of activities in rugby union is provided in the Laws of the Game.[149]

Injury severity was defined by the number of days an injured player was unavailable for training and match play without limitations.[71] All injured players were followed up to obtain their date of return to practice.

Informed consent and data regarding players' age, body mass, and height were collected prior to the beginning of the tournaments. Additionally, all players were requested to provide some individual data concerning their rugby sevens experience, training loads (type and number of training hours during the fifteens and sevens season) and if they had sevens-specific training sessions during the fifteens season. Data regarding training loads were collected by recall: each player self-reported the number of hours of field and gym training during both sevens and fifteens seasons.

Match exposures were calculated for each team based on seven players being exposed for 14 min per game (or 20 min for each tournament final *[accurate at the date of publication]*). No allowances were made for players removed from match (yellow cards, red cards, or medical treatment).[71] Ethical approval was obtained from the Ethical Committee of the local Regional Health Administration and institutional collaboration was granted by the Portuguese Union.

Players' data are reported as mean (±Standard Deviation [SD]) and rate of injury as injuries per 1000 player match-hours. Injury data are reported as proportion (%). Severity is reported as mean days. Ninety-five percent confidence intervals (95% CIs) were calculated for severity, proportions and injury rate.

Normality of the data was checked using Kolmogorov-Smirnov or Shapiro-Wilk tests. Significant differences in values for incidence and severity were assumed if the 95% CIs did not overlap. Differences in individual and anthropometric data from top and bottom-tier players were assessed using t tests or Mann-Whitney U tests. For each level of competition, differences between injured and non-injured players were also assessed using t tests or Mann-Whitney U tests. Spearman's Correlation Coefficient was used to assess the relationship between reported training loads and the severity of injuries at both levels of competition. Fisher's exact test was used to estimate the relative risk of suffering an injury during the sevens season and training sevens during the fifteens season, for each level of competition. Level of significance was set at $p < 0.05$, and statistical analysis was performed using SPSS software (version 22.0 for Windows, IBM Corp, Armonk, New York, USA).

**Results**

A total of 226 senior male players engaged in at least one of the four tournaments played. Table 13 shows the mean (± SD) age, stature, body mass and experience in rugby sevens. Significant differences were observed between players from the first and second levels of competition for stature, body mass and experience in the sport. Players competing at the highest level were

taller (p= 0.010) and heavier (p< 0.001), but less experienced in rugby sevens (p= 0.007). The match exposure (player match-hours) and the number of injuries recorded in both competitions are presented in table 14. The overall injury incidence rate for the Portuguese national rugby sevens circuit was 133.9 injuries per 1000 player match-hours (95% CI 90.1–192.2). Although not reaching statistical significance, the injury incidence rate was lower in the top-tier when compared with the second-tier group: 118 (95% CI 73.1–180.9) versus 197 (95% CI 91.5–374.2) injuries per 1000 player match-hours, respectively. However, injury severity in the former group was more than threefold that in the latter group. Again, no significant difference was found, but injured players from the top competition were on average absent from training and/or practice for 27.95 days (95%CI: 10.69–55.35), while those at the second-tier were only absent for 8.63 days (95% CI: 6.13–11.00).

**Table 13.** Anthropometric and rugby sevens experience data for the sample population (reproduced with permission from the Journal [Appendix B2])

| Level | *n* | Age (years) | Body Mass (kg) | Height (cm) | Experience in rugby (years) |
|---|---|---|---|---|---|
| First-tier | 142 | 22.27 (±4.09) | 88.83 (±12.75) | 181.23 (±6.62) | 5.75 (±3.52) |
| Second-tier | 84 | 23.30 (±4.59) | 81.49 (±12.37) | 178.60 (±6.22) | 7.38 (±4.27) |
| All | 226 | 22.62 (±4.29) | 86.18 (±13.06) | 180.28 (±6.58) | 6.39 (±3.92) |
| | | p=0.116 | p<0.001* | p=0.010* | p=0.007* |

Legend: Values are mean (SD); *Statistically significant

**Table 14.** Exposures and numbers and incidences of injuries in the Portuguese rugby sevens circuit (reproduced with permission from the Journal [Appendix B2])

| Level | Exposure (player match-hours) | Injuries (number) | Incidence rate (per 1000 player match-hours)# | Severity (days)# |
|---|---|---|---|---|
| First-tier | 161 | 19 | 118 (73.1-180.9) | 27.95 (10.69-55.35) |
| Second-tier | 40.6 | 8 | 197 (91.5-374.2) | 8.63 (6.13-11.00) |
| All | 201.6 | 27 | 133.9 (90.1-192.2) | 22.22 (10.07-40.84) |
| | | | | p=0.039 |

Legend: #Values are mean (95% confidence interval)

Table 15 provides an overview of the distribution of injuries in terms of type, location and event. Most injuries were preceded by contact events (81.5%, 95% CI: 65.5–93.7), with tackle being the event most frequently associated with injuries, with a total of 12: four while performing the tackle (19.0%, 95% CI: 4.8–38.1) and eight after being tackled (38.1%, 95% CI: 17.6–60.0).

**Table 15**. Location, type and event of injuries sustained as a function of competition level (reproduced with permission from the Journal [Appendix B2])

| | First-tier<br>Proportion %(95% CI) | Second-tier<br>Proportion %(95% CI) | All |
|---|---|---|---|
| Location | | | |
| Head/Neck | 10.5 (0.0-26.1) | 25.0 (0.0-62.4) | 14.8 (3.1-30.4) |
| Upper Limb | 10.5 (0.0-26.7) | 25.0 (0.0-60.0) | 14.8 (3.3-29.2) |
| Trunk | 5.3 (0.0-17.6) | - | 3.7 (0.0-12.9) |
| Lower Limb | 73.7 (52.4-93.8) | 50.0 (11.1-85.7) | 66.7 (50.0-84.2) |
| Type | | | |
| Joint/ligament | 42.1 (21.8-63.2) | 50.0 (14.3-87.5) | 44.4 (25.0-64.3) |
| Muscle/tendon | 47.4 (26.7-69.2) | 25.0 (0.0-62.5) | 40.7 (21.9-60.0) |
| Skin | - | 12.5 (0.0-45.4) | 3.7 (0.0-13.0) |
| CNS/PNS | 10.5 (0.0-26.1) | - | 7.4 (0.0-19.2) |
| Other injuries | - | 12.5 (0.0-40.0) | 3.7 (0.0-13.0) |
| Event | | | |
| Contact | 78.9 (59.1-95.0) | 87.5 (57.1-100.0) | 81.5 (65.5-93.7) |
| Non-contact | 21.1 (5.0-40.9) | 12.5 (0.0-42.9) | 18.5 (6.3-34.5) |
| Contact | | | |
| Collision | 14.3 (0.0-35.7) | - | 9.5 (0.0-23.5) |
| Ruck | 28.6 (7.1-53.8) | 42.9 (0.0-83.3) | 33.3 (14.3-55.0) |
| Tackle | 14.3 (0.0-35.7) | 28.6 (0.0-66.7) | 19.0 (4.8-38.1) |
| Being tackled | 42.9 (15.4-70.0) | 28.6 (0.0-66.7) | 38.1 (17.6-60.0) |

Legend: CI, confidence interval; CNS/PNS, central or peripheral nervous system

Lower limb was the most frequent site of injury (66.7%, 95% CI: 50.0–84.2), and joint/ligament the single most frequent type (44.4%, 95% CI: 25.0–64.3). However, muscle/tendon injuries were almost as frequent and occurred in 40.7% of the cases (95% CI: 21.9–60.0). The period of the match where most of the injuries occurred was the second half (59.3%, 95% CI: 41.4–76.0), and the defensive 22 m area was the field zone where most injuries took place (33.3%, 95% CI: 15.4–51.9), followed by the defensive midfield (25.9%) and the offensive midfield (22.2%). Backs sustained the higher number of injuries (59.3%).

Regarding age and experience, no significant differences were found between injured and non-injured players.

Training loads for injured and non-injured players from both levels of competition are presented in tables 16 and 17. This includes data from the fifteens and sevens season, and the structure of the training sessions. First-tier players, both injured and non-injured, were

exposed to a higher training load than second-tier players (see table 16). This was true for all sections of training analyzed (field and weight training during fifteens and sevens season).

**Table 16**. Training loads and structure during fifteens season for injured and non-injured players as a function of competition level (reproduced with permission from the Journal [Appendix B2])

| | First-tier: Mean hours (± SD) | Second-tier: Mean hours (± SD) |
|---|---|---|
| Weekly hours field training | | |
| Injured | 4.41 (±0.92) | 3.68 (±1.09) |
| Non-Injured | 4.84 (±0.99) | 3.96 (±1.21) |
| | p=0.219 | p=0.941 |
| Weekly hours weights training | | |
| Injured | 3.67 (±1.66) | 1.31 (±1.44) |
| Non-Injured | 3.28 (±2.22) | 2.41 (±1.92) |
| | p=0.298 | p=0.114 |
| Season total training load (hours) | | |
| Injured | 323.53 (±86.67) | 200.00 (±58.55) |
| Non-Injured | 325.10 (±106.15) | 254.60 (±93.06) |
| | p=0.650 | p=0.081 |

Values are mean (SD).

At the second level of competition, total training load during the sevens season was significantly lower among players that sustained injuries in this period (p= 0.021). Notably, regarding weight training, injured players at this level of competition also presented lower training averages and, again, statistical significance was achieved (p= 0.048). Injured players also had lower field and weight training loads during the fifteens season; however, no statistical significance was reached.

**Table 17.** Training loads and structure during sevens season for injured and non-injured players as a function of competition level (reproduced with permission from the Journal [Appendix B2])

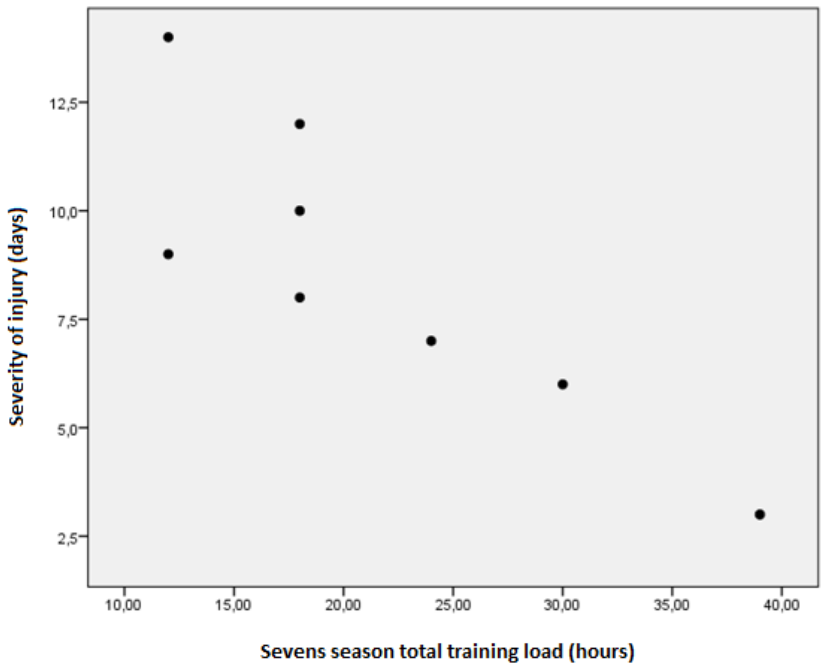
| | First-tier: Mean hours (± SD) | Second-tier: Mean hours (± SD) |
|---|---|---|
| Weekly hours field training | | |
| Injured | 3.32 (± 1.63) | 2.63 (±1.19) |
| Non-Injured | 3.54 (±1.50) | 3.16 (± 1.20) |
| | p=0.910 | p=0.209 |
| Weekly hours weights training | | |
| Injured | 3.41 (±1.71) | 0.94 (±1.26) |
| Non-Injured | 2.93 (±2.38) | 2.41 (±2.13) |
| | p=0.245 | **p=0.048*** |
| Season total training load (hours) | | |
| Injured | 40.41 (±16.19) | 21.38 (±9.27) |
| Non-Injured | 38.87 (±17.41) | 33.47 (±14.11) |
| | p=0.521 | **p=0.021*** |

Values are mean (SD); *Reaches statistical significance.

When the relationship between the reported training loads and the severity of injuries was assessed, a significant inverse correlation was identified (figure 2) between the total training load of second-tier players and the severity of their injuries (Spearmen's rho: −0.847, p= 0.008). No significant correlations were identified for the other variables at this level of competition. Training sevens during the fifteens season did not represent a significant risk of injury.

For the top-tier, no significant differences were found between injured and non-injured players training loads. However, regarding the training loads during the sevens season, injured players had higher mean times (40.41 ± 16.19 h) than non-injured players (38.87 ± 17.41 h). At this level of competition, a significant risk of injury during the sevens season (relative risk= 3.2, 95%CI: 1.37–7.44) was identified for players who underwent sevens specific training during the fifteens season (Fisher's exact test, p= 0.011). No relationship was found between training loads and the severity of injuries for the top-tier players.

**Figure 2.** Injury severity and training load (second-tier): Spearmen's rho: -0.847, p=0.008 (reproduced with permission from the Journal [Appendix B2])




**Discussion**

This study reports the first epidemiological data from non-elite rugby sevens competitions in a European country. We provide accurate data on sports injuries occurring during the entire season of a non-elite senior male rugby sevens competition. This also represents the first study to exclusively report data from non-elite senior male players. Both previous relevant studies reported data from college players or partially merged data from under-19 and senior, as well as male and female players.[43]

In order to ensure internal and external validity of our paper, a series of procedures were implemented: all data were collected using validated tools following the international consensus statement on injury surveillance studies for rugby[41] a series of meetings between the research team and a pilot study was conducted prior to the beginning of the 2015/16 senior rugby sevens season to improve the accuracy of data collection,[137] all data regarding injuries were collected by the researchers on the sidelines (and not recorded after their occurrence); all the teams (and their players) were briefed weeks before the event.

Nevertheless, a number of limitations to our study must be discussed: first of all, it covers only one season in only one country. Secondly, the length of the competition differs from the first (three tournaments) to the second level (only one tournament). In addition, injuries were recorded on the field by the researchers, while previous studies relied on self-report by the medical staff of each team – thus increasing the number of injuries recorded, as fewer (or none) of the injuries were unreported. Additionally, since these are non-professional athletes, the

level of medical support available to recover from their injuries must be regarded as a limitation, when comparing the severity of injuries with previous studies at elite level. Also, despite the fact that the present study only focused on club level competitions (and not national teams), data were not collected regarding each player's previous international experience. Although almost all athletes were amateur, some have played for the Portuguese National team in previous European and World events, thus leading to some heterogeneity in this cohort in terms of players' international experience. Finally, training load data were individually provided, as previously explained, which may have been associated with a recall bias. We acknowledge that relying on the players to recall individual training loads for the entire season represents a relevant limitation to our paper, and that comparison with training loads reported in previous studies was very difficult. Future studies should be conducted using a more accurate methodology to collect training loads data.

As expected, our results are unique and comparisons with previously published studies are very limited. However, injury incidence rate, type and location of injuries in our population seem to be mostly in agreement with the findings reported by Fuller et al.[136] for elite level players. In particular, when we separately consider data from the top-tier competition, injury incidence rate, type, and location of injuries, as well as average severity do not differ substantially from the reports by Fuller et al. for international elite players.[80] We believe that, at least partially, these numbers can be justified by the fact that some players competing at the top-tier Portuguese national sevens championship also play at international level (Rugby Europe Grand Prix Series and/or World Rugby Sevens Series). Thus, the level of preparation and intensity of play can be similar. On the other hand, there is a slight difference between the methodology of our study and previous studies. Unlike ours, where a team of researchers directly identified potential injury situations on the field, approaching the medical staff at the end of the match and following each player until the last day of absence following the incident, injury surveillance studies reported by Fuller et al.[32] relied on self-reported data from the medical staff of each team, after the end of the tournaments. Our methodology possibly led to a higher number of recorded injuries, thereby being associated with a slightly higher injury incidence rate compared to the international elite level. We also acknowledge that some of the injuries identified in our study, especially the least severe ones (under 7 days of absence) would not be recorded if we relied on self-report. Therefore, the lower severity of injuries in our study could be biased by the higher number of low severity injuries recorded.

For the same reason, but also due to the small sample and exposure on the second-tier, injury incidence rate and average severity for players at this level of competition cannot be compared separately with previous studies.

As reported for the players competing at the World Cup and Sevens Series, in our study the lower limb was the location of most injuries, unlike the reports from previous studies with amateur players where head/neck and the upper limb were the most frequent sites of injury.[43] A recent study by Rizi et al.,[83] reporting data from Hong Kong amateur college rugby players

(which includes under-20 and younger players) also found that the lower limb was the most frequent site of injury among those players. These data also differed from the single previous study on amateur rugby sevens, by López et al.,[43] where the upper limb was the most frequent site of injury.

Also in our study, regarding the type of injury, and as reported for elite level,[136] joint/ligament and muscle/tendon injuries accounted for more than three quarters of all time-loss injuries (85.1%). At amateur level, available data point to a greater heterogeneity of injury types.[43] López at al.[43] also reported that muscle/tendon and joint/ligament injuries were the most frequent ones among amateur players, but both types only represented 60.4% of all injuries, unlike previous studies with elite players and our findings.[3] Again, type and location of injuries in our study were more similar to those of elite international level players than those of amateurs.

As expected, and reported for both amateur and elite players, injuries usually occur after contact. The percentage reported in our study (81.5%) is in line with previously published data for both amateur (72.9%) and elite players (78.5%).[43,136]

The analysis of the influence of players' experience and training load was conducted separately for top and second-tier competitions. No association between players' experience and the occurrence of injuries was found for both levels of competition. For second-tier players, a direct association between the occurrence of injuries and the decrease in the volume of training was identified. As shown on table 16, the number of training hours during the sevens season was smaller in the injured group and, particularly regarding the weight training, a statistically significant difference in the number of hours for both groups was also found. Prevention of sports injuries includes a different number of aspects and resistance training is one of them.[45] For this group of players, the reduction of training hours (especially resistance training) during the sevens season does seem to predispose to the occurrence of sports injuries. The relationship between injuries and training, at this level of competition, is supported by the statistically significant inverse relationship between the number of training hours during the sevens season and the severity of injuries among second-tier players.

Regarding the top-tier competition, the title is contested by eight teams in three consecutive weekly one-day tournaments (four games played in a day). There are no bye weeks between the tournaments, and the sevens season takes place at the end of a long fifteens season that begins in September and ends in late April. Also, during this period of competition, many players also competed, or were engaged in the preparation of the World Rugby Sevens Series participation of the Portuguese National team. Therefore, it was not a surprise to identify the opposite relationship regarding training loads and injuries at this level of competition. For top-tier players, a higher training volume during the sevens season was associated with a higher occurrence of injuries. Also, a significant correlation was found between training sevens during the fifteens season and the risk of injury at this level of competition.

There is a wealth of relevant work on the relationship between training loads and the occurrence of sports injuries in several sports, especially in team sports. Orchard and Gabbett, in recent years, have published relevant papers that clearly point to a positive relationship between high training loads during a sports season and the occurrence of injuries.[96,97,101,102] On the other hand, Orchard also suggests that inadequate and low levels of training, and not only excessive loads, lead to a greater number of injuries, when compared to the 'hypothetical optimal training load'.[101] Gabbett goes further and suggests the existence of a 'training-injury prevention paradox,' leaving a clear recommendation for practitioners (coaches and health professionals) to monitor the training loads during the season. The same author highly recommends recording acute and chronic training loads, and modelling the acute:chronic workload ratio, as it might be the key to understanding players' state of 'fitness' (ie, net training recovery, lower than average risk of injury) or 'fatigue' (ie, net training stress, higher than average risk of injury).[102] Acknowledging that these papers are highly relevant, we must point out that most data come from elite players and teams of different football codes (e.g., soccer, Australian football, or rugby league), leaving us with two concerns: the lack of data from rugby sevens; the use of high-standard technology to collect data (e.g., heart rate monitors, global positioning systems) not available at lower levels of competition.[102] Therefore, although we believe that the same association will be found for rugby sevens, further studies are needed.

Based on our findings, we present a number of suggestions of changes to the competition formats and relevance of rugby sevens season in the non-elite setting, which include: (i) to avoid the decrease of training volume during the sevens season, and increase the focus on individual preparation of players; (ii) to increase the relative proportion regarding the duration of the sevens and fifteens season, thereby allowing an increase in the number of tournaments played; (iii) to implement bye weeks during the sevens season to allow players' recovery, as happens in Grand Prix Series and World Rugby Sevens Series (where no more than two consecutive tournaments are played); (iv) to increase the duration of the tournaments from one to two days, as occurs in all major sevens events; (v) to decrease the number of games played on the same day; (vi) to implement injury surveillance programmes.

**Conclusions**

We present the first study providing benchmark values for the incidence, severity and risk factors associated with injuries in senior male non-elite rugby sevens. Injury incidence rates were similar but injury severity in the Portuguese competition was lower compared with the available elite international data. As differences were found between the association of training volume and injuries in different levels of the competition, collective and individual loads and preparation for competition should be customized. Also, medical and coach staffs should be made more aware of the high incidence of injuries at this level of competition and the associated risk factors.

We hope to contribute towards the development and implementation of further epidemiological studies at senior male non-elite level in the near future. The methodology used was consistent with consensus statement for studies on rugby union and followed previous injury surveillance studies in rugby. Therefore, we believe that this study can be generalized to different and broader settings. It will be crucial to gather a greater body of evidence on such a relevant topic, to achieve a deeper understanding of the problem. With this knowledge, we hope to accurately formulate future injury prevention protocols or recommend further modifications to the game laws and competition formats, aiming at the promotion of players' welfare.

## 4.2.3. The relationship between trait anxiety and sports injuries in senior male Portuguese rugby sevens players

Considering only the top-level competition (the largest group in this study), the relationship between Sport Anxiety Scale scores and the occurrence of injuries was assessed. A total of 19 time-loss injuries were recorded, and athletes sustaining injuries had significantly higher scores on concentration disruption (p=0.003). In this group, concentration disruption was a significant factor associated with the occurrence of time-loss injuries during the competition, and these findings reinforce the need for all agents involved in the sport to develop and implement effective strategies for the management of precompetitive anxiety among amateur rugby sevens players, aiming at minimizing injury risk.

**Introduction**

Sports injuries are very common and represent a significant burden to athletes, teams and healthcare providers.[17,18,150] Rugby sevens is an increasingly popular variant of Rugby Union recently included in the official Olympic programme.[9] The specific characteristics of this sport, which include intense physical contact and high-speed running,[57,66,69,127] result in very high match injury incidence rates reported at all levels of competition. Recent studies have shown that injury incidence rates in rugby sevens are one of the highest in all collective sports, reaching 108.3 injuries per 1000 player-match-hours.[3,19,32,43,71,143,144,151] Naturally, there are many variables potentially associated with the occurrence of sports injuries,[4,81,82,115,128,152–155] especially in physically demanding sports such as rugby sevens. Many epidemiological studies have been published aiming at their identification.[19,85,89]

A number of studies have considered anxiety as a relevant predictor of sports injuries.[103–108] Still no data are available regarding the association between pre-competitive levels of anxiety among senior male rugby sevens players and the occurrence of injuries. However, one study by Lavallée and Flint (1996) attempted to identify the association between several psychological factors and injuries in rugby union.[109] Although this was a small study, assessing only 13 rugby union players and using the Sport Competition Anxiety Test,[110] the authors were able to conclude that injury frequency was related to anxiety.[109]

When considering research on anxiety in the context of sport competition, the relevant differences between trait and state anxiety must be acknowledged.[111] In fact, state anxiety does not seem to have a clear effect on sports injuries,[111,112] while trait anxiety appears to be of the utmost importance to sports injuries.[111] Several studies attempted to assess a hypothetical direct relationship between pre-competitive anxiety and injuries in different sports, and many have been able to demonstrate such association.[111–114,156] . Several authors have put forward the same explanation for the correlation between trait anxiety and injury risk. These authors suggest that it is likely that some personality traits, such as anxiety, may

increase the "likelihood that an individual will appraise a situation as threatening, thereby increasing the physiological stress response and the subsequent likelihood of injury".[103]

The assessment of athletes' anxiety can be performed using validated tools such as the Sport Anxiety Scale,[105] which is a multidimensional measure of trait anxiety and was designed to measure individual differences in cognitive (worry and concentration disruption) and somatic anxiety experienced by athletes. The Sport Anxiety Scale has already been translated and validated for the Portuguese population, and has been used in similar studies.[105]

The aim of this study is to correlate the trait of anxiety with the occurrence of sports injuries in a group of athletes competing in the 2015/16 top-tier Portuguese National Rugby Sevens tournaments. We hypothesize that trait anxiety is associated with injury occurrence in rugby sevens.

**Methods**

Ethical approval was obtained from the Ethics Committee of the local Regional Health Administration and institutional collaboration was granted by the Portuguese Rugby Union.

An observational field study to ascertain the injury incidence rate in the top-tier of the Portuguese National Rugby Sevens championship was prospectively assessed during the tournaments held in the 2015/16 season. Eight teams competed in three consecutive weeks, between May and June 2016, in three one-day tournaments played in different venues.

Prior to the beginning of the tournaments and after obtaining informed consent, all athletes were asked to self-fulfil the Portuguese version of the Sport Anxiety Scale questionnaire.[105] Previous validation studies of the Portuguese version of the SAS confirmed its factorial structure, and demonstrated adequate psychometric characteristics, with Cronbach's α of 0.72, 0.88 and 0.88 in the subscales of worry, concentration disruption and somatic anxiety, respectively.[104] This scale is a multidimensional measure of trait anxiety. It is composed of 21 items, subdivided into: somatic anxiety (9 questions); worry (7 questions) and concentration disruption (5 questions). Athletes rate how they feel from "not at all"(1) to "very much so"(4) [105]. Thus, results in each subscale range from 9 to 36 in "somatic anxiety"; 7 to 28 in "worry"; 5 to 20 in "concentration disruption".

Data regarding players' age, experience in rugby sevens, weight and height were also collected. The same data were also collected for players who did not fill in the questionnaire. Injury data were collected using a specific report instrument, in accordance with the consensus statement on injury definitions and data collection procedures in studies of injuries in Rugby Union.[41] Time-loss injury was defined as any physical complaint sustained by a player during a rugby sevens match that prevented the player from taking a full part in training and/or match play for more than one day following the day of injury.[1] Any injury event was reported by the teams' medical staff or identified by one of the researchers present at the event.

Athletes' data are presented as mean (± standard deviation). Mann-Whitney U test was used to investigate potential differences between the groups of injured and non-injured athletes on the questionnaire used (Sport Anxiety Scale). Effect sizes were calculated. Correlation between the Sport Anxiety Scale scores and rugby sevens' experience was assessed using Spearman correlation coefficient. Level of significance was set at $p<0.05$. Statistical analysis was performed using SPSS software (version 22.0 for Windows, IBM Corp, Armonk, New York, USA).

**Results**

One hundred and forty two athletes participated in the Circuit, with ages ranging from 17 to 38 years, with an average of 22.27 years (±4.09). As shown on table 18, average athlete's height was 181.23 cm (±6.62), and average weight was 88.83 kg (±12.75). Regarding their experience in the sevens variant of rugby union, an average of 5.75 (±3.52) years was recorded. Data from players that did not respond to the questionnaire were sparse. Only six players provided information on their experience in rugby sevens and thirteen on height and weight. The average experience reported for this group of players was 11.67 (±5.35) years. They were also older (23.5, ± 3.52 years), taller (184.85 ± 7.21 cm) and heavier (96.85 ± 8.75 kg) than the average.

During the three tournaments, 48 matches were played and a total of 19 time-loss injuries were identified. All injuries were sustained by different players.

From the 142 athletes participating in the competition, 102 (72%) completed the Sport Anxiety Scale questionnaire prior to the beginning of the tournaments.

The scores regarding each subscale of the Sport Anxiety Scale test were distinct. With regard to the "somatic anxiety" subscale, with a possible score from 9 to 36, a mean of 14.89 (± 4.09) was recorded. For the "worry" subscale, an average of 14.56 (± 4.19) points was calculated (scores from 7 to 28). As for "concentration disruption", with a maximum score of 20, an average of 8.22 (± 2.56) points was obtained.

We then compared scores obtained by injured and non-injured players. Injured athletes scored significantly higher in "concentration disruption", with a medium effect size (0.29) as shown on table 19.

The association between athletes' experience and the scores in each subscale of the questionnaire was also assessed. No statistically significant correlation was found between players' experience and somatic anxiety ($p= 0.098$), worry ($p= 0.658$) or concentration disruption ($p= 0.216$).

**Table 18.** Characteristics of the players

| | Minimum | Maximum | Mean | Standard Deviation |
|---|---|---|---|---|
| Age | 17 | 38 | 22.27 | 4.09 |
| Height (cm) | 165 | 200 | 181.23 | 6.62 |
| Weight (kg) | 61 | 120 | 88.83 | 12.74 |
| Experience in sevens | 0 | 21 | 5.75 | 3.52 |

Legend: cm – centimetres; kg – kilograms.

**Table 19.** Test scores and injuries: statistical analysis

| | | Injured | Non-Injured | Mann-Whitney U test | | |
|---|---|---|---|---|---|---|
| | n | Mean Rank | Mean Rank | *p* | Z | Effect Size* |
| Anxiety | 102 | 54,22 | 50,99 | 0.688 | -0.402 | 0.06 |
| Worry | 102 | 54,81 | 50,88 | 0.625 | -0.489 | 0.08 |
| Concentration Dirsuption | 102 | 71,69 | 47,74 | 0.003 | -2.998 | 0.29 |

Legend: * - Effect size: Z/Squared root (n)

**Discussion**

The results of this study suggest that athletes with higher scores on the subscale "concentration disruption" of the Sports Anxiety Scale were more prone to sustaining injuries during a rugby sevens tournament. However, no significant correlations were observed between "somatic anxiety" or "worry" scores and the occurrence of an injury throughout the competition.

As discussed before, extensive literature assessing the association between many psychological aspects and characteristics and the risk of injury in other sports, such as American football, soccer or running is available.[103,104,106,157]

According to Johnson and Ivarsson (2011), anxiety in the form of personality disposition is one of the main traits that can predict the occurrence of injuries.[106] Higher levels of anxiety may lead the athlete to appraise a situation as threatening, thereby increasing the physiological stress response and the subsequent likelihood of injury.[103] Kerr and Fowler (1988),[106,158] reported that athletes with high levels of cognitive anxiety experienced lower levels of concentration and attention, and in the following years many authors were able to find a positive relationship between sport injuries and cognitive anxiety.[111–114,156]

However, conflicting data exist, and previous studies carried out in American football, soccer and running athletes failed to clearly demonstrate that personality traits (such as anxiety) play a relevant role in predicting sports injuries.[111,159] Yang et al (2014) showed in a cohort of American football players that anxiety (as personality trait), unlike depression, could be protective. In that study, the number of injuries sustained by athletes reporting symptoms of anxiety was lower than those reporting depression.[159]

Some authors, as Junge (2000) suggest that anxiety, as a personality trait, does not have a direct impact on the occurrence of injuries. However, the opposite is likely with regard to competitive anxiety as a state.[111] The experience of cognitive anxiety prior to competition could be directly associated with the athletes' roles and performance on field and therefore constrain the athletes' ability to avoid injury prone situations.[111]

Nevertheless, it is important to stress that despite the difficulty in comparing the results of the various available studies, because of the different methodologies that have been used, context-dependent emotional states (such as cognitive anxiety) seem to have an effect on an athlete's risk of injury.[111]

To the best of our knowledge, our work represents the first ever assessment of trait anxiety in rugby sevens players, in Portugal. Previous studies investigated anxiety among athletes in many sports, such as American football, soccer, track and field, basketball and one even included 15-a-side rugby union athletes, but none have ever been conducted in rugby sevens.[109,111]

In the present study, although both cognitive and somatic anxiety scores were higher among injured players, only concentration disruption was significantly different between injured and non-injured athletes. Nevertheless, injured athletes scored higher on all items, thereby showing the relevance of anxiety as a factor associated with the occurrence of injuries.

Our findings are in accordance with the reports of Lavallée and Flint (1996) and suggest that the focus of all rugby agents should be on the management of anxiety. Injuries represent a significant burden to athletes, coaches and organizations and all attempts to identify risk factors, and active intervention aiming at its reduction are welcome. Therefore, it should be a major concern to academics in the field of sports science. In rugby union, World Rugby (the governing body of the sport) is very active and directly sponsors educational initiatives and academic studies aiming at the promotion of players' safety.[52,145]

As the Sport Anxiety Scale questionnaire can be performed prior to the competition, we believe that this is a useful tool to identify athletes that might be at higher risk of injury and actively intervene in order to implement effective coping strategies. In this effort all agents might play a role. The coaching staff, team physicians and physiotherapists but especially sports psychologists and mental coaches may have an important role to play. Many coping strategies have been assessed in previous reports, but more studies are needed to clarify recommendations on the type of interventions to be implemented.[105,160] Edvarsson et al(2012) reported that despite not reaching statistical significance a cognitive-behavioural biofeedback intervention was useful to reduce injuries in a group of junior football (soccer) players. These interventions included teaching of self-regulation techniques such as abdominal breeding, somatic relaxation or thought stopping and gradual presentation to environments similar to the training and competition settings, simulating real competitive atmosphere.[160]

Although we highlight the need for future studies to definitely recommend this type of interventions, it becomes clear that cognitive-behavioural biofeedback approaches might be

useful in controlling or reducing anxiety. Pusenjak et al. (2015) even concluded that this type of interventions might enhance athletes' performance.[161]

We suggest that both coaches and teams' medical staffs should work together, aiming at the early identification of athletes at risk, by routinely applying validated psychometric questionnaires such as the Sport Anxiety Scale. Following the identification of these athletes, a structured intervention, using cognitive-behavioural biofeedback in association with other intervention methods, should be planned in an attempt to reduce the risk of injury.

**Limitations**

In what respects limitations of the present study one must emphasize that it was conducted during only a single season in only one country with the population limited to the number of competing athletes. We attempted to minimize this shortage limitation by including all athletes competing in the Circuit. However, only a sample of 72% of all athletes accepted to participate. In future studies sample sizes can be enlarged by including more competitions and/or more seasons.

In addition, in our study, each variable was assessed individually, and no multivariate models were employed. Thus, there is still a lack of knowledge concerning the interaction of the different factors involved.

Our aim was to assess the correlation between trait anxiety and the occurrence of injuries. To study this we only used one psychometric test, unlike some previous studies. However, the identification of athletes' coping strategies and resources should be considered in future research as it will help the drawing and planning of a possible and relevant intervention.

It is also important to mention the differences regarding the number of years of experience in rugby sevens of the athletes that completed and those that did not complete the questionnaire. As the latter were older and more experienced, we can speculate that the average scores of the Sport Anxiety Scale would be different, if they had accepted to participate. However, as the number of athletes that reported their sevens experience, but did not respond to the questionnaire, was small (n= 6), compared to those included in our study who filled all the required data (n= 102), we believe that their inclusion would not change our results.

**Conclusions**

In this group of Portuguese rugby sevens athletes "concentration disruption" was a significant factor associated of the occurrence of time-loss injuries. These findings reinforce the need for all rugby sevens' agents to develop and implement effective strategies to manage anxiety among rugby sevens players, in order to reduce injury risk.

## 4.3. Conference "I Jornadas Médico-Desportivas do Rugby"

The scheduled conference took place on the date and venue previously selected. The programme of the conference was fulfilled. A significant number of agents expressed their will to join the event and many indeed actively participated in the works conducted. Parts of the conference outcome and main findings were published in the opinion article entitled "Promoting players' safety and welfare through the sharing of scientific knowledge with sports agents: the new reality of Portuguese rugby sevens" (corresponding to the final phase of this thesis; see subchapter *4.4. Relevant findings and recommendations*).

In the present subchapter we present the most relevant data from the assessment of the level of acceptability of the suggestions made following the presentation and discussions of the results of the second phase of the study.

