UNIVERSIDADE FEDERAL DE CIÊNCIAS DA SAÚDE DE PORTO ALEGRE
PROGRAMA DE PÓS-GRADUAÇÃO EM CIÊNCIAS DA REABILITAÇÃO

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Recovery no futebol: revisão sistemática da literatura e percepção de atletas profissionais

Porto Alegre

2022

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Dissertação submetida ao Programa de Pós-Graduação em Ciências da Reabilitação da Universidade Federal de Ciências da Saúde de Porto Alegre como requisito para a obtenção do grau de Mestre

Orientador: Prof. Dr. Bruno Manfredini Baroni

Porto Alegre

2022

Catalogação na Publicação

Michel, Rafael Cristane
Recovery no futebol : revisão sistemática da literatura e percepção de atletas profissionais / Rafael Cristane Michel. -- 2022.
57 p. : il., graf., tab. ; 30 cm.

Dissertação (mestrado) -- Universidade Federal de Ciências da Saúde de Porto Alegre, Programa de Pós-Graduação em Ciências da Reabilitação, 2022.

Orientador(a): Prof. Dr. Bruno Manfredini Baroni.

1. Esporte. 2. Ciência do Esporte. 3. Medicina Esportiva. 4. Fisioterapia Esportiva. 5. Recuperação pós-exercícios. I. Título.

Sistema de Geração de Ficha Catalográfica da UFCSPA com os dados fornecidos pelo(a) autor(a).

Recovery no futebol: revisão sistemática da literatura e percepção de atletas profissionais

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Porto Alegre
2022

AGRADECIMENTOS

Agradeço, primeiramente, à minha companheira Deborah que há mais de cinco anos juntou-se a mim nessa caminhada e vem, todos os dias, me tornando um homem, uma pessoa e um fisioterapeuta melhor em todos os sentidos. É inexplicável a sorte e a honra que eu tenho de ter logo ao meu lado a minha maior inspiração. Temos uma longa jornada pela frente, mas eu não poderia estar mais orgulhoso da nossa trajetória até aqui: tem sido uma alegria imensa percorrer este caminho contigo.

À minha família, em especial aos meus pais Claudio e Cristina, que confiaram, bancaram e lutaram ao meu lado nessa nova longa jornada e em todos outros aspectos da minha vida, ajudando a moldar meu caráter ético e pessoal, do qual me orgulho muito. Se hoje sou um bom ser-humano e um bom profissional é por mérito deles.

Ao meu orientador e professor Bruno Baroni que abriu as portas do seu grupo de pesquisa e extrapolou, sempre com ética e com um humanismo inestimáveis, o papel de orientador, de inspiração e de amigo para além dos portões da Universidade. Não consigo me imaginar trabalhando com nada além do mundo esportivo e sou, portanto, muito grato por poder fazer ciência com um dos melhores na área.

À banca avaliadora desta dissertação, por ter compartilhado do seu tempo e do seu conhecimento para tornar este trabalho o melhor possível.

Aos meus amigos e colegas que, de diversas maneiras, ajudaram a tornar essa jornada mais leve e prazerosa, em especial aos colegas do Grupo de Ciência no Esporte & Exercício que, desde o início, me receberam com muito carinho e me auxiliaram sempre que necessário.

Gostaria de expressar minha gratidão por esta oportunidade e pelo privilégio de ter conseguido chegar até este momento. O ensino superior, especialmente em uma Universidade Federal – e ainda mais em uma pós-graduação – é uma realidade para uma pequeníssima parcela da população brasileira e, por isso, prometo honrar minha responsabilidade neste papel que me encontro.

