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Estratégias de prevenção de lesões no futebol: Uma análise sobre protocolos, efetividade e qualidade metodológica.

Dissertação de Mestrado apresentado com vista à obtenção do grau de Mestre em Ciências do Treino Desportivo, na área de especialização em Treino de Alto Rendimento, da Faculdade de Desporto da Universidade do Porto, ao abrigo do Decreto-Lei nº 74/2006, de 24 de março, na redação dada pelo Decreto-Lei nº 65/2018 de 16 de agosto.

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PALAVRAS-CHAVE: PREVENÇÃO DE LESÕES, FUTEBOL, REVISÃO SISTEMÁTICA.

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Resumo

Introdução: Uma extensiva amplitude de consequências negativas, resultantes das lesões, preocupa todos os profissionais envolvidos em esportes que apresentam um risco elevado. Os profissionais do esporte assumem uma difícil tomada de decisão, ao planear e implementar as melhores metodologias para desenvolver a performance dos atletas. Neste contexto, este estudo tem como objetivo: Identificar a efetividade das estratégias de prevenção de lesões; avaliar a qualidade metodológica e o risco de viés dos estudos; compilar os resultados apresentados na literatura científica. **Metodologia:** A diretriz PRISMA foi utilizada nesta revisão. A estratégia de busca foi aplicada sobre as bases de dados Cochrane Library, Scielo, Scopus, PubMed e Web of Science. Uma busca adicional foi executada sobre o Google Acadêmico e listas de referências. Somente meta-análises, que avaliaram estudos randomizados sobre o futebol, foram incluídas. A qualidade metodológica foi analisada com a ferramenta AMSTAR 2. A estratégia de busca e avaliação metodológica foram realizadas entre dois revisores independentes. **Resultados:** A partir de 139 estudos iniciais, somente cinco atenderam aos critérios de elegibilidade. Os estudos usualmente apresentaram estratégias multimodais, incluindo exercícios de força, corrida, equilíbrio e mobilidade. Quatro das revisões sistemáticas incluídas, apresentaram uma qualidade metodológica criticamente baixa, e somente uma, atendeu os critérios para qualidade moderada. O resultado mais comum, avaliado entre os estudos, foi o número geral de lesões entre grupo experimental e controle. **Considerações finais:** Nosso principal achado foi a redução de 26% das lesões sobre o joelho, comparados com o grupo controle. Este dado apresentou qualidade metodológica moderada, mas somente em uma meta-análise. Outras medidas de efeito, apesar de apresentarem uma redução sobre o risco relativo de lesões, devem ser interpretadas com cautela devido ao alto risco de viés apresentado.

PALAVRAS-CHAVE: PREVENÇÃO DE LESÕES, FUTEBOL, REVISÃO SISTEMÁTICA

Abstract

Introduction: An extensive range of negative consequences, generated by injuries, concern all professionals involved in sports that present an elevated risk. Sports stakeholders assume a difficult decision-making process while designing and implementing the best methodologies, to develop athlete's performance. In this scenario, this review aims to: identify the effectiveness of injury prevention strategies; assess the methodological quality and risk of bias from the studies; compile the outcomes presented in the scientific literature. **Methodology:** The PRISMA guideline was used in this review. The search strategy was applied in Cochrane Library, Scielo, Scopus, PubMed and Web of science databases. An additional search over Goggle Scholar and reference lists were executed. Only meta-analyses that assessed soccer/football with randomized studies were included. Methodological quality was assessed with the AMSTAR 2 tool. Two independently reviewers executed the search strategy and methodological assessments. **Results:** From the initial 139 papers, only five were eligible for the review. The studies commonly presented multimodal strategies, including exercises for strength, running, balance and mobility. Four of the included systematic reviews presented a critically low methodological quality, and only one fulfilled the criteria for moderate quality. The most common reported outcome was differences in overall injury between control and intervention group. **Final considerations:** Our main finding, was a reduction of 26% over knee injuries, compared to control. This data obtained moderate quality, but only in one meta-analysis. Other measures of effect, even though presented reduction over the injuries relative risk, must be interpreted with prudence due to the high risk of bias presented.

KEYWORDS: INJURY PREVENTION; FOOTBALL; SISTEMATIC REVIEW.

Capítulo I – Introdução

A. Âmbito geral do estudo

As ciências do desporto têm aumentado seus esforços para diminuir as lesões nos atletas. Este fato deve-se a múltiplos desfechos negativos que acarretam, como o declínio do desempenho individual e da equipe, além do afastamento do atleta, alto custo financeiro e encerramento precoce de carreiras desportivas (Bahr et al., 2020). Apesar de lesões esportivas possuírem uma origem multifatorial, os fatores de risco interagem em uma rede complexa de determinantes. Entender como elas ocorrem e implementar estratégias de prevenção adequadas, possibilita diminuir o número e intensidade de sua ocorrência (Emery & Pasanem, 2019; Hulme et al., 2019).

Conforme o último consenso do Comitê Olímpico Internacional, lesão é definida como um dano tecidual ou desarranjo da função fisiológica normal, resultante de rápidas ou repetitivas transferências de energia cinética. Estes picos de energia, desencadeiam lesões ao exceder a capacidade biológica de suportar essas cargas. Diferentes mecanismos podem romper esta tolerância biológica como: Uma quantidade de energia excessiva e abrupta, como ocorre em traumas; acúmulo de energia de forma longitudinal, sem o reparo tecidual adequado, como o caso de fraturas por estresse; ou situações que associam ambas características, como um tecido biológico que ao ser submetido a cargas prolongadas, tem o seu limiar de tolerância diminuído, tornando-se incapaz de suportar uma provável carga aguda (Bahr et al., 2020). Este conceito corrobora com publicações anteriores de que a capacidade do indivíduo em tolerar as diversas fontes de cargas e estresses mecânicos é fundamental para administrar o risco de lesões (Bittencourt, 2015).