**Methods**

A total of 67 participants were present during the conference. The large majority of the participants (52, 78%) were rugby agents (either athletes, coaches, directors, referees, physiotherapists or doctors). The remaining group consisted of healthcare professionals and students of healthcare degrees (Medicine, Physiotherapy and Nursing).

From the 52 agents, 35 returned the questionnaires fully filled, and their feedback with regard to the findings of the study and suggestions to mitigate the burden of injuries (see Discussion of *4.2.2. Epidemiology of injuries in senior male Portuguese rugby union sevens: a cohort prospective study*) was assessed using the methodology presented in the subchapter *3.3. Third Phase*.

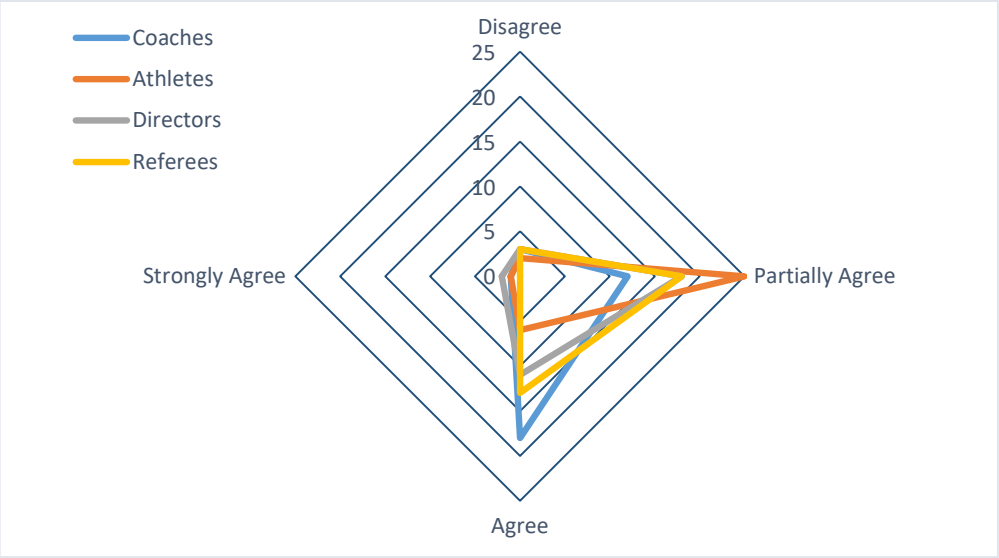
**Results**

As previously mentioned, 35 of the 52 participants that were rugby agents returned the questionnaires used to assess their feedback and the level of agreement/disagreement with some suggestions made aiming at the mitigation of sports injuries in Portuguese rugby. The questionnaire design and the questions/suggestions made were already presented in the subchapter *3.3.5. Assessment of agents' feedback*).

The first four questions concerned the agreement on the level of knowledge of coaches, players, directors and referees regarding injury prevention in rugby seven. As we can see in graph 3, most respondents considered that the knowledge regarding injury prevention in rugby sevens was not very high, irrespectively of the professional groups (athletes, coaches, directors, referrers). Participants considered that the group with the lowest level of knowledge was the athletes, followed by the directors, while the opposite was recorded for coaches (56% of the

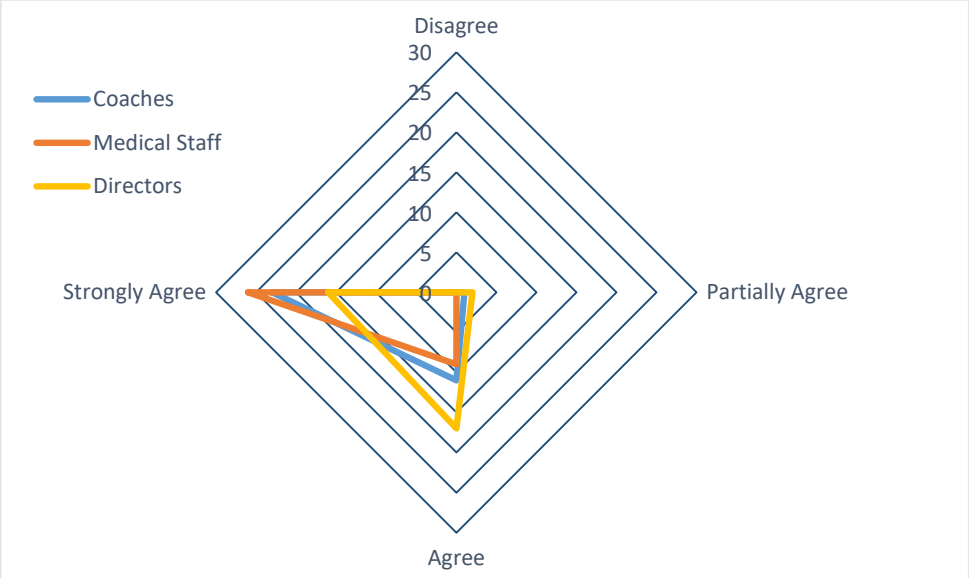
valid answers agreed that coaches' knowledge was sufficient). Regarding the relevance of sports injuries burden in rugby sevens for the sport and for the individual agent (e.g. athlete, coach, directors) all respondents (100%) agreed that this was a highly relevant topic (42% agreed and 58% strongly agreed).

**Graph 3**. Level of knowledge regarding injuries is sufficient among rugby agents




For the role of medical staff, directors and coaches in the prevention of sports injuries, results were quite different, as shown in graph 4. The overwhelming majority of participants considered the role of each of the agents in the prevention of sports injuries to be critical and valuable.

**Graph 4.** Agents' role in injury prevention



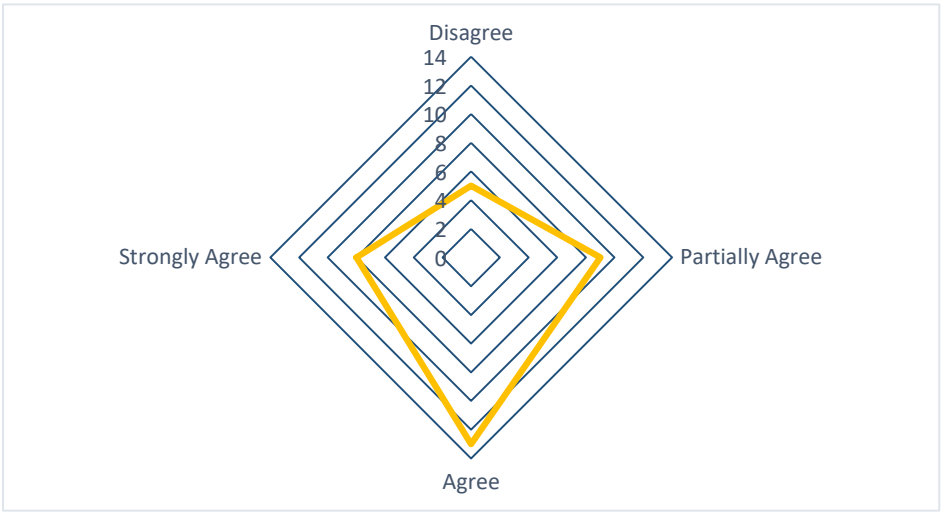
The following ten questions were related to the preparation of the sevens season and the current competitive format, as well as the assessment of the agents' level of agreement regarding some suggestions of modifications to competition formats and athletes' preparation.

Sixty percent of the respondents regarded a clear separation between the fifteens and the sevens season as necessary, which seems to partially contradict the same recommendation made by 50% of the participants that the rugby sevens season should take place throughout the year (graphs 5 and 6). We acknowledge, nevertheless, that some of the respondents could consider that a total separation between athletes who compete in rugby sevens and rugby fifteens should exist, which might account for the suggestion of simultaneous competitions being played in parallel. That is something that, at the moment, is not a reality among Portuguese rugby players.

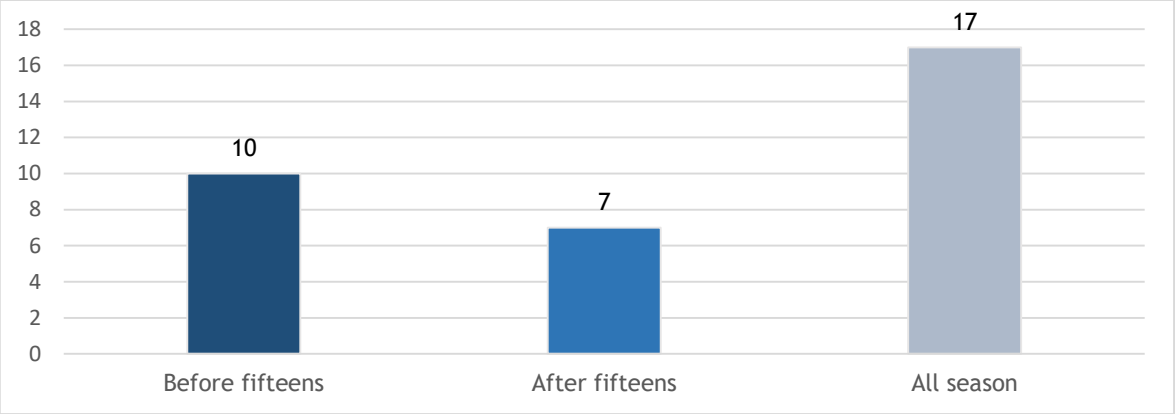
This difference of opinion indicates that a more in-depth debate on whether it is feasible, in view of the small number of athletes at national level, to work towards separating competitions and players of both variants.

Regarding the format of the competitions, it is also important to stress that only a small minority (20%) of sports agents preferred maintaining the current competitive period at the end of the fifteens season. Finally, when asked about athletes' preparation, 65.7% disagree with the concept of a decrease in training loads during the sevens season.

**Graph 5.** Level of agreement regarding the need to separate sevens from fifteens season

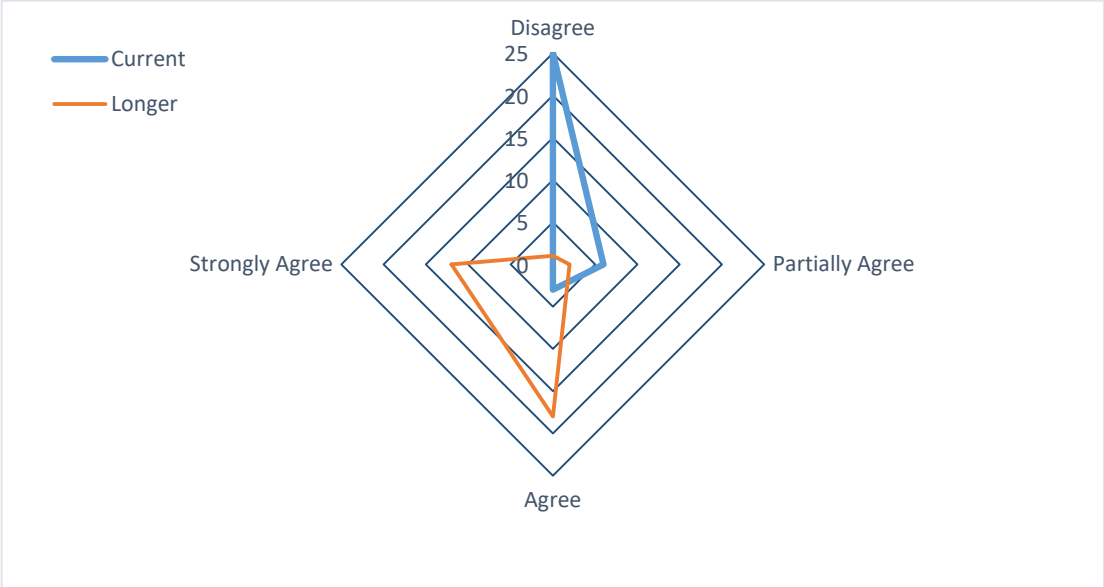


**Graph 6.** Preferred dates for the sevens competition




As for the competition formats, most of the respondents considered that they do not fit the needs or reality of Portuguese rugby. Overall, 68.75% of participants disagreed with the season length, while 20% only partially agreed. On the other hand, 88.6% agreed or strongly agreed that sevens season should be longer (graph 7).

**Graph 7**. Length of sevens season



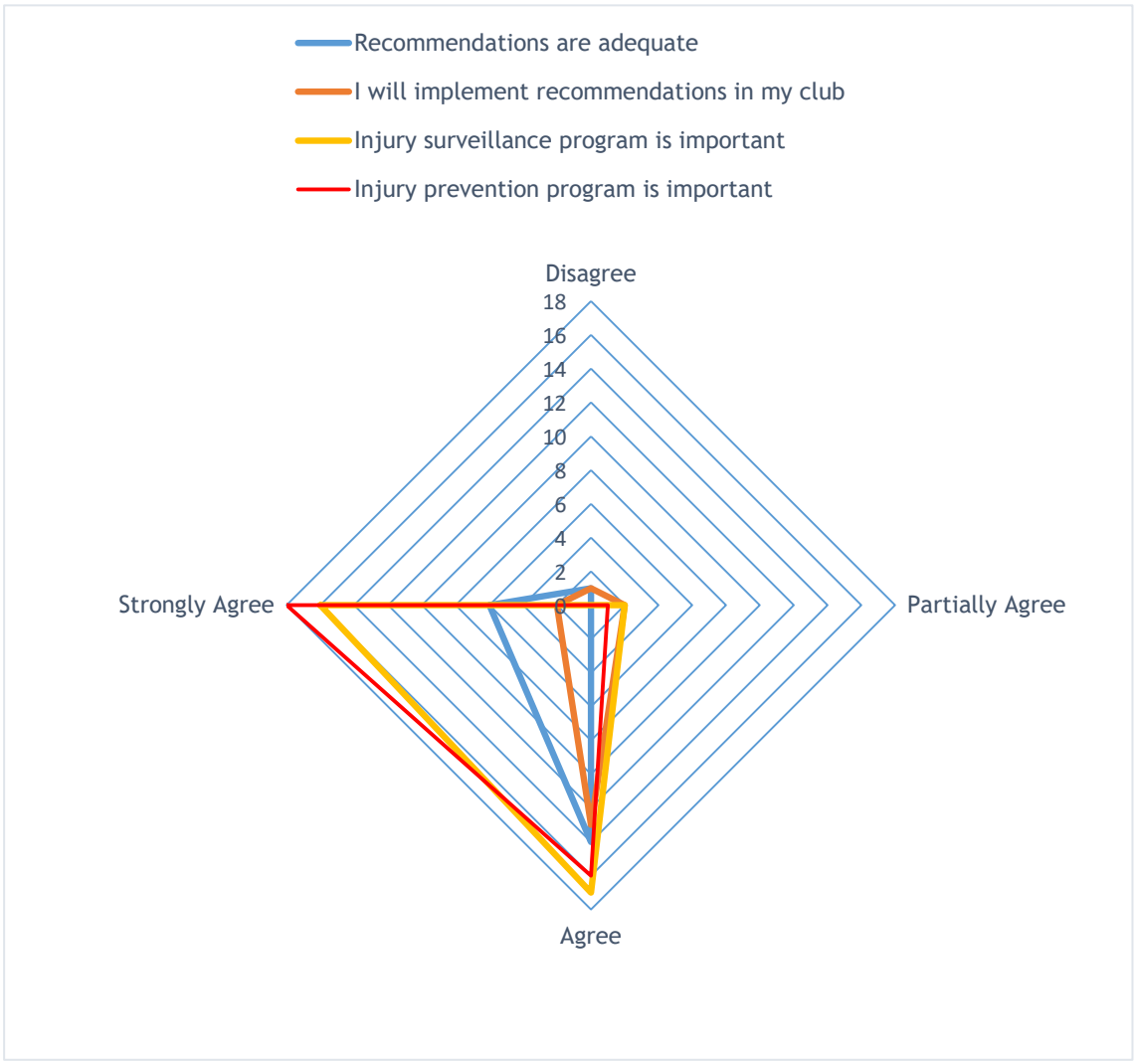

Likewise, 91% of the participants agreed with the need of a larger number of tournaments during the sevens season, with a slight majority (51%) agreeing or strongly agreeing on the need to lower the number of matches played each day. On the other hand, 77% agreed or strongly agreed that tournaments should be played in two days and not just in one day, while 71% also agreed with paired tournaments played on consecutive weeks with at least one bye weekend between them.

When the reduction of the field size was suggested as a strategy aiming at the mitigation of injuries, 80% of the respondents stated that they disagreed with it.

Four questions, regarding the recommendations presented at the conference and the need to monitor sports injuries in Portuguese rugby were asked. A total of 95% of the respondents agreed with the recommendations made, but only 81% agreed or strongly agreed with the possibility of implementing them at their own clubs.

Concerning the need for an institutional programme aiming at the prevention of sports injuries, 97% of the participants agreed (or strongly agreed) with it. Concerning the need to implement an injury surveillance program of sports injuries in rugby sevens, 94% of the participants also agreed (or strongly agreed) (graph 8).

**Graph 8.** Assessment of agents' level of agreement with the recommendations made



**Discussion**

Considering the study design, the discussion of this subchapter is conducted along with the next subchapter (4.4. Relevant findings and recommendations) which led to the publication of an opinion article entitled *"Promoting players' safety and welfare through the sharing of scientific knowledge with sports agents: the new reality of Portuguese rugby sevens."*

Feedback and relevant data obtained from the agents' replies to the questionnaires was critically analyzed and integrated with the findings from the previous phases of the study to draft a set of valuable recommendations aiming at reducing the incidence rate of sports injuries in rugby sevens and promoting the safety of athletes.

## 4.4. Relevant findings and recommendations

This last subchapter of the results represents the culmination of all the work conducted by the research team. As initially planned, in this phase of the study data obtained since the beginning were collected, analysed and two separate documents were written and presented. The first one, a summary of relevant findings and recommendations aiming at the mitigation of sports injuries in Portuguese rugby was sent to the Portuguese Union (Appendix E), following the "I Jornadas Médico-Desportivas do Rugby" Conference. The second one was an opinion article published as an editorial of *Physician and Sportsmedicine*, where we discuss the role and the need for Universities to step into the sports 'real world' and attempt to make a positive impact upon the lives of athletes.

Citation: Cruz-Ferreira AM, Cruz-Ferreira EM, Santiago LM, Taborda-Barata L. Promoting players' safety and welfare through the sharing of scientific knowledge with sports agents: the new reality of Portuguese rugby sevens. Phys Sportsmed. 2017 Oct 5:1-2. doi: 10.1080/00913847.2017.1386067. (Permission to reproduce granted from the Journal [http://www.tandfonline.com]. This is the authors accepted manuscript of an article published as the version of record in The Physician and Sportsmedicine © 5th October 2017 https://doi.org/10.1080/00913847.2017.1386067 [Appendix B3])

As the authors of the recently published article 'Epidemiology of injuries in senior male rugby union sevens: a systematic review',[3] we would like to share with you its impact on the Portuguese rugby community and our achievements since then.

As we stated in the article, we believe that the medical staff and all other agents (athletes, coaches, and researchers) must work together aiming at creating a safer environment in a sport with such a high injury incidence rate. We also reported that few data were available regarding injuries in non-elite rugby sevens and that more studies were needed in order to broaden current knowledge.

Following the publication of our article, we were granted the support from the board and the medical department of the Portuguese Rugby Union to hold a Medical Conference to present our research on rugby sports medicine, which took place in Portugal on the 10th of June 2017.[162]

In this scientific event, we were able to sit on the same stage athletes, coaches, directors, physiotherapists, doctors, and researchers from different parts of the country with the single purpose of debating the need to focus on the epidemiology of sevens injuries and the pathways to a deeper knowledge and mitigation of the problem. During the meeting two relevant pieces of data were presented, followed by a rich discussion: the systematic review that we have

published in *The Physician and Sports Medicine*; a set of data collected in the 2015/16 season of the Portuguese National Rugby Sevens Championship by the same authors.

Although data from the systematic review had already been published, it still made a significant impact on the delegates, especially on the members of the Rugby Union that agreed on the need for further studies and research. The data from the study conducted during the national championship, which revealed an overall injury incidence rate of 133.9 injuries per 1000 player match-hours caused significant concern and a long discussion. These figures are much higher than those reported by López et al.[43] for amateur rugby competitions, but more surprisingly, are higher than those reported for international elite sevens.[3] A deeper analysis of the data allowed the authors to present the 'Portuguese paradox,' where the injury incidence rate for the group of athletes playing in the lower division was higher (197) than of those in the top division (118 injuries per 1000 player match-hours), unlike what was previously reported for sevens and fifteens Rugby. However, injury severity was inversely related, with top-tier athletes' average severity being similar to that in athletes at elite level (28 days per injury) unlike the injuries of bottom-tier athletes (8.63 days). No other relevant differences were found in our data compared to the literature.

We tried to deepen our analysis by collecting data regarding competition formats, athletes' experience, age, height, weight, training load, and warm-up and to relate it to the occurrence of injuries in those athletes.

The bottom-tier was contested by seven teams playing in a single 1-day event, 6 weeks after the end of the fifteens season. A direct association between the occurrence of injuries and the decrease in the volume of training (especially resistance training) was identified, as well as an inverse relation between the number of training hours during the sevens season and the severity of injuries.

In the top-tier, contested by eight teams in three consecutive weekly 1-day tournaments (four games played in a day), the opposite relationship regarding training loads and injuries was identified: a higher training volume during the sevens season was associated with a higher occurrence of injuries. Players who trained sevens and fifteens simultaneously during the year presented a significant increase in the risk of injury.

Based on our findings, we presented a number of suggestions of changes to the competition formats and relevance of rugby sevens season in the Portuguese setting, which included:

1 – avoiding the decrease of training volume during the sevens season, and increasing the focus on individual preparation of athletes;

2 – highlighting the relevance of rugby sevens to the sport and its promotion by increasing the duration of the season and the number of tournaments;

3 – implementing bye weeks during the season to allow players' recovery;

4 – increasing the duration of the tournaments from 1–2 days, as occurs in all major sevens events;

5 – decreasing the number of games played on the same day;

6 – implementing an injury surveillance project in Portuguese rugby sevens competitions.

The level of acceptance of our recommendations was then assessed by an anonymous questionnaire, following its presentation. We were surprised to acknowledge that 95% of the participants agreed with our recommendations and 81% clearly stated that they will implement them at their own clubs. Regarding the need for an injury surveillance programme there was a 94% agreement.

Following this meeting, the authors received an invitation to present a brief report of the conference and a summary of the recommendations to the Board of the Portuguese Rugby Union for their consideration. The authors were also granted the authorization and official support of the Union to implement two injury surveillance programmes in Portuguese rugby next season: one on rugby sevens and one on fifteens.

We believe that the chain of events that we are reporting now was triggered by the publication of the systematic review in your Journal, and we are thankful for the enthusiastic support of the Editorial Board. In addition, the possibility of establishing strong and effective bridges of communication with all agents and with the national rugby governing body allowed us to make our message effective in this audience, who is able to relate the reported data with their own reality. We strongly believe that in order to implement changes in the real world, academics must leave their offices and connect with agents on the field and with those who regulate the object of the study.

Although we agree that the real impact of our recommendations will only be assessed by future studies, the first goal of our work was achieved: to use scientific evidence aiming at promoting players' safety and welfare in Portuguese rugby sevens.

It is our hope that the testimony presented here helps other researchers to believe in the impact of these types of interventions, and similar studies will take place in other countries.

# Chapter Five: Discussion and final conclusions

# 5. Discussion and validation of hypotheses

Given the format of presentation of the present study, most of the discussion and conclusions of this thesis have already been presented as part of the articles published. It is, nevertheless, extremely important to summarize and highlight the most relevant findings and their discussion.

The first ever systematic review on the epidemiology of injuries in senior male rugby sevens was conducted as part of the first phase of this thesis. For the first time, accurate data on the incidence rate, severity, type and location of injuries as well as their association with contact events have been published. These data included mostly studies from elite level competitions, thus strengthening the need for data on amateur (or non-elite) competitions.

Incidence rates in rugby sevens were found to be higher than in the fifteens variant. That was an expected outcome, as that was precisely one of the hypotheses that triggered this research. Not only were the incidence rates high, but also the severity of injuries in this variant was found to be higher than in fifteens rugby union. With regard to all the remaining aspects of injuries, such as location, type or event, the systematic review confirmed no differences between both major variants of rugby union.

Being such a relevant burden for athletes and clubs of a sport with such good implementation in Portugal, and considering the sparsity of data regarding injuries (but also regarding the players' profile) in Portuguese rugby sevens, a cohort prospective study during a sports season was designed and implemented. It was aimed at determining the incidence rate of injuries in the two top-tiers of the Portuguese senior male sevens circuit, characterizing them and identifying associated factors.

The cohort prospective study was performed during the 2015/16 season and led to the publication of an article were all data were presented. This study confirmed all the hypotheses formulated, thus strengthening the pertinence, but also the quality of methodology of this research.

Injury incidence rate in Portuguese senior male rugby sevens is higher than the previously reported for non-elite competitions. In fact, for the Portuguese competitions, an injury incidence rate paradox, with higher rates reported for the lower tiers of competitions was

noticed and explanations presented. It was already discussed that in the second-tier, sevens competition was contested by seven teams that played in a single 1-day event, 6 weeks after the end of the fifteens season. We also reported that the number of hours of training for these players was lower than the reported for the top-tier. An additional decrease in the number of hours of training (both gym and field training) was found for the first group, during the sevens season. And if all these factors were not sufficient to attempt an explanation for the findings reported, a direct association between the occurrence of injuries and the decrease in the volume of training (especially resistance training) was identified. Therefore, for the bottom tier, injury incidence rates could be explained by the low levels of preparation for the competition, in a sport with such a number of high-speed running, turning manoeuvers and contact events such as rugby sevens. Continuing the analysis of the relationship between training loads and types and their association with the occurrence of injuries, for the same level of competition, an inverse relationship was observed between training load and the severity of injuries, thereby alerting to the risk of players reducing their level of preparation for the sevens season (or even the lack of preparation at this level of play).

For the top-tier, injury incidence rates and severity were closer to those reported for elite level competitions. Naturally, we must stress that some Portuguese athletes compete at international level in rugby sevens, and the 2015/16 was the last season of the national participation as a core team in the World Rugby Sevens Series. Also, the anthropometric profile of the Portuguese top players did not differ significantly from that of athletes competing in the World Rugby Sevens Series, so it is possible to anticipate that high speed running and contact events with the opponents might generate similar impacts to those at elite level, thus leading to significant transfers of energies between players.

Nevertheless, with the exception of the small group of players also engaged in the preparation of the national team, the majority of the cohort (if not all) are amateur and their level of commitment to the sport cannot be compared with that of the group of players competing the whole season in the Sevens Season. We acknowledged, however, this as limitation of our study: the heterogeneity of the cohort. Irrespectively of this limitation, the number and incidence rates identified for the top-tier level of Portuguese rugby, confirmed the relevance of the problem and the burden of sports injuries for Portuguese athletes and clubs.

Unlike the bottom-tier, in the top-tier, sevens competition is contested by eight teams in three consecutive weekly 1-day tournaments (four games played in a day), at the end of a long fifteens season, where many of the athletes were also engaged in international activities with the national team. In this group, the opposite relationship regarding training loads and injuries was identified: a higher training load during the sevens season was associated with a higher occurrence of injuries. Also, players who trained sevens and fifteens simultaneously during the year presented a significant increase in the risk of injury. These data point to a relationship between fatigue as well as excessive training loads and the occurrence of sports injuries, thus reinforcing the need to accurately manage the individual preparation and exposure to

competition of the Portuguese sevens players. However, no relationship was found between training loads and the severity of injuries at the top-tier of competition. Further studies aimed at assessing the training loads, but also the physical demands and movement patterns during the match and their relationship with the occurrence of sports injuries, will be paramount to deepen the knowledge regarding injuries and risk factors in Portuguese rugby sevens.

To describe the type and location of injury, as well as the period of the game, the event that leads to injury and the players' position, was one of the aims of this study. The results were consistent with the previous reports for the elite level, and no differences were found between tiers of competition in Portugal. As we hypothesized, lower limb injuries and joint/ligament were the most frequent ones. Also, most injuries occurred in the second half and the distribution per playing position followed the 3:4 ratio of players on the field (3 forwards and 4 backs, so 57% of players are backs and these accounted for 59% of injured players).

Compared to the sparse data available, injury type and location in Portuguese sevens (for both tiers of competition analysed) was different from previous reports from non-elite tournaments. These findings reinforce the similarity of the Portuguese rugby sevens circuit to elite competitions, in terms of injury incidence, type and location, but also to the level and intensity of play, compared to an absolute amateur level. Again, further studies will help to determine the demands of the Portuguese competition and better assess the level of play, thus helping to customize the preparation of athletes and teams for the event.

One of the research questions suggested the existence of factors associated with the occurrence of injuries in Portuguese senior male rugby sevens. We already identified and discussed the role of training loads and type of training in the occurrence of injuries for both tiers, but one other relevant finding of our study was the association between anxiety and the occurrence of injuries. Specifically, using the *Sport Anxiety Scale* test scores, we were able to identify, for the top-tier group, an association between higher scores on the subscale "concentration disruption" score and the occurrence of injuries. No significant differences were found for the other subscales, despite the higher scores identified for injured players. As this was the first study ever conducted in rugby sevens that assessed the level of anxiety and its association with sports injuries, no external validation of our findings was possible. However, it is important to stress, as done before, that anxiety (both trait and state) have been identified as potential risk factors for injuries, although data are ambiguous.

Again, we recommend the need to consider and prepare athletes for this dimension of the sport as part of the individual and collective training plan. The implementation of specific measures such as the training, simulation and exposure to scenarios emulating competition, aiming at the management of anxiety among rugby players, could be relevant and have an impact on the levels of precompetitive anxiety of athletes.

All these data allowed us to confirm the existence and identify several factors associated with the occurrence of sports injuries in Portuguese senior male rugby sevens, thus answering one of the research questions formulated.

As a result of the cohort prospective study and the analysis of data conducted, we made a number of recommendations aiming at the mitigation of the injury burden in Portuguese rugby sevens, that we already presented in the text. Again, they included:

1- avoiding the decrease of training volume during the sevens season, and increasing the focus on individual preparation of players;

2- increasing the relative proportion regarding the duration of the sevens and fifteens season, thereby allowing an increase in the number of tournaments played;

3- implementing bye weeks during the sevens season to allow players' recovery, as happens in Grand Prix Series and World Rugby Sevens Series (where no more than two consecutive tournaments are played);

4- increasing the duration of the tournaments from one to two days, as occurs in all major sevens events;

5- decreasing the number of games played on the same day;

6- implementing injury surveillance programs in Portuguese rugby.

If the determination of the injury incidence rate in Portuguese senior male rugby sevens competitions, the identification of factors associated with its occurrence, and the draft and presentation of suggestions aiming at its mitigation is possible using science and analyzing data, the change of the *status quo* demands further action. To ensure the implementation of these recommendations in the *"real world"* of Portuguese rugby sevens, agents (athletes, coaches, directors and medical staff) must understand the reasons and the scope of the intervention. So, we believed it would be crucial to hold a conference and discuss our study findings and suggestions during that event, followed by an assessment of the level of acceptability of those recommendations. Thankfully, most of the measures were considered relevant by the agents present at the conference and a high percentage said they will implement them at their clubs. Irrespectively of the relevance of these findings, and the confirmation of our hypothesis that rugby agents were open to discuss and accept changes to their practice aiming at the mitigation of injuries in sevens, further studies will be needed, not only to assess the impact of these recommendations, but also the level of their implementation in the clubs and in the competitions. Naturally, only after the analysis of data from future research will it be possible to understand the impact and the adequacy of our suggestions.

With regard to the positive feedback shown by the Portuguese Rugby Union, the possibility of further cooperation between the governing body and researchers in the field of sports medicine and sports science will lead to the improvement of players' safety and welfare. The openness, support and positive attitude demonstrated by the Union towards further research under their auspices confirms the relevance and impact of the findings and suggestions of this study. These future studies will be paramount to understand if the recommendations made can lead to improvements in players' welfare in Portuguese rugby, regarding the incidence but also the severity of injuries.

In summary, and answering the last of the research questions, rugby agents were open to listening and gave us the opportunity to present our findings and recommendations. They also assessed and accepted our suggestions aiming at the mitigation of the burden of injuries in rugby sevens, and the same positive feedback was shown by the Union.

Finally, although we agree that the real impact of this effort will only be assessed by future studies, the main goal of this project was achieved and scientific evidence was used aiming at the promotion of players' safety and welfare in Portuguese senior male rugby sevens.

## 5.1. Final conclusions

A systematic review of the literature in the epidemiology of injuries in rugby sevens was conducted and it was found that incidence rate in this variant is higher than in rugby fifteens and injuries are more severe.

In the Portuguese competition, injury incidence rate is very high, similar to that previously reported for elite competitions, despite being less severe. The type, location, period and event leading to the injury are consistent with previous reports for elite rugby. Most injuries occur in the lower limb and are of the joint/ligament or muscle/tendon type. They also occur more frequently in the second half of games and after contact events, especially after tackle.

Despite being an non-elite competition, in the 2015/16 season the Portuguese circuit was played by a heterogeneous group of players, consisting of a large group of amateur 'national level' athletes but also some international players engaged in regular competition in the World Rugby Sevens Series and the European Grand Prix Series. This was reflected in the different training loads reported, which were also associated with the occurrence of injuries.

Briefly, an association between injuries and lower volume of training during the sevens season was identified for the second-tier. For the same level, an inverse relation between training hours and injury severity was also found. And for the top-tier players engaged in specific sevens training simultaneously with the fifteens preparation during the year, a significant increase of injury risk was identified.

A more thorough analysis of the data allowed the identification of the 'Portuguese paradox,' where the injury incidence rate for the group of athletes playing in the bottom-tier was higher than of that of those players in the top-tier, unlike what was previously reported for sevens and fifteens. However, injury severity was inversely related. These seem to be a reflection of the lack of preparation from athletes in the lower levels of competition.

Following the assessment of injury incidence rate, severity and the identification of factors associated with the burden of sports injuries in Portuguese rugby evens, a series of recommendations were made and accepted by agents and the governing body of the sport. These recommendations include changes in the competition formats, but also in the individual and collective preparation of the sevens season, targeting the role of several agents (directors, coaches, athletes and medical staff) that need to be actively engaged.

Considering the sparsity of data available regarding non-elite rugby sevens, further studies at this level of competition are needed to gather significant data to accurately formulate future injury prevention protocols or recommend modifications to game laws or competition formats. Also, with regard to the assessment of the real impact of our findings, the efficacy of the recommendations made and their applicability, further studies are needed.

# Chapter Six: Future perspectives

# 6. Practical implications and future perspectives

Many practical implications result directly from our study and are transversal to the different groups of agents involved in rugby sevens. This study confirmed the relevance of sports injuries in rugby sevens and the need to actively study and intervene aiming at the identification of associated factors. The findings of our study allowed us to suggest changes in the daily activities of athletes, coaches, medical staff, but also to suggest actions that fall within the scope of action of the sports' governing body.

Distinct areas of training and players' preparation, but also competition formats can be transformed/improved aiming at the mitigation of the identified problems. It will be extremely interesting and scientifically relevant to assess the level of implementation of the recommendations resulting from this thesis.

We expect that the relevant stakeholders will be able to avoid the decrease of training volume during the sevens season, and increase the focus on individual preparation of athletes. Additionally, we believe it is necessary to implement bye weeks during the season to allow players' recovery; to increase the duration of tournaments, thereby allowing a decrease in the number of games played on the same day, as tournaments should ideally be played over two days. We also hope that the relevance of rugby sevens to the sport will be highlighted and promoted, by increasing the duration of the season and the number of tournaments, and that injury surveillance studies will be regularly implemented in Portuguese rugby competitions.

The level of acceptability shown in the future by coaches and athletes in the improvement of the management of training loads, adequacy to the period of the season as well as the systematic approach (and assessment) of the psychological needs of athletes, will have a positive impact on the will of researchers to conduct further studies in this field.

Also, the pro-activity (or its absence) from the Portuguese Rugby Union to address the suggestions made for changes in the competition formats and in the relevance of sevens within the Portuguese rugby will also be an important indicator of the governing body's will to promote safety and welfare in the sport.