RESUMO

Estratégias de recuperação pós-exercício, ou estratégias de "*recovery*", fazem parte da rotina de atletas e clubes de futebol de ambos os sexos e de diferentes níveis de participação. Diante da popularização da Prática Baseada em Evidência (PBE), chama atenção o fato de não existir uma revisão sistemática acerca da eficácia destas estratégias aplicadas especificamente no contexto no futebol. Além disso, apesar de os valores do paciente constituírem um dos pilares da PBE, a percepção dos atletas acerca das estratégias comumente utilizadas no futebol permanece inexplorada. Diante deste cenário, a presente dissertação contempla dois estudos. O estudo 1 teve por objetivo revisar de maneira sistemática a evidência disponível acerca das intervenções fisioterapêuticas utilizadas para *recovery* em atletas de futebol. Dois pesquisadores realizaram buscas independentes nas bases de dados PubMed, CENTRAL, Scielo e Pedro utilizando combinações de termos relacionados ao tema. De um total de 2.925 estudos identificados nas buscas, 25 atenderam aos critérios de seleção e foram incluídos na revisão. Vinte e três destes estudos (92%) apresentaram escore menor ou igual a 6 na escala PeDRO, sugerindo alto risco de viés. Ao todo, 429 atletas participaram dos estudos, sendo a maioria atletas profissionais do sexo masculino. Recuperação ativa, imersão em água fria e roupas de compressão foram as intervenções mais investigadas. Outras intervenções (como *foam rolling*, plataforma vibratória e imersão de contraste) foram avaliadas por apenas um ou dois estudos. A revisão descreve os efeitos destas e outras intervenções sobre parâmetros relacionados à performance física, percepção de recuperação e biomarcadores. Em síntese, apesar de alguns recursos apresentarem resultados promissores sobre determinados desfechos, não há evidência suficiente para destacar um recurso fisioterapêutico capaz de atuar simultaneamente sobre os aspectos de recuperação relacionados à performance, percepção e biomarcadores. O estudo 2 teve por objetivo descrever a percepção de atletas profissionais sobre a eficácia das estratégias comumente adotadas no meio do futebol. Ao todo, 100 atletas profissionais de futebol masculino da 1ª à 4ª divisão do Campeonato Brasileiro responderam a um questionário online. Imersão em água fria (88% de aprovação), suplementos nutricionais (71%), massagem (66%), alongamento (64%) e recuperação ativa (60%) foram as 5 principais estratégias classificadas. Após a realização dos dois estudos desta dissertação, conclui-se que: (1) a literatura acerca dos efeitos das intervenções fisioterapêuticas utilizadas para *recovery* no futebol é composta, em sua maioria, por estudos com elevado risco de viés; (2) apesar de algumas intervenções terem se mostrado benéficas sobre alguns desfechos relacionados à recuperação, parece não haver um recurso capaz de otimizar simultaneamente a recuperação da performance, percepção e biomarcadores; e (3) os atletas profissionais do sexo masculino têm confiança na efetividade de algumas, mas não todas, estratégias de *recovery* comumente aplicadas no contexto do futebol. Considerando a inconsistência da literatura, conhecer as crenças e preferências dos jogadores pode ser crucial para melhorar a adesão e aumentar as chances de sucesso das estratégias de *recovery* escolhidas pelos profissionais de saúde.

Palavras-chave: Esporte; Ciência do esporte; Medicina esportiva; Fisioterapia esportiva; Recuperação pós-exercício.