O contexto do futebol, se apresenta como um esporte de contato, com diversas ações anaeróbicas e força máxima, sendo altamente competitivo. A nível profissional, este esporte apresenta uma incidência de lesões entre 2.48 a 9.4 lesões a cada 1000 horas de exposição. Estes dados, quando restritos a competições, passam a revelar uma incidência entre 8.7 a 65.9 lesões a cada 1000 horas de exposição. Os valores absolutos variam em função do conceito

de lesão adotado e métodos de avaliação utilizados (Pfirrmann et al., 2016; Van Beijsterveldt et al., 2013).

O estudo epidemiológico realizado com os 25 times em melhor classificação da UEFA, entre 2001 e 2008 (Ekstrand et al., 2011), mostrou que em média, cada atleta sofre 2 lesões por época desportiva, ou seja, uma estimativa de 50 lesões em uma equipe composta por 25 jogadores. Os autores apresentaram que 80% das lesões ocorreram nos membros inferiores, sendo os locais mais afetados: coxa (Isquiotibiais - 12%, n=525; Quadríceps - 5%, n=218), joelho (Ligamento colateral medial - 5%, n=2020), tornozelo (entorse do tornozelo - 7%, n=318) e região do púbis (Adutores de quadril - 9%, n=399). As lesões consideradas como severas (com um período de afastamento superior a 28 dias, 16%), foram mais prevalentes sobre: Isquiotibiais (n=83, 12%), ligamento colateral medial (n=63, 9%), quadríceps (n=48, 7%), adutores de quadril (n=42, 6%). Em média, cada atleta lesionado, foi afastado por 37 dias por temporada.

Estes dados respaldam o estudo de Stubbe et al. (2014), em que ao acompanhar oito equipes da *Premier League* holandesa, entre 2009 e 2010, encontraram um total 286 lesões. Destas, 21.3% ocorreram sobre o joelho (n=61), 15.4% sobre região posterior da coxa (n=44), 11.9% sobre perna / tendão de Aquiles (n=34), 10.5 % tornozelo (n=30) e 10.5% sobre região púbica (n=30). Disfunções musculares são uma grande preocupação relacionada ao futebol, representando mais de ⅓ de todas as lesões desta modalidade, estendendo-se a uma taxa de recorrência de 17%. Os músculos posteriores de coxa, são os mais afetados, representando 12% de todas as condições médicas relacionadas ao futebol. Esta condição estima um afastamento médio de 19.7 dias a cada 1000h de exposição (Vatovec et al., 2019).

O estudo de Ekstrand et al. (2016), alerta para um dado preocupante, indicando um aumento da prevalência deste tipo de lesão ao longo dos anos. O mecanismo destas ocorrências, podem ser de forma direta, através de uma força externa, ou de forma indireta, ocorrendo geralmente durante a fase *late swing* em sprints ou corridas de alta velocidade (Vatovec et al., 2019; Pereira et al.,

2019). Estes dados são relevantes a todos envolvidos com o treinamento de atletas de elite. Além de afetar a performance, o impacto financeiro é um indicador importante, não limitado somente aos tratamentos médicos, mas sendo também associado aos salários destes atletas. Segundo o CEO do clube Shakhtar, se um atleta determinante, é afastado por um mês, este pode ter um custo de 500.000 € (Ekstrand, 2013). Estes dados ilustram a importância de desenvolver estratégias de prevenção de lesões eficazes, buscando diminuir o tempo de afastamento dos atletas assim como os custos associados (Mohib et al., 2014).

B. Âmbito particular do estudo

Esta realidade traz uma preocupação a todos os envolvidos com a performance dos atletas, o que motiva o surgimento de diferentes abordagens para prevenir lesões. A realidade multifatorial das lesões, permite uma abordagem sobre diferentes níveis, como: escala micro, como interações celulares e moleculares; meso, englobando o indivíduo; nível macro, em mudanças de regras e políticas, promoção do *fair play,* etc. (Hulme et al., 2018; Donaldson & Finch, 2013).

Atualmente existem diversas metodologias e diferentes organizações de programas de prevenção de lesões. Os programas de prevenção, em sua maioria consistem em abordagens multimodais, associando exercícios gerais e específicos como: Fortalecimento muscular; exercícios pliométricos; agilidade; controle motor, incluindo técnica de corrida, mudança de direções e aterrissagem; além de exercícios de mobilidade articular e desenvolvimento das cadeias cinéticas. A implementação de exercícios neuromusculares tem se demonstrado com um elevado potencial para impactar o contexto de risco dos atletas, deixando-os mais aptos a gerir as demandas de estresse da modalidade (Pereira et al., 2019; Emery & Pasanem, 2019).

C. Objetivos do estudo

O objetivo do estudo foi identificar estratégias de prevenção eficazes reportadas na literatura, sobre a frequência e severidade das lesões, além do custo associado a estas condições. Além disso, este estudo busca explorar as melhores evidências científicas sobre a temática, avaliando a qualidade metodológica e risco de viés nestes estudos. Devido ao tema abranger fatores múltiplos e complexos, ele permite a elaboração de diversas estratégias. Porém, mesmo com as limitações inerentes ao contexto ecológico, é importante que estas estratégias sejam confrontadas com outros grupos experimentais, além de outros critérios metodológicos, a fim de entender os reais impactos oriundos destas intervenções.

D. Estrutura geral do trabalho

A presente dissertação foi estruturada conforme o modelo escandinavo e está dividida em quatro capítulos principais: I - Introdução; II - Artigo científico, III - Conclusões finais e IV - Referências Bibliográficas.

O capítulo I apresenta o contexto geral e específico do tema, objetivos do estudo e estrutura do trabalho.

No capítulo II apresentamos o artigo científico intitulado: Effectiveness of injury prevention strategies in soccer: An overview of meta-analyses with randomized controlled trials. Uma revisão sistemática sobre os estudos de revisões sistemáticas com meta-análises, buscando a melhor evidência científica disponível reportada na literatura.