There is, and it has been clearly stated throughout the thesis, ample place and urgent need of new and robust research in this field. As a result of this study, it becomes clear that sparse data are available regarding non-elite rugby sevens epidemiology of injuries, but also regarding physical demands and movement patterns of sevens at this level of competition. So, we believe

that new studies focused on these topics should take place, not only in the Portuguese competition but also in other non-elite settings.

As little evidence has been gathered to this moment, and considering the novelty of this research, we believe that this know-how should not be wasted and a research unit/department in Sports Medicine (especially Rugby Medicine) could be created in the University of Beira Interior (or integrated into an existing research unit). Thus, the continuity of this work and its expansion to the other identified relevant paths of research could be guaranteed and enhanced.

In conclusion, the results from this study provided a further and relevant contribution to our understanding of the epidemiology of injuries in Rugby Union sevens, especially in senior male Portuguese sevens, and might have significant implications in the preparation of future competitions and injury management, as well as in the research in the field of rugby sevens.

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# Appendices

## Appendix – PhD course commission's approval – Thesis

FACULDADE CIÊNCIAS DA SAÚDE

**PARECER**

Na reunião da Comissão de Curso do 3º Ciclo em Medicina, que decorreu a 20 de Junho do corrente ano, foi analisado o pedido de submissão da tese de doutoramento em Medicina, do aluno António Miguel da Cruz Ferreira (D1747).

Com base no cumprimento total de todos os critérios exigidos para a submissão de tese para provas públicas de defesa da tese de doutoramento, nomeadamente através da publicação, por parte deste aluno, de quatro artigos em revistas de circulação internacional com factor de impacto (FI) (num total de FI de 4,905, como 1º autor), ultrapassando a mediana de FI de revistas da área científica de publicação (Sprts Science; FImed=1,704), bem como pela produção de uma tese que cumpre a formatação das teses do 3º Ciclo da Universidade da Beira Interior, é parecer desta Comissão de Curso que a referida tese reúne todas as condições para ser submetida a provas públicas.

Covilhã e UBI, 20 de Junho de 2018

O Director de Curso

Professor Doutor Luís Taborda Barata

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# Appendix – PhD course commission's approval – Thesis 3A

FACULDADE CIÊNCIAS DA SAÚDE

3°CM CICLO EM MEDICINA

**PARECER**

Na reunião da Comissão de Curso do 3º Ciclo em Medicina, que decorreu a 12 de Setembro do corrente ano, foi analisado o pedido de aprovação do aluno António Miguel da Cruz Ferreira (nº D1746), à Unidade Curricular Tese 3A do programa de doutoramento.

Com base na publicação, por parte deste aluno, de quatro artigos em revistas de circulação internacional com factor de impacto/FI (num total de FI de 4,905, como 1º autor), ultrapassando a mediana de FI de revistas da área científica de publicação (*Sports Science*; FImed=1,704), sempre como 1º autor, ultrapassando assim os critérios mínimos para aprovação à referida unidade curricular, é parecer desta Comissão de Curso que deve ser atribuída a classificação de "Aprovação" a Tese 3A, com a atribuição de 30 ECTS.

Covilhã e UBI, 13 de Março de 2018

O Director de Curso

Professor Doutor Luís Taborda Barata

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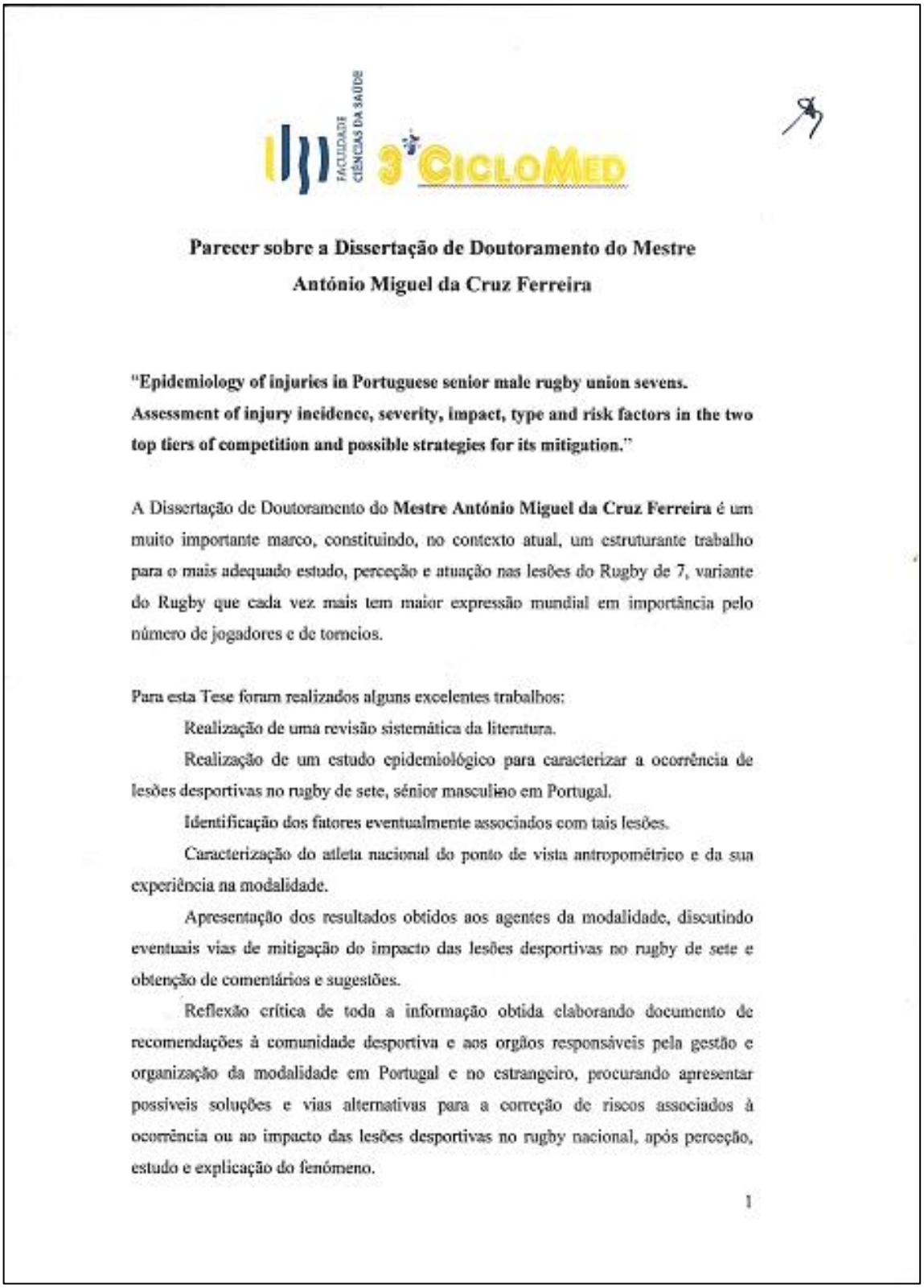
# Appendix – Supervisor's approval



FACULDADE CIÊNCIAS DA SAÚDE

3º CICLOMED

**Parecer sobre a Dissertação de Doutoramento do Mestre**
**António Miguel da Cruz Ferreira**

**"Epidemiology of injuries in Portuguese senior male rugby union sevens. Assessment of injury incidence, severity, impact, type and risk factors in the two top tiers of competition and possible strategies for its mitigation."**

A Dissertação de Doutoramento do **Mestre António Miguel da Cruz Ferreira** é um muito importante marco, constituindo, no contexto atual, um estruturante trabalho para o mais adequado estudo, perceção e atuação nas lesões do Rugby de 7, variante do Rugby que cada vez mais tem maior expressão mundial em importância pelo número de jogadores e de torneios.

Para esta Tese foram realizados alguns excelentes trabalhos:

Realização de uma revisão sistemática da literatura.

Realização de um estudo epidemiológico para caracterizar a ocorrência de lesões desportivas no rugby de sete, sénior masculino em Portugal.

Identificação dos fatores eventualmente associados com tais lesões.

Caracterização do atleta nacional do ponto de vista antropométrico e da sua experiência na modalidade.

Apresentação dos resultados obtidos aos agentes da modalidade, discutindo eventuais vias de mitigação do impacto das lesões desportivas no rugby de sete e obtenção de comentários e sugestões.

Reflexão crítica de toda a informação obtida elaborando documento de recomendações à comunidade desportiva e aos orgãos responsáveis pela gestão e organização da modalidade em Portugal e no estrangeiro, procurando apresentar possíveis soluções e vias alternativas para a correção de riscos associados à ocorrência ou ao impacto das lesões desportivas no rugby nacional, após perceção, estudo e explicação do fenómeno.

1

Metodologicamente bem desenhada e excecionalmente bem desenvolvida esta Tese percorreu quatro fases distintas:

1.Revisão sistemática da literatura sobre a epidemiologia das lesões desportivas no rugby de sete sénior masculino.

2.Realização de um estudo de coorte prospetivo incluindo todos os atletas participantes no Circuito Nacional de rugby de sete do primeiro e segundo escalão competitivos

3.Conferência médico-desportiva para apresentação e discussão dos resultados, tendo para o efeito sido convidados todos os clubes registados na Federação Portuguesa de Rugby, assim como a própria estrutura federativa.

4.Elaboração de documento de resumo geral do estudo e de recomendações gerais e específicas.

Como principais resultados:

Foi possível identificar as taxas globais de incidência de lesões em torneios de rugby de sete de elite que variaram de 101,5 a 119,8 lesões por 1000 horas de jogo-jogador. O único estudo sobre jogadores amadores revelou uma menor taxa de incidência de lesões (74,7 por 1000 horas de jogo-jogador). A maioria das lesões ocorreu após contacto com o adversário (72,8 a 83,7%) e a gravidade média das lesões foi superior a 34,1 dias. O membro inferior foi a localização anatómica mais frequente das lesões desportivas nos atletas de elite (56,3 a 70,4%) e no grupo amador, as lesões da cabeça/pescoço e do membro superior foram mais frequentes. Quanto ao tipo de lesão, as articulares/ligamentares foram as mais frequentes em atletas de elite (34,3 a 51,5%), mas no único estudo em amadores as mais frequentes foram as lesões musculares/tendinosas (37,5%).

2

No estudo de coorte prospetivo na população portuguesa, identificou-se taxa de incidência de 133,9 lesões por 1000 horas de jogo-jogador. A gravidade média das lesões foi de 22,22 dias e os eventos com contato precederam 81,5% de todas as lesões registadas. Na sua maioria, o membro inferior foi o principal local da lesão (66,7%) e as lesões articulares/ligamentares e musculares/tendinosas as mais frequentes, correspondendo a 85,1% de todos os casos. Uma associação entre a ocorrência de lesão desportiva e um menor volume de treino durante a temporada rugby de sete foi identificada para o segundo patamar competitivo ($p = 0,021$). Para o mesmo patamar, foi igualmente identificada uma relação inversa entre o número de horas de treino durante a época de rugby de sete e a gravidade das lesões identificadas neste grupo de atletas ($p = 0,008$). Para os atletas a competir no nível superior, aqueles que habitualmente realizaram treino específico de *sevens* em simultâneo com o treino de quinze durante a época de rugby de quinze, apresentaram um aumento significativo do risco de lesão (risco relativo = 3.2; $p = 0,011$). Nenhum dado relevante foi identificado relativamente à associação entre rotinas de aquecimento e a ocorrência de lesões desportivas. Quanto ao nível de ansiedade pré-competitiva, apenas no grupo de atletas de topo e para a sub-categoria "disrupção da concentração" foi identificada uma associação entre valores mais elevados e a ocorrência de lesão.

Na apresentação dos resultados do trabalho de campo a maioria dos respondentes a inquérito realizado concordou com a necessidade de serem monitorizadas de forma programada as lesões desportivas no rugby português sendo menor o número de respostas favoráveis à monitorização dentro do seu Clube.

Quanto à necessidade de um programa institucional destinado à prevenção de lesões desportivas, 97% dos participantes concordaram ou concordaram muito com o mesmo. Já sobre a necessidade de implementar um programa de vigilância epidemiológica das lesões desportivas no rugby de sete, 94% dos participantes referiram concordar ou concordar muito.

Na última fase do estudo, com base nos dados obtidos nas três etapas anteriores, foi publicado um editorial na revista *The Physician and Sportsmedicine* contendo as

3

recomendações do grupo de trabalho e a receção às mesmas por parte dos agentes da modalidade e da Federação Portuguesa de Rugby.

**Respigamos as Conclusões:**

"Apresentamos o primeiro estudo de revisão sistemática da literatura relativamente à epidemiologia das lesões no rugby de sete e, também, o primeiro estudo apresentando padrões de referência para a incidência, gravidade e fatores de risco associados a lesões desportivas no rugby de sete senior masculino amador. As taxas de incidência de lesões desportivas identificadas foram semelhantes às registadas nas competições internacionais, mas a gravidade das lesões no Circuito Nacional foi inferior.

Como foram identificadas associações estatisticamente significativas entre o volume de treino e a ocorrência de lesões desportivas nos diferentes níveis da competição, apesar de em sentidos opostos para cada um, reforça-se a noção de que os volumes coletivos e individuais de treino, assim como a preparação para a competição devem ser personalizadas. Adicionalmente, devem as equipas médicas e os treinadores ter presente que a taxa de incidência de lesões desportivas no rugby de sete nacional é elevada, reveste-se de custos para atletas e equipas existindo fatores de risco bem identificados para esta ocorrência.

Esperamos, com este trabalho, contribuir para o desenvolvimento e implementação de novos estudos epidemiológicos no rugby de sete senior masculino amador em Portugal e noutros países. A metodologia utilizada pode ser generalizada para contextos diferentes e mais amplos, por ter sido criada com base no documento de consenso para estudos epidemiológicos em rugby que serviu de base à maioria dos estudos semelhantes previamente publicados. Será crucial, todavia, reunir uma maior evidência sobre um assunto tão relevante, para podermos alcançar um nível de conhecimento mais aprofundado e, com ele, formular com maior precisão estratégias de prevenção de lesões ou recomendar modificações às leis do jogo e aos formatos das competições, visando a promoção da segurança e do bem-estar dos atletas."

4

Desta Tese extraem-se magníficas, fortes e bem pensadas soluções para a melhoria da segurança da prática, ao mesmo tempo que ressaltando a competitividade.

O candidato satisfaz o estipulado na alínea d) do nº1 do artigo 28º do DL nº 74/2006, pois estão publicados:

Cruz-Ferreira AM, Cruz-Ferreira EM, Santiago LM, Taborda-Barata L. Epidemiology of injuries in senior male rugby union sevens: a systematic review. Phys Sportsmed. 2017 Feb;45(1):41-48. doi: 10.1080/00913847.2017.1248224. (Appendices A1, B1)

Cruz-Ferreira AM, Cruz-Ferreira EM, Santiago LM, Taborda-Barata L. Epidemiology of injuries in senior male Portuguese rugby union sevens: a cohort prospective study. Phys Sportsmed. 2018 May;46(2):255-261. doi: 10.1080/00913847.2018.1441581. (Appendices A2, B2)

Cruz-Ferreira AM, Cruz-Ferreira EM, Santiago LM, Taborda-Barata L. Promoting players' safety and welfare through the sharing of scientific knowledge with sports agents: the new reality of Portuguese rugby sevens. Phys Sportsmed. 2017 Oct 5:1-2. doi: 10.1080/00913847.2017.1386067. (Appendices A3, B3)

Cruz-Ferreira AM, Cruz-Ferreira EM, Ribeiro P, Santiago LM, Taborda-Barata L. Epidemiology of time-loss injuries in senior and under-18 Portuguese male rugby players. Journal of Human Kinetics. 2018; 2: 73-80. doi: 10.1515/hukin-2017-0159 (Appendices A4, B4)

Ainda foram efetuadas as seguintes Conferências / Comunicações em congressos ou reuniões com o adequado nível:

Cruz-Ferreira AM, Cruz-Ferreira EM, Taborda-Barata L, Santiago LM. Epidemiology of injuries in Portuguese senior male rugby union sevens. 5th ECOSEP Congress and

5

FIFA Update. Dubai, 9-10 Dec 2017 (Appendices A5, B5) Epidemiology of injuries in Portuguese sénior male rugby union sevens

A tese está em condições de ser apresentada em provas públicas.

Coimbra, 13 de Junho de 2018,

O Orientador,

Luiz Miguel Santiago
MD, PhD
Professor Associado com Agregação

6

# Appendix – Thesis title change (to English)

Ex.mos Senhores
Serviços Académicos da
Universidade da Beira Interior

Covilhã, 12 de fevereiro de 2018

Assunto: Pedido de alteração de título de tese de Doutoramento

António Miguel da Cruz Ferreira, aluno do 3º ciclo em Medicina da Faculdade de Ciências da Saúde da Universidade da Beira Interior, com o número de aluno D1747, vem por este meio solicitar autorização para alteração do título do seu trabalho de Tese Final.

Para o efeito, o presente documento e o requerimento fazem-se acompanhar dos pareceres dos orientadores (Professor Doutor Luiz Santiago e Professor Doutor Luís Taborda Barata).

Assim, solicita-se a alteração do título da Tese *"Lesões desportivas no rugby de sete português. Avaliação da incidência no primeiro e segundo patamar competitivo masculino, do seu impacto, recorrência, tipo e fatores de risco associados, bem como de estratégias para a sua redução."* para *"Epidemiology of injuries in Portuguese senior male rugby union sevens. Assessment of injury incidence, severity, impact, type and risk factors in the two top tiers of competition and possible strategies for its mitigation."*

Com os melhores cumprimentos,

António Cruz Ferreira – D1747

FACULDADE CIÊNCIAS DA SAÚDE

## PARECER

Na minha qualidade de orientador da tese de doutoramento do aluno do 3º Ciclo em Medicina, António Miguel da Cruz Ferreira (D1747), é meu parecer que, considerando o âmbito de internacionalização desejável para a sua tese de doutoramento, bem como a publicação de vários artigos científicos em inglês, em revistas de circulação internacional, como resultado dos seus trabalhos, o título e conteúdo da Tese Final deverão ser elaborados na língua inglesa.

Assim, concordo que o actual título "*Lesões desportivas no rugby de sete português. Avaliação da incidência no primeiro e segundo patamar competitivo masculino, do seu impacto, recorrência, tipo e fatores de risco associados, bem como estratégias para a sua redução*" deverá ser alterado para "*Epidemiology of injuries in Portuguese senior male rugby union sevens. Assessment of injury incidence, severity, impact, type and risk factors in the two top tiers of competition and possible strategies for its mitigation.*"

Covilhã, 10 de Fevereiro de 2018

O Orientador

Prof. Doutor Luiz Miguel Santiago

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FACULDADE CIÊNCIAS DA SAÚDE

3ºCM CICLO EM MEDICINA

## PARECER

Na minha qualidade de co-orientador da tese de doutoramento do aluno do 3º Ciclo em Medicina, António Miguel da Cruz Ferreira (D1747), é meu parecer que, considerando o âmbito de internacionalização desejável para a sua tese de doutoramento, bem como a publicação de vários artigos científicos em inglês, em revistas de circulação internacional, como resultado dos seus trabalhos, o título e conteúdo da Tese Final deverão ser elaborados na língua inglesa.

Assim, concordo que o actual título *"Lesões desportivas no rugby de sete português. Avaliação da incidência no primeiro e segundo patamar competitivo masculino, do seu impacto, recorrência, tipo e fatores de risco associados, bem como estratégias para a sua redução"* deverá ser alterado para *"Epidemiology of injuries in Portuguese senior male rugby union sevens. Assessment of injury incidence, severity, impact, type and risk factos in the two top tiers of competition and possible strategies for its mitigation."*

Covilhã e UBI, 9 de Fevereiro de 2018

O Co-Orientador

Prof. Doutor Luís Taborda Barata

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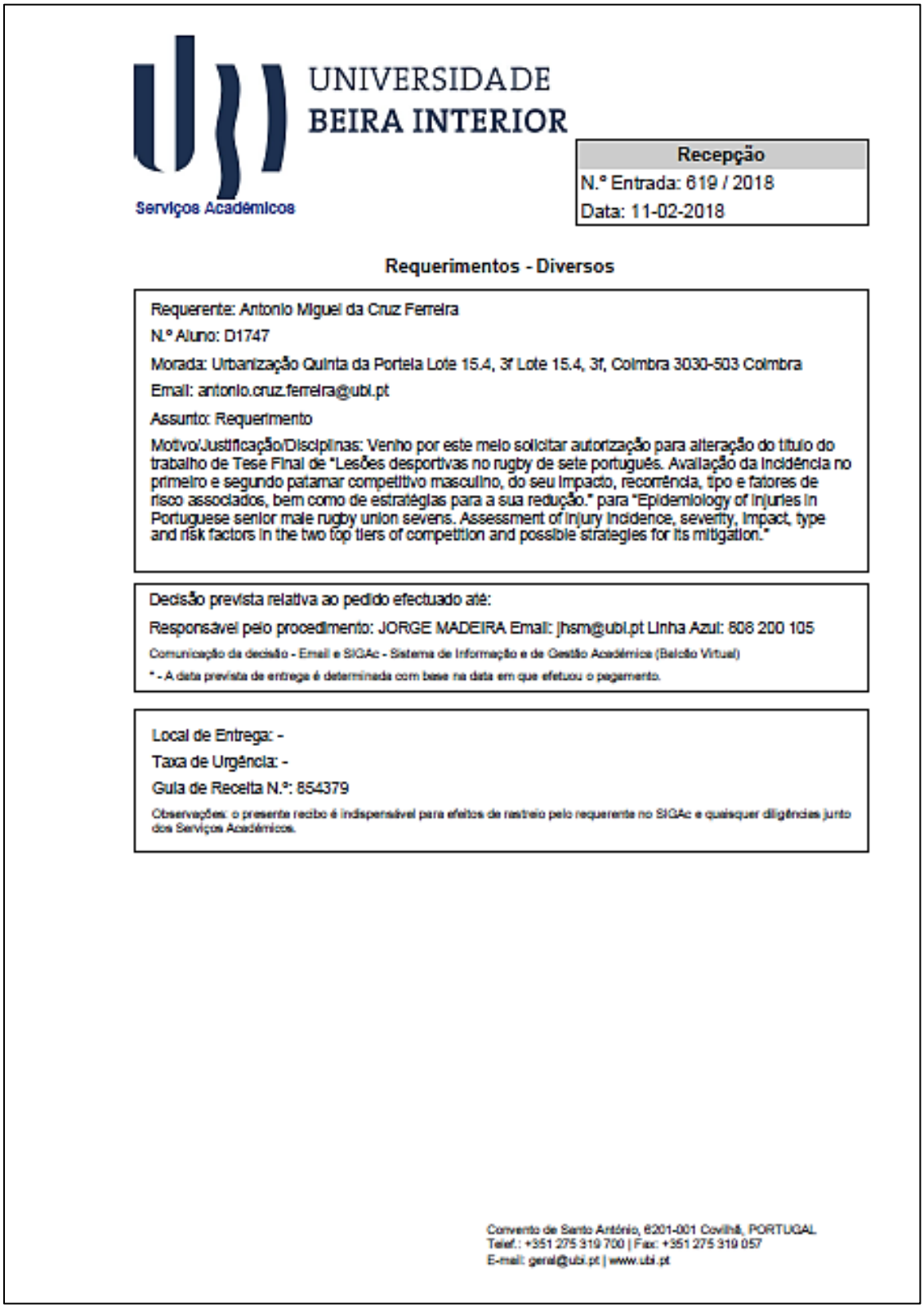

UNIVERSIDADE
BEIRA INTERIOR

Serviços Académicos

| Recepção |
| --- |
| N.º Entrada: 619 / 2018 |
| Data: 11-02-2018 |

**Requerimentos - Diversos**

Requerente: Antonio Miguel da Cruz Ferreira

N.º Aluno: D1747

Morada: Urbanização Quinta da Portela Lote 15.4, 3f Lote 15.4, 3f, Coimbra 3030-503 Coimbra

Email: antonio.cruz.ferreira@ubi.pt

Assunto: Requerimento

Motivo/Justificação/Disciplinas: Venho por este meio solicitar autorização para alteração do título do trabalho de Tese Final de "Lesões desportivas no rugby de sete português. Avaliação da incidência no primeiro e segundo patamar competitivo masculino, do seu impacto, recorrência, tipo e fatores de risco associados, bem como de estratégias para a sua redução." para "Epidemiology of injuries in Portuguese senior male rugby union sevens. Assessment of injury incidence, severity, impact, type and risk factors in the two top tiers of competition and possible strategies for its mitigation."

Decisão prevista relativa ao pedido efectuado até:

Responsável pelo procedimento: JORGE MADEIRA Email: jhsm@ubi.pt Linha Azul: 808 200 105

Comunicação da decisão - Email e SIGAc - Sistema de Informação e de Gestão Académica (Balcão Virtual)

* - A data prevista de entrega é determinada com base na data em que efetuou o pagamento.

Local de Entrega: -

Taxa de Urgência: -

Guia de Receita N.º: 854379

Observações: o presente recibo é indispensável para efeitos de rastreio pelo requerente no SIGAc e quaisquer diligências junto dos Serviços Académicos.

Convento de Santo António, 6201-001 Covilhã, PORTUGAL
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# Appendix A1 - Epidemiology of injuries in senior male rugby union sevens: a systematic review

THE PHYSICIAN AND SPORTSMEDICINE, 2017
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CLINICAL FEATURE
REVIEW

## Epidemiology of injuries in senior male rugby union sevens: a systematic review

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ABSTRACT

Objectives: In 2016 the Rugby Union variant of sevens will enter the official Olympic Programme. Until now, most of injury surveillance studies in Rugby Union focus on elite 15-a-side cohorts, with reported injury incidence rates reaching 96 per 1000 player-match-hours, and mean severity set at 20 days. Sparse data is available regarding rugby sevens. The aim of this study was to systematically review available data regarding the epidemiology of injuries in senior male rugby sevens.

Methods: Electronic databases (Pubmed, Google Scholar, SCOPUS, Scielo and IndexRMP) were searched in September 2015, complemented by manual searches of bibliographies and relevant "grey literature".

Results: Seven prospective cohort original articles addressing injuries in senior male rugby sevens players were included in this review. Overall injury incidence rates in elite rugby sevens tournaments ranged 101.5 to 119.8 per 1000 player-match-hours. Mean severity was greater than 34.1 days. Lower limb and joint/ligament injuries were the most frequent in elite players. The only study on amateur players revealed a lower injury incidence rate (74.7 per 1000 player-match-hours), and a higher proportion of muscle/tendon (37.5 %) injuries.

Conclusion: Injury incidence rates in rugby sevens are higher than those reported for the 15-a-side variant, at the same level of competition. Injuries are also more severe, resulting in longer absence periods. This might result from the fact that rugby sevens is played with greater speed, leading to an increase in energy transfers during tackles, more running and turning manoeuvers, that can possibly cause more severe injuries.

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### 1. Introduction

Rugby Union is definitely one of the fastest growing sports in the world, especially after the introduction of professionalism in 1995. In 2009, Rugby Union has been accepted as one of the new summer Olympic sports [1], making its return to the Olympic family in the 7-a-side variant. Recent numbers released by the Rugby Union governing body (World Rugby) claim that the sport is played in 120 countries by more than 7 million players, with 102 member unions and 18 associated unions being responsible for developing the sport and organizing competitions within their borders [2].

Although most rugby players in the world play 15-a-side Rugby Union, it is also undeniable that rugby sevens has become an increasingly popular format [3–5]. It is played in the same field, and with almost the same rules, but over two 7-minute halves (finals with 10-minute halves) by teams of seven players, three designated as forwards and four as backs, although their roles are not as clear as in rugby 15-a-side [3–6]. Currently, World Rugby holds a Rugby Sevens World Series played in a multistage tournament throughout 7 months, from December to May, in cities from five continents. Tournaments are scheduled as rounds of 2 tournaments with each round separated by 6–8 weeks [5]. Each tournament takes place in 2 days (sometimes 3 days), with teams playing up to three matches each day [5,6].

In the same way as the original 15-a-side variant, rugby sevens is also a dynamic, high intensity, intermittent full-contact sport [7], requiring a combination of physical, psychological, technical, and tactical skills for success at national and international levels [3,8,9]. As no differences in the dimensions of the field are found in Rugby sevens, and fewer players are engaged in each phase of the game, a tendency toward a higher number of sprints [10] and contacts with the opponents [6] during competitive matches is expected.

Although it is known that rugby union has had a good sports medicine service over the years, and that player welfare is a main concern for World Rugby [1], injury surveillance studies in rugby union are essentially focused on the 15-a-side variant, with a significant body of evidence being published in recent years [11–18]. At elite or professional level, injury incidence rates in rugby union 15-a-side reaches 89.1–96 injuries per 1000 player match-hours, with an average severity of 20 days of absence from competition and training [11,17,19]. The most frequent location of injuries is the lower limb, while muscle/tendon is the most common type of injury [11,17,19]. The aim of our study was to systematically review the available literature regarding the epidemiological aspects of injuries in senior male rugby sevens, especially those regarding the incidence, type, location, period of match, and

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severity of injuries. We chose to include data from all levels of play and playing positions.

## 1. Methods

The present study was conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [20]. No ethical approval was requested, since this was just a review of already published studies.

### 1.1. Search strategy

We have conducted a search on PubMed databases from 1995 to September 2015, using the following search strategy: ('Football' [Mesh]) AND ('Athletic Injuries' [Mesh]) OR 'Rugby Sevens.' The same strategy was then adapted to perform a similar search on Google Scholar, SCOPUS, Scielo, and IndexRMP. We also searched the reference lists of included studies and 'grey literature' to identify other potentially relevant studies. Inclusion criteria for retrieved studies were: (i) Original articles (prospective or retrospective cohort and randomized controlled design), review articles, and meta-analyses; (ii) study population comprising 7-a-side senior male rugby teams; (iii) studies clearly defining athletic injuries; (iv) studies providing relevant epidemiological data, such as injury incidence for match or tournament, incidence of new and recurrent injuries, incidence of injuries by playing position, type and site of injury, severity of injury or injury mechanism. Studies with all types of design including longitudinal (prospective and retrospective), cross-sectional, observational, and ecological, were included. Studies were excluded from our analysis if: they were focused on under-18 or female players only; focused on 15-a-side Rugby Union only; concerned other football codes (Rugby League, Australian Football, American Football, Gaelic sports, or similar); did not report Rugby Sevens injury surveillance studies or data.

### 1.2. Study selection and quality assessment

Following the literature search, two reviewers (ACF and ECF) conducted a screening of the title and abstract of the retrieved articles. Whenever necessary, full texts were also analyzed. The relevant studies, according to the eligibility criteria, were selected and underwent a qualitative analysis of the data included, using the 22-item checklist provided by the 'Strengthening the reporting of Observational Studies in Epidemiology' statement for cohort, case–control, and cross-sectional studies (combined) [21], aiming to make the evaluation and interpretation of results more objective. Using a previously accepted methodology [11,22], studies were categorized as of poor, moderate, or good reporting quality.

### 1.3. Data collection

From all the selected articles, relevant data were extracted and compiled (see Table 1), which included: level of the competition; number of athletes; length of the competition; relevant epidemiological data as considered before. Our aim was to determine the level of play, playing position, type and site of injury, injury incident and severity of injuries reported in the relevant studies selected. When available, data were collected using the items of the international consensus statement on injury definitions and data collec- tion procedures in studies of injuries in rugby union [23], to ease further analysis and interpretation. Determination of time at risk for injuries is reported as player match-hours; incidence rate is reported as number of injuries per 1000 player match-hours; injury severity is given in days of absence from competition and training.

It is also important to define the variable not contemplated in the consensus statement: level of competition. For the present study, we opted to use the traditional division in tiers according to playing strength and potential usually used by World Rugby and authors engaged in injury surveillances studies in rugby union [11]. Thus, taking into consideration the World Rugby ranking of Rugby Unions (male) [31], competitions where considered of 'level one' if disputed by top clubs or national teams of at least one tier-1 nation (including England, France, Ireland, Wales, Scotland, Italy, New Zealand, Australia, South Africa, and Argentina); 'level two' if disputed by teams of the second division of tier-1 nations or by top clubs or national teams of at least one tier-2 nation (other Rugby Unions ranked until the 20th position of World Rugby rankings); 'level three' if disputed only by teams or nations in none of the previous circumstances.

## 2. Results

A summary of the study process can be seen in Figure 1, which shows a flow diagram of the article selection process. The initial electronic database search returned a total of 1372 articles, and an additional manual search returned 5 more relevant articles. By removing the duplicated, the nonrelevant articles and those related to different football codes, to women or youth rugby only, 209 potentially relevant papers were assessed for inclusion in the review, based on the previously determined inclusion criteria. As expected, most of the studies involved 15-a-side rugby union, and those were explicitly presented separately from other reasons for noninclusion. Seven cohort prospective studies were included in this review (see Table 1). The quality of the studies ranged from poor to moderate. Of the seven articles included, five collected data prospectively from the injury incidence from the men's World Rugby Sevens World Series tournaments over the course of one or several sea- sons [25–28,30]. These studies were conducted by the World Rugby Medical and Research Staff [27]. One study reported data prospectively collected from injury incidence in a series of amateur rugby tournaments in the USA [24], while one last study prospectively reported data regarding the inci- dence of concussion in three World Rugby Sevens World Series tournaments (2008/2009, 2010/2011, and 2012/2013) [29]. Regarding the study of Lopez et al. [24], included in

Table 1. Data extracted from the studies included in this review.

| Author | Lopez et al. [24] | Fuller et al. [25] | Fuller and Taylor [26] | Fuller and Taylor [27] | Fuller and Taylor [28] | Fuller et al. [29] | Fuller and Taylor [30] | Fuller and Taylor [30] |
|---|---|---|---|---|---|---|---|---|
| Level | Amateur | Elite | Elite | Elite | Elite | Elite | Elite | Elite |
| Tournament | USA Rugby | IRBSWS, ISWC | IRBSWS | IRBSWS, ISWC | IRBSWS | IRBSWS | IRBSWS | IRBSWS |
| Year | 2010 | 2008–2009 | 2010–2011 | 2012–2013 | 2013–2014 | 2008–2013 | 2014–2015 | 2008–2015 |
| Quality | Moderate | Moderate | Poor | Poor | Poor | Moderate | Poor | Poor |
| Number of players | 1536 | 290 | Not given | 312 | 357 | Not given | 331 | 1824 |
| Total exposure (player/hours) | 866.3 | 979.1 | 965.8 | 11683 | 12196 | 4006 | 1253.9 | 6490.6 |
| Incidence rate (per 1000 player/hours, 95% CI) | 55.4 (42.3–68.5)[a] | 106.2 (87.8–128.9) | 101.5 | 119.8 (101.5–141.4) | 109.9 (92.8–130.1) | 83 (59–114)[b] | 107.7 (90.9–127.4) | 108.3 (100.6–116.6) |
| Mean severity (days absent from sport) | NA | 45.0 | 34.1 | 42.7 (35.2–50.3) | 51.5 (40.3–62.7) | 19.3 (14.8–23.6) | 41.3 (36.2–48.15) | 44.2 (40.6–48.1) |
| Injury incidence as function of injury severity (per 1000 player/hours, 95% CI) | | | | | | | | |
| Slight (0–1 day) | 25.0 (0.0–37.0) | NA | | | | NA | 8.1 (3.5–12.8) | 8.4 (6.4–10.5) |
| Minimal (2–3 days) | 6.3 (0.0–13.0) | 8.2 (4.1–16.4) | NA | NA | NA | NA | 17.0 (10.7–23.4) | 11.6 (9.2–13.9) |
| Mild (4–7 days) | 22.9 (11.0–35.0) | 16.5 (10.0–26.7) | NA | NA | NA | NA | 40.0 (31.7–48.3) | 44.5 (40.8–48.2) |
| Moderate (8–28 days) | 33.3 (20.0–47.0) | 31.7 (22.3–45.1) | NA | NA | NA | NA | 31.1 (23.3–38.9) | 32.4 (28.9–35.8) |
| Severe (>28 days) | 12.5 (3.0–22.0) | 49.0 (37.9–65.2) | NA | NA | NA | NA | 3.0 (0.1–5.8) | 1.9 (0.9–2.9) |
| Type (%, 95% CI) | | | | | | | | |
| Bone | 6.3 (0.0–14.0) | 8.7 (3.3–14.2) | 8.2 | 10.7 (5.6–15.8) | 9.7 (4.7–14.7) | – | 8.1 (3.5–12.8) | 8.4 (6.4–10.5) |
| CNS/PNS | 16.7 (7.0–29.0) | 4.9 (0.7–9.0) | 6.1 | 14.3 (8.5–20.1) | 13.4 (7.3–19.2) | 1.00 | 17.0 (10.7–23.4) | 11.6 (9.2–13.9) |
| Joint/ligament | 22.9 (12.0–37.0) | 51.5 (41.8–61.1) | 49.6 | 34.3 (26.4–42.1) | 49.3 (40.8–57.7) | – | 40.0 (31.7–48.3) | 44.5 (40.8–48.2) |
| Muscle/tendon | 37.5 (23.0–54.0) | 33.0 (23.9–42.1) | 35.7 | 36.4 (28.5–44.4) | 24.6 (17.3–31.9) | – | 31.1 (23.3–38.9) | 32.4 (28.9–35.8) |
| Skin | 14.6 (5.0–26.0) | | 2.0 | 2.1 (0.0–4.5) | 2.2 (0.0–4.7) | – | 3.0 (0.1–5.8) | 1.9 (0.9–2.9) |
| Other injuries | 2.1 (0.0–7.0) | 1.9 (0–4.6) | 1.0 | 2.1 (0.0–4.5) | 0.7 (0.0–2.2) | – | 0.7 (0.0–2.2) | 1.3 (0.5–2.1) |
| Location (%, 95% CI) | | | | | | | | |
| Head/neck | 33.3 | 4.9 (0.7–9.0) | 12.2 | 18.6 (12.1–25.0) | 19.4 (12.7–26.1) | 100 | 21.5 (14.6–28.4) | 15.8 (13.1–18.5) |
| Upper limb | 31.3 | 17.5 (10.1–24.8) | 9.2 | 15.0 (9.1–20.9) | 17.2 (10.8–23.5) | – | 17.8 (11.3–24.2) | 17.0 (14.2–19.8) |
| Trunk | 18.8 | 7.8 (2.6–12.9) | 8.2 | 5.7 (1.9–9.6) | 4.5 (1.0–8.0) | – | 4.4 (1.0–7.9) | 6.1 (4.4–7.9) |
| Lower limb | 14.6 | 69.9 (61.0–78.8) | 70.4 | 60.7 (52.6–68.8) | 59.0 (50.6–67.3) | – | 56.3 (47.9–64.7) | 61.1 (57.4–64.7) |
| Cause (%, 95% CI) | | | | | | | | |
| Contact | 72.9 (59.0–85.0) | 77.8 (69.7–85.8) | 72.8 | 76.8 (69.8–83.9) | 83.7 (77.4–90.1) | 100 | 77.7 (70.5–84.8) | 78.5 (75.4–81.6) |
| No contact | 27.1 (15.0–39.0) | 22.2 (14.2–30.3) | 27.2 | 23.2 (16.1–30.2) | 21.3 (17.8–24.7) | – | 22.3 (15.2–29.5) | 21.5 (18.4–24.6) |

[a]Refers to overall rate (trainings injury incidence was of 74.7); [b]injury incidence related to concussion only; CI: confidence interval; CNS/PNS: Central nervous system/peripheral nervous system; NA: not available; IRBSWS: Rugby Board Sevens World Series; ISWC: Rugby Sevens World Cup.