ABSTRACT

Post-exercise recovery strategies, commonly called “recovery” strategies, are part of the routine of athletes and football clubs of both sexes and of different levels of participation. In view of the popularization of Evidence-Based Practice (EBP), it is noteworthy that there is no systematic review about the effectiveness of these strategies applied specifically in the context of football. In addition, although patient values constitute one of the pillars of EBP, athletes' perception of commonly used strategies in soccer remains unexplored. Given this scenario, the present dissertation includes two studies. Study 1 aimed to systematically review the available evidence about the physical therapy interventions used for recovery in football athletes. Two researchers performed independent searches in PubMed, CENTRAL, Scielo and Pedro databases using combinations of terms related to the topic. Of a total of 2,925 studies identified in the searches, 25 met the selection criteria and were included in the review. Twenty-three of these studies (92%) had a score less than or equal to 6 on the PEDro scale, suggesting a high risk of bias. In all, 429 athletes participated in the studies, most of them male professional athletes. Active recovery, cold water immersion and compression garments were the most investigated interventions. Other interventions (such as foam rolling, whole-body vibration and contrast water immersion) were evaluated by only one or two studies. The review describes the effects of these and other interventions on parameters related to physical performance, perception of recovery and biomarkers. In summary, despite some resources showing promising results on certain outcomes, there is not enough evidence to highlight a specific physical therapy resource capable of acting simultaneously on aspects of recovery related to performance, perception and biomarkers. Study 2 aimed to describe the perception of professional athletes about the effectiveness of strategies commonly adopted in football. A hundred professional male soccer athletes from the 1st to 4th division of the Brazilian Championship answered an online questionnaire. Cold water immersion (88% approval), nutritional supplements (71%), massage (66%), stretching (64%) and active recovery (60%) were the top 5 ranked strategies. After carrying out the two studies of this dissertation, it is concluded that: (1) the literature on the effects of physical therapy interventions used for recovery in soccer is composed, mostly, of studies with a high risk of bias; (2) although some interventions have been shown to be beneficial on some outcomes related to recovery, there seems to be no resource capable of simultaneously optimizing the recovery of performance, perception and biomarkers; and (3) professional male athletes are confident in the effectiveness of some, but not all, recovery strategies commonly applied in the soccer context. Considering the inconsistency of the literature, knowing the players' beliefs and preferences can be crucial to improve adherence and increase the chances of success of the recovery strategies chosen by health professionals.

Key-words: Sport; Sport science; Sports Medicine; Sports Physical Therapy; Post-exercise recovery.

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LISTA DE ABREVIATURAS E SIGLAS

AST	Aspartato aminotransferase
CK	Creatina quinase
CMJ	Salto contramovimento
CTI	Imersão em contraste
CWI	Crioimersão
FLC	Compressão completa de membro inferior
HR	Frequência cardíaca
LASER	Amplificação da luz por emissão estimulada de radiação
LDH	Lactato desidrogenase
LED	Diodo emissor de luz
LIST	Teste intermitente de Loughborough
MVIC	Contração isométrica voluntária máxima
RPE	Percepção subjetiva de esforço
SHC	*Shorts* de compressão
SJ	Salto em posição de agachamento
STC	Meias de compressão
TQR	Questionário de qualidade de recuperação
TWI	Imersão em temperatura ambiente
WBC	Crioterapia de corpo inteiro (câmara de crioterapia)
WBV	Vibração de corpo inteiro (plataforma vibratória)
Y	Anos
YYIR	Teste Yo-Yo de recuperação intermitente

SUMÁRIO

1 CONTEXTUALIZAÇÃO

O termo “*recovery*” tem se popularizado no meio do esporte como uma forma simplificada de se referir ao processo de recuperação do atleta após sua exposição a uma sessão de treinamento ou competição. De forma geral, o *recovery* está relacionado à recuperação do equilíbrio alostático do organismo, sendo caracterizado pelo reestabelecimento dos recursos investidos pelo atleta em nível fisiológico e psicológico (Kellman et al., 2018). Em tese, a exposição de um atleta a uma sessão de treinamento/competição sem que o mesmo esteja totalmente recuperado do desequilíbrio causado por uma sessão prévia é potencialmente prejudicial a sua performance física e esportiva, além de aumentar o seu risco de ser acometido por lesões do esporte (Bengtsson et al., 2013). Nesse sentido, a otimização do processo de recuperação pós-exercício é de fundamental importância para o sucesso de atletas e suas equipes, de modo que o tema *recovery* vem ganhando cada vez mais notoriedade no meio esportivo.

O fisioterapeuta possui um papel de protagonismo no que tange o processo de recuperação pós-exercício (Field et al., 2021). Este profissional faz o uso de intervenções não-invasivas e não-farmacológicas para propiciar as melhores condições para que atletas de diferentes esportes e níveis de participação estejam aptos o mais brevemente possível para uma nova exposição. A atuação dos fisioterapeutas no âmbito do *recovery* ocorre em esportes individuais e coletivos, tanto na esfera do esporte amador quanto no esporte de alto rendimento, fazendo com que os fisioterapeutas trabalhem com intervenções voltadas ao *recovery* dentro de clubes esportivos, federações, centros multiprofissionais de saúde, clínicas e consultórios de fisioterapia.