No capítulo III são expostos conclusões gerais e considerações finais da dissertação.

As referências bibliográficas, utilizados no artigo, encontram-se ao final do capítulo II. Outras referências são apresentadas no capítulo VI.

Capítulo II – Artigo Científico

Effectiveness of injury prevention strategies in soccer: An overview of meta-analyses with randomized controlled trials

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Abstract

Background: An extensive range of negative consequences, generated by injuries, concern all professionals involved in sports that present an elevated risk. Sports stakeholders assume a difficult decision-making process while designing and implementing the best methodologies, to develop athlete's performance**. Objective:** Identify the effectiveness of injury prevention strategies and assess the methodological quality and risk of bias presented in the scientific literature. **Design:** Overview of systematic reviews with meta-analysis. **Participants:** Soccer/ Football players. **Main outcomes measures:** Any effect related to injuries. **Results:** From the initial 139 papers, only five were eligible for the review. The studies commonly presented multimodal strategies, including exercises for strength, running, balance and mobility. Four of the included systematic reviews presented a critically low methodological quality, and only one fulfilled the criteria for moderate quality. The most common reported outcome was relative risk for overall injuries (any reported) between control and intervention groups. Our main finding was a reduction of 26% over knee injuries, compared to control, with moderate quality in one meta-analysis. Other measures of effect, even though presenting a reduction over injury rates, should be interpreted with prudence due to the high risk of bias presented. **Conclusions:** Considering the range of benefits from injury prevention, neuromuscular exercises are potentially a cost-effective strategy for soccer players at different performance levels. However, four of the five systematic reviews present low

methodological quality and therefore results may be biased towards positive effects of interventions on reduction of injury risk.

Keywords: Sports medicine; injury prevention; soccer; football; meta-analysis

Introduction

According to the International Olympic Committee, injuries are defined as a tissue damage or other disarrangement of normal physiological function, resulting from rapid or repetitive transfer of kinetic energy, as a consequence of sports participation. This definition includes a range of clinical conditions with high economic consequences and a negative impact over athlete's health and performance. Some of these consequences come with the period away from practice, affecting conditioning aspects and the inter-player coordination during the game. Furthermore, the injury is likely to generate a gap in the tactical model, that will be modified and adjusted to maintain the team playing in the best possible way (Bahr et al., 2020).

Soccer is a contact sport associated with a high injury risk. Injury incidence in professional soccer players represents a range of 2.48 to 9.4 injuries per 1000 hours of exposure. Specifically, in competitions, this incidence reaches an amplitude of 8.7 to 65.9 injuries per 1000 hours of exposure. Although these injuries come from strains, sprains and contusions, fractures need to be highlighted from its severity. Lower limbs are the most affected site are, and despite the multifactorial wellspring, previous injury is the highest risk factor for its occurrence (Crossley et al., 2020; Pfirrmann et al., 2016).

This data illustrates the big concern that all stakeholders feel about injuries. Within this context, injury prevention/ injury risk management strategies emerge trying to mitigate the negative impacts of those injuries (Vatovec et al., 2019). Previous reviews assessed multiple sports (Faude et al, 2017), evaluated only FIFA preventive programs (Al Attar & Alshehri, 2019) or narrowed the findings to a specific type of injury (Fanchini et al., 2020). As injury prevention is a broad topic, and reviews present different perspectives, methodologies and

findings towards the subject, we understand that a summary of meta-analyses' findings, over the effectiveness of preventive randomized strategies in soccer, it is needed.

In order to help soccer stakeholders with their decision making process, this review aim to provide an overview of systematic reviews, identifying what injury prevention strategies are recommended to decrease number of injuries, days away from practice and associated costs, assessing: (i) effectiveness of the interventions, identifying the outcomes reported in the literature; (ii) methodological quality and risk of bias of the studies and; (iii) evidence concerning the cost effectiveness of injury preventions strategies.

Methods

Eligibility criteria

The Preferred Reporting Items for Systematic review and Meta-Analysis (PRISMA) checklist guideline were used to structure the current paper (Shamseer et al., 2015). This protocol was registered with the International Platform of Registered Systematic review and Meta-Analysis protocol. (Registration number: INPLASY202090036). The P.I.C.O.S. strategy addressed was: *Participants:* Soccer players of any age, sex, training level or health status. We excluded studies related to other sports than soccer or football, including American football and Australian football. We decided to exclude meta-analyses over multiple sports modalities to decrease heterogeneity of the effects.

Interventions: Any systematic review with meta-analysis including randomized interventions with at least two distinct experimental groups. Interventions must be overtly designed to try to prevent injuries or to reduce the injury risk. *Comparators:* At least one randomized comparison group; additional experimental groups and/or a control group can be present. *Outcomes:* Any effect related to sports injuries (Bahr et al., 2020) will be considered. Relevant outcomes: Number of days away from practice (training and competitions); injury incidence; performance and health reported consequences; clinical extent of injury and costs associated with the injury's events; perceived Quality of Life. *Study design:* systematic reviews with meta-analyses including randomized

controlled trials (RCT's). We decided to exclude studies with non-randomized trials and other designs that are more susceptible to bias. No restrictions were established regarding publication date or language eligibility.

Information sources and search

The search was conducted in Cochrane Library, PubMed, Scielo, Scopus and Web of Science, during the period of June 2020 and using Boolean operators. The adopted criteria required the title, abstract or keywords to contain the expressions: (i) injury OR injuries; AND (ii) prevention OR preventive OR risk; AND (iii) football OR soccer; AND (iv) randomized; AND (v) "systematic review"; AND (vi) "meta-analysis". Regarding specificities of each database, Cochrane Library and Scopus include title, abstract and keywords on their search. During the Cochrane library search, the term "meta-analysis" was left out, because of the limited number of search lines. PubMed and Scielo permit their search over title and abstract. For Web of Science the option topic, allow the search to be conducted on title, abstract and keywords. In addition to this search, we conducted a manual search over Google Scholar and a screen over the biographical references of the articles, to identify possible missed studies. No limitation was imposed relative to publication date.