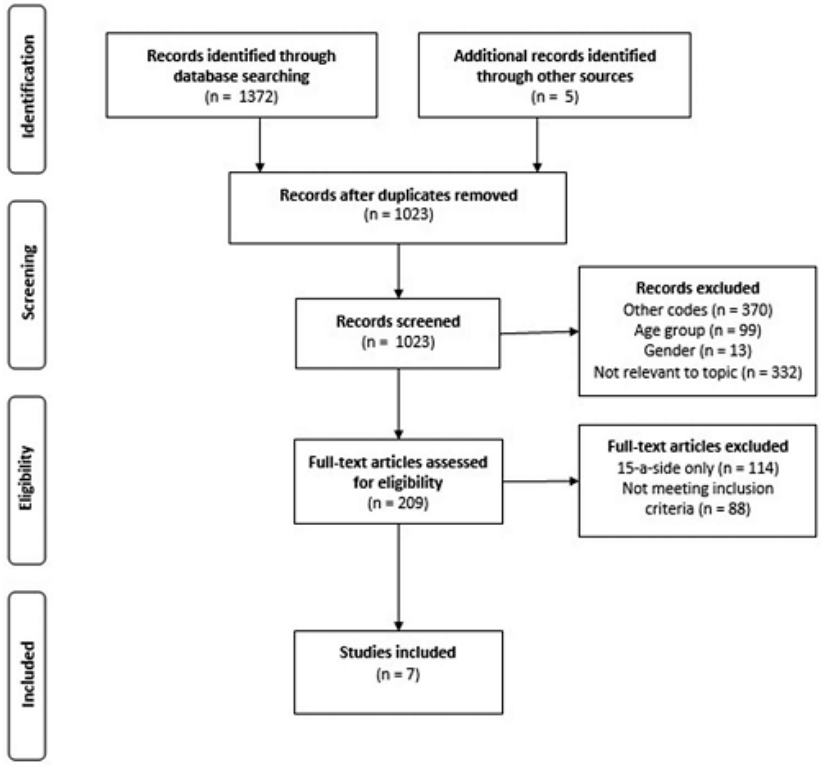


Figure 1. Search strategy flow diagram.

this systematic review, only data on male players were considered.

### 1.1. Level of play

Most (six) of the studies selected for this review [25–30] were conducted by the Rugby Union Governing Body's (World Rugby) Medical and Research Staff [32] in World Rugby Sevens World Series or World Cup, focusing upon a population of level one (elite) rugby players, while only one study [24] was conducted at a nonprofessional level, in 4 amateur 1-day tournaments in a USA local Rugby Union (level three). All of the studies were conducted between 2008 and 2015.

### 1.2. Total match exposure

The reported total exposure for players ranged between 866.3 player match-hours for the amateur tournament series reported and 6480.6 player match-hours for the largest collection of data of the injury surveillance studies of the Sevens World Series and World Cup compiled by Fuller and Taylor [30] between 2008 and 2015. When taking into consideration each annual World Rugby Sevens Series, we can identify a growth in the total match exposure between the initial series considered (2008/2009) with a total of 979.1 player match-hours and the last one (2014/2015) with 1253.9 player match-hours.

### 1.3. Injury definition

All articles selected for this systematic review provided clear definitions of injuries, essentially in line with the international consensus statement on injury definitions and data collection procedures in studies of injuries in Rugby Union [17], but with slight differences. Injury was defined by Fuller et al. [25] as

'*any physical complaint sustained by a player during a Rugby Sevens match that prevented the player from taking a full part in training and/or match play for more than one day following the day of injury*,'

while the same author in the World Rugby Sevens World Series (Men) Surveillance studies [26–28,30] defined injury as

'*any injury sustained during Sevens World Series Tournament match or training activity that prevents a player from taking a full part in normal training activities and/or match play for more than one day following the day of injury*.'

Lopez et al. [24] chose to define injury as

'*any physical complaint caused by transfer of energy that exceeded the body's ability to maintain its structural and/or functional integrity, sustained by a player during a rugby match*.'

The other study included in our review [29], that only reported the incidence of concussions in World Rugby Sevens World Series, defined injury as

'*any concussion sustained by a player during a match that prevented the player from taking a full part in all training*

*activities or match play for more than 1 day following the day of injury, irrespective of whether match or training sessions were actually scheduled.'*

### 1.1. Overall injury incidence rate

Five studies provided overall match injury incidence for level one rugby sevens tournaments [25–28,30], one only provided the match injury incidence of concussion in level one rugby sevens tournaments [29], and one the overall match injury incidence of an Amateur (level three) tournament [24]. The overall injury incidence rate amongst level one players ranged from 101.5 per 1000 player match-hours [26] to 119.8 per 1000 player match-hours (95% CI, 101.5–141.4) [27], respectively, in the Rugby Sevens World Series of 2010/2011 and 2012/2013. For all seasons between 2008/2009 and 2014/2015, the overall match injury incidence reported was 108.3 per 1000 player match-hours (95% CI, 100.6–116.6) [30]. For amateur players (level three), the reported injury incidence of the only study available was 55.4 per 1000 player match-hours (95% CI, 42.3–68.5), including both male and female athletes. For male athletes only, the reported injury incidence of the same study was 74.7 per 1000 player match-hours [24].

### 1.2. Severity of injuries

All studies with level one players provided injury severity data [25–28,30]. The mean severity of injuries ranged between 34.1 days in 2010/2011 [26] and 51.5 days (95% CI, 40.3–62.7) in 2013/2014, while the overall mean severity for injuries sustained at the level one tournaments considered in this analysis was 44.2 (95% CI, 40.6–48.1) [30]. No data were available for the mean severity of injuries in amateur players [24]. Using the international consensus statement on injury definitions and data collection procedures in studies of injuries in Rugby Union [23] definition of injury severity, most of the injuries reported at international level were considered severe (28 days or more) [25], while at amateur level most were moderate (8–28 days) [24].

### 1.3. Type of injuries

All studies with level one players provided information on the type of injures [25–28,30]. The most frequent type of injuries sustained by elite players, taking into consideration the definition of the international consensus statement on injury definitions and data collection procedures in studies of injuries in Rugby Union [23], was joint/ligament injuries, ranging from 34.3% (95% CI, 26.4–42.1) in 2012/2013 to 51.5% (95% CI, 41.8–61.1) in 2008/2009 [25], and an overall 44.5% (95% CI, 40.8–48.2) for all tournaments between 2008/2009 and 2014/2015 [30]. Muscle/tendon was the second most frequent site of injury, being responsible for 32.4% of all injuries (95% CI, 28.9–35.8), followed by central nervous system/peripheral nervous system in 11.6% (95% CI, 9.2–13.9) and bone injuries in 8.4% (95% CI, 6.4–10.5) of cases [30]. Both skin and other injuries accounted for less than 2% of cases each [30]. At amateur level, muscle/tendon accounted for 37.5% (23.0–54.0) of all injuries, followed by joint/ligament in 22.9% (95% CI, 12.0–37.0), central nervous system/peripheral nervous system in 16.7% (95% CI, 7.0–29.0), and skin in 14.6% (95% CI, 5.0–26.0) of cases.

### 1.4. Location of injuries

All studies included in our review provided clear information on the location of injuries reported [24–30]. Lower limb injuries occurred more often than injuries to all other body regions together, as reported in all level one tournaments, with its proportion ranging from 56.3% (95% CI, 47.9–64.7) in 2014/2015 [30] to 70.4% in 2010/2011 [26]. Upper limb and head/neck were the locations, respectively, in 17.0% (95% CI, 14.2–19.8) and 15.8% (95% 13.1–18.5) of all injuries reported between 2008/2009 and 2015/2015 at World Rugby sevens World Series and Rugby sevens World Cup [30], and Trunk was the site for only 6.1% (95% 4.4–7.9) of cases. However, at amateur level, lower limb injuries were the least frequent site for reported injuries (14.6%) and head/neck the first (33.3%), followed by the upper limb (31.3%) and trunk (18.8%) [24].

### 1.5. Injury incident

All studies reported that the ratio between contact and non-contact events leading to injuries was 3:1, with overall percentages ranging from 72.8% to 83.7% (95% CI, 77.4–90.1) [24–30]. The tackle is the event of the game where more injuries occur at both amateur (74.5%; 95% CI 60.0–85.0) [24] and international rugby (51.9%) [30]. Being tackled, however, at level one rugby tournaments, is usually more frequently associated with injuries (33.6%; 95% CI, 30.1–37.2) than tackling (21.3%; 95% CI, 18.2–24.4) [30]. While running and collision with the opponent, respectively, accounted for 19.3% (95% CI, 16.3–22.2) and 12.0% (95% CI, 9.5–14.5) of the all injuries at elite level [30].

### 1.6. Period of match

Six of the seven articles reported the period of match when injury occurred [24,25,27–30]. Injuries were more frequent in the second half of the games for both backs and forwards. Data regarding all elite tournaments from 2008/2009 to 2014/2015 shows an incidence, in the first half, of 37.7 (95% CI: 33.1–42.3) to 40.5 (95% CI: 34.4–46.5) injuries per 1000 player match-hours, respectively, for backs and forwards. During the second half, backs sustained an average of 62.3 (95% CI: 57.7–66.9) injuries per 1000 player match-hours, while forwards suffered 59.5 (95% CI: 53.5–65.6) injuries per 1000 player match-hours. According to Fuller and Taylor [30], a significant statistical difference is reached ($p < 0.001$) in terms of injury incidence between halves at elite rugby. No data were available for amateur players.

### 1.7. Playing position

Six studies included in our systematic review provided infor- mation on the incidence of injures according to playing posi- tion in male rugby sevens [25–30]. At elite level tournaments,

105.0–158.8) injuries per 1000 player match-hours [26,28]. For the same level of competition, injury incidence amongst forwards ranged between 81.9 (95% CI: 60.9–110.0) to 119.8 (95% CI: 93.0–154.3) injuries per 1000 player match-hours. Data regarding all World Rugby Sevens World Series from 2008/2009 to 2014/2015 [30] confirmed an overall incidence rate of 91.5 (95% CI: 80.9–103.4) injuries per 1000 player match-hours for forwards and 121.0 (95% CI: 110.3–132.7) injuries per 1000 player match-hours for backs, revealing a significant difference between them ($p < 0.001$) [30]. For amateur players, it is reported that backs also sustained more injuries, with no significant differences regarding mean severity, type, location, or cause of injuries between players of different positional groups; however, no data regarding male players only are reported [24].

## 1. Discussion

The present study reports the first systematic review of injury incidence rate in elite and amateur rugby sevens. We collected a relevant amount of epidemiological data related to injury incidence, type, location, period of match, and severity in senior male rugby sevens players from all levels of play and playing positions.

It is clear that injury surveillance studies in rugby sevens, when compared to the 15-a-side variant, are scarce and that most of the available data rely on grey literature and the work of the World Rugby Medical and Research Staff [32]. We chose to discuss the results of the present review while simultaneously comparing them with the available literature on injury surveillance and epidemiology of injuries in the 15-a-side variant of rugby union. Both types of rugby formats involve players of the same football code, the same field dimensions, basic rules, match events and moments of the game, as well as the definitions and methodologies recommended by the international rugby consensus statement [23].

The largest collection of data, as mentioned before, relates to the World Rugby Sevens World Series [25–28,30], and shows some interesting aspects. First, a constant growth in the number of games (player match-hours) that athletes are exposed to is clear: from 979.1 player match-hours in 2008/2009 [25] to 1253.9 player match-hours in 2014/2015 [30], showing an increase of almost 30% in match exposure over a period of 6 years. Despite this relevant increase in the number of hours that athletes had to be on the field, the overall injury incidence rate at level one tournaments remained stable, with 106.2 injuries per 1000 player match-hours in 2008/2009 and 107.7 in 2014/2015. In fact, between each annual Series, not much difference is seen in the injury incidence rate at the World Rugby Sevens World Series tournaments, with numbers ranging from 101.5 [26] to 119.8 [27] injuries per 1000 player match-hours, with an average of 108.3 per 1000 player match-hours for all tournaments held between 2008 and 2015 [30]. At amateur level, the only available study revealed an injury incidence rate of 74.7 per 1000 player match-hours in an American local seven series of tournaments [24]. At both levels, the injury incidence rates reported are higher than those reported for 15-a-side rugby union, where injury incidence rates were 89.1–96 per 1000 player match-hours, at professional/elite level [11,17] 21.7–25 per 1000 player match-hours, at amateur level [14,15].

One other aspect that becomes clear after the analysis of the collected data is that injuries in rugby sevens are more severe than in the 15-a-side variant. From our review, we concluded that injuries lead, on average, to 34.1–51.5 days of absence in rugby sevens level one players whereas in the 15-a-side variant, at the same level of competition, the mean severity of match injuries was 20 days of absence from competition and training [11]. However, the under- reporting of minor injuries in rugby sevens might influence the average severities recorded [29]. Rugby sevens is played with greater speed, thereby leading to an increase in energy transfers during tackles and other contact events. In addition, it also involves more running [33], cutting, and turning manoeuvers possibly causing more severe knee and ankle ligament injuries associated with longer absences from practice [25]. It is also important to remember that rugby sevens tournaments consist of several matches played during the same day, or two days. Recent data seem to confirm that match demands remain consistent across tournament rounds, and that players are involved in up to 40% more contact events in a rugby sevens tour- nament than in a 15-a-side match, which could lead to higher fatigue [6,33,34].

In 15-a-side rugby, the most frequent site of injury at level one competitions are muscle/tendon [12] and, at amateur level, joint/ligament [30]. The opposite was seen in rugby sevens. At level one sevens tournaments, joint/ligament injuries were more frequent, while muscle/tendon were of higher frequency in the only level three tournament considered. This might also be used to advocate that at elite level, rugby sevens is played with greater speed and with more open field running and turning movements that can lead to this type of injuries. However, larger and more detailed studies should be taken in order to make such statements.

Despite these differences, both at rugby sevens or 15-a-side and amateur or elite level, joint/ligament and muscle/tendon are responsible for over two-thirds [12,31] of all injuries and should be the main focus of future interventions designed to reduce injury incidence rates in rugby union. Nevertheless, due to the risk associated with severe/catastrophic injuries, head/neck injuries should remain an important field of intervention by World Rugby Medical Research Group, as it currently happens [26].

Regarding the location of injuries, no differences were found between rugby sevens and 15-a-side. Lower limb injuries were more frequent at level one competitions, and accounted for about half of the reported injuries [11]. At amateur level, the largest meta-analysis of injury surveillance studies in rugby 15-a-side, reported that injuries at this level were also most frequent in the lower limbs. However, in our review, the only study available with nonelite players does not support that conclusion. It is important to notice, in any case, that in order to draw any significant conclusions, more data would have to be available. Injuries sustained on the head/neck and upper limb were less frequent, with the former ranging from 4.9 to 21.5% and the

latter from 9.2 to 17.8%, at international level. However, at level three competitions, a significant number of head and neck injuries were reported, being the single most frequent site of injuries. These data are ambiguous and are not in agreement with the available literature for amateur rugby 15-a-side, in which head/neck injuries are \sed to be of a lesser frequency [14]. For this fact, health professionals providing medical care at rugby sevens tournaments should be familiar with the guidelines and protocols on the management of head and neck injuries in rugby union [29].

In agreement with all literature [11,14,24,30], at level one and level three competitions, most injuries result from contact events, particularly tackle (tackling and especially being tackled) [11,30], but also with collision resulting from high speed running. This highlights the nature and demands of rugby union, and might account for the high injury incidence rate of the sport. The rugby sevens variant, due to its specificities, might be associated with even greater incidence rates.

With this paper, we aimed to contribute to establish the extent of the problem, which had yet not been done, but also to highlight some reasons that could explain the relevant numbers of injuries found. The high number of matches played in the same day and in subsequent days by Sevens' players, possibly leading to higher levels of fatigue, as suggested by recent studies [6], should be taken in consideration by all agents. Changing the competition models, aiming to reduce the number of matches played in a day and increasing the time between each game in order to reduce the number of injuries, seems a reasonable hypothesis to test in future studies.

In order to allow an effective intervention, further research at all levels of competition and capable of providing consistent evidence is needed. The authors believe that future focus of research in rugby sevens should include larger, high-quality injury surveillance studies in level two and level three competitions held at national and international level.

At international level, Sevens Series are played throughout the year, with tournaments taking place in two consecutive weeks, with players involved in 3 games per day for two consecutive days [20]. At amateur level, competitions take place with three 1-day tournaments played in consecutive weeks during 1 month, at the end of the season [25,34]. A question that should be raised in future research is whether the competition format in rugby sevens is appropriate or if it might be responsible for the high level of injuries and severity reported. Changes in the tournament formats must be considered and tested, aiming to assess strategies to reduce injury incidence rates and severity.

Rugby sevens has the same basic set of rules as rugby union 15-a-side, which allows players to move from one to other variant during the same season [20]. Whether lack of specific training and player's mobility between variants is or not a cause for the high injury rates and severity, should also be a question raised in future investigations.

### 1.1. Limitations

It is important to report that, despite being of the knowledge of the authors, our systematic review did not include a search in EMBASE and SPORTDISCUS databases due to their inaccessibility at the authors' institutions.

Regarding the selected articles, although a significant homogeneity in the methodology was found, since the consensus statement on injury definitions and data collection procedures in studies of injuries in Rugby Union [23] was followed by all authors in their study design, and injury definitions were very similar, there are some limitations to report.

First, most of data available has not yet been published and are available only at World Rugby website [26–28,30]. Second, it represents the effort of the same group of investigators, who are also members of the World Rugby Medical and Research Staff [32]. And third, even from the published data, only one article is not from the same main author. Therefore, we have to consider that there could be a bias in the data reported.

Data regarding nonelite players reported in our systematic review are naturally biased, since only one study [24] reported data for nonelite players and included mixed data from male and female athletes, while data from elite players were reported by six of the selected articles [25–28,30].

## 2. Conclusion

Rugby sevens, being a high-speed, high-intensity variant of rugby union, holds a significantly high injury risk for players. Injuries sustained by rugby sevens players are severe, leading to higher average absences from training and playing, when compared to the 15-a-side variant. Joint or ligament injuries on the lower limb, and injuries following contact events are the most common among elite athletes.

Taking into consideration the recent growth of rugby sevens, and the acceptance of this sport among the Olympic Family, a growing interest of the medical and scientific community in the topic of injury surveillance and injury prevention is expected, as occurred after the introduction of professionalism in the most popular variant of Rugby Union (15-a-side).

The relevant numbers identified for injury incidence and its severity in rugby sevens should drive all rugby agents to consider the discussion of rule changes or tournament organizational changes in this variant of the sport, as has previously happened with rugby 15-a-side [35].

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## Declaration of interest

The authors have no relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

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# Appendix A2 - Epidemiology of injuries in senior male Portuguese rugby union sevens: a cohort prospective study

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CLINICAL FEATURE
ORIGINAL RESEARCH

## Epidemiology of injuries in Portuguese senior male rugby union sevens: a cohort prospective study

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ABSTRACT

Objectives: To assess the incidence, type and location of injuries sustained during the Portuguese rugby union sevens circuit. To investigate the influence of players' training loads on injury risk.

Methods: A prospective cohort study recording time-loss injuries was conducted with all teams competing in the Portuguese national rugby sevens circuit (eight from the top-tier and seven from the second-tier). Main outcome measures included: incidence rate, anatomical location, type, injury incident and severity. Data were also collected regarding players' training loads. Fisher's exact test was used to estimate the relative risk of suffering an injury during the sevens season and training sevens during the fifteens season.

Results: A total of 27 injuries were recorded corresponding to an incidence rate of 133.9 injuries per 1000 player match-hours. The average severity was 22.22 days. Contact events preceded 81.5% of injuries. Most injuries occurred in the lower limb (66.7%) and were joint/ligament or muscle/tendon injuries (85.1%). The association between injuries and lower volume of training during the sevens season was identified for the second-tier ($p = 0.021$). For the same level, an inverse relation between training hours and injury severity was also found ($p = 0.008$). Top-tier players training sevens and fifteens simultaneously during the year presented a significant increase of injury risk (relative risk = 3.2; $p = 0.011$).

Conclusions: Injury incidence in our study is similar to that reported for international sevens, although severity is lower. An association between training loads and the occurrence of injuries was found for both tiers, although with differential results, thus reinforcing the need to customize players' preparation. Further studies at non-elite competitions are needed to gather significant data to accurately formulate future injury prevention protocols or recommend modifications to game laws or competition formats, aiming at players' welfare.

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### Introduction

Rugby Union is played by more than 7.7 million players worldwide [1] and the sevens variant has recently become an Olympic sport [2]. Being a very demanding sport, with a high number of physical contacts per match and frequent high intensity activities such as running, sprinting or tackling, injury incidence rates in rugby union are reported to be very high [3–5]. A significant body of evidence has been published in the past years, reporting the injury incidence rates in Rugby Union 15-a-side [6].

In contrast, sparse data are available regarding injuries in rugby sevens, although a recent systematic review confirmed the higher injury incidence rate in sevens compared with rugby fifteens [7]. Most of these data concerned elite players and competitions and revealed an injury incidence rate ranging from 101.5 to 119.8 per 1000 player match-hours, and a mean severity higher than 34 days per injury [7]. Injury distribution by type and location did not differ from the fifteens variant, with lower limb being the most frequent site of injury, and muscle/tendon and joint/ligament injuries the most frequent type [7]. One epidemiological study, published after the release of this systematic review, reporting the injuries which occurred during the 2016 rugby sevens Olympic tournament concluded that the incidence, severity and nature of the injuries sustained during the men's tournaments fell within the normal range of values for international rugby sevens tournaments [8].

If at elite level one must acknowledge the shortage of available data in the literature regarding rugby sevens injuries, for amateur and national levels, data are even sparser [7]. Besides the research published by López et al. in 2012 [9], only one other study in non-elite college rugby sevens players is available. This study was published in 2017 and also suggests a lower injury incidence rate among amateur players (59.3–74.7 injuries per 1000 player match-hours in senior

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male competitions) [10]. Injury type and location do not seem to differ significantly from amateur to elite level [7]. The only minor detail reported by Cruz-Ferreira et al [7], based on the single study assessing amateur players was that unlike at elite level, muscle/tendon injuries were of relative higher frequency at that level of competition [7].

It is also important to understand the exposure of players to training and match load and its association with sports injuries. All the major international competitions, such as the World Rugby Sevens Series, the Rugby Sevens World Cup, or the Olympic Tournament are played during multiple days (two or three), with teams competing in two or three matches a day [8,11,12]. The Rugby World Cup and the Olympic Tournament are played in a single week however, the Sevens Series is played throughout the year, in 10 stages around the world [11]. Amateur competitions usually involve players competing in one or multiple one-day tournaments contested during summer or at the end of the fifteens season [9,13].

Regarding risk factors associated with the occurrence of injuries in rugby sevens, evidence is not abundant [14]. A recent paper authored by Williams et al [14]. while agreeing with the lack of evidence in the literature, presented the accumulated and recent match load (both high and low) as targets for rugby players and coaches assessment as it substantially influences the risk of injury [14].

The Portuguese national rugby sevens team has been one of the most successful teams in Europe and one of the few that have been able to compete regularly in the major rugby sevens competitions, and its roster is mainly composed of home-based players. Portugal has been a core team at the World Rugby Sevens Series from 2012 to 2016 and won the European Rugby Sevens Grand Prix (top European nations competition) eight times between 2002 and 2012. They have also been present in five Rugby Sevens World Cups, finishing in 10th place in 2005; and won the Silver Medal at the 2009 World Games [15].

Considering the four-step 'sequence of prevention model' suggested by Van Mechelen in 1992 [16], which remains the gold-standard for all injury prevention interventions in sports, to be able to work aiming at the reduction of the burden of injuries in rugby sevens, the extent of the problem must be identified and described. As little evidence is available regarding non-elite rugby sevens injuries, the aim of this study was to determine the injury incidence rate, type, location and severity of injuries which occurred during the Portuguese national senior male rugby sevens circuit. It was also our objective to investigate the influence of players' experience in the sport and training load on the occurrence of sports injuries.

## Methods

The study followed a prospective cohort design and included data collected during the 2015/16 Portuguese national rugby sevens circuit. All definitions and procedures used in this study were compliant with the international consensus statement on injury surveillance studies for rugby [17], and the methodology used is similar to that in previously published studies [8,11,18]. The reporting of this study conforms to the STROBE statement [19].

All players taking part in the top two levels of the Portuguese national senior male rugby sevens circuit were included in the study. This is an annual competition contested by the top senior male rugby sevens teams in Portugal, played nationwide after the end of the fifteens season in the months of May to June [13]. In the 2015/16 season, the top-tier included the eight highest ranked teams in the country that competed in three one-day tournaments, contested in three consecutive weekends, with each team playing four games per day. The remaining seven teams competed in a single one-day tournament, aiming at promotion to the top level for the following year, playing three–four games each [13].

A group of researchers was present at each tournament, identifying every injury occurring during the tournaments. Injury was defined as 'any physical complaint sustained by a player during a rugby sevens match that prevented the player from taking a full part in training and/or match play for more than one day following the day of injury' [18]. Data were collected using a specific report instrument modeled after the consensus statement on injury definitions and data collec- tion procedures in studies of injuries in rugby union [17].

The researchers were responsible for recording details of each injury: date of injury, playing position (forward, back), number of games played, period of game (first half, second half, or extra time), activity at the time of injury (tackling, being tackled, collision, scrum, line-out, ruck, maul, or other), location of injury (head/neck, upper limb, trunk, or lower limb), type of injury (bone, joint/ligament, muscle/tendon, skin, brain/spine/peripheral nervous system, or other) [17]. A description of the various types of activities in rugby union is provided in the Laws of the Game [20].

Injury severity was defined by the number of days an injured player was unavailable for training and match play without limitations [11]. All injured players were followed up to obtain their date of return to practice.

Informed consent and data regarding players' age, body mass, and height were collected prior to the beginning of the tournaments. Additionally, all players were requested to provide some individual data concerning their rugby sevens experience, training loads (type and number of training hours during the fifteens and sevens season) and if they had sevens-specific training sessions during the fifteens season. Data regarding training loads were collected by recall: each player self-reported the number of hours of field and gym training during both sevens and fifteens season.

Match exposures were calculated for each team based on seven players being exposed for 14 min per game (or 20 min for each tournament final). No allowances were made for players removed from match (yellow cards, red cards, or medical treatment) [11]. Ethical approval was obtained from the Ethical Committee of the local Regional Health Administration and institutional collaboration was granted by the Portuguese Rugby Union.

Players' data are reported as mean (±Standard Deviation [SD]) and rate of injury as injuries per 1000 player match-hours. Injury data are reported as proportion (%). Severity is reported as mean days. Ninety-five percent confidence intervals (95% CIs) were calculated for severity, proportions and injury rate.

Normality of the data was checked using Kolmogorov-Smirnov or Shapiro-Wilk tests. Significant differences in values for incidence and severity were assumed if the 95% CIs did not overlap. Differences in individual and anthropometric data from top and bottom-tier players were assessed using t tests or Mann-Whitney U tests. For each level of competition, differences between injured and non-injured players were also assessed using t tests or Mann-Whitney U tests. Spearman's Correlation Coefficient was used to assess the relationship between reported training loads and the severity of injuries at both levels of competition. Fisher's exact test was used to estimate the relative risk of suffering an injury during the sevens season and training sevens during the fifteens season, for each level of competition. Level of significance was set at $p < 0.05$, and statistical analysis was performed using SPSS software (Version 22.0. Armonk, NY).

## Results

A total of 226 senior male players engaged in at least one of the four tournaments played. Table 1 shows the mean (± SD) age, stature, body mass and experience in rugby sevens. Significant differences were observed between players from the first and second levels of competition for stature, body mass and experience in the sport. Players competing at the highest level were taller ($p = 0.010$) and heavier ($p < 0.001$), but less experienced in rugby sevens ($p = 0.007$). The match exposure (player match-hours) and the number of injuries recorded in both competitions are presented in Table 2. The overall injury incidence rate for the Portuguese national rugby sevens circuit was 133.9 injuries per 1000 player match-hours (95% CI 90.1–192.2). Although not reaching statistical significance, the injury incidence rate was lower in the top-tier when compared to the second-tier group: 118 (95% CI 73.1–180.9) versus 197 (95% CI 91.5–374.2) injuries per 1000 player match-hours, respectively. However, injury severity in the former group was more than threefold that in the latter group. Again, no significant difference was found, but injured players from the top competition were on average absent from train- ing and/or practice for 27.95 days (95%CI: 10.69–55.35), while those at the second-tier were only absent for 8.63 days (95% CI: 6.13–11.00)

Table 3 provides an overview of the distribution of injuries in terms of type, location and event. Most injuries were preceded by contact events (81.5%, 95% CI: 65.5–93.7), with tackle being the event most frequently associated with injuries, with a total of 12: four while performing the tackle (19.0%, 95% CI: 4.8–38.1) and eight after being tackled (38.1%, 95% CI: 17.6–60.0).

Lower limb was the most frequent site of injury (66.7%, 95% CI: 50.0–84.2), and joint/ligament the single most frequent type (44.4%, 95% CI: 25.0–64.3). However, muscle/tendon injuries were almost as frequent and occurred in 40.7% of the cases (95% CI: 21.9–60.0). The period of the match where most of the injuries occurred was the second half (59.3%, 95% CI: 41.4–76.0), and the defensive 22 m area was the field zone where most injuries took place (33.3%, 95% CI: 15.4–51.9), followed by the defensive midfield (25.9%) and the offensive midfield (22.2%). Backs sustained the higher number of injuries (59.3%).

Regarding age and experience, no significant differences were found between injured and non-injured players.

Training loads for injured and non-injured players from both levels of competition are presented in Table 4. This includes data from the fifteens and sevens season, and the structure of the training sessions. First-tier players, both injured and non-injured, were exposed to a higher training load than second-tier players (see Table 4). This was true for all sections of training analyzed (field and weight training during fifteens and sevens season).

At the second level of competition, total training load during the sevens season was significantly lower among players that sustained injuries in this period ($p = 0.021$). Notably, regarding weight training, injured players at this level of competition also presented lower training averages and, again, statistical significance was achieved ($p = 0.048$). Injured players also had lower field and weight training loads during the fifteens season; however, no statistical significance was reached.

When the relationship between the reported training loads and the severity of injuries was assessed, a significant inverse correlation was identified (Figure 1) between the total training load of second-tier players and the severity of their injuries (Spearmen's rho: - 0.847, $p = 0.008$). No significant correlations were identified for the other variables at this level of competition. Training sevens during the fifteens season did not represent a significant risk of injury.

Table 1. Anthropometric and rugby sevens experience data for the sample population.

| Level | *n* | Age (years) | Body mass (kg) | Height (cm) | Experience in rugby (years) |
|---|---|---|---|---|---|
| First-tier | 142 | 22.27 (±4.09) | 88.83 (±12.75) | 181.23 (±6.62) | 5.75 (±3.52) |
| Second-tier | 84 | 23.30 (±4.59) | 81.49 (±12.37) | 178.60 (±6.22) | 7.38 (±4.27) |
| All | 226 | 22.62 (±4.29) | 86.18 (±13.06) | 180.28 (±6.58) | 6.39 (±3.92) |
| | | $p = 0.116$ | $p < 0.001$* | $p = 0.010$* | $p = 0.007$* |

Values are mean (SD); *Statistically significant

Table 2. Exposures and numbers and incidences of injuries in the Portuguese rugby sevens circuit.

| Level | Exposure (player match-hours) | Injuries (number) | Incidence rate (per 1000 player match-hours)[a] | Severity (days)[a] |
|---|---|---|---|---|
| First-tier | 161 | 19 | 118 (73.1–180.9) | 27.95 (10.69–55.35) |
| Second-tier | 40.6 | 8 | 197 (91.5–374.2) | 8.63 (6.13–11.00) |
| All | 201.6 | 27 | 133.9 (90.1–192.2) | 22.22 (10.07–40.84) |
| | | | | $p = 0.039$ |

[a]Values are mean (95% confidence interval)

Table 3. Location, type, and event of injuries sustained as a function of competition level.

| | First-tier proportion % (95% CI) | Second-tier proportion % (95% CI) | All |
|---|---|---|---|
| Location | | | |
| Head/Neck | 10.5 (0.0–26.1) | 25.0 (0.0–62.4) | 14.8 (3.1–30.4) |
| Upper limb | 10.5 (0.0–26.7) | 25.0 (0.0–60.0) | 14.8 (3.3–29.2) |
| Trunk | 5.3 (0.0–17.6) | - | 3.7 (0.0–12.9) |
| Lower limb | 73.7 (52.4–93.8) | 50.0 (11.1–85.7) | 66.7 (50.0–84.2) |
| Type | | | |
| Joint/ligament | 42.1 (21.8–63.2) | 50.0 (14.3–87.5) | 44.4 (25.0–64.3) |
| Muscle/tendon | 47.4 (26.7–69.2) | 25.0 (0.0–62.5) | 40.7 (21.9–60.0) |
| Skin | - | 12.5 (0.0–45.4) | 3.7 (0.0–13.0) |
| C/PNS | 10.5 (0.0–26.1) | - | 7.4 (0.0–19.2) |
| Other injuries | - | 12.5 (0.0–40.0) | 3.7 (0.0–13.0) |
| Event | | | |
| Contact | 78.9 (59.1–95.0) | 87.5 (57.1–100.0) | 81.5 (65.5–93.7) |
| Non-contact | 21.1 (5.0–40.9) | 12.5 (0.0–42.9) | 18.5 (6.3–34.5) |
| Contact | | | |
| Collision | 14.3 (0.0–35.7) | - | 9.5 (0.0–23.5) |
| Ruck | 28.6 (7.1–53.8) | 42.9 (0.0–83.3) | 33.3 (14.3–55.0) |
| Tackle | 14.3 (0.0–35.7) | 28.6 (0.0–66.7) | 19.0 (4.8–38.1) |
| Being tackled | 42.9 (15.4–70.0) | 28.6 (0.0–66.7) | 38.1 (17.6–60.0) |

CI: confidence interval; C/PNS: central or peripheral nervous system.