Recuperação ativa (ou seja, o uso de exercícios ativos) (Ortiz et al., 2018) imersão em água fria (Higgins et al., 2017), massoterapia (Davis et al., 2020) e técnicas de alongamento (Afonso et al., 2021), entre outras, são algumas das intervenções utilizadas há várias décadas com o intuito de otimizar a recuperação pós-exercício. Mais recentemente, outros recuros têm sido

lançados no mercado para fins de *recovery*, como vestimentas de compressão (Brown et al., 2022), dispositivos pneumáticos (Stedge & Armstrong, 2021), plataformas para vibração de corpo inteiro (Alam et al., 2018) e equipamentos de fotobiomodulação (Ferlito et al., 2022), entre outras. As evidências científicas acerca dos reais efeitos de muitas destas estratégias de *recovery* disponíveis nos dias de hoje ainda são escassas ou contraditórias. Porém, não há dúvida que inúmeros atletas, sobretudo no contexto do alto rendimento esportivo, investem recursos e dedicam parte de sua rotina habitual à utilização de estratégias de *recovery*.

O futebol é o esporte mais popular do planeta, com mais de 270 milhões de praticantes (FIFA, 2007). Trata-se de um esporte de natureza intermitente, em que os atletas realizam uma gama de ações de alta intensidade (tais quais sprints, corridas em alta velocidade, acelerações, desacelerações, saltos, chutes, etc.), frequentemente em situações de combate com oponentes, durante dois tempos de 45 minutos (Stølen et al., 2005). As demandas impostas pelo esporte tendem a promover um perfil específico de estresse biológico sobre os atletas, de modo que as necessidades de recuperação após uma partida de futebol sejam distintas daquelas encontradas em outros tipos de exercícios, como uma maratona ou uma sessão de treinamento de força, por exemplo. Logo, é plausível supor que profissionais de saúde engajados no meio do futebol devam buscar estratégias de *recovery* com eficácia evidenciada por estudos científicos desenvolvidos em populações de futebolistas.

Duas revisões narrativas com foco na recuperação da fadiga relacionada ao futebol (Rey et al., 2018; Nédélec et al., 2013) forneceram informações valiosas para orientar a tomada de decisão dos profissionais, mas carecem da qualidade metodológica e da imparcialidade das revisões sistemáticas. Ao mesmo tempo, as conclusões da única revisão sistemática neste campo (Altarriba-Bartes et al., 2020) são limitadas devido ao pequeno número de estudos analisados (cinco ensaios; três estratégias de recuperação pós-exercício; 69 participantes). Dessa forma, a literatura carece de uma revisão sistemática abrangente para auxiliar a tomada de decisão do profissional fisioterapeuta.

Além da evidência científica (que parece ser deficiente em relação à recuperação no futebol) e da experiência clínica, a Prática Baseada em

Evidência (PBE) é apoiada por um terceiro pilar igualmente importante: os 'valores do paciente' (ou seja, crenças individuais, preferências, preocupações e expectativas) (Herbert et al., 2011). As percepções dos pacientes são cruciais para determinar a adesão e o sucesso de uma intervenção (Babatunde et al., 2017; Finch & Donaldson, 2010), ainda mais quando a percepção de recuperação pós-exercício por parte dos jogadores envolve parâmetros subjetivos que podem ser afetados pelo efeito placebo (Tavel, 2014). Curiosamente, apesar das recentes investigações sobre as percepções de jogadores profissionais de futebol sobre prevenção de lesões (Zech & Wellmann, 2017; Liporaci et al., 2021), suas opiniões sobre estratégias de recuperação pós-exercício permanecem inexploradas.

Em síntese, duas lacunas encontradas na literatura acerca do *recovery* no contexto do futebol justificam a realização da presente dissertação. A primeira lacuna, relacionada à ausência de uma revisão sistemática abrangente na área, incentivou o Artigo 1 desta dissertação, intitulado *"Which Physiotherapeutic Interventions Work for Football-Related Fatigue Recovery? A Systematic Review"*. A segunda lacuna, relacionada à ausência de investigações originais sobre a percepção de atletas de futebol sobre a eficácia de estratégias de *recovery*, motivou o Artigo 2 da dissertação, intitulado *"Perceptions of Professional Male Football Players on Post-Exercise Recovery Strategies"*.