Data collection and analysis

Study Selection Procedure: Two reviewers independently conducted the article selection process. First the reviewers screened the titles and abstracts resulted from the database research, assessing their eligibility criteria. The full paper was obtained when suitable for the review. Disagreements between the reviewers were discussed for a consensus. *Data extraction*: The articles that met the inclusion criteria, had their data extracted by two independent reviewers. Data items: Title, author(s), publication year, sample characteristics, objective of the study, sample, type of injuries analyzed, type of intervention proposed, comparison groups, length of the protocol, outcomes and main results

Risk-of-Bias Assessment:

In order to inform evidence-based practices, helping stakeholders in their decision-making processes, systematic reviews represent the main guide

towards the best evidence available on a scientific field. This methodological design is relevant to professionals as they sum up key information from the scientific literature, about the specific topic, while discussing their flaws and possible benefits. However, those studies must present good methodological quality, enhancing information accuracy, while diminishing bias and error (Charrois, 2015).

Methodological quality and risk of bias of the studies were evaluated with AMSTAR 2 (A measurement tool to assess systematic reviews) instrument. This assessment approach scopes 16 items, punctuated as Yes, Partial Yes or No, according to a checklist of characteristics for each one of them. Seven of the items are classified as critical domains (items: two, four, seven, nine, eleven, thirteen, fifteen). Flaws specially on critical points, have a higher impact decreasing the confidence of the review results. The authors recommend avoiding quantitative scores, as the sum of low value items may hide important aspects of bias. Results classification is presented as: high, moderate, low and critically low (Shea et al., 2017).

The original version of AMSTAR includes eleven items. As they are evaluated equally, less relevant points could mask critical aspects of methodological confidence. Besides that, another critic towards this version, lay on the criteria for each point not being as specific as the AMSTAR 2 version, generating doubts for its use among the evaluators (Shea et al., 2017). In our review, two independent evaluators assessed the methodology and risk of bias of each review with AMSTAR 2 tool criteria, comparing their results and disagreements were solved by discussion.

Results

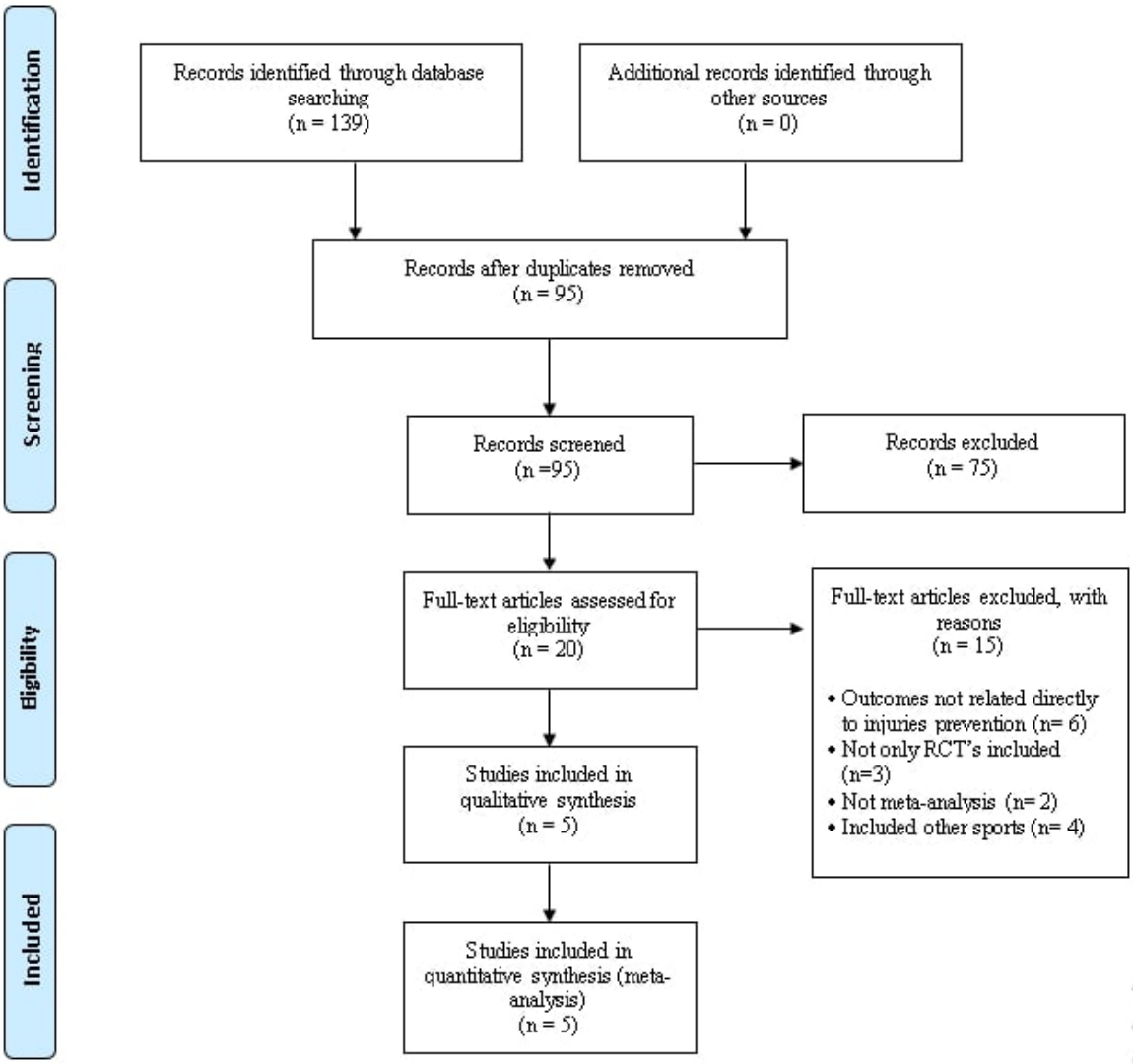
Study selection

Initial 139 papers were provided from database search. No studies emerged from the additional manual search. After removing duplicates, 95 articles had their titles and abstract screened. Studies that were not relevant to our research question were removed (n=75). Full text of relevant papers (n= 20) were analyzed, with the exclusion of 15 studies for not being suitable on the

previous established inclusion criteria. Two of the excluded studies did not include meta-analysis in their review, however, they explained that it wasn't possible due to the lack of data homogeneity (Hanlon et al., 2019; Porter & Rushton, 2015).