Table 4. Training loads and structure during fifteens and sevens season for injured and non-injured players as a function of competition level.

| | First-tier mean hours (± SD) | Second-tier mean hours (± SD) |
|---|---|---|
| Fifteens season | | |
| Weekly hours field training | | |
| Injured | 4.41 (±0.92) | 3.68 (±1.09) |
| Non-injured | 4.84 (±0.99) | 3.96 (±1.21) |
| | $p = 0.219$ | $p = 0.941$ |
| Weekly hours weights training | | |
| Injured | 3.67 (±1.66) | 1.31 (±1.44) |
| Non-injured | 3.28 (±2.22) | 2.41 (±1.92) |
| | $p = 0.298$ | $p = 0.114$ |
| Season total training load (hours) | | |
| Injured | 323.53 (±86.67) | 200.00 (±58.55) |
| Non-injured | 325.10 (±106.15) | 254.60 (±93.06) |
| | $p = 0.650$ | $p = 0.081$ |
| Sevens season | | |
| Weekly hours field training | | |
| Injured | 3.32 (± 1.63) | 2.63 (±1.19) |
| Non-injured | 3.54 (±1.50) | 3.16 (± 1.20) |
| | $p = 0.910$ | $p = 0.209$ |
| Weekly hours weights training | | |
| Injured | 3.41 (±1.71) | 0.94 (±1.26) |
| Non-injured | 2.93 (±2.38) | 2.41 (±2.13) |
| | $p = 0.245$ | $p = 0.048$* |
| Season total training load (hours) | | |
| Injured | 40.41 (±16.19) | 21.38 (±9.27) |
| Non-injured | 38.87 (±17.41) | 33.47 (±14.11) |
| | $p = 0.521$ | $p = 0.021$* |

Values are mean (SD); *Reaches statistical significance.

For the top-tier, no significant differences were found between injured and non-injured players training loads. However, regarding the training loads during the sevens season, injured players had higher mean times (40.41 ± 16.19 h) than non-injured players (38.87 ± 17.41 h). At this level of competition, a significant risk of injury during the sevens season (relative risk = 3.2, 95%CI: 1.37–7.44) was identified for players who underwent sevens specific training during the fifteens season (Fisher's exact test, $p = 0.011$). No relationship was found between training loads and the severity of injuries for the top-tier players.

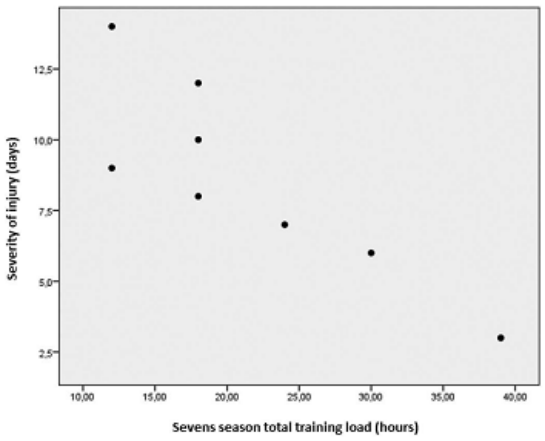


Figure 1. Injury severity and training load (second-tier): Spearmen's rho: - 0.847, $p = 0.008$.

## Discussion

This study reports the first epidemiological data on non-elite rugby sevens competitions in a European country. We provide accurate data on sports injuries occurring during the entire season of a non-elite senior male rugby sevens competition. This also represents the first study to exclusively report data from senior male players. Both previous relevant studies reported data from college players or partially merged data from under-19 and senior, as well as male and female players [9].

In order to ensure internal and external validity of our paper, a series of procedures were implemented: all data were collected using validated tools following the interna- tional consensus statement on injury surveillance studies for rugby 17 a series of meetings between the research team and

a pilot study was conducted prior to the beginning of the 2015/16 senior rugby sevens season to improve the accuracy of data collection 21 all data regarding injuries were collected by the researchers on the sidelines (and not recorded after its occurrence); all the teams (and their players) were briefed weeks before the event.

Nevertheless, a number of limitations to our study must be discussed: first of all, it covers only one season in only one country. Secondly, the length of the competition differs from the first (three tournaments) to the second level (only one tournament). In addition, injuries were recorded on the field by the researchers, while previous studies relied on self-report by the medical staff of each team – thus increasing the number of injuries recorded, as fewer (or none) of the injuries were unreported. Additionally, since these are non-professional athletes, the level of medical support available to recover from their injuries must be regarded as a limitation, when comparing the severity of injuries with previous studies at elite level. Also, despite the fact that the present study only focused on club level competitions (and not national teams), data was not collected regarding each player previous international experience. Although all athletes were amateur, some have played for the Portuguese National team in previous European and World events, thus leading to some heterogeneity to this cohort in terms of players' international experience. Finally, training load data were individually provided, as previously explained, which may have been associated with a recall bias. We acknowledge that relying on the players to recall individual training loads for the entire season represents a relevant limitation to our paper, and that comparison with training loads reported in previous studies was very difficult. Future studies should be conducted using a more accurate methodology to collect training loads data.

As expected, our results are unique and comparisons with previously published studies are very limited. However, injury incidence rate, type and location of injuries in our population seem to be mostly in agreement with the findings reported by Fuller et al [22]. for elite level players. In particular, when we consider separately data from the top-tier competition, injury incidence rate, type, and location of injuries, as well as average severity do not differ substantially from the reports of Fuller et al [12,22] for international elite players. We believe that, at least partially, these numbers can be justified by the fact that some players competing at the top-tier Portuguese national sevens championship also play at international level (Rugby Europe Grand Prix Series and/or World Rugby Sevens Series). Thus, the level of preparation and intensity of play can be similar. On the other hand, there is a slight difference between the methodology of our study and previous studies. Unlike ours, where a team of researchers directly identified potential injury situations on the field, approaching the medical staff at the end of the match and following each player until the last day of absence following the incident, injury surveillance studies reported by Fuller et al [12] relied on self-reported data from the medical staff of each team, after the end of the tournaments. Our methodology possibly led to a higher number of recorded injuries, thereby being associated with a slightly higher injury incidence rate compared to the international elite level. We also acknowledge that some of the injuries identified in our study, especially the least severe (under 7 days of absence) would not be recorded if we relied on self-report. Therefore, the lower severity of injuries in our study could be biased by the higher number of low severity injuries recorded.

For the same reason, but also due to the small sample and exposure on the second-tier, injury incidence rate and average severity for players at this level of competition cannot be compared separately to previous studies.

As reported for the players competing at the World Cup and Sevens Series, in our study the lower limb was the location of most injuries, unlike the reports from previous studies with amateur players where head/neck and the upper limb were the most frequent sites of injury[9]. A recent study by Rizi et al [10], reporting data from Hong Kong amateur college rugby players (which includes under-20 and younger players) also found that the lower limb was the most frequent site of injury among those players. These data differed from the single previous study on amateur rugby sevens, by López et al., [9] where the upper limb was the most frequent site of injury.

Also in our study, regarding the type of injury, and as reported for elite level [22], joint/ligament and muscle/tendon injuries accounted for more than three quarters of all time-loss injuries (85.1%). At amateur level, available data points to a greater heterogeneity of injury types [9]. López at al [9]. also reported that muscle/tendon and joint/ligament injuries were the most frequent among amateur players, but both types only represented 60.4% of all injuries, unlike previous studies with elite players and our findings [7]. Again, type and location of injuries in our study were more similar to those of elite international level players than those of amateurs.

As expected, and reported for both amateur and elite players, injuries usually occur after contact. The percentage reported in our study (81.5%) is in line with previously published data for both amateur (72.9%) and elite players (78.5%) [9,22].

The analysis of the influence of players' experience and training load was conducted separately for top and second-tier competitions. For second-tier players, a direct association between the occurrence of injuries and the decrease in the volume of training was identified. As shown on Table 4, the number of training hours during the sevens season was smaller in the injured group and, particularly regarding the weight training, a statistically significant difference in the number of hours for both groups was also found. Prevention of sports injuries includes a different number of aspects and resistance training is one of them [23]. For this group of players, the reduction of training hours (especially resistance training) during the sevens season does seem to predispose to the occurrence of sports injuries. The relationship between injuries and training, at this level of competition, is supported by the statistically significant inverse relation between the number of training hours during the sevens season and the severity of injuries among second-tier players.

Regarding the top-tier competition, the title is contested by eight teams in three consecutive weekly one-day tournaments (four games played in a day). There are no bye weeks between the tournaments, and the sevens season takes place at the end of a long fifteens season that begins in September and ends in late April. Also, during this period of competition, many players

also competed, or were engaged in the preparation of the World Rugby Sevens Series participation of the Portuguese National team. Therefore, it was not a surprise to identify the opposite relation regarding training loads and injuries at this level of competition. For top-tier players, a higher training volume during the sevens season was associated with a higher occurrence of injuries. Also, a significant correlation was found between training sevens during the fifteens season and the risk of injury at this level of competition.

There is a wealth of relevant work on the relationship between training loads and the occurrence of sports injuries in several sports, especially in team sports. Orchard and Gabbett, in recent years, have published relevant papers that clearly point to a positive relationship between high training loads during a sports season and the occurrence of injuries [24–27]. On the other hand, Orchard also suggests that inadequate and low levels of training, and not only excessive loads, lead to a greater number of injuries, when compared to the 'hypothetical optimal training load' [24]. Gabbett goes further and suggests the existence of a 'training-injury prevention paradox,' leaving a clear recommendation for practitioners (coaches and health professionals) to monitor the training loads during the season. The same author highly recommends to *record acute and chronic training loads, and modelling the acute:chronic workload ratio, as it might be the key to understanding players' state of 'fitness' (ie, net training recovery, lower than average risk of injury) or 'fatigue' (ie, net training stress, higher than average risk of injury)* [27]. Acknowledging that these papers are highly relevant, we must point out that most data come from elite players and teams of different football codes (e.g., soccer, Australian football, or rugby league), leaving us with two concerns: the lack of data from rugby sevens; the use of high-standard technology to collect data (e.g., heart rate monitors, global positioning systems) not available at lower levels of competition [27]. Therefore, although we believe that the same association will be found for rugby sevens, further studies are needed.

Based on our findings, we present a number of suggestions of changes to the competition formats and relevance of rugby sevens season in the non-elite setting, which include: (i) to avoid the decrease of training volume during the sevens season, and increase the focus on individual preparation of players; (ii) to increase the relative proportion regarding the duration of the sevens and fifteens season, thereby allowing an increase in the number of tournaments played; (iii) to implement bye weeks during the sevens season to allow players' recovery, as happens in Grand Prix Series and World Rugby Sevens Series (where no more than two consecutive tournaments are played); (iv) to increase the duration of the tournaments from one to two days, as occurs in all major sevens events; (v) to decrease the number of games played in the same day; (vi) to implement injury surveillance programs.

## Conclusions

We present the first study providing benchmark values for the incidence, severity and risk factors associated with injuries in senior male non-elite rugby sevens. Injury incidence rates were similar but injury severity in the Portuguese competition was smaller compared to the elite international data available.

As differences were found between the association of training volume and injuries in different levels of the competition, collective and individual loads and preparation for competition should be customized. Also, medical and coach staffs should be made more aware of the high incidence of injuries at this level of competition and the risk factors associated.

We hope to contribute toward the development and implementation of further epidemiological studies at senior male non-elite level in the near future. The methodology used was consistent with consensus statement for studies on rugby union and followed previous injury surveillance studies in rugby. Therefore, we believe that this study can be generalized to different and broader settings. It will be crucial to gather a greater body of evidence on such a relevant topic, to achieve a deeper understanding of the problem. With this knowledge, we hope to accurately formulate future injury prevention protocols or recommend further modifications to the game laws and competition formats, aiming at the promotion of players' welfare.

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## Declaration of interest

Antonio Miguel Cruz-Ferreira works for the Portuguese Rugby Union as a Medical Officer and Educator, and is a member of Rugby Europe Medical and Insurance committee. The authors have no other relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript apart from those disclosed. Peer reviewers on this manuscript have no relevant financial relationships or otherwise to disclose.

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# Appendix A3 - Promoting players' safety and welfare through the sharing of scientific knowledge with sports agents: the new reality of Portuguese rugby sevens

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CLINICAL FEATURE
EDITORIAL

## Promoting players' safety and welfare through the sharing of scientific knowledge with sports agents: the new reality of Portuguese rugby sevens

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KEYWORDS Rugby sevens; athletic injuries; sports medicine; injury prevention

As the authors of the recently published article 'Epidemiology of injuries in senior male rugby union sevens: a systematic review' [1], we would like to share with you its impact on the Portuguese rugby community and our achievements since then.

As we stated in the article, we believe that the medical staff and all other agents (athletes, coaches, and researchers) must work together aiming at creating a safer environment in a sport with such a high injury incidence rate. We also reported that few data were available regarding injuries in non-elite rugby sevens and that more studies were needed in order to broad current knowledge.

Following the publication of our article, we were granted the support from the board and the medical department of the Portuguese Rugby Union to hold a Medical Conference to present our research on rugby sports medicine, which took place in Portugal on the 10th of June 2017 [2.]

In this scientific event, we were able to sit in the same stage athletes, coaches, directors, physiotherapists, doctors, and researchers from different parts of the country with the single purpose of debating the need to focus on the epidemiology of sevens injuries and the pathways to a deeper knowledge and mitigation of the problem. During the meeting two relevant pieces of data were presented, followed by a rich discussion: the systematic review that we have published in *The Physician and Sports Medicine*; a set of data collected in the 2015/16 season of the Portuguese National Rugby Sevens Championship by the same authors that we expect to publish in detail soon.

Although data from the systematic review had already been published, it still made a significant impact on the delegates, especially on the members of the Rugby Union that agreed on the need of further studies and research. The data from the study conducted during the national championship, which revealed an overall injury incidence rate of 133.9 injuries per 1000 player match-hours caused a significant concern and long discussion. These figures are much higher than those reported by López et al. [3] for amateur rugby competitions, but more surprising, are higher than those reported for international elite sevens [1]. A deeper analysis of the data allowed the authors to present the 'Portuguese paradox,' where the injury incidence rate for the group of athletes playing in the lower division was higher (197) than of those in the top division (118 injuries per 1000 player match-hours), unlike what was previously reported for sevens and fifteens Rugby. However, injury severity was inversely related, with top-tier athlete's average severity being similar to those at elite level (28 days per injury) unlike the injuries of bottom-tier athletes (8.63 days). No other relevant differences were found in our data compared to the literature.

We tried to deepen our analysis by collecting data regarding competition formats, athlete's experience, age, height, weight, training load, and warm-up and to relate it to the occurrence of injuries in those athletes.

The bottom-tier was contested by seven teams playing in a single 1-day event, 6 weeks after the end of the fifteens season. A direct association between the occurrence of injuries and the decrease in the volume of training (especially resistance training) was identified, as well as an inverse relation between the number of training hours during the sevens season and the severity of injuries.

In the top-tier, contested by eight teams in three consecutive weekly 1-day tournaments (four games played in a day), the opposite relation regarding training loads and injuries was identified: a higher training volume during the sevens season was associated with a higher occurrence of injuries. Players who trained sevens and fifteens simultaneously during the year presented a significant increase in the risk of injury.

Based on our findings, we presented a number of suggestions of changes to the competition formats and relevance of rugby sevens season in the Portuguese setting, which included: 1 – avoid the decrease of training volume during the sevens season, and increase the focus on individual preparation of athletes; 2 – highlight the relevance of rugby sevens to the sport and its promotion by increasing the duration of the season and the number of tournaments; 3 – implement bye weeks during the season to allow players' recovery; 4 – increase the duration of the tournaments from 1–2 days, as

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occurs in all major sevens events; 5 – decrease the number of games played in the same day; and 6 – implement an injury surveillance project in Portuguese rugby sevens competitions.

The level of acceptance of our recommendations was then assessed by an anonymous questionnaire, following its presentation. We were surprised to acknowledge that 95% of the participants agreed with our recommendations and 81% clearly stated that they will implement them at their own clubs. Regarding the need for an injury surveillance program there was a 94% agreement.

Following this meeting, the authors received an invitation to present a brief report of the conference and a summary of the recommendations to the Board of the Portuguese Rugby Union for their consideration. The authors were also granted the authorization and official support of the Union to implement two injury surveillance programs in Portuguese rugby next season: one on rugby sevens and one on fifteens.

We believe that the chain of events that we are reporting now was trigged by the publication of the systematic review in your Journal, and we are thankful for the enthusiastic support of the Editorial Board. In addition, the possibility of establishing strong and effective bridges of communication with all agents and with the national rugby governing body allowed us to make our message effective in this audience, who is able to relate the reported data with their own reality.

We strongly believe that in order to implement changes in the real world, academics must leave their offices and connect with agents on the field and with those who regulate the object of the study.

Although we agree that the real impact of our recommendations will only be assessed by future studies, the first goal of our work was achieved: to use scientific evidence aiming at promoting player's safety and welfare in Portuguese rugby sevens.

It is our hope that the testimony here presented helps other researchers to believe in the impact of these types of interventions, and similar studies will take place in other countries.

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## Declaration of interest

The authors have no relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

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# Appendix A4 - Epidemiology of time-loss injuries in senior and under-18 Portuguese male rugby players

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Section II- Exercise Physiology & Sports Medicine

DE GRUYTER OPEN

## Epidemiology of Time-Loss Injuries in Senior and Under-18 Portuguese Male Rugby Players

*by*

*Antonio Miguel Cruz-Ferreira[1,2,3], Eduardo Miguel Cruz-Ferreira[1,3,4], Pedro Barbosa Ribeiro[3], Luiz Miguel Santiago[5,6], Luis Taborda-Barata[1,7]*

*Rugby union has one of the highest injury incidence rates in team sports, however, most of the available data focus on the epidemiology of injuries in countries where rugby is popular. We aimed to report the incidence rate and relevant epidemiological aspects of injuries occurred in a group of Portuguese male rugby players. A prospective cohort study was conducted with a group of 45 senior and 32 under-18 male players (total of 77 players). Outcome measures included injury incidence, position, type, location and severity of injuries. The match injury incidence for all players was 55.84 per 1000 player match-hours (66.66 for seniors, 42.85 for under-18), while mean time-loss for injury was 20.79 days. No statistical differences were found between groups. Lower limb injuries accounted for 60.5% of all injuries, while joint/ligament injuries were the most prevalent type. Contact events were responsible for 65.1% of injuries. Despite the limitations, the obtained data are consistent with the literature. Time-loss injuries seem highly prevalent in rugby union and the incidence rates found in this Portuguese-based study were lower than the reported for international and senior men's professional rugby union, but higher than those occurring in community rugby in tier-1 countries. The authors believe these data reinforce the need to develop and implement effective injury surveillance and prevention programs.*

***Key words:*** athletic injuries; injury surveillance; rugby union.

### Introduction

Rugby is a fast growing sport, gaining significant relevance and interest from the general public and the scientific community, especially after the introduction of professionalism, 20 years ago (Freitag et al., 2015). A major aspect that draws the attention of researchers is the incidence of injuries, associated with the nature of the sport, which involves significant, intense and repeated contact with the opponent (Bathgate et al., 2002; Fuller et al., 2008, 2013; Williams et al., 2013; Lehnert et al. 2018). Rugby specific characteristics include players intense physical confrontation and high-speed running, resulting in a significant risk of injury with several studies reporting injury incidences of up to 89.1 per 1000 player match-hours in international and professional rugby fifteens levels (Fuller et al., 2013; Williams et al., 2013; Stastny et al., 2016), whereas at junior level, the injury incidence ranged from 34 to 45 per 1000 player match-hours, in relevant studies published (Haseler et al., 2010; Palmer-Green et al., 2013). At lower competitive levels in senior rugby

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(community and amateur), however, injury incidence rates are lower and studies published until now, particularly in countries where rugby is more popular, report rates of 21.7 per 1000 player match-hours (Roberts et al., 2013), which are even lower than those reported for youth levels. The higher incidence of injuries reported in some studies conducted in youth rugby, when compared to amateur senior players, has not yet been fully explained. However, it can be associated to high levels of intensity in athletes with a mismatch in terms of physical attributes, as well as poor tackle and contact techniques (Palmer-Green et al., 2013).

Most data suggest that in rugby union, muscle/tendon and joint/ligament injuries of the lower limb are most prevalent, and that there are no significant differences between players from different positions in terms of injury incidence rates (Fuller et al., 2013; Palmer-Green et al., 2013; Roberts et al., 2013; Williams et al., 2013). On average, injuries in rugby union fifteen players result in an absence of 20 days (Fuller et al., 2013; Palmer-Green et al., 2013; Roberts et al., 2013; Williams et al., 2013).

In Portugal, senior male competitions are divided into three competitive levels: the lowest and the intermediate levels are almost exclusively amateurs; the highest competitive level (Divisao de Honra) has several professional and semiprofessional players, thus enhancing the competitive standards of the league (Cruz-Ferreira and Ribeiro, 2013a, 2013b). At youth levels, competition formats vary quite significantly, but teams usually compete in a national tournament played throughout the season on natural and artificial grass fields.

As seen before, injury report studies in rugby are very common in countries where rugby is a popular sport as England, Australia, New Zealand or South Africa. However, little is known regarding the epidemiology of time-loss injuries in countries struggling to grow in the world of rugby, as Portugal.

Considering the growing interest in this sport and the increasing number of players engaging in regular competition, the authors considered it relevant to promote the awareness regarding sport injuries in Portuguese rugby, as well as in all second and third tier countries, by collecting and reporting relevant data regarding match injuries in a group of senior and under 18 athletes, aiming to launch the basis for future larger and more relevant studies in this field.

We aimed to report the incidence rate and relevant epidemiological aspects of injuries, such as association to contact and non-contact events, player's position, type, location and severity of injury, for each group.

## Methods

### *Participants*

All senior male players (n = 45) from a top division Portuguese rugby club (age: 21.40 ± 3.55 years; body height: 1.79 ± 0.06 m; body mass: 87.06 ± 12.54 kg), and all under-18 male players (n = 32) from an under-18 top division Portuguese rugby club (age: 16.04 ± 0.58 years; body height: 1.77 ± 0.05 m; body mass: 75.10 ± 13.15 kg), were included in this study.

Senior players engaged in a total of 21 official matches, each lasting 80 min, and an average of 15 athletes played every minute of each match. Under-18s competed in a total of 20 official matches, each lasting 70 min, and an average of 15 athletes played every minute of each match. Total match exposure time of players in hours for a team was given by Nm*Pm*Dm/60, where Nm is the number of matches played, Pm is the number of players in the team (fifteen) and Dm is the duration of the match in minutes (Fuller et al., 2008). Therefore, senior players were exposed to a total of 420 player match-hours and under-18s to 350 player match-hours.

The study conformed to the standards set by the Declaration of Helsinki, and all players were informed about the procedures, potential risks and benefits of the research.

### *Measures*

As considered in the consensus statement on injury definitions and data collection procedures for studies of injuries in rugby union (Fuller et al., 2007, 2008), information was recorded on the date of the injury, the return to play date, characteristics of the time-loss injury (new versus recurrent, type and its location and event) and the player's position (Fuller et al., 2007, 2008). Injury severity was defined by the number of days missed by the player and grouped as: minimal (2–3 days), mild (4–7 days), moderate (8– 28 days) and severe (>28 days). Recurrent injury was defined as an injury of the same type and at

the same location as an index injury and which occurred after a player's return to full participation from the index injury. Injuries were classified, according to the consensus statement on injury definitions and data collection procedures for studies of injuries in rugby union by location, type and injury event (Fuller et al., 2007, 2008). Absences from training or match play due to other causes (illness or injuries occurring in other activities) were not considered by the research team, since only match injuries were reported. Playing positions were grouped as forwards (props, hooker, second row and back row) and backs (scrum and fly halves, centres, wingers and full backs).

*Design and Procedures*

We conducted a prospective cohort study, between August 2014 and May 2015. The methodology used in our study was compliant with the consensus statement on injury definitions and data collection procedures for studies of injuries in rugby union (Fuller et al., 2007, 2008). To gather the significant data, the authors relied on the collaboration of the team's medical staff, who reported all injuries occurring in matches during the 2014/15 season.

*Statistical analysis*

The incidence of injury is reported as injuries per 1000 player match-hours; severities as mean days; proportions as percentages. For continuous variables, normality was assessed using Shapiro Wilk or Kolmogorov-Smirnov tests, when appropriate. As continuous variables were not normally distributed, Mann-Whitney and Kruskal Wallis tests were used to compare the severity of injuries between groups, type and site of injury, when appropriate. The level of significance was set at $p < 0.05$. All data was recorded, and descriptive and inferential analysis was performed using SPSS®v20.0.

## Results

A total of 43 injuries were reported, 28 occurring in senior players and 15 in the under-18s, corresponding to an overall incidence rate of 55.84 injuries per 1000 player match-hours. Assessing each group separately, the incidence rate was of 66.66 injuries per 1000 player match-hours for senior players and 42.86 injuries per 1000 player match-hours for the under-18s. No significant differences were found between each age group ($p = 0.102$) or between the four age/position groups ($p = 0.392$). Details are presented in Table 1.

Forwards sustained more injuries than backs in the senior group (71.42 per 1000 player match-hours, with a total of 16 injuries, compared to 61.22 per 1000 player match-hours, with a total of 12 injuries, for backs), while no differences were found between backs and forwards in the under-18 group: 42.86 per 1000 player match-hours, for both backs and forwards, respectively, with a total of 7 and 8 injuries. When comparing the total number of injuries that occurred in each age group, no statistical differences were found ($p = 0.193$), nor when forwards and backs incidence rates were compared ($p = 0.647$).

Regarding the severity of injuries, no fatal or catastrophic injuries were reported. For senior players, most of the injuries were mild (50%) or moderate (32%). However, 18% of injuries were severe, with athletes missing training sessions or matches for 28 or more days. For the under 18 group of players, only one injury caused more than 28 days of absence, and most were classified as mild (46%) or moderate (46%). No statistical differences were found between the four groups previously considered ($p = 0.087$), nor between backs and forwards ($p = 0.174$) or between seniors and under-18s ($p = 0.343$).

The mean number of days missed per injury for all players was 20.79 days. The higher average injury severity was reported for the senior backs (31.83 days), followed by the under-18 forwards (20.63 days), senior forwards (15.56 days) and under-18 backs (14.00 days), as presented in Figure 1. No statistical differences were found concerning the severity of injuries between the four groups ($p = 0.269$), nor between backs and forwards ($p = 0.171$) or between seniors and under-18s ($p = 0.781$).

Regarding the injury site (Figure 2), they were more frequent in lower limbs (60.50%), followed by the trunk and upper limb (both with 14%) and the head (11.60%). When considering the injury site, lower limb injuries resulted in a higher mean number of days missed (24.27 days per injury), compared to trunk (19.33 days per injuries), head (18.20 days per injuries) or upper limb injuries (9.33 days per injuries). No statistical differences were found between the injury site and days missed ($p = 0.201$) or injury severity

grade ($p = 0.315$).

The most common injury types reported were joint/ligament injury (44.20%), haematoma/contusion/bruise (18.60%), muscle rupture/strain/tears/cramps (14%), concussion (9.30%), fracture and dislocation (each 7%).

The single most severe injury recorded was a knee ligament injury (120 days missed), however, fractures were responsible for the highest mean severity (29.33 days), followed by joint/ligament injury (25.63 days), and concussion (17.50 days). See Table 2 and Figure 3 for graphical analysis of time lost by injury type. No statistical differences were found between the injury type and days missed ($p = 0.495$) or injury severity grade ($p = 0.579$).

As expected, most injuries occurred with contact (65.10%), but no statistical differences were found between contact and non-contact injuries in terms of days missed ($p = 0.176$) or injury severity grade ($p = 0.143$).

Table 1

*Match exposure, overall injury incidence and severity*

| Group | Total player match-hours | Total match injuries | Injury incidence[1] | Mild Injuries | Moderate Injuries | Severe Injuries |
|---|---|---|---|---|---|---|
| Senior | 420 | 28 | 66.66 | 14 | 9 | 5 |
| Forwards | 224 | 16 | 71.42 | 8 | 6 | 1 |
| Backs | 196 | 12 | 61.22 | 6 | 3 | 4 |
| Under 18 | 280 | 15 | 42.85 | 7 | 7 | 1 |
| Forwards | 186.7 | 8 | 42.85 | 3 | 4 | 1 |
| Backs | 163.3 | 7 | 42.85 | 4 | 3 | 0 |

1- *Injury incidence by 1000 player match-hours.*

Table 2

*Injury type and severity*

| Type | Mean days missed |
|---|---|
| Joint/ligament injury | 25.63 |
| Haematoma/contusion/bruise | 16.25 |
| Muscle rupture/strain/tears/cramps | 15.17 |
| Fracture | 29.33 |
| Concussion | 17.50 |
| Dislocation/subluxation | 9.33 |

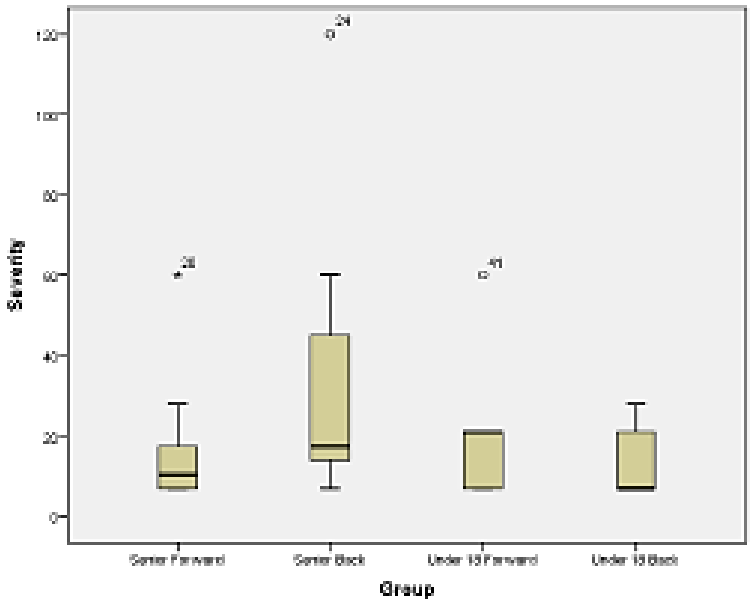


**Figure 1**

*Severity of injuries (days missed) by positional and age group*

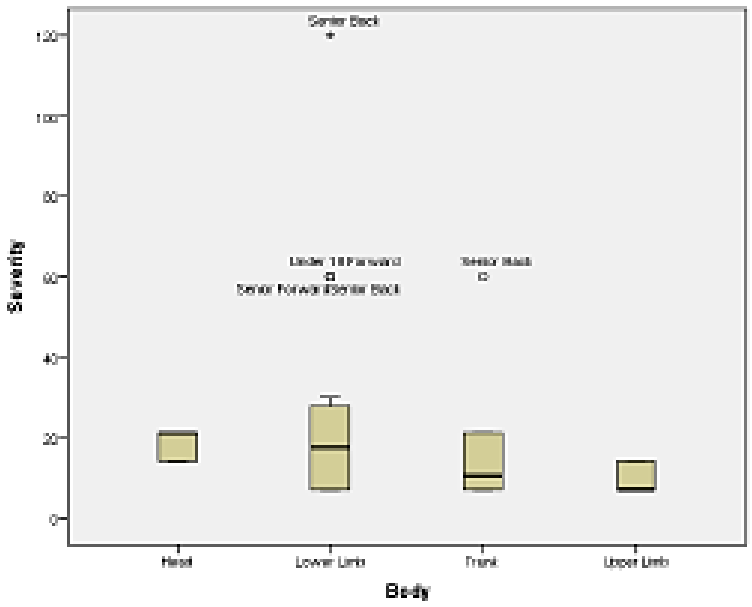


**Figure 2**

*Severity of injuries (days missed) by injury site*

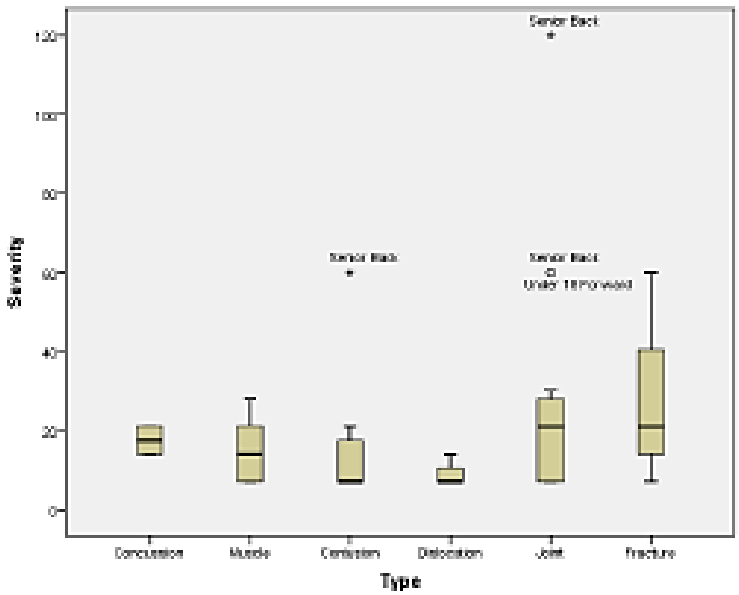


**Figure 3**

*Severity of injuries (days missed) by injury type*

## Discussion

With this paper we aimed to report the incidence rate and relevant epidemiological aspects of injuries in senior and under-18 Portuguese rugby union players. As far as we know, this is one of the first studies of time-loss injuries in Portuguese rugby union ever published.

We demonstrated that the injury incidence rate in this group of Portuguese rugby players was high and contact events were associated with two thirds of injuries. Our overall injury incidence in the group of senior players (66.66 injuries per 1000 player match-hours) was, as expected, lower than that reported for professional rugby (99.1 per 1000 player match-hours) (Fuller et al., 2013; Williams et al., 2013). However, in the under-18 group, the injury incidence was in line with the available literature for that age group (Haseler et al., 2010; Palmer-Green et al., 2013).

Nevertheless, the incidence that we report for the senior group is higher than that of studies in community or semi-professional-level rugby in New Zealand (25 per 1000 player match-hours) (Schneiders et al., 2009) or England (21.7 per 1000 player match-hours) (Roberts et al., 2013).

According to literature, it is possible to link higher injury incidence to higher levels of competition, greater match play intensity and different match play demands that comprise more contact events per match (Williams et al., 2013). Although there are many limitations in our study, we believe that we showed that Portuguese rugby clubs are attempting to raise their level of competitiveness, which naturally leads to more

intensity and greater physical demands during match play. The injury incidence rate found for the under-18 group, being approximately the same reported for British youth levels, also suggests the relatively higher level of Portuguese teams in the international rugby scene, as the recent 6th place in the Under-18 Elite Rugby Europe Championship and the second place in the Under-20 World Rugby Trophy in 2017 may reflect, with Portugal finishing above countries with more tradition in this sport (Rugby Europe, 2015).