REFERÊNCIAS

Afonso, J., Clemente, F. M., Nakamura, F. Y., Morouço, P., Sarmento, H., Inman, R. A., & Ramirez-Campillo, R. The Effectiveness of Post-exercise Stretching in Short-Term and Delayed Recovery of Strength, Range of Motion and Delayed Onset Muscle Soreness: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Frontiers in Physiology, 12. 2021. https://doi.org/10.3389/FPHYS.2021.677581

Altarriba-Bartes, A., Peña, J., Vicens-Bordas, J., Milà-Villaroel, R., & Calleja-González, J. . Post-competition recovery strategies in elite male soccer players. Effects on performance: A systematic review and meta-analysis. PloS One, 15(10). 2020 https://doi.org/10.1371/JOURNAL.PONE.0240135

Babatunde, F., MacDermid, J., & MacIntyre, N. . Characteristics of therapeutic alliance in musculoskeletal physiotherapy and occupational therapy practice: a scoping review of the literature. BMC health services research, 17(1), 375. 2017. https://doi.org/10.1186/s12913-017-2311-3.

Bengtsson, H., Ekstrand, J., & Hägglund, M. Muscle injury rates in professional football increase with fixture congestion: an 11-year follow-up of the UEFA Champions League injury study. *British journal of sports medicine*, *47*(12), 743–747. 2013. https://doi.org/10.1136/bjsports-2013-092383

Brown, F. C. W., Hill, J. A., & Pedlar, C. R. Compression Garments for Recovery from Muscle Damage: Evidence and Implications of Dose Responses. Current Sports Medicine Reports, 21(2), 45–52. 2022. https://doi.org/10.1249/JSR.0000000000000933

Cullen, M. L., Casazza, G. A., & Davis, B. A. Passive Recovery Strategies after Exercise: A Narrative Literature Review of the Current Evidence. *Current sports medicine reports*, *20*(7), 351–358. 2021. https://doi.org/10.1249/JSR.0000000000000859

Davis, H. L., Alabed, S., & Chico, T. J. A. Effect of sports massage on performance and recovery: a systematic review and meta-analysis. BMJ Open Sport & Exercise Medicine, 6, 1, 2020. e000614. https://doi.org/10.1136/BMJSEM-2019-000614

Ferlito, J. V., Ferlito, M. V., Leal-Junior, E., Tomazoni, S. S., & De Marchi, T. Comparison between cryotherapy and photobiomodulation in muscle

recovery: a systematic review and meta-analysis. *Lasers in medical science*, *37*(3), 1375–1388. 2022. https://doi.org/10.1007/s10103-021-03442-7

Field, A., Harper, L. D., Chrismas, B., Fowler, P. M., McCall, A., Paul, D. J., Chamari, K., & Taylor, L. The Use of Recovery Strategies in Professional Soccer: A Worldwide Survey. *International journal of sports physiology and performance*, *16*(12), 1804–1815. 2021. https://doi.org/10.1123/ijspp.2020-0799

FIFA Big Count 2006: 270 million people active in football [Internet]. 2007 [accessed 2020 Apr].

Finch, C. F., & Donaldson, A. A sports setting matrix for understanding the implementation context for community sport. British journal of sports medicine, 44(13), 973–978. 2010. https://doi.org/10.1136/bjsm.2008.056069

Herbert, R., Jamtvedt, G., Mead, J., Hagen, K. B. Practical evidence-based physiotherapy. Oxford: Elsevier Butterworth-Heinemann. 2011.

Higgins, T. R., Greene, D. A., & Baker, M. K. Effects of Cold Water Immersion and Contrast Water Therapy for Recovery From Team Sport: A Systematic Review and Meta-analysis. Journal of Strength and Conditioning Research, 31(5), 1443–1460. 2017. https://doi.org/10.1519/JSC.0000000000001559

https://www.fifa.com/mm/document/fifafacts/bcoffsurv/bigcount.statspackage_7024.pdf.