Three excluded studies included other methodological designs than only RCT's (Al Attar et al., 2017; Al Attar et al., 2015; Gagnier et al., 2012). Four studies were excluded for embracing multiple sports (Vatovec et al., 2019; Faude et al, 2017; Esteve et al., 2015; Goldman & Jones, 2011). Six reviews were excluded for outcomes not being directly related to effects on sports injuries (Pérez-Gómez et al., 2020; Cuthbert et al., 2019; Lam et al., 2019; Cruz-Ferreira et al., 2016; Amoako et al., 2017; Slysz et al., 2015). Therefore, five studies were eligible for this review. Figure 1 presents the search and exclusion procedure.

Figure 1 PRISMA diagram of the search strategy



Characteristics of included studies

Meta-analyses on the topic were published between 2015 and 2020, including between six and twelve RCT's as primary studies. Tables 1 and 2 show matrices with databases used and primary studies in each included review, respectively. PubMed was the most used search database (5/5), followed by Cochrane central, Embase and CINAHL (4/5). PEDro, AMED, Scopus, were consulted only by Crossley et al. (2020), and Lilacs, Scielo and Science direct were used only by Sadigursky et al. (2017).

The meta-analysis from Crossley et al. (2020), analyzed twelve RCT's being the one with more studies included. Grimm et al. (2016) compiled ten RCT's and Grimm et al. (2015) included nine studies. Both Sadigursky et al. (2017) and

Thorborg et al. (2017) included six trials. Regarding primary studies, the paper from Soligard et al. (2008) was the most cited (5/5), followed by Steffen et al. (2008) (4/5). Eight studies were cited only once between the five reviews (Foss et al., 2018; Espinosa et al., 2015; LaBella et al., 2011; Rössler et al., 2018; Zebis et al., 2018; Tropp et al., 1985; Mohammadi et al., 2007; Steffen et al., 2013).

Table 1 – Databases used in review

Primary study	Crossley et al (2020)	Grimm et al (2016)	Grimm et al (2015)	Sadigursky et al (2017)	Thorborg et al (2017)
Pubmed (Medline)	x	x	x	x	x
Embase	x	x	x		x
CINAHL	x	x	x		x
Cochrane Central	x	x	x		x
AMED	x				
PEDro	x				
Scopus	x				
SPORTDiscus	x				x
Web of Science	x				x
LILACS				x	
SciELO				x	
ScienceDirect				x	

Table 2 – Primary studies in each review

Primary study	Crossley et al (2020)	Grimm et al (2016)	Grimm et al (2015)	Sadigursky et al (2017)	Thorborg et al (2017)
Barber Foss et al (2018)	x				
Emery & Meeuwisse (2010)	x	x	x		
Espinosa et al (2015)	x				
Gilchrist et al (2008)	x		x		
Heidt et al (2000)	x	x			
LaBella et al (2011)	x				
Rössler et al (2018)	x				
Söderman et al (2000)	x	x	x		
Soligard et al (2008)	x	x	x	x	x
Steffen et al (2008)	x		x	x	x
Waldén et al (2012)	x		x		
Zebis et al (2018)	x				
Engebretsen et al (2008)		x	x		
Ekstrand et al (1983)		x	x		
Tropp et al (1985)		x			
Mohammadi (2007)		x			
Van Beijsterveldt et al (2012)		x	x		x
Hammes et al (2014)				x	x
Owoeye (2014)				x	x
Silvers-Granelli et al (2015)				x	x
Steffen et al (2013)				x	

Specificities of the eligible studies are presented in Table 3. Reviews included soccer players from different contexts, experiences and competition levels. All studies randomly compared exercised-based interventions to a non-exposed control group. The control groups maintained normal football practice, without the additional interventions. The most common outcome reported was injury rates, being calculates as the number of injuries per 1000h of exposure, following the International Olympic Committee consensus (Bahr et al., 2020).

Synthesis of results

Protocols follow up, in primary studies, ranged between three and twelve months. The results presented in each meta-analysis concerning the injury prevention effects are exposed in Table 4. Crossley et al. (2020) showed reduction on Hamstrings and overall injury incidences. Then, the authors made a subgroup analysis where multicomponent protocols exhibit a reduction on ACL and overall injury rates. Knee, ankle and Hip/ Groin injury rates did not show a reduction. The meta-analysis from Thorborg et al. (2017) aimed to evaluate FIFA preventive programs. A reduction of the overall injury rates was found for these protocols. Although a secondary analysis comparing FIFA 11 and FIFA 11+ protocols showed significant results only for FIFA 11+ programmes.

A review from Sadigursky et al. (2017) corroborated with these findings while narrowing their search to FIFA 11+ protocols. They identified a reduction of the overall injury rates over the intervention group. Grimm et al. (2016) assessed studies reporting ankle injury rates. This review presents a reduction of the injury rates favoring the exercise-based preventive programs. Finally, the meta-analysis from Grimm et al. (2015), while evaluating knee injury incidences, found a reduction of knee injuries for exercise-based protocols. However, no significant reductions were presented, when analyzing ACL incidences.