The most common site of injuries was the lower limb, which is in accordance with data from the available literature (Fuller et al., 2013; Palmer-Green et al., 2013; Roberts et al., 2013; Williams et al., 2013).

Another finding from our study supported by the literature is the absence of significant differences in injuries sustained by forwards and backs (Williams et al., 2013), which are minimal in the senior level and non-existent in the under-18.

Regarding the type of injury, joint/ligament injuries were the most common followed by contusions, with most of injuries associated to contact events. These findings are also in accordance with the literature and seem to stress the fact that high-speed running, tackle, collisions and energy transfers in open phases of the game might justify the relevant incidence of injuries found in amateur rugby players (Roberts et al., 2013).

The greater incidence of joint injuries should make rugby agents aware of the need of proper implementation of strategies to reduce these injuries. It may be beneficial to implement appropriate training routines and warm-up exercises, as well as the use of adequate protection when previous injuries are reported, although this is still a grey area (Freitag et al., 2015; Murray et al., 2014).

A large meta-analysis published in 2013, compiling information from 15 papers addressing injuries in senior men's professional rugby union (Williams et al., 2013), suggested that the mean severity for match injuries was of 20 days, which is precisely the same reported in our study.

Overall, no relevant differences were found between our study and other major studies conducted in countries with greater rugby tradition, and most of our findings were consistent with the literature. In our opinion, this study serves its purpose and should become the basis for future larger and superior quality studies to implement, with the help of all rugby agents, at top-club and elite national levels in Portugal.

Despite the obvious limitations (small sample, all athletes belonging to the same team and covering only one season), the methodology adopted, meeting the consensus statement on injury definitions and data collection procedures for studies of injuries in rugby union, ensures the quality of the conclusions that we can draw from our study.

This is, certainly, an important milestone to Portuguese rugby, especially as it helps to raise the awareness towards the need to implement effective injury surveillance and injury prevention programs in the near future.

## Acknowledgements

To the board, coaches and medical staff of Associação Académica de Coimbra Rugby.

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# Appendix A5 – 5th ECOSEP Presentations

## Presentation/Speaker Declaration Form

This form has to be filled for each presentation in a program requesting accreditation from DHA:

**General Information**

| | | |
|---|---|---|
| **CPD Program Name:** 5th ECOSEP Congress & FIFA Update | **Program Date:** 9-10 December 2017 | **Location:** Mohammed Bin Rashid University of Medicine and Health Sciences; Mohammed Rashid Academic Medical Center; Building 14, Dubai Healthcare City |
| **Speaker Name:** Antonio Miguel Cruz-Ferreira | | |
| **Presentation Title:** Epidemiology of injuries in Portuguese senior male rugby union sevens | **Presentation Date:** 10 December 2017 | **Presentation Time:** From: 15.30 To: 17.30 |
| **Speaker's contact number:** +351914315716 | **E-Mail Address:** krusferreira@hotmail.com | |

**Outline/Abstract of the presentation:** Introduction: Rugby sevens is a fast growing variant of rugby union that made its debut at the Olympics in the 2016 games. Teams compete in one or multiple-day tournaments, with several games being played by a team each day. A recent systematic review revealed that injury incidence rates in rugby sevens are higher than in fifteens, but little data was available regarding non-multinational elite competitions. Our aim was to investigate the incidence rate, type and location of sports injuries sustained during the Portuguese senior male rugby sevens circuit. Methods: An observational one-season prospective cohort study was conducted, during the 2015/16 Portuguese Circuit. Top-15 teams were included in the research (total of 226 players). Main outcome measures included: incidence rate of injuries (injuries per 1000 player match-hours); anatomical location; type and injury incident; severity of injuries (days of absence from competition). Ninety-five confidence intervals were calculated for injury rates. Injury data are presented as percentages. Results: A total of twenty-seven time-loss injuries were recorded, for an injury rate of 133.9 per 1000 player match-hours (95%CI: 90.1-192.2). Backs sustained the higher number of injuries (59.3%). Contact events preceded 77.8% of all injuries. Being tackled was the main contact event that led to an injury (38%). Lower limb was the most frequent site (66.7%) and joint/ligament the most frequent type of injury (44.4%). Average severity of injuries was 22.2 days (minimum 3 and maximum 227 days). Conclusions: In order to accurately formulate future injury prevention protocols and/or to recommend modifications to the game laws and competition formats, a deeper understanding of injury patterns in amateur rugby sevens is crucial. At elite level, injury incidence rate is reported to be high, with numbers ranging from 101.5 to 119.8 per 1000 player-match-hours. Also, lower limb and joint/ligament are the most frequent site and type of injuries. The results of our study show that rate, type and location of injuries seem to be in accordance to the findings reported for elite athletes. These data must alert all rugby agents for the need to implement effective strategies to mitigate the burden of injuries in Portuguese rugby sevens.

Please tick the related box:

| Statement | Agree | Disagree |
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**I have carefully read and declare that I am the above mentioned speaker and I have filled this form to the best of my ability.**

**Signature** **Date 20th October 2017**

# Presentation/Speaker Declaration Form

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| General Information | | | |
|---|---|---|---|
| **CPD Program Name:** 5th ECOSEP Congress & FIFA Update | **Program Date:** 9-10 December 2017 | **Location:** Mohammed Bin Rashid University of Medicine and Health Sciences; Mohammed Rashid Academic Medical Center; Building 14, Dubai Healthcare City | |
| **Speaker Name:** Antonio Miguel Cruz-Ferreira | | | |
| **Presentation Title:** The relationship between precompetitive somatic anxiety, worry and concentration disruption and the occurrence of sports injuries in Portuguese senior male rugby sevens players | **Presentation Date:** 10 December 2017 | **Presentation Time:** From: 11.45am To: 12.00am | |
| **Speaker's contact number:** +351914315716 | **E-Mail Address:** krusferreira@hotmail.com | | |

**Outline/Abstract of the presentation:** Introduction: Rugby sevens is a fast growing sport with one of the highest injury incidence rates of all Olympic sports. A significant number of variables have been associated with the occurrence of sports injuries in all sports. Previous studies have considered anxiety as a relevant predictor of sports injuries, but limited data are available for senior male rugby sevens. The assessment of athletes' anxiety can be performed using validated tools such as the Sport Anxiety Scale(SAS), designed to measure individual differences in cognitive (worry and concentration disruption) and somatic anxiety experienced by athletes. Methods: An observational one-season prospective cohort study was conducted, during the 2016 Portuguese Rugby Sevens Circuit. All participating athletes were invited to complete the SAS questionnaire prior to the beginning of the competition. During the tournaments, researchers identified all occurring injuries. Athletes' data is presented as mean (± standard deviation). Mann-Whitney U test was used to investigate potential differences between the groups of injured and non-injured athletes on the questionnaire used. Effect sizes were calculated. Level of significance was set at $p<0.05$. Results: A total of 148 athletes participated in the competition and 102 completed the questionnaire prior to its start. During the season, nineteen time-loss injuries were recorded. Athletes sustaining injuries had significantly higher scores on concentration disruption ($p=0.003$), with a medium effect size (0.3). Despite no statistical significance, injured athletes scored higher on somatic anxiety and precompetitive worry. Conclusions: We acknowledge that the present study has some limitations: small sample; only one psychometric test used; each variable assessed individually. However, to the best of our knowledge, this is the first ever assessment of anxiety and its relationship with injuries in rugby sevens. Our results show that concentration disruption was a significant predictor of the occurrence of time-loss injuries during the competition. We believe that this data reinforces the need for all agents (athletes, coaches and medical staff) to develop and implement effective strategies for reduction, or best management of precompetitive anxiety among athletes, aiming at minimizing the risk of sports injuries in rugby sevens.

Please tick the related box:

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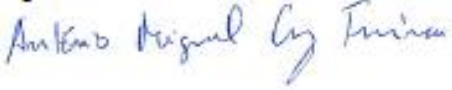
| If I am presenting research funded by a commercial company, the information presented will be based on generally accepted scientific principles and methods, and will not promote the commercial interest of the funding company. | ☒ | ☐ |

**I have carefully read and declare that I am the above mentioned speaker and I have filled this form to the best of my ability.**

**Signature** **Date 20th October 2017**



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| General Information | | |
|---|---|---|
| **CPD Program Name:** 5th ECOSEP Congress & FIFA Update | **Program Date:** 9-10 December 2017 | **Location:** Mohammed Bin Rashid University of Medicine and Health Sciences; Mohammed Rashid Academic Medical Center; Building 14, Dubai Healthcare City |
| **Speaker Name:** Antonio Miguel Cruz-Ferreira | | |
| **Presentation Title:** Time-loss injuries in senior and under-18 Portuguese male rugby union players | **Presentation Date:** 10 December 2017 | **Presentation Time:** From: 15.30 To: 17.30 |
| **Speaker's contact number:** +351914315716 | **E-Mail Address:** krusferreira@hotmail.com | |
| **Outline/Abstract of the presentation:** Introduction: Rugby union has one of the highest injury incidence rates in team sports, however most of the available data focus on the epidemiology of injuries in countries where rugby is a popular sport. We aimed to report the incidence rate and relevant epidemiological aspects of injuries occurred in a group of Portuguese male rugby players.<br>Methods: A prospective cohort study was conducted with a group of 45 senior and 32 under-18 male players competing in the respective national top division, during a complete season (from September to June). Outcome measures included injury incidence, position, type, location and severity of injuries. Mann-Whitney and Kruskal Wallis tests were used to compare severity, type and site of injury between groups. Level of significance was set at $p<0.05$.<br>Results: Match injury incidence for all players was 55.84 per 1000 player match-hours (66.66 for seniors, 48.86 for under-18), while mean time-loss for injury was 20.79 days. No statistical differences were found between groups. Lower limb injuries accounted for 60.5% of all injuries, while joint/ligament injuries were the most prevalent type. Contact events were responsible for 65.1% of injuries.<br>Conclusions: Despite the limitations, data obtained is consistent with the literature. Time-loss injuries seem highly prevalent in rugby union and the incidence rates found in this Portuguese-based study were lower than the reported for international and senior men's professional rugby union, but higher than those occurring in community rugby in tier-1 countries. Authors believe these data reinforces the need to develop and implement effective injury surveillance and prevention programs. | | |

Please tick the related box:

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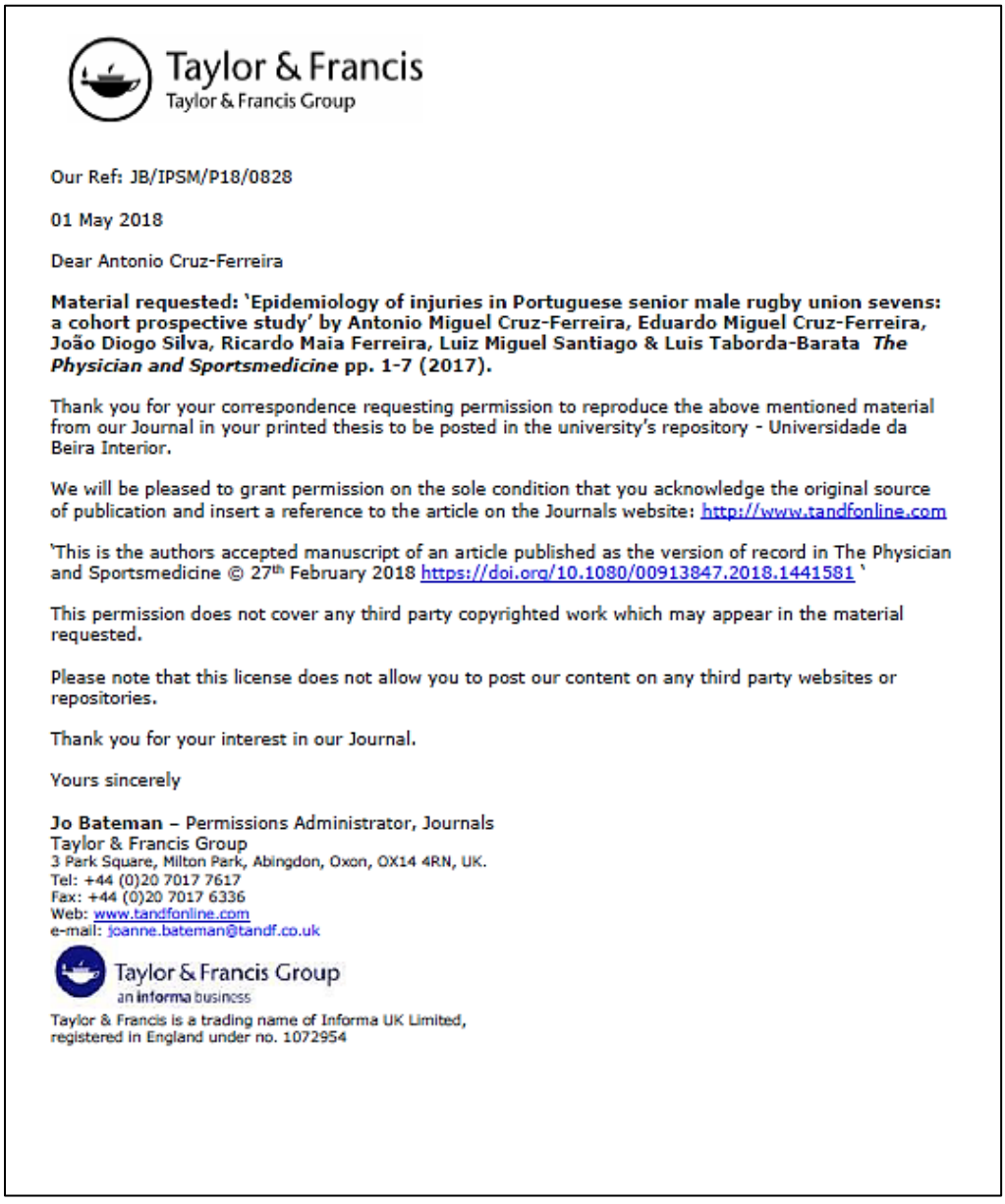

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António Miguel Cruz-Ferreira, Eduardo Miguel Cruz-Ferreira, Pedro Barbosa Ribeiro, Luís Miguel Santiago, Luís Taborda-Barata

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Name printed:

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Date:

May 15th 2018

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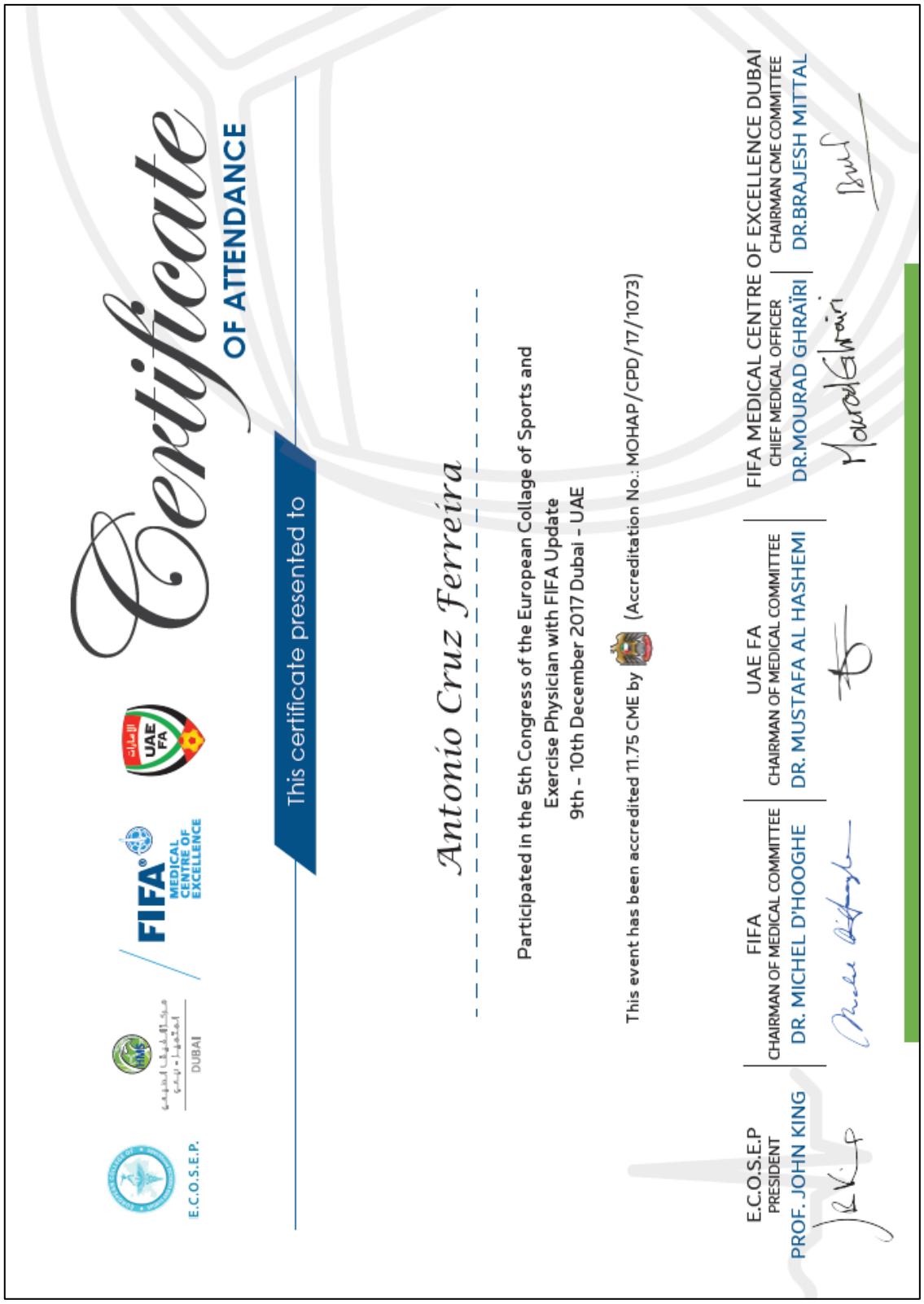
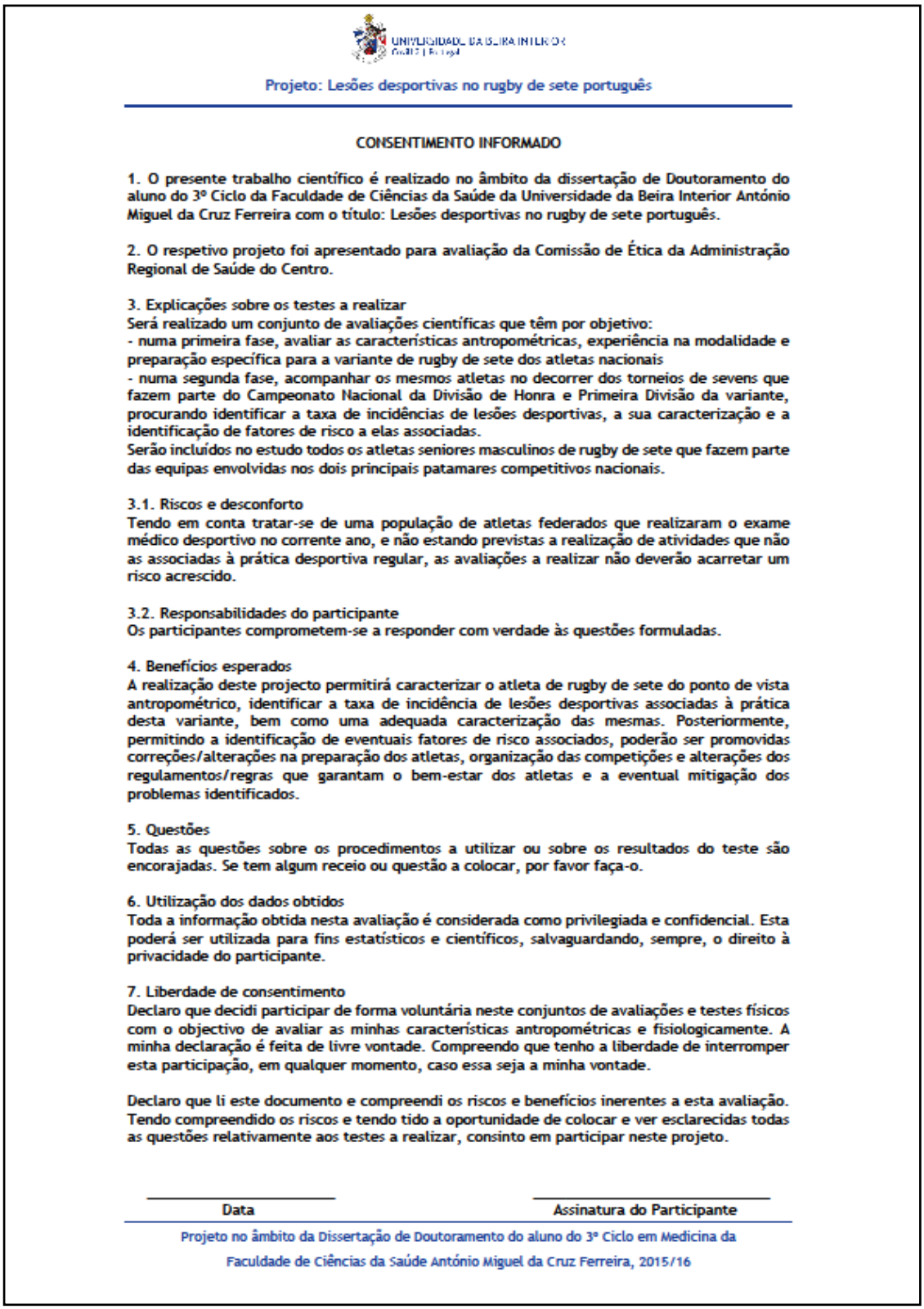


# Appendix C1 – Informed consent form



UNIVERSIDADE DA BEIRA INTERIOR
Covilhã | Portugal

Projeto: Lesões desportivas no rugby de sete português

**CONSENTIMENTO INFORMADO**

1. O presente trabalho científico é realizado no âmbito da dissertação de Doutoramento do aluno do 3º Ciclo da Faculdade de Ciências da Saúde da Universidade da Beira Interior António Miguel da Cruz Ferreira com o título: Lesões desportivas no rugby de sete português.

2. O respetivo projeto foi apresentado para avaliação da Comissão de Ética da Administração Regional de Saúde do Centro.

3. Explicações sobre os testes a realizar
Será realizado um conjunto de avaliações científicas que têm por objetivo:
- numa primeira fase, avaliar as características antropométricas, experiência na modalidade e preparação específica para a variante de rugby de sete dos atletas nacionais
- numa segunda fase, acompanhar os mesmos atletas no decorrer dos torneios de sevens que fazem parte do Campeonato Nacional da Divisão de Honra e Primeira Divisão da variante, procurando identificar a taxa de incidências de lesões desportivas, a sua caracterização e a identificação de fatores de risco a elas associadas.
Serão incluídos no estudo todos os atletas seniores masculinos de rugby de sete que fazem parte das equipas envolvidas nos dois principais patamares competitivos nacionais.

3.1. Riscos e desconforto
Tendo em conta tratar-se de uma população de atletas federados que realizaram o exame médico desportivo no corrente ano, e não estando previstas a realização de atividades que não as associadas à prática desportiva regular, as avaliações a realizar não deverão acarretar um risco acrescido.

3.2. Responsabilidades do participante
Os participantes comprometem-se a responder com verdade às questões formuladas.

4. Benefícios esperados
A realização deste projecto permitirá caracterizar o atleta de rugby de sete do ponto de vista antropométrico, identificar a taxa de incidência de lesões desportivas associadas à prática desta variante, bem como uma adequada caracterização das mesmas. Posteriormente, permitindo a identificação de eventuais fatores de risco associados, poderão ser promovidas correções/alterações na preparação dos atletas, organização das competições e alterações dos regulamentos/regras que garantam o bem-estar dos atletas e a eventual mitigação dos problemas identificados.

5. Questões
Todas as questões sobre os procedimentos a utilizar ou sobre os resultados do teste são encorajadas. Se tem algum receio ou questão a colocar, por favor faça-o.

6. Utilização dos dados obtidos
Toda a informação obtida nesta avaliação é considerada como privilegiada e confidencial. Esta poderá ser utilizada para fins estatísticos e científicos, salvaguardando, sempre, o direito à privacidade do participante.

7. Liberdade de consentimento
Declaro que decidi participar de forma voluntária neste conjuntos de avaliações e testes físicos com o objectivo de avaliar as minhas características antropométricas e fisiologicamente. A minha declaração é feita de livre vontade. Compreendo que tenho a liberdade de interromper esta participação, em qualquer momento, caso essa seja a minha vontade.

Declaro que li este documento e compreendi os riscos e benefícios inerentes a esta avaliação. Tendo compreendido os riscos e tendo tido a oportunidade de colocar e ver esclarecidas todas as questões relativamente aos testes a realizar, consinto em participar neste projeto.

Data _____ Assinatura do Participante _____

Projeto no âmbito da Dissertação de Doutoramento do aluno do 3º Ciclo em Medicina da Faculdade de Ciências da Saúde António Miguel da Cruz Ferreira, 2015/16

# Appendix C2 – Sports Anxiety Scale

Projeto: Lesões desportivas no rugby de sete português

## Escala de Ansidedade Desportiva[1]

A seguir apresentam-se várias afirmações que os atletas utilizam para descrever os seus pensamentos e sentimentos antes ou durante a competição. Leia cada afirmação e assinale, com um círculo/cruz, o número apropriado para indicar como se sente antes ou durante a competição. Alguns atletas acham que não devem admitir sentimentos de preocupação ou nervosismo, mas tais reacções são muito frequentes, mesmo em profissionais. Não há respostas certas nem erradas. Não demore muito tempo para responder a cada afirmação. Escolha apenas o número que melhor descrever como reage geralmente.

| | Nada | Um pouco | Mais ou menos | Muito |
|---|---|---|---|---|
| 1. Sinto-me nervoso. | 1 | 2 | 3 | 4 |
| 2. Durante a competição, dou comigo a pensar em coisas que não estão relacionadas com o que estou a fazer. | 1 | 2 | 3 | 4 |
| 3.Tenho dúvidas acerca de mim próprio. | 1 | 2 | 3 | 4 |
| 4. Sinto o meu corpo tenso. | 1 | 2 | 3 | 4 |
| 5. Estou preocupado por não ter um rendimento tão bom como poderia. | 1 | 2 | 3 | 4 |
| 6. A minha mente "vagueia" ou "fica no ar" durante a competição. | 1 | 2 | 3 | 4 |
| 7. Muitas vez es, enquanto estou a competir não presto atenção ao que se está a passar. | 1 | 2 | 3 | 4 |
| 8. Sinto tensão no estômago. | 1 | 2 | 3 | 4 |
| 9. Pensamentos acerca de um mau rendimento interferem com a minha concentração durante a competição. | 1 | 2 | 3 | 4 |
| 10. Estou preocupado por poder falhar sob a pressão da competição. | 1 | 2 | 3 | 4 |
| 11. O meu coração bate muito depressa. | 1 | 2 | 3 | 4 |
| 12. Sinto o meu estômago "às voltas" | 1 | 2 | 3 | 4 |
| 13. Estou preocupado com o facto de poder ter um mau rendimento. | 1 | 2 | 3 | 4 |
| 14. Tenho quebras de concentração durante a competição por causa do nervosismo. | 1 | 2 | 3 | 4 |
| 15. Algumas vez es dou comigo a tremer antes ou durante a competição. | 1 | 2 | 3 | 4 |
| 16. Estou preocupado com o facto de poder não atingir os meus objectivos. | 1 | 2 | 3 | 4 |
| 17. Sinto o meu corpo rígido. | 1 | 2 | 3 | 4 |
| 18. Estou preocupado com o facto dos outros poderem ficar desapontados com o meu rendimento. | 1 | 2 | 3 | 4 |
| 19. O meu estômago fica "perturbado" antes ou durante a competição. | 1 | 2 | 3 | 4 |
| 20. Estou preocupado por poder não ser capaz de me concentrar. | 1 | 2 | 3 | 4 |
| 21. Antes da competição o meu coração bate com força. | 1 | 2 | 3 | 4 |

[1] Dias C, Cruz JF, Fonseca AM. Anxiety and coping strategies in sport contexts: a look at the psychometric properties of Portuguese instruments for their assessment. Span J Psychol. 2009 May;12(1):338-48.

Projeto no âmbito da Dissertação de Doutoramento do aluno do 3º Ciclo em Medicina da Faculdade de Ciências da Saúde António Miguel da Cruz Ferreira, 2015/16

# Appendix C3 – Injury report form

UNIVERSIDADE DA BEIRA INTERIOR
Covilhã | Portugal

FICHA NÚMERO:
TELEMÓVEL:
EMAIL:

Projeto: Lesões desportivas no rugby de sete português

1. Preencha todos os campos abaixo:

| | | | |
|---|---|---|---|
| Nome | | | |
| Equipa | | Posição | Avançado ☐ Três-Quartos ☐ |
| Data da Lesão | / /2016 | Data de regresso à competição: | |

2. Assinale (X) a opção adequada:

| | |
|---|---|
| Jogos disputados antes da lesão | ☐ 0 jogos ☐1 jogo ☐ 2 jogos ☐3 jogos ☐ 4 jogos ☐ >4 jogos |
| Período da lesão | ☐1ª Parte ☐ 2ª Parte ☐ Prolongamento |
| Local no campo | ☐ 22 m defensivos ☐ Entre 22 defensivos e meio campo<br>☐ Entre 22 m ofensivos e meio campo ☐ 22m ofensivos |
| Duração do aquecimento antes do jogo | ☐ 0-9 minutos ☐ 10-19 min ☐ 20-29 min ☐ ≥30 min |

3. Local da lesão, assinale (X):

| | | |
|---|---|---|
| ☐ Cabeça/face | ☐ Ombro/clavícula | ☐ Anca/virilha |
| ☐ Pescoço/cervical | ☐ Braço | ☐ Coxa anterior |
| ☐ Esterno/costelas/ região dorsal | ☐ Antebraço | ☐ Coxa posterior |
| ☐ Abdomen | ☐ Cotovelo | ☐ Joelho |
| ☐ Lombar | ☐ Punho | ☐ Tendão Aquiles |
| ☐ Sacro/Pelvis | ☐ Mão/dedo | ☐ Perna |
| Observações: | | ☐ Tornozelo |
| | | ☐ Pé |

4. Lateralidade:

| | | | |
|---|---|---|---|
| ☐ Esquerdo | ☐ Direito | ☐ Bilateral | ☐ Não aplicável |

5. Tipo de lesão:

| | | |
|---|---|---|
| ☐ Concussão cerebral | ☐ Entorse/ lesão ligamentar | ☐ Abrasão |
| ☐ Lesão cerebral estrutural | ☐ Lesão meniscal/cartilagem/disco | ☐ Laceração |
| ☐ Lesão medular | ☐ Rotura muscular/estiramento | ☐ Lesão de nervo |
| ☐ Fratura | ☐ Cãimbras | ☐ Lesão dentária |
| ☐ Outra lesão óssea | ☐ Hematoma/equimose/contusão | ☐ Lesão órgão visceral |
| ☐ Luxação/subluxação | ☐ Lesão tendinosa/rotura/tendinopatia/bursite | |
| ☐ Outra (especificar): | | |

6. O atleta sofreu lesão prévia do mesmo tipo e no mesmo local? ☐ Sim ☐ Não

6.1. Se sim, em que data retomou a atividade após recuperação da lesão? _____

7. A lesão foi causada por: ☐ Sobreuso? ☐ Trauma?

8. A lesão ocorreu no: ☐ Aquecimento ☐ Jogo

9. A lesão ocorreu após contacto com outro atleta? ☐ Sim ☐ Não

9.1. se sim, após que momento de jogo, assinale (X):

| | | | | |
|---|---|---|---|---|
| ☐ Formação espontânea (maul) | ☐ Formação ordenada (melée) | | | ☐ Alinhamento |
| ☐ Colisão com oponente | ☐ Ruck | ☐ A placar | ☐ A ser placado | ☐ Outra |

9.2. O árbito assinalou falta na ação que causou a lesão? ☐ Sim ☐ Não

9.3. O árbito considerou jogada perigosa (Lei 10.4)? ☐ Sim ☐ Não

Projeto no âmbito da Dissertação de Doutoramento do aluno do 3º Ciclo em Medicina da Faculdade de Ciências da Saúde António Miguel da Cruz Ferreira, 2015/16

# Appendix C4 - Agent's feedback form

## I Jornadas Médico-Desportivas do Rugby do Centro - QUESTIONÁRIO

Após estas jornadas apresentam-se várias afirmações para conhecimento do seu impacto.
Leia cada afirmação e assinale a sua concordância. Não há respostas certas nem erradas. Procura-se perceber o grau de concordância com a afirmação realizada.

| Concorda que: | Nada | Um pouco | Concordo | Concordo Muito |
|---|---|---|---|---|
| 1. O nível de conhecimentos dos treinadores acerca da prevenção de lesões em rugby de sete (treino e jogo) é o adequado. | 1 | 2 | 3 | 4 |
| 2. O nível de conhecimentos dos jogadores acerca da prevenção de lesões em rugby de sete (treino e jogo) é o adequado. | 1 | 2 | 3 | 4 |
| 3. O nível de conhecimentos dos directores de clube/dirigentes desportivos acerca da prevenção de lesões em rugby de sete (treino e jogo) é o adequado. | 1 | 2 | 3 | 4 |
| 4. O nível de conhecimentos dos árbitros acerca da prevenção de lesões em rugby de sete (treino e jogo) é o adequado. | 1 | 2 | 3 | 4 |
| 5. As lesões desportivas no rugby são um problema relevante para todos os agentes da modalidade | 1 | 2 | 3 | 4 |
| 6. Os treinadores têm um papel a desempenhar na redução da incidência de lesões desportivas (p.e. alterações no tipo e duração dos treinos) | 1 | 2 | 3 | 4 |
| 7. Os médicos e os fisioterapeutas têm um papel a desempenhar na redução da incidência de lesões desportivas (p.e. implementação de programas de prevenção de lesões) | 1 | 2 | 3 | 4 |
| 8. Os dirigentes têm um papel a desempenhar na redução da incidência de lesões desportivas (p.e. mudanças nos modelos competitivos) | 1 | 2 | 3 | 4 |
| 9. Nas condições atuais do rugby nacional, deve haver uma clara distinção entre o período de competição de rugby de sete e de quinze | 1 | 2 | 3 | 4 |
| 10. E aceitável uma diminuição nas horas de treino (de campo e ginásio) durante o período de competição de rugby de sete, em Portugal | 1 | 2 | 3 | 4 |
| 11. A época de rugby de sete em Portugal tem, atualmente, a duração adequada | 1 | 2 | 3 | 4 |
| 12. A duração da época de rugby de sete em Portugal devia ser superior | 1 | 2 | 3 | 4 |
| 13. O número de torneios anuais de rugby de sete senior masculino organizados pela FPR é adequado | 1 | 2 | 3 | 4 |
| 14. O número de torneios anuais de rugby de sete senior masculino organizados pela FPR deve ser superior | 1 | 2 | 3 | 4 |
| 15. O número de jogos de rugby de sete realizados em cada dia de torneio é adequado | 1 | 2 | 3 | 4 |
| 16. O número de jogos de rugby de sete realizados em cada dia de torneio devia ser inferior | 1 | 2 | 3 | 4 |
| 17. Cada torneio de rugby de sete deveria ser disputado em dois dias e não apenas num dia | 1 | 2 | 3 | 4 |
| 18. Na impossibilidade de se realizarem torneios em dias consecutivos, poderia haver a divisão entre fase de grupos e fase a eliminar em semanas distintas, reduzindo o número de jogos diários (p.e. como acontece no Campeonato Inglês de Rugby de Sete). | 1 | 2 | 3 | 4 |
| 19. As dimensões do campo deveriam ser repensadas para a redução das lesões e aumentar a atractividade | 1 | 2 | 3 | 4 |
| 20. As medidas de intervenção para a redução de lesões aqui hoje transmitidas são adequadas à redução de lesões. | 1 | 2 | 3 | 4 |
| 21. As medidas de intervenção para a redução de lesões aqui hoje transmitidas serão implementadas no meu clube. | 1 | 2 | 3 | 4 |
| 22. É fundamental implementar-se um programa de formação formal e obrigatório de Prevenção de lesões no rugby de sete, para treinadores, jogadores, directores de clube e árbitros. | 1 | 2 | 3 | 4 |
| 23. E fundamental implementar-se um programa de monitorização nacional de lesões no rugby de sete. | 1 | 2 | 3 | 4 |

**Quanto ao rugby de sete nacional, qual a altura mais adequada para realizar os torneios:**

1.No final da época de rugby de quinze (abril a junho) ☐ 2. Antes do início da época de rugby de quinze ☐ 3. Ao longo de toda época ☐

**Indique, por favor, a sua ligação à modalidade:**

Atleta ☐ Dirigente ☐ Investigador ☐ Fisioterapeuta ☐ Médico ☐ Treinador ☐ Outro ☐ _____

# Appendix D1 – Letter of approval from the Portuguese Rugby Union

PORTUGAL RUGBY

DECLARAÇÃO

Para os devidos efeitos, a Direção Clínica da FEDERAÇÃO PORTUGUESA DE RUGBY manifesta o apoio à realização do estudo 'Lesões desportivas no rugby de sete português.' no âmbito do projeto de dissertação de Doutoramento na Universidade da Beira Interior de António Miguel da Cruz Ferreira.