Kellmann, M., Bertollo, M., Bosquet, L., Brink, M., Coutts, A. J., Duffield, R., Erlacher, D., Halson, S. L., Hecksteden, A., Heidari, J., Wolfgang Kallus, K., Meeusen, R., Mujika, I., Robazza, C., Skorski, S., Venter, R., & Beckmann, J. Recovery and Performance in Sport: Consensus Statement. International Journal of Sports Physiology and Performance, 13(2), 240–245. 2018. https://doi.org/10.1123/IJSPP.2017-0759

Nédélec, M., McCall, A., Carling, C., Legall, F., Berthoin, S., & Dupont, G. Recovery in soccer: Part II-recovery strategies. Sports Medicine, 43(1), 9–22. 2013. https://doi.org/10.1007/S40279-012-0002-0

Ortiz, R. O., Sinclair Elder, A. J., Elder, C. L., & Dawes, J. J. A Systematic Review on the Effectiveness of Active Recovery Interventions on Athletic

Performance of Professional-, Collegiate-, and Competitive-Level Adult Athletes. Journal of Strength and Conditioning Research, 33(8), 2275–2287. 2019. https://doi.org/10.1519/JSC.0000000000002589

Rey, E., Padrón-Cabo, A., Barcala-Furelos, R., Casamichana, D., & Romo-Pérez, V. Practical active and passive recovery strategies for soccer players. Strength and Conditioning Journal, 40(3), 45–57. 2018. https://doi.org/10.1519/SSC.0000000000000247

Rogério Ferreira Liporaci, Sergio Yoshimura & Bruno Manfredini Baroni. Perceptions of Professional Football Players on Injury Risk Factors and Prevention Strategies, Science and Medicine in Football. 2021. DOI: 10.1080/24733938.2021.1937689

Stedge, H. L., & Armstrong, K. The Effects of Intermittent Pneumatic Compression on the Reduction of Exercise-Induced Muscle Damage in Endurance Athletes: A Critically Appraised Topic. *Journal of sport rehabilitation*, *30*(4), 668–671. 2021. https://doi.org/10.1123/jsr.2020-0364

Stølen, T., Chamari, K., Castagna, C., & Wisløff, U. Physiology of soccer: an update. *Sports medicine*, *35*, 6, 501–536. 2005. https://doi.org/10.2165/00007256-200535060-00004

Tavel M. E. The placebo effect: the good, the bad, and the ugly. The American journal of medicine, 127(6), 484–488. 2014. https://doi.org/10.1016/j.amjmed.2014.02.002

Zech, A., & Wellmann, K. Perceptions of football players regarding injury risk factors and prevention strategies. *PloS one*, *12*(5), e0176829. 2017. https://doi.org/10.1371/journal.pone.0176829

2 OBJETIVOS

Artigo 1

Revisar de maneira sistemática a evidência disponível acerca das intervenções fisioterapêuticas utilizadas para *recovery* em atletas de futebol.

Artigo 2

Descrever a percepção de atletas profissionais sobre a eficácia das estratégias comumente adotadas no meio do futebol.

3 ARTIGO 1

WHICH PHYSIOTHERAPEUTIC INTERVENTIONS WORK FOR FOOTBALL-RELATED FATIGUE RECOVERY? A SYSTEMATIC REVIEW

Formatado conforme normas do periódico International Journal of Sports Physical Therapy (Fator de Impacto 0.229)

ABSTRACT

Background: Post-exercise recovery strategies are already part of the routine of football clubs and physical therapists have a key role in this field. However, a comprehensive systematic review to guide practitioners on physiotherapeutic interventions used for football-related recovery is lacking.

Purpose: To review the available evidence regarding physiotherapeutic interventions used for football-related fatigue recovery.

Study Design: Systematic review.

Methods: Searches were carried out on PubMed, CENTRAL, Scielo, and PEDro databases. Original trials investigating football-related fatigue recovery were included. Information regarding study population, protocol, recovery strategy, and outcomes related to performance, perception and biomarkers were extracted.