Methodological quality and risk of bias assessment

Table 5 shows the AMSTAR 2 assessment for each item. According to the AMSTAR 2 tool (Shea et al., 2017), four studies had the lowest score of critically low quality, indicating a high risk of bias. The review of Crossley et al. (2020), presented critical flaws at 13 and 15 items, and non-critical with 10 and 16. Grimm et al. (2016) had critical flaws at 7 and 13 items, and non-critical with 10 and 12. Sadigursky et al. (2017) showed critical flaws at 7 and 9 items and non-critical with 5, 6, 10 and 12. Thorborg et al. (2017) presented critical flaws at 7, 13 and 15 while non-critical flaws was 10, 12 and 16. The tool suggest that these results should not be relied to provide an accurate and comprehensive summary of the available studies. The only meta-analysis with moderate quality was from Grimm et al. (2015). This study only presented non-critical flaws at items 10, 12 and 16, indicating that it may provide an accurate summary of the available studies.

The diagnosed critical flaws were: item 13 – If the impact of the Rob was discussed in the results; 15 – If publication bias was assessed, presenting a funnel plot graph; 7 – If a list of potential excluded studies was provided, with justification; 9 – If the studies properly assessed Rob, according to the tool checklist. The non-critical flaws identified were: 10 – If reviews stated that financial support from primary studies were assessed; 16 – If reviews reported how possible conflicts of interest were managed; 12 – If the reviews made a differential analysis with studies that presented a minor Rob, considering a possible correlation between bias and results; 5 – If study selection was performed in duplicate; 6 – If data extraction was performed in duplicate.

Table 3 – Characteristics of the included meta-analysis

Review title **Authors** **Last assessed as up to date**	**Number of studies** **Sample size (range)**	**Population**	**Interventions**	**Comparison**	**Outcomes**
Making football safer for women: a systematic review and meta-analysis of injury prevention programmes in 11773 female football (soccer) players Crossley KM, Patterson BE, Culvenor AG, Bruder AM, Mosler AB, Mentiplay BF August 2019	12 11773 (43 – 4564)	Female soccer players National divisions; NCAA college teams I division; Adults; Adolescents < 18 years	Exercise- based programs	Control group not exposed	Any outcome related to injury incidence
Ankle injury prevention programs for soccer athletes are protective: A level-I meta-analysis Grimm NL, Jacobs Jr JC, Kim J, Amendola A, Shea KG February 2015	10 4121 (40 – 1892)	Soccer players from both genders; Adults; Adolescents < 18 years	Exercise-based programs	Control group not exposed	Ankle injury rates
Anterior cruciate ligament and knee injury prevention programs for soccer players Grimm NL, Jacobs JC, Kim J, Denney BS, Shea KG February 2014	9 11562 (180 – 4564) 7889 evaluated specific for ACL	Soccer players from both genders; Adults; Adolescents < 18 years	Exercise-based programs	Control group not exposed	Knee injury rates

The FIFA 11+ injury prevention program for soccer players: a systematic review Sadigursky D, Braid JA, De Lira DNL, Machado BAB, Carneiro RJF, Colavolpe PO March 2016	6 6,344 (265 – 2020)	Soccer players from both gender; Male NCAA collegiate division (I and II); Premier league of the Lagos junior league; Veterans >32 years; Adults; Adolescents < 18 years	FIFA 11+ program	Control group not exposed	Overall injuries incidence
Effect of specific exercise-based football injury prevention programmes on the overall injury rate in football: a systematic review and meta-analysis of the FIFA 11 and 11+ programmes Thorborg K, Krommes KK, Esteve E, Clausen MB, Bartels EM, Rathleff MS March 2016	6 6574 (265 – 2020)	Soccer players from both gender; Adults; Adolescents < 18 years	FIFA 11+ and FIFA 11 programs	Control group not exposed	Overall injuries incidence

Table 4 – Meta-analyses results

Study	Follow up range (months)	Measure of effect (95% CI)	I^2	Findings	Quality of Evidence (AMSTAR 2)
Crossley et al (2020)	3 – 12	IRR 0.78 (0.64 – 0.95); p= NP	60.3%; p= 0.005	Reduction of overall injuries with all exercise-based programs compared to control (22%)	Critically low
		IRR 0.73 (0.59 – 0.91); p= NP	64.7%; p= 0.004	Reduction of overall injuries analyzing only multiple component training compared to control (27%)	
		IRR 0.55 (0.32 – 0.92); p= NP	0.0%; p= 0.931	Reduction of ACL injuries analyzing only multiple component training compared to control (45%)	
		IRR0.62 (0.37 – 1.05); p= NP	0.0%; p= 0.525	ACL injuries reduction was not significant compared to control, with the inclusion of one balance board training study	
		IRR 0.85 (0.67 – 1.09); p= NP	21.9%; p= 0.242	Knee injuries reduction was not significant compared to control	
		IRR 0.83 (0.65 – 1.07); p= NP	13.1%; p= 0.327	Ankle injuries reduction was not significant compared to control	
		IRR 0.75 (0.41 – 1.40); p= NP	0.0%; p= 0.528	Hip/ Groin injuries reduction was not significant compared to control	
		IRR 0.40 (0.17 – 0.95); p= NP	0.0%; p= 0.607	Reduction of Hamstring injuries with all exercise-based programs compared to control	

Grimm et al (2016)	6 – 12	RR 0.60 (0.40 – 0.92); p= 0.002)	65.2%; p= 0.002	Reduction in ankle injuries compared to control group (40%)	Critically low
Grimm et al (2015)	3 – 12	RR 0.74 (0.55 – 0.89); p= 0.039 RR 0.66 (0.33 – 1.32); p= 0.38	50.2%; p= 0.041 31.7%; p= 0.222	Reduction in knee injuries (26%) compared to control ACL injuries reduction was not present compared to control	Moderate
Sadigursky et al (2017)	4,5 – 9	RR 0.70 (0.52 – 0.93); p= 0.01	91%; p< 0.0001	Reduction of overall injuries with FIFA 11+ compared to control (30%)	Critically low
Thorborg et al (2017)	5 – 9	RR 0.75 (0.57 – 0.98); p= 0.036 RR 0.61 (0.48 – 0.77); p<0.001 RR 0.99 (0.80 – 1.23); p= 0.94	68.9%; p= 0.007 25.5%; p= 0.259 0.0%; p= 0.982	Reduction of overall injuries with both programs (FIFA 11 and FIFA 11+) compared to control Reduction of overall injuries with FIFA 11+ compared to control Injuries reduction with FIFA 11 was not present compared to control	Critically low