Mais se informa que o referido projeto foi apresentado e nenhuma objeção identificada.

Lisboa, 1 de março de 2016.

Francisco S. L. Moreira
Direcção Clínica
Federação Portuguesa de Rugby

# Appendix D2 – Ethics committee approval

GOVERNO DE PORTUGAL

ARSC ADMINISTRAÇÃO REGIONAL DE SAÚDE DO CENTRO I.P.

## COMISSÃO DE ÉTICA PARA A SAÚDE

PARECER FINAL:

FAVORÁVEL
(O autor deve enviar o relatório final)

DESPACHO:

Homologado
16.04.06
Dr. José Manuel Azenha Tereso
Presidente do Conselho Diretivo
da A.R.S. Centro, I.P.

ASSUNTO:

**Estudo:** "Lesões desportivas no rugby de sete português. Avaliação da incidência, impacto, recorrência, tipo e fatores de risco associados, bem como de estratégias para a sua redução" (Proc. nº 32/2016).

**Autores:** António Miguel da Cruz Ferreira, Médico na Unidade de Cuidados de Saúde Personalizados da Mealhada; MSc e aluno de Doutoramento em Medicina da Faculdade de Ciências da Saúde da Universidade da Beira Interior

Objetivos Gerais: Identificar a magnitude do problema no âmbito do rugby de sete português, identificar fatores de risco independentes associados, desenvolver e avaliar estratégias para reduzir a incidência e/ou severidade das lesões.
O estudo desenvolve-se em 4 fases:
Fase 1: Estudo observacional com avaliação do perfil antropométrico e caracterização dos atletas das diferentes equipas que irão disputar os torneios de rugby de sete;
Fase 2: Estudo coorte prospetivo, acompanhando os atletas envolvidos nos campeonatos nacionais do 1º e 2º nível competitivo, registando e caracterizando as lesões desportivas ocorridas durante a época desportiva 2015/16;
Fase 3: Organização de uma conferência com os agentes da modalidade, com vista à apresentação dos dados e conclusões alcançadas e à avaliação da perceção da sua importância pelos mesmos;
Fase 4: Elaboração de documento contendo recomendações para correção/minoração de riscos identificados.
O trabalho será feito nos torneios de rugby de sete realizados a nível nacional.
Há concordância da Federação Portuguesa de Rugby.
O consentimento informado está presente e é aceitável.
O financiamento é do próprio autor.

NOTA: O autor é médico de medicina desportiva e diretor do departamento médico de rugby da AAC.

O Relator e Presidente da Comissão de Ética,

Carlos A. Fontes Ribeiro

# Appendix D3 – Support from the Portuguese Rugby Union

RE: Pedido de apoio e convite FPR

Ana Martins - FPR <anamartins@fpr.pt>

seg 29-05-2017 15:27

Para:'Antonio Ferreira' <krusferreira@hotmail.com>;

Cc:'Mário Costa - FPR' <mariocosta@fpr.pt>;

Boa tarde

Espero que esteja tudo bem consigo.
Tendo em conta que o Sr. Presidente da FPR vai estar fora do país no dia 10 de Junho, informo que se fará representar na cerimónia pelo Vice-Presidente Gonçalo Neto.

Melhores cumprimentos

**Ana Martins**
Dep. Administrativo
anamartins@fpr.pt
T: +351 217991690/97 | Fax: +351 217936135

**Federação Portuguesa de Rugby**
Rua Julieta Ferrão nº12 3ºAndar
1600-131 Lisboa
Siga-nos | Follow us

# Appendix D4 – Support from the Faculty of Health Sciences of the University of Beira Interior

Coimbra, 9 de Maio de 2017

Ex.mo Sr. Presidente da

Faculdade de Ciências da Saúde da Universidade da Beira Interior

**Prof. Doutor Luis Taborda Barata**

**Assunto:** Pedido de patrocínio científico para as Primeiras Jornadas Médico-Desportivas do Rugby ao Centro

A Comissão Organizadora das Primeiras Jornadas Médico-Desportivas do Rugby ao Centro que se realizarão em Coimbra a 10 de Junho de 2017 vem, por este meio, solicitar a V.a Ex.a que se digne atribuir o patrocínio científico da Faculdade de Ciências da Saúde da Universidade da Beira Interior ao nosso evento que abordará temas relevantes da área da Medicina Desportiva e do Rugby.

Conhecendo a tradição, o entusiasmo e o conhecimento que tanto o corpo docente como os alunos e investigadores da V.a instituição têm relativamente aos temas a serem abordados, acreditamos tratar-se de uma associação que resultará em mútuo benefício.

Solicitamos, igualmente, a autorização para utilizar o logótipo da vossa instituição em toda a documentação das Jornadas, com a informação de que nos concederam o "Patrocínio Científico".

Para melhor análise deste pedido, segue em anexo o Programa Provisório das Jornadas com informações detalhadas relativas à data, local, horário, Comissão Organizadora, Comissão Científica, Comissão de Honra e Presidência, assim como dos oradores convidados.

Certos de que partilharão o mesmo entusiasmo na promoção do bem-estar e da segurança dos atletas de uma modalidade que nos diz tanto, despedimo-nos aguardando o vosso parecer.

Com os melhores cumprimentos,

Comissão Organizadora das Primeiras Jornadas Médico-Desportivas do Rugby ao Centro

ANTÓNIO FERREIRA

# Appendix E – Conference summary and list of recommendations to the Portuguese Rugby Union

ACADÉMICA RUGBY

# I JORNADAS MÉDICO-DESPORTIVAS DO RUGBY

## Lesões Desportivas no Rugby de Sete Masculino

## 10 de Junho

Auditório da Idealmed

**RESUMO DAS JORNADAS E**

**APRESENTAÇÃO DE RECOMENDAÇÕES COM VISTA À**

**REDUÇÃO DO RISCO DE LESÃO NO RUGBY DE SETE PORTUGUÊS**

Autores: António Cruz-Ferreira, Luis Taborda Barata e Luiz Miguel Santiago

# Introdução

Este documento visa a apresentação do resumo das I Jornadas Médico-Desportivas do Rugby, realizadas no passado dia 10 de Junho de 2017 no Auditório da IDEALMED em Coimbra, organizadas pelas Secção de Rugby a Associação Académica de Coimbra e que contaram com o patrocínio científico da Faculdade de Ciências da Saúde da Universidade da Beira Interior e o patrocínio institucional da IDEALMED e da Federação Portuguesa de Rugby.

Procura-se, também, com base na análise dos dados apresentados e da discussão que se seguiu, apresentar à Federação Portuguesa de Rugby um conjunto de recomendações para as próximas épocas desportivas que possam, de acordo com a evidência apurada, conduzir a uma melhoria da segurança dos atletas e à redução do risco de lesão desportiva no rugby de sete nacional.

Estas Jornadas enquadram-se numa das fases do projeto de inevestigação conduzido por António Cruz Ferreira, médico especialista em Medicina Desportiva e aluno do 3º Ciclo do Doutoramento em Medicina na Universidade da Beira Interior, cujo tema é a "Epidemiologia das Lesões Desportivas no Rugby de Sete" e que tem como orientadores os Prof. Doutores Luiz Miguel Santiago e Luís Taborda Barata.

Neste evento científico foram realizadas três mesas redondas de discussão:

- a primeira dedicada ao "Rugby de sete: desafios de uma variante em expansão", que contou com três oradores (Prof. Rui Carvoeira, selecionador nacional de sub-18; João Luís Pinto, treinador da Associação Académica de Coimbra; Dr. Ricardo Dias, ex-atleta internacional de rugby de sete). Esta mesa foi moderada pelo Prof. Doutor Luís Taborda Barata, Presidente da Faculdade de Ciências da Saúde da Universidade da Beira interior e foi seguida de um período de discussão entre todos os presentes;

- a segunda, dedicada à "Epidemiologia das lesões desportivas no rugby de sete" que contou com duas apresentações orais, uma do Dr. António Cruz Ferreira, médico da Associação Académica de Coimbra e doutorando na Universidade da Beira Interior e outrado Fisioterapeuta Ricardo Ferreira, fisioterapeuta da Associação Académica de Coimbra. A moderação desta mesa esteve à responsabilidade do Prof. Doutor Luiz Miguel Santiago, Professor Assistente Convidado da Faculdade de Ciências da Saúde da Universidade da Beira interior e foi seguida de um período de discussão;

- a terceira e última mesa, moderada pelo Dr. Pedro Henriques, Vice-Presidente da Secção de Rugby da Associação Académica de Coimbra, foi dedicada aos "Modelos competitivos: conciliar o bem-estar do atleta, a sustentabilidade e o espetáculo" e contou com a participação, para além de todos os palestrantes e moderadores já referidos, do Dr. Paulo Picão Eusébio, Presidente da Secção de Rugby da Associação Académica de Coimbra e do Dr. Gonçalo Neto, Vice-Presidente da Federação Portuguesa de Rugby.

# Resumo das Jornadas

## 1. Rugby de sete: desafios de uma variante em expansão

Nesta primeira mesa houve a intervenção de agentes desportivos com experiência significativa na modalidade e na variante em questão, tendo sido possível estabelecer um nível elevado de discussão sobre as especificidades do rugby de sete e o seu papel determinante no crescimento da modalidade.

Na intervenção inicial, conduzida pelo Prof. Rui Carvoeiro, houve a apresentação de dados objetivos, publicados pela World Rugby e por académicos interessados na modalidade, relativos às exigências do jogo de rugby de sete. Identificou-se a existência de um mais elevado número de fases do jogo, contacto com o adversário e realização de corrida de alta intensidade, por unidade de tempo de jogo, quando comparado com a variante de XV.Estas caracteristas da variante tornam-na mais dinâmica e apelativa para o público, pela velocidade de jogo e pela constante alteração do resultado, mas associa-se a um risco de lesão e a uma severidade de lesões desportivas superiores.

A intervenção do treinador de seniores da Associação Académica de Coimbra, que viria a sagrar-se vice-Campeão Nacional de Rugby e Sete na semana seguinte, João Luís Pinto, centrou-se nos aspetos específicos da preparação técnica para um tonrneio de rugby de sete. Foi apresentada a metodologia de treino normalmente utilizada na preparação de um evento de rugby de sete e discutidas as diferenças na necessidade de preparação, tendo em conta as particularidades da variante, já anteriormente referidas.

A terceira intervenção, do Dr. Ricardo Dias, centrou-se na apresentação individual da perspetiva do atleta praticante de rugby de sete, tanto a nível nacional como internacional. Tendo em conta a extensa experiência do aplestrante, foram discutidas as particularidades dos torneios domésticos e do Circuito Mundial de Rugby de Sete, do ponto de vista do desportista – os seus receios, a sua preparação, a sua sensibilidade.

No final das intervenções dos palestrantes, foi aberta a discussão aos presentes, tendo sido colocadas várias questões. O foco da discussão centrou-se na importância, reconhecida por todos, da visibilidade da variante de sete no crescimento (ou no potencial de crescimento) do rugby nos países onde este é menos popular. No rugby de sete, existe uma maior competitividade nos diferentes torneios disputados, existindo uma clara possibilidade de seleções com menor histórico no rugby de XV competirem em igualdade de circunstâncias com outras de países onde o rugby é mais popular.

Foi, ainda, destacada a possibilidade de se centrar o desenvolvimento da modalidade (não na sua totalidade, mas em parte) e a formação de atletas na variante de sete, tanto pela possibilidade de formar equipas com menos atletas, mas também por se tratar de uma variante com maior visibilidade, desde a introdução no programa olímpico e por permitir uma transição fácil para o rugby de XV.

## 2. Acompanhamento de um torneio de rugby de sete

Na segunda mesa do evento, o fisioterapeuta coordenador da Secção de Rugby da Académica, Ricardo Ferreira, apresentou com muita clareza os apetos relaventes do acompanhamento médico de um torneio de rugby de sete e que incluem: a segurança do atleta, a articulação entre o corpo clínico e a equipa técnica, a hidração e nutrição, o aquecimento, a recuperação entre jogos e após o torneio, a gestão do esforço e a gestão das lesões ao longo das partidas. Tratou-se de uma paresentação muito clara, bem desenhada e orientada e que permitiu uma discussão participada e envolvente no final da mesa-redonda.

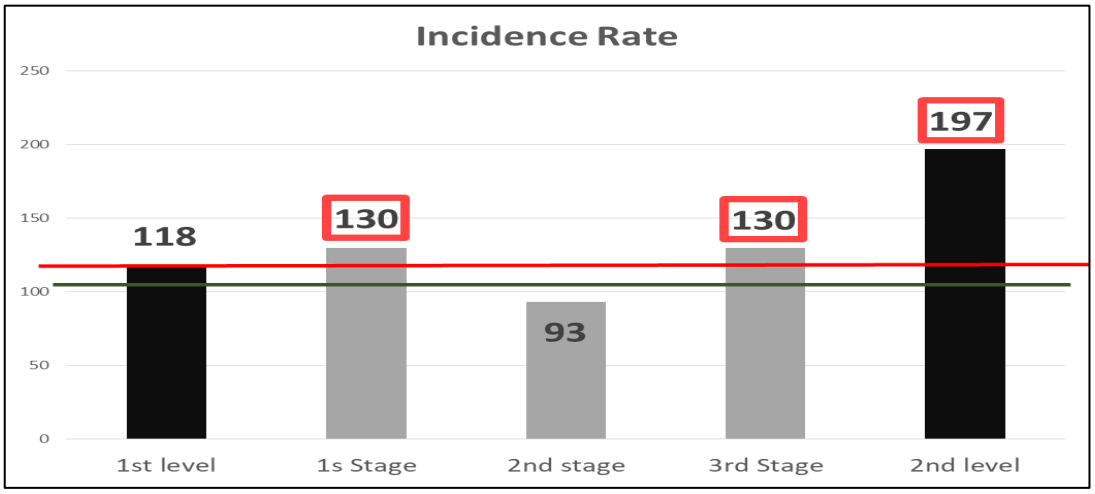
## 3. Epidemiologia das lesões desportivas no rugby de sete

Na segunda fase das Jornadas, foi apresentado o estudo "Epidemiologia das lesões desportivas no Rugby de Sete" realizado pelo aluno de Doutoramento da Faculdade de Ciências da Saúde da Universidade da Beira Interior e médico especialista em Medicina Desportiva, António Cruz Ferreira, realizado durante a época de 2015/16, avaliando as lesões desportivas ocorridas no primeiro e segundo patamar competitivo nacional.

O estudo incluiu um total de 226 atletas (142 do Circuito Nacional de Rugby de Sete e 84 da Primeira Divisão), correspondendo a uma exposição total de 201,6 horas de jogo-jogador (161 horas no Circuito Nacional e 40,6 na Primeira Divisão). Ao longo dos quatro eventos competitivos incluídos (três etapas do Circuito Nacional e uma etapa da Primeira Divisão), foram registadas 27 lesões (19 no primeiro caso e 8 no segundo), correspondendo a uma taxa de incidência de 133,9 lesões por 1000 horas de jogo-jogador.

Este valor é muito superior ao verificado para as competições amadoras de rugby de sete reportados por Lopéz et al.,[43] mas mais surpreendente, é superior ao reportado para o rugby de sete de elite internacional.[3] No entanto, se avaliadas individualmente as competições incluídas no estudo, verifica-se que o Circuito Nacional (1º nível competitivo) apresenta uma taxa de incidência sobreponível à da World Rugby Sevens Series e é no grupo de atletas da Primeira Divisão (segundo nível), que os valores são anormalmente elevados (ver gráfico 1).

**Gráfico 1** - Incidência de lesões por nível competitivo e etapa



Uma análise detalhada da incidência por torneio, no Circuito Nacional (primeiro patamar competitivo) permite identificar um pico de lesões no primeiro momento de competição, marcadamente reduzido no evento da semana seguinte. No entanto, no terceiro evento disputado em semanas consecutivas, volta a registar-se um pico de incidência de lesões. Sendo aceitável do ponto de vista conceptual a existência de um pico de lesões quando se expõe um grupo de atletas, pela primeira vez, a um tipo de competição que não realizavam há um ano, o mesmo não se poderá dizer do pico no terceiro torneio. Ao contrário do que se verifica na maioria das competições internacionais, em Portugal, na época de 2015/16, optou-se por realizar três torneios em semanas consecutivas. Alertam-se os agentes responsáveis pelo calendário desportivo para a eventual necessidade de introduzir uma semana de repouso entre dois eventos consecutivos.

A distribuição por tipo e local de lesão no presente estudo foi sobreponível à verificada na literatura internacional. Apenas no que respeita ao momento de jogo que condiciona a lesão, apesar de se manter a placagem como principal evento causador (principalmente ser placado), verificámos, na população portuguesa avaliada, uma incidência elevada de lesões ocorrendo após o ruck.

Relativamente à distribuição por grupo posicional, 59% das lesões ocorreram em atletas pertencentes ao grupo dos três-quartos e 41% aos avançados. Estes dados são consistentes com a distribuição posicional no jogo de rugby de sete: três avançados e quatro três-quartos.

A gravidade média das lesões, que se situou em 22,2 dias, é semelhante à do rugby de 15 de elite,[2] mas corresponde a metada da verificada para os atletas de rugby de sete do mesmo nível.[3] No entanto, tal como verificado para a taxa de incidência, numa análise mais fina dos dados verificamos que a severidade reportada nos atletas de nível competitivo superior (Circuito Nacional de Rugby de Sete) é muito próxima da verificda nos patamares competitivos de elite do rugby de sete (com um média de 28 dias/lesão), enquanto que no segundo nível de competição, a gravidade média das lesões é anormalmente baixa (correspondendo a 8,63 dias).

Torna-se, assim, claro que existem marcadas diferenças na ocorrência e gravidade das lesões no Primeiro e Segundo patamar competitivo nacional.

Para tentar perceber este fenómeno e poder caracterizá-lo em maior detalhe, antes do início dos torneios, foi solicitado aos atletas participantes que fornecessem dados relativos a: volume de treino ao longo da época de XV (até maio); volume de treino durante a época de sete (até ao último torneio); se faziam treino específico de 7s durante a época de XV; qual a duração do aquecimento antes das sessões de treino e jogo. Avaliámos, também, o Nível de Ansiedade Pré-Competitiva, a idade, o peso, a estatura, a experiência no rugby e no rugby de sete.

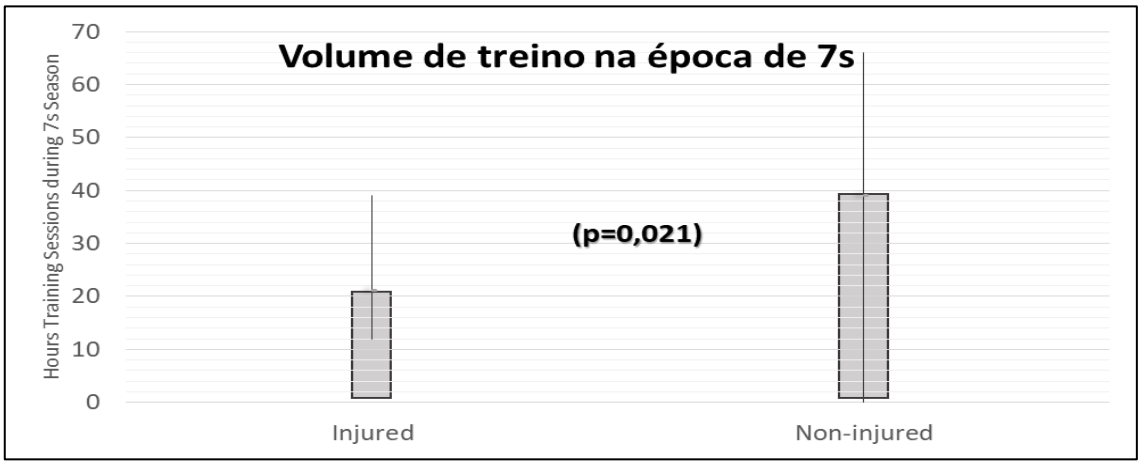
Com base nos dados fornecidos e da sau correlação com as lesões desportivas identificadas, verificámos que existem diferenças importantes no que respeita ao perfil antropométrico e à experiência dos atletas dos diferentes patamares competitivos. Os atletas do Circuito Nacional são mais jovens e menos experientes, mas apresentam estatura e peso mais elevados. Detalhes no quadro 1.

**Quadro 1** – Perfil antropométrico e experiência na modalidade dos atletas

| | Circuito Nacional | Primeira Divisão |
|---|---|---|
| Idade (anos) | 22,27 (±4,09) | 23,30 (±4,59) |
| Peso (kg) | 88,83 (±12,75) | 81,49 (±12,37) |
| Estatura (cm) | 181,23 (±6,62) | 178,60 (±6,22) |
| Anos a jogar rugby | 10,17 (±4,89) | 10,38 (±5,25) |
| Anos a jogar rugby de sete | 5,75 (±3,52) | 7,38 (±4,27) |

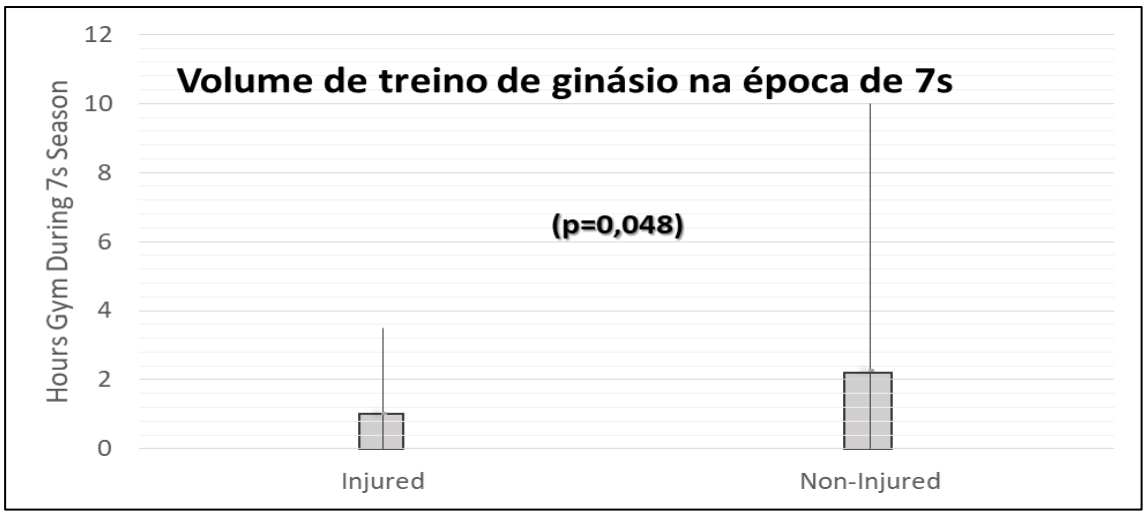
Focando a análise no segundo patamar competitivo, e procurando identificar associações entre a preparação para a competição e o risco de lesão, verificou-se uma associação, com significância estatística, entre o menor volume de treino na época de rugby de setee o maior risco de lesão desportiva durante o torneio (gráfico 2).

**Gráfico 2** - Comparação entre o volume de treino na época de rugby de sete dos atletas lesionados e não lesionados



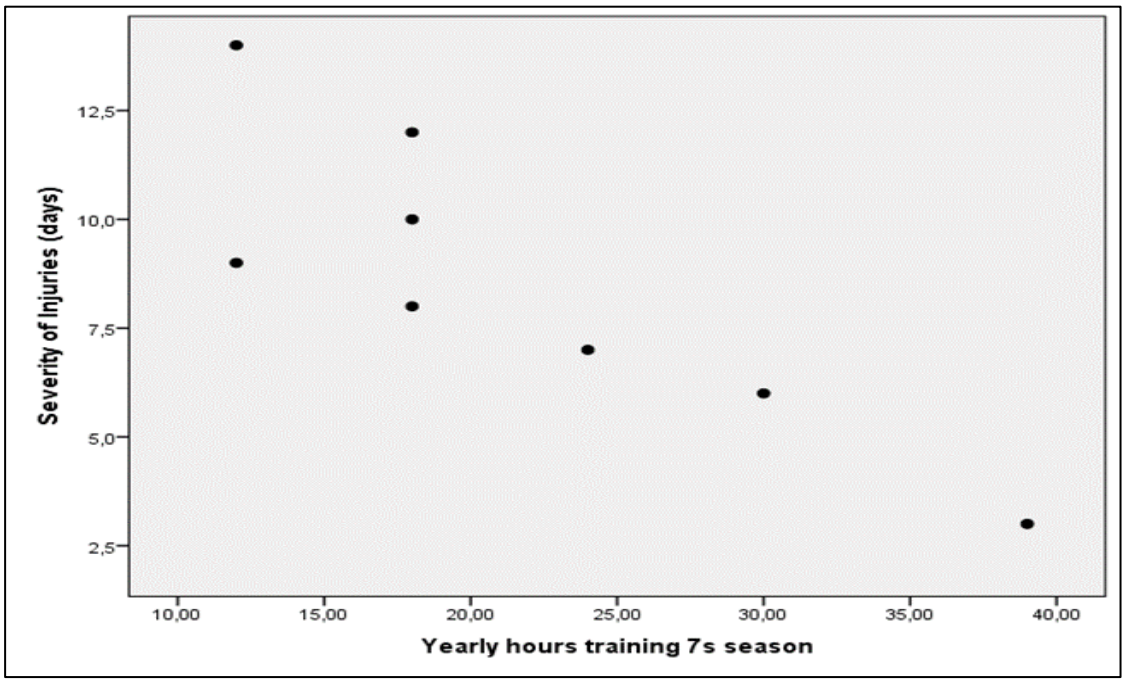

Essa relação verifica-se, igualmente, para a comparação entre o volume de treino de ginásio no mesmo período e a ocorrência de lesão desportiva (gráfico 3), com significância estatística. Este dado parece reforçar a importância do treino de resistência na estratégia de prevenção das lesões desportivas (em todas as modalidades, mas também no rugby de sete).

**Gráfico 3** - Comparação entre o volume de treino de ginásio na época de rugby de sete dos atletas lesionados e não lesionados




Ainda para o segundo patamar competitivo e, de certa forma, reforçando os dados já apresentados, verificou-se neste nível de competição uma correlação negativa estatisticamente significativa entre o volume de treino durante a época de rugby de sete (gráfico 4).

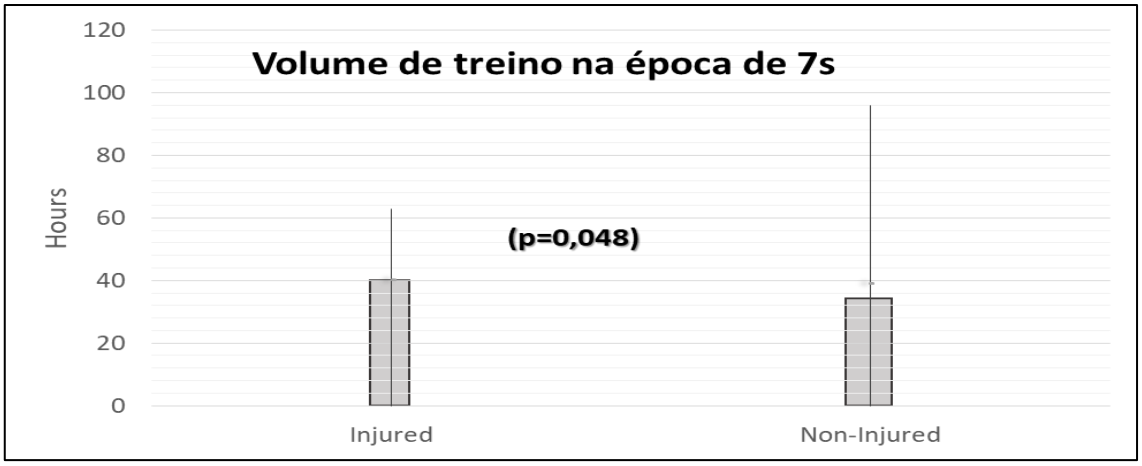
**Gráfico 4** – Correlação entre o volume de treino na época de rugby de sete e a severidade das lesões desportivas (Correlação de Spearman: p=0,008)




No primeiro patamar competitivo, provavelmente devido ao facto de os atletas estarem expostos a três eventos realizados em semanas consecutivas, provocando maior fadiga e porporcionando pouco tempo de recuperação, verificou-se uma relação

estatisticamente significativa entre um maior volume de treino durante a época de de rugby de sete e a ocorrência de lesão (gráfico 5).

**Gráfico 5** - Comparação entre o volume de treino na época de rugby de sete dos atletas lesionados e não lesionados




Neste nível competitivo, foi igualmente possível identificar um risco relativo de lesão superior para os atletas que ao longo da época de XV realizavam algum tipo de treino específico de rugby de sete. Este risco foi estimado em 220% (Risk Estimate 3.2, usando o Teste Exato de Ficher, com p= 0.011) relativamente aos atletas que não realizavam treino de rugby de sete (tabela 2).

**Tabela 2** – Calculo do risco de lesão dos atletas que treinam rugby de sete durante a época de XV

| Risk Estimate | | | |
|---|---|---|---|
| | Value | 95% Confidence Interval | |
| | | Lower | Upper |
| Odds Ratio for Training 7s during XVs season (Yes / No) | 4.235 | 1.429 | 12.552 |
| For cohort Injuried = Yes | 3.200 | 1.377 | 7.435 |
| For cohort Injuried = No | 0.756 | 0.572 | 0.997 |
| N of Valid Cases | 115 | | |

Para este patamar competitivo, foram, igualmente, identificadas associações positivas, com significado estatístico, para a ocorrência de lesão nos atletas que apresentavam valores mais elevados de Disrupção da Concentração no teste de avaliação da ansiedade pré-competitiva (p= 0,003) e para os atletas com hábitos de aquecimento antes dos treinos e jogos de menor duração ao longo da época (p= 0,015).

**Em conclusão, no segundo patamar competitivo verificou-se:**

1- Uma incidência de lesões correspondendo ao dobro da observada no rugby de sete de elite internacional;

2- A competição envolve um evento único várias semanas após fim da época de XV;

3- O desinvestimento no treino por parte dos atletas condicionou um aumento da incidência de lesões;

4- Particularmente, o desinvestimento no treino de ginásio aumentou o risco de lesão, aqui demonstando, acreditamos, a influência do treino de resistência na prevenção de lesões;

5- Uma relação inversa entre o número de horas de treino e a gravidade das lesões.

6- Da mesma forma, no grupo de atletas que apresentava duração inferior no tempo de aquecimento pré-competitivo ao longo da época se verificou uma maior ocorrência de lesões desportivas.

**No primeiro patamar competitivo, por sua vez, verificou-se:**

1- Os atletas neste patamar competitivos eram mais jovens e menos experientes no rugby de sete do que no patamar inferior;

2- Apesar dea época de XV ser mais longa, à qual se acrescenta os trabalhos das seleções nacionais, a época de rugby de 7 foi projetada com três eventos em semanas consecutivas, sem paragem;

3- Todos os eventos foram de dia único, com quatro jogos por dia e intervalos entre jogos inferiores a 90 minutos;

4- Tendo em conta a maior carga de treino e competição já acumulada, nos atletas do primeiro nível competitivo, um maior volume de treino durante o período de rugby de sete esteve associado a maior ocorrência de lesões;

5- No mesmo sentido, atletas que para além da preparação para a época de XV, durante o ano realizaram treino específico para rugby de sete simultaneamente, apresentaram um aumento significativo do risco de lesão;

6- Simultaneamente, provavelmente em função da idade inferior e menor experiência na modalidade, foram identificadas associações significativas entre níveis inferiores de concentração competitiva e risco de lesão neste grupo de atletas;

## 4. Modelos competitivos: conciliar o bem-estar do atleta, a sustentabilidade e o espetáculo

A mesa de encerramento das Jornadas foi dedicada à discussão dos modelos competitivos no rugby de sete e foi moderada pelo Dr. Pedro Henriques, vice-presidente da Secção de Rugby da Académica de Coimbra que fez, também, uma pequena nota introdutória onde apresentou os diferentes modelos competitivos nacionais e internacionais existentes. Para além de incluir no painel de discussão todos os palestrantes que já tinham intervido anteriormente, esta mesa contou com a participação do Dr. Gonçalo Neto, vice-presidente da Federação Portuguesa de Rugby, em representação da direção da instituição.

Foi unânime a ideia de que o rugby de sete é, atualmente, um importante veículo de divulgação e promoção a modalidade, devendo merecer da parte de todos os agentes uma particular atenção, acrescida pelo fato de recentemente ter conseguido a entrada no grupo restrito de modalidades olímpicas.

De igual forma, foi considerado importante moldar os modelos competitivos às necessidades dos atletas, tendo em conta os riscos de lesão desportiva tão elevados nesta variante, e não considerar apenas os interesses dos clubes e da Federação na organização das competições.

Reconhecendo as dificuldades reportadas no estudo apresentado no mesmo evento, foi identificada a necessidade de divulgação do mesmo junto dos distintos agentes responsáveis pela modalidade em Portugal, como forma de ativamente agir com vista à resolução dos problemas, nomeadamente a existência de torneios únicos, de vários jogos no mesmo dia com pouco tempo de intervalo e da distância entre o final da época de quinze e as competições de rugby de sete.

Apesar de se terem reconhecido alguns constrangimentos financeiros e de logistica relativamente a algumas propostas de alteração dos modelos competitivos nacionais, a organização das jornadas e o grupo de investigadores que apresentou o trabalho sobre a epidemiologia das lesões no rugby de sete foi instado a dialogar ativamente com os clubes e federações, com vista à promoção da segurança e bem estar dos atletas.

## 5. Questionário: avaliação do nível de concordância relativamente aos dados apresentados e às propostas realizadas

Após a conclusão das Jornadas e antes da realização do Circuito Nacional de Rugby de Sete, foi solicitado aos participantes a resposta a um questionário de 24 questões sobre aspetos relevantes da prevenção de lesões e promoção da segurança e bem estar dos atletas praticantes de rugby de sete.