Results: From a total of 2,925 studies identified in the searches, 25 met the selection criteria and were included in the review. Twenty-three of included studies (92%) had PeDRO scores suggestive of a high risk of bias. Thirteen physiotherapeutic interventions for football-related fatigue recovery were assessed. Active recovery, cold water immersion and compression garments were the most investigated interventions. Other interventions (such as foam rolling, whole-body vibration and contrast water immersion) were assessed by only one or two studies. In summary, despite some interventions showing promising results on specific outcomes (see discussion sections for details), there is not enough evidence to highlight a physiotherapeutic intervention capable of acting simultaneously on aspects of recovery related to performance, perception and biomarkers.

Conclusion: There is no physiotherapy intervention able to improve all football-related fatigue recovery markers, it seems recommended that practitioners

choose the recovery strategy based on the target outcomes (performance, perception or biomarkers) for their athletes.

Level of evidence: level 1.

Key terms: Post-exercise recovery; Soccer; Sport; Sport science; Sports Medicine; Sports Physical Therapy.

Clinical relevance: aid physiotherapists to choose the best interventions for each objective, aiming at better use of resources, recovery and injury prevention.

What is known about the subject: conclusions of the single systematic review in this field are limited due the small number of studies analyzed. A comprehensive systematic review focusing on football-specific recovery is lacking.

What this study adds to existing knowledge: The present study highlights the lack of articles of good methodological quality that provide scientific foundations for the use of physiotherapeutic interventions commonly used for recovery purposes in football. Although some interventions have been shown to be beneficial on some recovery-related outcomes, there seems to be no resource capable of simultaneously optimize the recovery of performance, perception and biomarkers. Therefore, it is recommended that physical therapists' decision-making always consider the outcome related to post-exercise recovery that the intervention aims to achieve.

INTRODUCTION

Football (soccer) match fatigue and recovery has become a 'hot topic' in the sports medicine community in the last decades [1; 2]. Despite the total distance covered during a male professional match have increased only ~2% from season 2006/2007 to season 2012/2013, high-speed running and sprints distances covered increased by ~29% and ~51%, respectively [3]. This means that matches have been played with increasing intensity, and it probably tends to continue rising in the coming years [4]. It is already known that a period of 72 h post-match play is not long enough to completely restore the players' physical performance (e.g., muscle strength, jump and sprint ability), as well as their perception of well-being status (e.g., delayed-onset muscle soreness) and the biochemical milieu homeostasis (e.g., creatine kinase levels) [1]. Despite recommendations from the International Olympic Committee that football matches should be interspersed by at least 96 h to protect players from injury [5], players are often subjected to matches less than 72 h apart to meet calendar needs. This short interval between matches increases the injury risk [6], potentially impairing the team's performance and finances [7].

Adopting strategies to optimize athletes' post-exercise recovery is a common practice in competitive sports, especially in the professional level. According to a worldwide survey with professional football clubs' practitioners, the primary objectives for recovery strategy use are 'alleviating muscle damage and fatigue', 'minimizing injury risk', and 'performance optimization' [8]. Physiotherapeutic interventions (i.e., those not related with ingestion of any substance, such as medicines, food, drinks, vitamins, supplements, etc.) play a role on post-exercise recovery of football players. Recent studies showed that cold-water immersion, low-intensity exercise (i.e., active recovery), stretching, massage, and self-myofascial release (i.e., foam rolling) are frequently employed for post-match recovery in professional clubs [8;9;10]. However, scientific evidence suggests caution on effectiveness of such interventions [11;12;13], specially because a few studies have been carried out in the professional sports context [14].