RR – Risk ratio; IRR – Incidence rate ratio; NP – Not provided

3

Table 5 – AMSTAR 2 assessments results

AMSTAR 2 items	Crossley et al (2020)	Grimm et al (2016)	Grimm et al (2015)	Sadigursky et al (2017)	Thorborg et al (2017)
1.	Yes	Yes	Yes	Yes	Yes
2.	Yes	P. Yes	Yes	Yes	Yes
3.	Yes	Yes	Yes	Yes	Yes
4.	P. Yes	P. Yes	P yes	P. Yes	Yes
5.	Yes	Yes	Yes	No	Yes
6.	Yes	Yes	Yes	No	Yes
7.	Yes	No	yes	No	No
8.	Yes	Yes	Yes	Yes	Yes
9.	Yes	Yes	Yes	No	Yes
10.	No	No	No	No	No
11.	Yes	Yes	Yes	Yes	Yes
12.	No	No	No	No	No
13.	No	No	Yes	Yes	No
14.	Yes	Yes	Yes	Yes	Yes
15.	No	Yes	Yes	Yes	No
16.	No	Yes	No	Yes	No
Methodological quality	Critically low	Critically low	Moderate	Critically low	Critically low

Rating overall confidence in the results: High – Maximum of one non-critical flaw: Accurate and comprehensive summary of results; **Moderate** – Without critical flaws, but accept more than one non-critical: May provide an accurate summary of the results; **Low** – Only one critical flaw: May not provide an accurate and comprehensive summary of the available studies; **Critically low** – More than one critical flaw: Review should not be relied to provide an accurate and comprehensive summary of the available studies. **Critical flaws include items:** two, four, seven, nine, eleven, thirteen, fifteen.

Discussion

The performance, health and financial burden, generated from injuries, calls for effective preventive strategies. This review explores not only the effectiveness of the interventions, reported in literature, but contrast the results with the risk of bias and methodological quality. This is a noticeable step to assist decision making processes. In our understanding, it is important to analyze the injury preventive strategies, under the perspective of the design of the protocols, barriers of adherence and implementation cost-effectiveness.

Protocols

In our overview of meta-analyses, all included studies used exercise-based strategies to prevent injuries. Exercise prescription it is a challenge in the ecological context, and it is important to understand how the protocols were organized to stimulate the desired physiological adaptations and consequently decrease injuries. Crossley et al., (2020) analyzed the type of intervention that was included in the protocols. Strength training was present in 91%, running in 73%, plyometric training in 82%, balance in 64% and only 45% included mobility and agility components. However, as stated by authors, only 30% met the muscular strength guidelines – Minimal of 2 sets, 8-15 repetitions or 20-30 seconds of duration, and one progression of intensity – and 67% of the protocols met the plyometric/power training guidelines – Minimal of 1 set, 3-15 repetitions or 10-30 seconds of duration and one progression of intensity. This review showed that these protocols were enough to decrease overall and ACL injuries, even though the study present critically low confidence in the results.

This approach of different training components was previously investigated in a meta-analysis from Lauersen et al. (2014). The authors evaluated exercise preventive interventions among different sports, identifying that stretching showed no beneficial effects (RR 0.96 [0.85 – 1.09]). On the other hand, a preventive effect was revealed over strength training (RR 0.31 [0.20 – 0.48]), proprioception training (RR 0.55 [0.34 – 0.87]) and multiple interventions, that also included a strength component (RR 0.65 [0.52 – 0.82]). The exercise interventions were effective to reduce both acute (RR 0.64 [0.50 – 0.83]) and

overuse injuries (RR 0.52 [0.37 – 0.74]). A meta-analysis assessing soccer players, from Al Attar et al. (2016), found a reduction in hamstrings injuries, in programs that included the Nordic hamstring exercise (IRR 0.49 [0.29 – 0.82]). This exercise is also included in the FIFA preventive programs.

In the current study, the two reviews that assed FIFA protocols, favored the FIFA 11+ to decrease the risk of injuries (Thorborg et al., 2017; Soligard et al., 2017), even though these results may be seen critically due to the high risk of bias included. A previous study, from Al Attar and Alshehri (2019), made a meta-analysis of meta-analyses analyzing FIFA preventive programs. The authors included four papers, being two of them present in our overview of meta-analyses (Thorborg et al., 2017; Soligard et al., 2017). They estimate a risk reduction of 34% (RR 0.66 [0.60 – 0.73]) for all injuries and a risk reduction of 29% (RR 0.71 [0.63 – 0.81]) for lower limbs injuries, corroborating with our findings. The authors also used the AMSTAR 2 tool. However, they classified the meta-analysis from Thorborg et al. (2017) as moderate methodological quality.

Pre-established protocols for exercise interventions, such as FIFA 11+, may present positive benefits on injury rates, while facilitating the management of time and load for teams training. On the other hand, Bittencourt et al. (2016), explained that interventions should consider the risk profile of the athletes, prescribing individualized strategies, instead of solely looking at risk factors. Moreover, contextual barriers must be considered, whenever implementing evidence-based strategies (Padua et al., 2014).