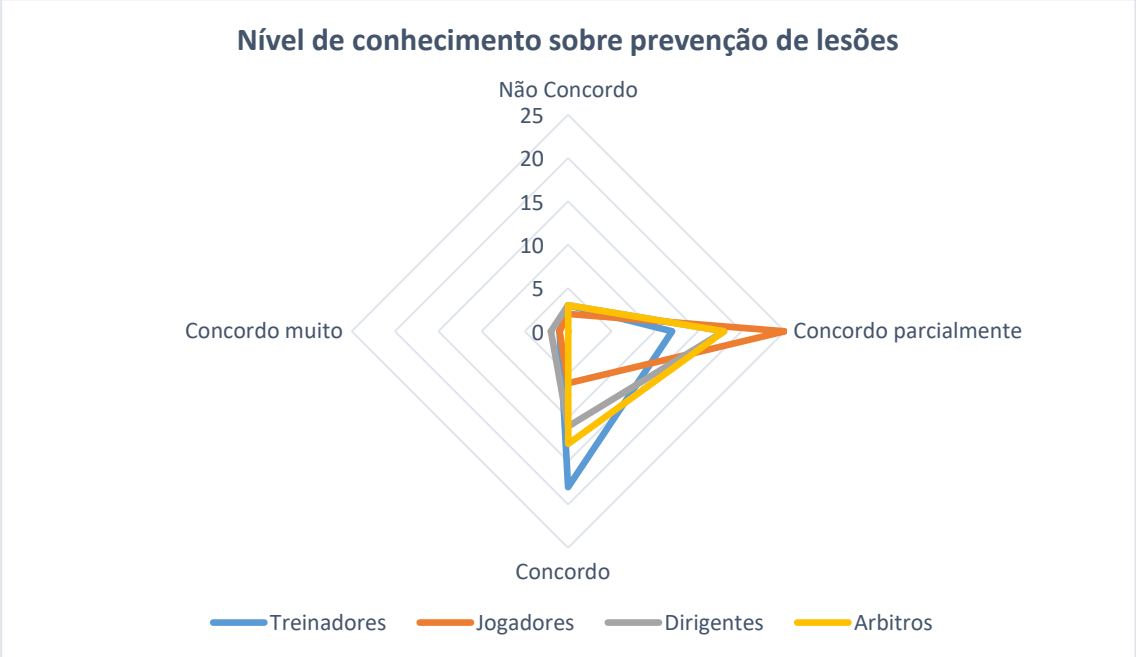
As primeiras 23 questões podiam ser respondidas utilizando um escala de concordância com a afirmação realizada: 1- nada de acordo; 2- apenas parcialmente de acordo; 3- de acordo; 4- muito de acordo. A última questão compreendia três possibilidades de resposta e era relativa ao período em que deveria decorrer a época de rugby de sete: 1- no final da época de quinze; 2- antes da época de quinze; 3- ao longo de toda a época.

Relativamente à questão sobre a importância das lesões desportivas para a modalidade e para cada um dos agentes, todos concordaram tratar-se de um tópico de elevado relevo (42% concordaram e 58% concordaram muito tratar-se de um problema relevante)

As primeiras quatro questões colocadas respeitavam à concordância sobre o nível de conhecimento de treinadores, jogadores, diretores e árbitros relativamente à prevenção de lesões no rugby de sete.

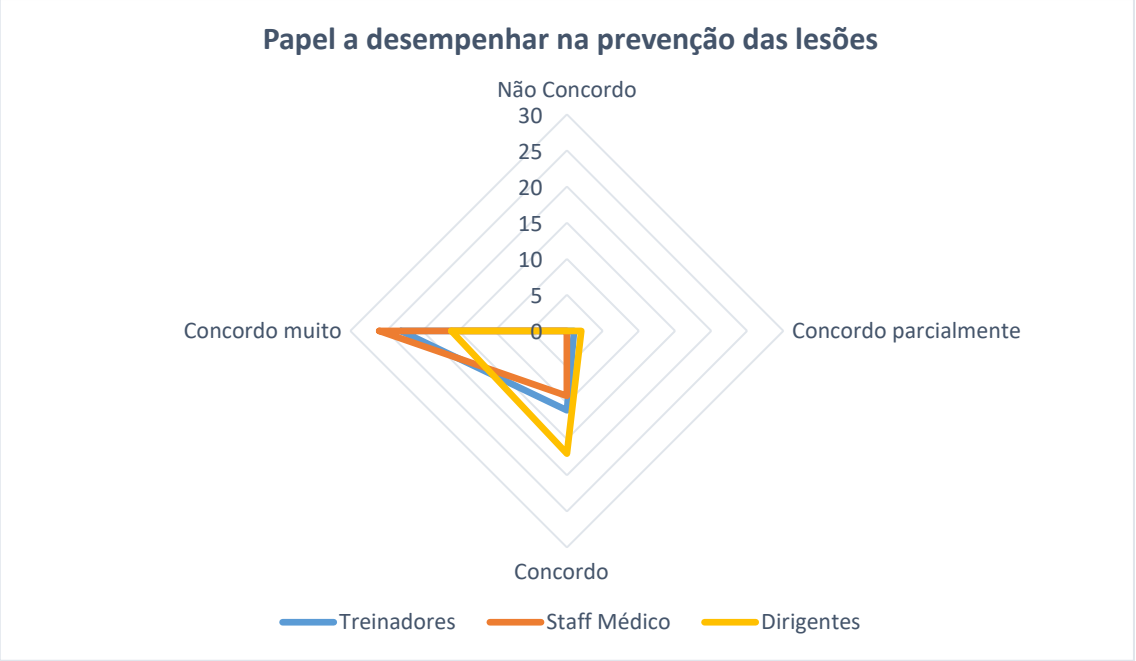
Para cada um dos grupos profissionais, a maior parte dos respondentes considerou que o nível de conhecimento não era muito elevado, como se pode verificar no gráfico 6.

**Gráfico 6** – Nível de conhecimento dos agentes sobre prevenção de lesões




Já no que respeita ao papel que cada um destes grupos tem na prevenção das lesões desportivas, juntamente com o staff médico, os resultados são bem diferentes, como se pode ver no gráfico sete. Neste âmbito, a esmagadora maioria dos participantes considera fundamental o papel de cada um dos agentes no trabalho de prevenção de lesões desportivas.

**Gráfico 7** – Os agentes desportivos têm um papel a desempenhar na prevenção das lesões




As 10 questões seguintes eram referentes à preparação da época de rugby de sete e aos modelos competitivos atuais, assim como a avaliação da concordância relativa a algumas alterações.

Três quintos dos respondentes consideraram necessária a existência de uma separação clara entre a época de XV e a de rugby de sete, o que contrasta em parte com a recomendação de 50% dos respondentes de que a época de rugby de sete deveria ter lugar ao longo de todo o ano (gráfico 8 e 9). Admite-se que, ao ser proposta em simultâneo uma época de XV e de sete a decorrer em paralelo, se pretenda a total separação dos praticantes de uma e de outra variante.

A divisão de opiniões verificada transporta-nos para a necessidade de um debate mais aprofundado sobre se é viável, tendo em conta o reduzido número de praticantes a nível nacional, trabalhar no sentido da separação entre praticantes das distintas variantes.

Torna-se, no entanto, relevante referir que é uma minoria (20%) a percentagem dos agentes desportivos que prefere a manutenção do atual período competitivo apenas no final da época de rugby de XV.

Relativamente à preparação dos atletas durante a época de rugby de sete, 65.7% desaprovam a ideia de que se deverá reduzir a carga de treino durante esta fase da temporada.

**Gráfico 8** – Concordância com separação das épocas de rugby de sete e de XV

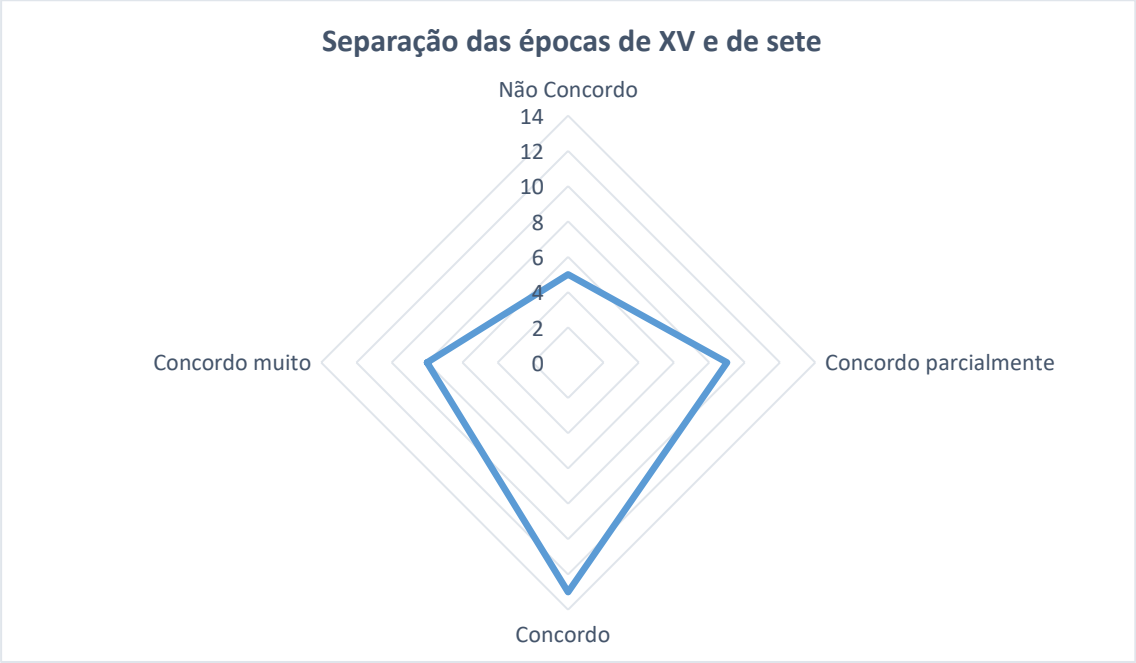
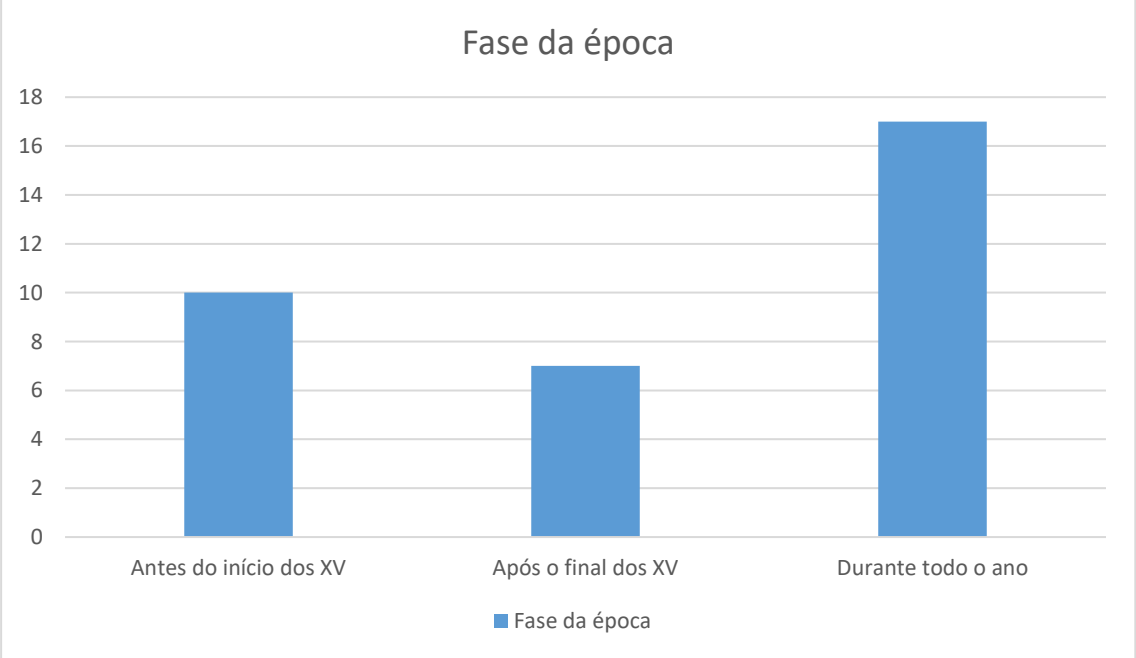
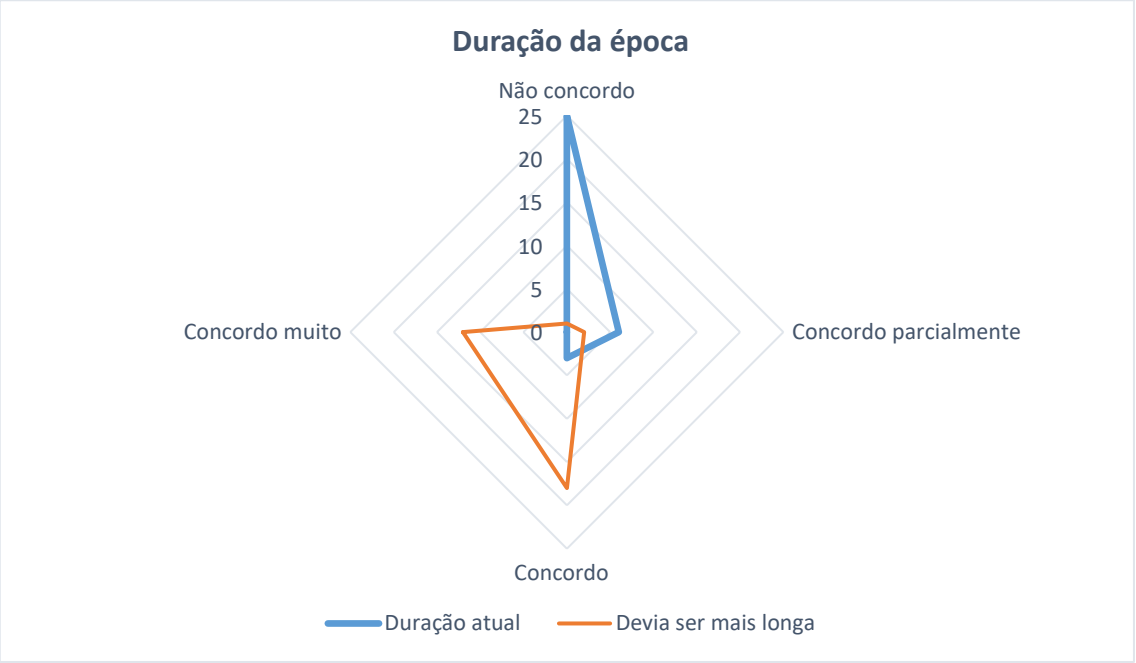



**Gráfico 9** – Fase da época em que deve ter lugar o rugby de sete




Quanto à forma como os quadros competitivos se encontram atualmente organizados, os participantes consideraram (na sua maioria) que não se enquadram adequados nem às necessidades nem à realidade do rugby nacional. No total, 68.75% dos participantes no questionário responderam estar em desacordo com a duração da época e 20% apenas concordavam parcialmente. Por outro lado, 88,6% consideravam estar de acordo ou muito de acordo em que a época tivesse uma duração superior (gráfico 10).

**Gráfico 10** – Duração dos época de rugby de sete




No mesmo sentido, 91% dos participantes concordaram com a existência de um número superior de torneios ao longa da época de rugby de sete, com uma ligeira maioria (51%) a concordarem ou a concordarem muito com a necessidade de reduzir o número de jogos por dia. Por outro lado, 77% concordaram ou concordaram muito com a possibilidade de os torneios serem disputados em dois dias e não em apenas um e 71% tinham a mesma opinião sobre a realização de torneios pareados em semanas consecutivas com pelo menos uma de intervalo.

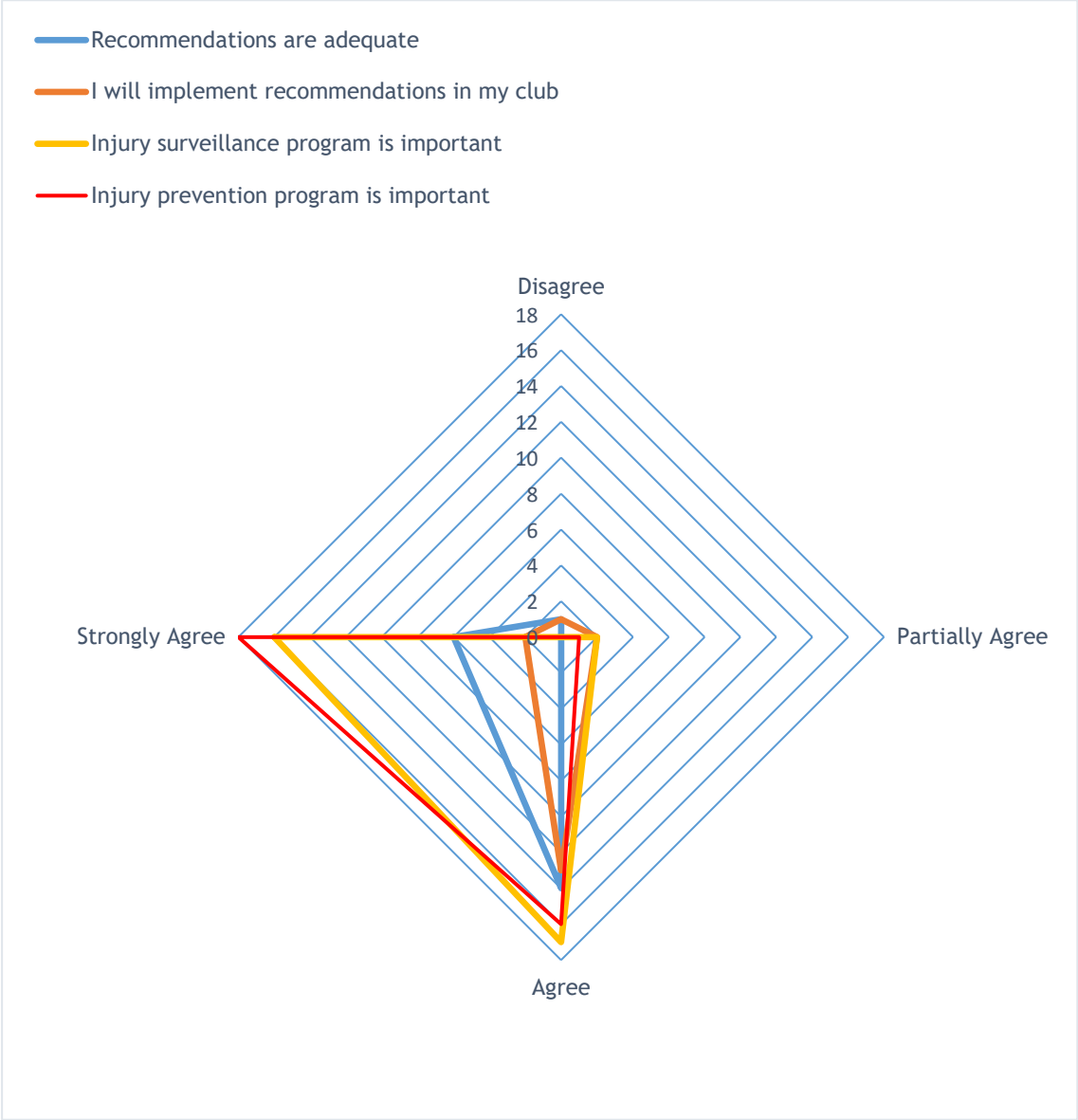
No que respeita à possibilidade teórica de se propor uma redução das dimensões do recinto de jogo como medida de redução da incidência de lesões desportivas, a proposta não mereceu a concordância de 80% dos participantes.

No final do questionário, foram ainda colocadas quatro questões relativas às medidas apresentadas nas jornadas e à necessidade de serem monitorizadas de forma programada as lesões desportivas no rugby português.

Concordaram com as medidas apresentadas 95% dos participantes nos questionários, mas apenas 83% afirmaram concordar ou concordar muito com a vontade de as aplicar nos próprios clubes.

Quanto à necessidade haver um programa institucional destinado à prevenção de lesões desportivas, 97% dos participantes concordaram ou concordaram muito com o mesmo. Já sobre a necessidade de implementar um programa de vigilância epidemiológica das lesões desportivas no rugby de sete, 94% dos participantes referiram concordar ou concordar muito com essa possibilidade (gráfico 11).

**Gráfico 11** – Medidas propostas nas Jornadas Médico-Desportivas



## 6. Recomendações

Tendo em conta os dados obtidos neste estudo e a análise realizada, assim como a discussão sobre modelos competitivos realizada e as repostas aos questionários aplicados após a conclusão do evento e durante o Circuito Nacional de Rugby de Sete da época de 2016/17, são os autores de opinião que as seguintes medidas deverão ser implementadas pela Federação Portuguesa de Rugby, com vista à redução da taxa de incidência de lesões desportivas e à promoção da segurança e bem estar dos atletas:

1-Junto dos atletas e das equipas técnicas, trabalhar para evitar a redução do volume de treino na época de sete, particularmente o treino de resistência muscular;

2- Contribuir para aumentar o foco na preparação individual: concentração, aquecimento, hidratação, nutrição;

3- Contribuir para o aumento da importância dada ao rugby de sete, aumentando o número de torneios anuais;

4- Promover um circuito de rugby de sete nacional, com séries pareadas (semanas consecutivas) e uma semana de intervalo a cada duas semanas de competição;

5- Aumentar a duração dos torneios para dois dias e não apenas um;

6- Reduzir o número de jogos/dia e aumentar o intervalo entre jogos nas competições nacionais;

7- Monitorizar a incidência de lesões desportivas.

# Autores

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# Appendix F – Candidate's Curriculum Vitae

**Antonio Miguel Cruz Ferreira**

**Date of birth:** 10 August 1984

**Nationality:** Portuguese

**Address:** Rua Central 54, 1º Dto

Póvoa de São Martinho, 3045-405 Coimbra, Portugal

**Phone:** +351 91 431 5716 **Email:** krusferreira@hotmail.com | antonio.cruz.ferreira@ubi.pt

## Work Experience

**Chief Medical Officer and Educator** **2018-present**

Portuguese Rugby Union (Portugal)

**Family Doctor / GP** **2015-present**

UCSP Mealhada, Mealhada (Portugal)

**Head of Medical Department and First Team Doctor** **2013-present**

Associação Académica de Coimbra Rugby (Portugal)

**Family Medicine Trainee** **2011-2015**

UCSP Mealhada, Mealhada (Portugal)

**Resident Doctor** **2010**

Coimbra University and Hospital Centre, Coimbra (Portugal)

## Professional Qualifications

**Sports Medicine Specialist** **2016**

Portuguese College of Sports Medicine, Portuguese Medical Association (Portugal)

**Family Medicine Specialist/General Practitioner** **2015**

Portuguese College of Family Medicine, Portuguese Medical Association (Portugal)

## Education

**PhD Student** **2015-present**

Faculty of Health Science of the University of Beira Interior, Covilha (Portugal)

**MSc in Sports Medicine** **2010-2012**

Faculty of Medicine of the University of Coimbra (Portugal)

**Medicine (Medical Degree)** **2002-2009**

Faculty of Medicine of the University of Coimbra (Portugal)

**Certificates**

- Advanced Cardiac Life Support, Portuguese National Emergency Institute, Coimbra, 2014
- World Rugby Medical Educator, World Rugby, Lisbon 2014
- Immediate Care In Rugby Level 2, World Rugby, London 2017
- Minor Surgery, Royal College of General Practitioners of England, London 2017

**Committee appointments**

**Member of the Medical and Insurance Committee** **2017-present**
Rugby Europe (European Rugby Governing Body)

**Member of the Physical Activity Promotion Plan Joint Group** **2017-present**
Baixo Mondego Healthcare Units Cluster (Centro Region of Portugal)

**Sports Medicine Experience**

- Match Doctor for Academica Coimbra Rugby (Portuguese Top Division), since 2013
- Member of the Medical Staff:
    - 2014 U18 European Championship – Qualifying, Lisbon (PT)
    - 2015 World Rugby U20 Trophy, Lisbon (PT)
    - 2015 U19 Rugby Europe Championship, Lisbon (PT)
    - 2018 U20 Rugby Europe Championship, Coimbra (PT)
- Match Day Doctor for the following international rugby matches:
    - Russia-Romania, U18 European Championship - Qualifying, 28 Oct 2014, Lisbon (PT)
    - Portugal-Spain, European Nations Cup, 14 Mar 2015, Coimbra (PT)
    - Georgia-Portugal, World Rugby U20 Trophy, 20 May 2015, Lisbon (PT)
    - Fiji-Uruguai, World Rugby U20 Trophy, 20 May 2015, Lisbon (PT)
    - Portugal-Hong Kong, World Rugby U20 Trophy, 24 May 2015, Lisbon (PT)
    - Fiji-Namibia, World Rugby U20 Trophy, 24 May 2015, Lisbon (PT)
    - Uruguai-Tonga, World Rugby U20 Trophy, 24 May 2015, Lisbon (PT)
    - Georgia-Canada, World Rugby U20 Trophy Final Match, 24 May 2015, Lisbon (PT)
    - Poland-Belgium, U19 Rugby Europe Championship, 31 Oct 2015, Lisbon (PT)
    - Portugal-Russia, U19 Rugby Europe Championship, 31 Oct 2015, Lisbon (PT)
    - Spain-Romania, U19 Rugby Europe Championship Final Match, 31 Oct 2015, Lisbon (PT)

- Portugal-Brasil, Autumn Internationals Test-Match, 1 Dec 2016, Coimbra (PT)

- Romania-Netherlands, U20 Rugby Europe Championship, 8 Apr 2018, Coimbra (PT)

- Ukraine-Poland, U20 Rugby Europe Championship, 11 Apr 2018, Coimbra (PT)

- Spain-Russia, U20 Rugby Europe Championship, 11 Apr 2018, Coimbra (PT)

- Portugal Regional-Poland, U20 Rugby Europe Championship, 14 Apr 2018, Coimbra (PT)

- Tournament Doctor of the 2018 European U20 Rugby Championship (Apr 2018)

- Match Day Doctor Shadow at the London stage of the World Rugby Sevens Series 2018

**Publications**

- Cruz-Ferreira AM, et al. Epidemiology of injuries in senior male Portuguese rugby union sevens: a cohort prospective study. Phys Sportsmed. 2018 May;46(2):255-261. doi: 10.1080/00913847.2018.1441581.

- Cruz-Ferreira AM. Craniofacial polyostotic fibrous dysplasia initially diagnosed in a primary care unit. Korean Journal of Family Medicine [accepted for publication}

- Cruz-Ferreira AM, et al. Epidemiology of time-loss injuries in senior and under-18 Portuguese male rugby players. Journal of Human Kinetics. 2018; 2: 73-80. doi: 10.1515/hukin-2017-0159

- Cruz-Ferreira AM, et al. Promoting players' safety and welfare through the sharing of scientific knowledge with sports agents: the new reality of Portuguese rugby sevens. Phys Sportsmed. 2017 Oct 5:1-2. doi: 10.1080/00913847.2017.1386067.

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- Cruz-Ferreira E, Cruz-Ferreira AM. Shoulder injuries in rugby: Report of its incidence and severity in a group of Portuguese male players during a season. Rev Andal Med Deporte. 2016. [Epub] DOI: http://dx.doi.org/10.1016/j.ramd.2016.09.003

- Cruz-Ferreira AM, Lugarinho-Monteiro T. Perioperative management of the new oral anticoagulants: are Portuguese General Practiotioners aware of the Portuguese Society of Anesthesiology Consensus? Eur J Anaesthesiol 2016;33(e-Supplement):452-3

- Cruz-Ferreira AM, Lugarinho T. Diabetic peripheral neuropathic pain in primary care: prevalence and treatment. Eur J Anesthesiology. 2015;32(Supplement 53):306

- Cruz-Ferreira AM, Lugarinho T. Physical exercise therapy for chronic low back pain treatment: a case report. Eur J Anesthesiology. 2015;32(Supplement 53):332

- Cruz-Ferreira AM, Ribeiro C. Anthropometric and physiological profile of Portuguese rugby players- Part I: comparison between athletes of different position groups. Rev Bras Med Esporte. 2013;9(1):48-51

- Cruz-Ferreira AM, Ribeiro C. Anthropometric and physiological profile of Portuguese rugby players- Part II: comparison between athletes with different competitive levels. Rev Bras Med Esporte. 2013;9(1): 52-55

- Cruz-Ferreira AM. Will there be Room for a Sports Medicine Consultation Within Primary Care? Report of a One-Year Project. Rev Port Hipertensão e Risco Cardiovascular. March/April 2017; 58:6-9 [Portuguese original]

- Lugarinho-Monteiro T, Cruz-Ferreira AM. Peri-Operative Management of Antithrombotic Agents: Are Primary Care Doctors Aware of the 2014 Portuguese Society of Anesthesiology Consensus?. Rev Port Hipertensão e Risco Cardiovascular. Sept/Oct 2017; 61:12-16 [Portuguese original]

- Cruz-Ferreira AM, et al. Assessment of physical activity and sedentarism levels in a group of diabetic patients. Rev Brasileira Prescrição Fisiologia do Exercício. Mar 2015; 9(53):188-198 [Portuguese original]

- Cruz-Ferreira AM, et al. Diabetes consultation: Unde Venis et Quo Vadis.Rev Port Hipertensão e Risco Cardiovascular. July/August 2015; 48:6-10 [Portuguese original]

- Cruz-Ferreira AM, et al. The role of exercise in weight management. Rev Fact Risco. 2014; 34:42-48 [Portuguese original]

- Cruz-Ferreira AM, et al. Exercise in the management of hypertension: a case report. Rev Port Med Geral Fam. 2013;29:126-30 [Portuguese original]

- Loureiro E, Cruz-Ferreira AM, et al. A case of phagophobia: when fear consumes us. Rev Port Med Geral Fam 2016;32:212-6 [Portuguese original]

- Oliveira JP, Cruz-Ferreira AM, Faisca J. Atypical femoral fracture and biphosphonate treatment: a case report. Rev Port Ortop Traum. 2013;21(4):535-541[Portuguese original]

**Major Conference Presentations**

- Cruz-Ferreira AM. Polyostotic fibrous dysplasia incidentally diagnosed: a rare case report. 23th WONCA 2018, Krakow. 24-27 May 2018.

- Cruz-Ferreira AM, Cruz-Ferreira E, Taborda-Barata L, Santiago LM. Epidemiology of injuries in Portuguese senior male rugby union sevens. 5th ECOSEP Congress and FIFA Update. Dubai, 9-10 Dez 2017

- Cruz-Ferreira AM, Cruz-Ferreira E, Taborda-Barata L, Santiago LM. Time-loss injuries in senior and under-18 Portuguese male rugby union players. 5th ECOSEP Congress and FIFA Update. Dubai, 9-10 Dez 2017

- Cruz-Ferreira AM, Cruz-Ferreira E, Taborda-Barata L, Santiago LM. The relationship between precompetitive somatic anxiety, worry and concentration disruption and the occurrence of

sports injuries in Portuguese senior male rugby sevens players. 5th ECOSEP Congress and FIFA Update. Dubai, 9-10 Dez 2017

- Cruz-Ferreira AM, Maia J, Rodrigues A. Thromboembolic events prevention in Atrial Fibrillation: are we doing enough? 22ª WONCA 2017, Prague. 28 Jun a 01 Jul 2017.

- Cruz-Ferreira AM, Maia J, Rodrigues A. Will there be room for a Sports Medicine consultation within primary health care? The Portuguese reality. 22th WONCA 2017, Prague. 28 Jun to 01 Jul 2017.

- Cruz-Ferreira E, Cruz-Ferreira AM. An arthroscopic option for ulnar collateral ligament rupture of the metacarpofalangeal Joint, with a Stener lesion; 16th EFORT Congress Prague, 27-29.05.2015 [co-author]

- Cruz-Ferreira AM, Lugarinho-Monteiro T. Diabetic Peripheral Neuropathic Pain in Primary Care: prevalence and treatment; Euroanesthesia 2015, Berlin, 31 May to 02 Jun 2015

- Cruz-Ferreira AM, Lugarinho-Monteiro T. Physical exercise therapy for chronic low back pain treatment: a case report; Euroanesthesia 2015, Berlin, 31 May to 02 Jun 2015

- Cruz-Ferreira AM, et al. Bilateral spontaneous femoral fracture and the chronic ingestion of bisphosphonates is there a relationship; 19th WONCA Europe, Lisbon (Portugal), 2-5 Jul 2014

- Loureiro E, Cruz-Ferreira AM, et al. An eating disorder or just fear?; 19th WONCA Europe; Lisbon (Portugal), 2-5 Jul 2014

- Cruz-Ferreira AM, et al. Diabetes Care at a Portuguese Primary Health Care Unit 1-year clinical practice report; 19th WONCA Europe, Lisbon (Portugal), 2-5 Jul 2014

- Cruz-Ferreira AM, Ribeiro CAF.The introduction of professionalism in Portuguese rugby teams-first steps? XXXII World Congress of Sports Medicine; Rome (Italy) 30 Sep 2012

- Cruz-Ferreira AM, Ribeiro CAF. Anthropometric and Physiological Evaluation of Portuguese Rugby Players. XXXII World Congress of Sports Medicine; Rome (Italy) 30 Sep 2012

- Cruz-Ferreira AM, et al. Physical exercise prescription as part of weight loss and weight gain prevention programs; 20th WONCA World, Prague (Czech Republic), 25-29 Jun 2013

- Several other national and international conference presentations

**Other Research/Scientific Activities**

- Reviewer for the Journal of Sports Science

- Reviewer for the PeerJ Journal

- Reviewer for the Revista Portuguesa de Medicina Geral e Familiar

- Member of the Scientific Committee - Urologia ao Centro Congress, Coimbra (24-25 May 2018)

- Organizer of the 1st Rugby Sports Medicine Conference in Portugal (10 Jun 2017)

- World Rugby Medical Educator in several First Aid in Rugby Level 1 courses

- Facilitator/Educator in several non-rugby medical workshops (e.g. Exercise prescription for Family Doctors; Pre-hospital care of injured athletes; Precompetitve Screening for Family Doctors; Minor surgery):

  - Making the preparticipation sports evaluation easy for Primary Care Physicians, 23th WONCA, Krakow, 24-27 May 2018 (75 minutes)

  - All you need to know about the management of common acute traumatic lower limb injuries in Primary Care, 23th WONCA, Krakow, 24-27 May 2018 (75 minutes)

  - Physical examination of shoulder, hip and knee of the elderly made easy, 23th WONCA, Krakow, 24-27 May 2018 (75 minutes)

  - I Curso de Pequena Cirurgia para Cuidados de Saúde Primários, Coimbra, 28-29 Nov 2017 (16 hours)

  - Exercício Físico na Gravidez: porquê, quem, quanto, como? 20th Congresso Nacional de Medicina Geral e Familiar, Castelo Branco 30 Set – 2 Oct 2016 [Portuguese] (90 minutes)

  - Abordagem de lesões traumáticas desportivas em ambiente pré-hospitalar, 32nd Encontro Nacional da APMGF, Estoril, 05 Mar 2015 [Portuguese] (90 minutes)

  - Abordagem de lesões traumáticas desportivas em ambiente pré-hospitalar, Mealhada, 27 Feb 2015 [Portuguese] (90 minutes)

  - Exame Médico Desportivo na Medicina Geral e Familiar, I Jornadas da Bairrada, 28 Nov 2014 [Portuguese] (90 minutes)

**Professional Affiliations**

- Member of the Portuguese Medical Association (number 49573)

- Member of the Portuguese College of Sports Medicine

- Member of the Portuguese College of Family Medicine

- Member of the Portuguese Association of Family Physicians (number 6600)

- Member of the Portuguese Society of Sports Medicine (number 217)

**Language Skills**

- Portuguese (Native)

- English (Full professional proficiency)

- Spanish (Professional working proficiency)

- French and Italian (Limited working proficiency)

**Other Experience and Interests**

- Former rugby player for Academica Coimbra (played from youth levels to senior)

Covilhã, 8th of January 2019

Luiz Miguel de Mendonça Soares Santiago, MD, PhD, orientador da Dissertação de Doutoramento **"Epidemiology of injuries in Portuguese senior male rugby union sevens"** da autoria de **António Miguel da Cruz Ferreira**, MD, PhD, declara que o livro entregue para defesa corresponde à versão definitiva e arguida em provas públicas na Reitoria da Universidade da Beira Interior em 8 de Janeiro de 2019, estando conforme o necessário.

Coimbra, 15 de Janeiro de 2019

Assinado por: **LUIZ MIGUEL DE MENDONÇA SOARES SANTIAGO**
Num. de Identificação Civil: BI040569063
Data: 2019.01.08 19:22:18 Hora padrão de GMT

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