Adherence

Effective injury prevention strategies are a promising path to raise sports performance. Nevertheless, many obstacles challenge the adequate implementation as presented by Donaldson et al. (2018). The authors identified some of the barriers, to implement preventive programs: Knowledge among coaches; lack of player enjoyment and engagement; not being related to the training goals; lack of leadership; lack of facilities and resources; and lack of time. Aspects like these must be considering while planning and implementing preventive strategies. Previous papers pointed that compliance affects the

preventive programs results. Interventions that had higher compliance from players presented a lower injury risk than players with intermediate compliance (van Reijen et al., 2016; Soligard et al., 2010). Interestingly, Ekstrand et al. (2019), found a higher incidence and burden of severe injuries in teams' staff with low quality of communication. The internal communication among coach and medical team was correlated to injury rates, training attendance and match availability.

In our study, the review from Thorborg et al. (2017) discussed about the possibility that the null results for FIFA 11, could be attributed to the confounding factor of compliance. The authors did not identify any association between, number of sessions performed per week, and overall injury incidence. This metric was used to discuss about compliance in the programs. On the other hand, this association revealed to be positive for the FIFA 11+, where the program appears to have better efficacy over individuals with high compliance rates.

Cost-effectiveness

An elevated risk of bias tends to overestimate or to underestimate the results, being a relevant variable to be analyzed in research. Research in team sports naturally present ecological barriers that elevate the risk of bias, such as proper participants blinding (Lauersen et al., 2014). This fact is expected in primary studies researching about injury prevention. However, as we limited our studies to RCTs, the results are less prone to bias compared to other study designs, as there is a methodological effort to diminish them.

Even if being skeptical about the results, due to the risk of bias identified in the meta-analyses, minor changes on injury rates, may justify the use of preventive programs in soccer athletes, considering the manifold benefits originated from it. The risk reduction of 26% in knee injuries presented by Grimm et al. (2015), with moderate bias, is an important finding. Injuries over the knee, is one of the most prevalent in football, being associated with a high absence for rehabilitation (Stubbe et al., 2014). Corroborating with our conclusion, Swart et al. (2014), stated that neuromuscular training portrays a cost-effective strategy to reduce costs and morbidity of knee injuries, due to the ease and low cost to

implement it. No evidence of adverse effects was formally reported in the included studies.

Evidence that the FIFA 11 program induce no or only minimal physiological adaptations, is presented in our study. Interestingly, a cohort study from Nouni-Garcia et al. (2019), analyzed the economic impacts of this program, over lateral ankle ligaments and hamstrings injuries. For the ankle injuries, the group that was exposed to the FIFA 11 protocol, presented a mean cost per player of 647 Euros, while in the control group, the cost was 928 Euros (p=0.19). For the hamstring's injuries, the FIFA 11 group revealed a mean cost per player of 742 Euros, compared to the 1271 Euros of the unexposed group (p=0.028). The FIFA 11+ Kids, were addressed by Rössler et al. (2019), and may also present cost-effective benefits. According to the authors, it reduced 51% of the healthcare costs compared to usual warm-ups, over Switzerland youth teams.

Conclusion

Our main finding was a reduction of 26% over knee injuries, with moderate quality, in one meta-analysis. Other measures of effect, even though presented reduction over the injury rates, must be interpreted with prudence due to the high risk of bias presented. Considering the range of benefits from injury prevention, neuromuscular exercises are a cost-effective strategy for soccer players at different performance levels.

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Capítulo III – Considerações finais e Conclusão

As lesões no contexto esportivo do futebol, representam um problema de elevada magnitude e complexidade. A origem multifatorial e não-linear das lesões desportivas, aumentam o desafio para encontrar as estratégias de manejo mais adequadas, para cada contexto específico. Este cenário, aparentemente caótico na prática desportiva, demanda um embasamento sobre os as evidências científicas, de forma que os esforços para mitigar o problema, sejam os mais eficazes. Assim, este trabalho contribui muito para o desenvolvimento teórico e prático nesta temática, compilando os achados científicos e expondo limitações destes estudos.

Padua et al. (2014), apresentam um modelo para desenvolver e implementar um programa de prevenção de lesões. Segundo os autores, a base deste programa deve ser: Suporte administrativo; equipe multidisciplinar; identificar as barreiras logísticas e soluções. Estes primeiros passos, diminuem as barreiras ecológicas, facilitando a implementação de programas preventivos baseados nas melhores evidências. As próximas etapas do modelo são: O treinamento de staff e atletas, controle da aderência e manutenção do programa, fortalecendo-o a longo prazo.

O trabalho aqui apresentado teve como objetivo analisar as estratégias reportadas na literatura com maior rigor metodológico, como forma de auxiliar este processo de desenvolvimento e implementação de programas preventivos. Ao elencar para a análise, revisões sistemáticas com meta-análises sobre estudos controlados randomizados, partimos de um pressuposto de maior qualidade metodológica, diminuindo riscos de viés e aumentando a confiança sobre os resultados encontrados. Relativamente aos resultados de nosso estudo, a literatura científica recomenda estratégias baseadas em exercícios neuromusculares, para a prevenção de lesões. Porém apesar dos resultados estatísticos favorecerem estas abordagens, estes devem ser interpretados com cautela, uma vez que o risco de viés apresentado sobre as meta-análises, podem superestimar os resultados.

O fato de todas as revisões incluídas, avaliarem estratégias baseadas em exercícios, pode indicar uma limitação de nosso estudo. Conforme explicado por

Hulme et al. (2018), as origens multifatoriais das lesões, permitem intervenções sobre diferentes níveis. Exercícios preventivos podem influenciar os atletas sobre uma perspectiva individual e coletiva, porém, estratégias institucionais, administrativas, políticas, financeiras e mudanças de regras, podem ter vantagens ainda maiores em uma mais complexa. Delimitar a nossa análise sobre revisões sistemáticas com meta-análises de RCTs, pode ter excluído outras estratégias interessantes, que apresentam menor evidência científica. Estudos futuros poderão explorar a influência de outras estratégias, considerando o rigor metodológico. O avanço do conhecimento científico nesta área é importante para de auxiliar as decisões do contexto prático, suportando programas preventivos mais informados e assertivos.

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