The impact of a range of interventions on different markers of post-exercise recovery have been summarized by comprehensive systematic reviews [11;12;13], as well as by systematic reviews with focus on specific recovery

strategies such as stretching [15], massage [16], cold water immersion [17], and others. Such reviews included original trials that assessed the time-course of post-exercise recovery markers along subsequent days of a wide range of exercise protocols, most of them with resistance exercises that characteristically raise markers of muscle damage and inflammatory response. Given the difference in physical demand from a resistance exercise session to a football match, it is reasonable to assume that practitioners should opt for specific recovery interventions against the deleterious effects of football-related fatigue. Past experiences from practitioners and athletes traditionally play a role on the choice for recovery strategies [18]. Narrative reviews with focus in post-football match recovery [19;20] have provided valuable information to guide the practitioners' decision-making but lack the methodological quality and impartiality of systematic reviews. Concurrently, conclusions of the single systematic review in this field [21] are limited due the small number of studies analyzed (i.e., five trials, three post-exercise recovery strategies, 69 participants).

In summary, post-exercise recovery strategies are already part of the routine of football clubs of both sexes and at different competitive levels. Physiotherapists play a key role in planning and applying interventions aimed at recovering players from matches and training sessions. A comprehensive systematic review focusing on football-specific recovery is lacking. Therefore, the aim of this study was to review the available evidence regarding physiotherapeutic interventions used for football-related fatigue recovery. Considering that post-exercise recovery is a complex process involving both physiological and psychological pathways [22], and that there is no gold-standard marker of recovery, this review assessed the effect of such interventions on players' physical performance, perception and biomarkers.

METHODS

This systematic review was undertaken in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [23]. The review methods were planned prior to carrying out the searches and no significant changes were made to the original protocol.

Study selection procedure

Studies of interest were obtained through searches in PubMed, Cochrane CENTRAL, SciELO and PEDro online databases, including studies from inception to December 2021. The search method was adapted for each database using the following combination of terms: (soccer OR football) AND (recovery OR strategy OR modality) AND (biomarker OR performance OR strength OR perception OR soreness).

The present review included original trials in which football players were submitted to physiotherapeutic interventions used for football-related fatigue recovery. The PICO method was used for inclusion and exclusion criteria (Table 1). Only studies published in English, Spanish and Portuguese languages were included.

The search and selection of potential studies were performed by two independent researchers (R.M. and D.M.). Mendeley Reference Manager (Elsevier, Amsterdam, Netherlands) was used to organize the included/excluded studies and remove duplicates. Titles and abstracts of all articles identified by the search strategy were independently evaluated in duplicate. Abstracts that did not provide sufficient information regarding the inclusion and exclusion criteria were selected for full-text evaluation. Reviewers independently evaluated these full-text articles and selected them in accordance with the eligibility criteria. Disagreements between reviewers were resolved by a third researcher (B.B.)

Table 1. Criteria for inclusion and exclusion according to PICO method

DEFINITION	INCLUSION CRITERIA	EXCLUSION CRITERIA
Population	Football players (with no restriction on competitive level, age or sex)	Studies including different athletes apart from football players with no sub-analysis by sport
Intervention	Recovery interventions applied after football-specific fatigue protocols (field tests, simulated games, official and friendly games)	Nutritional and/or pharmacological interventions
Comparator	Control/placebo group vs. intervention group	-
Outcome	Physical performance tests, perception-related outcomes, and biomarkers	Assessments performed <24h after exercise

Data extraction

The data extraction was performed via a standardized form in Excel spreadsheet by two independent researchers (R.M. and D.M.). Disagreements between extractions were resolved by a third researcher (B.B.). The following information were extracted: sample size, athletes' sex and average age, exercise-induced fatigue protocol, recovery intervention, and results reported for performance, perception and biomarkers of post-exercise recovery.

Risk of bias

Studies were assessed independently by two authors (R.M. and D.M.) regarding risk of bias by Physiotherapy Evidence Database (PEDro) Scale (Sherrington et al., 2000). The tool consists of 11 criteria (item 1 is not included in the final score). Each criterion could be Yes (one point) or No (0 points), with a maximum score of 10. Studies with a score greater than 6 were classified as having a lower risk of bias, while studies with equal or less than 6 were classified as having a high risk of bias [24].

RESULTS

Literature search and study selection

As detailed by the flowchart in Figure 1, online databases search yielded 2,925 results, with 2,048 potential records retained for screening after duplicate

removals. Of these, 2,007 were excluded after title and abstract analysis. From the 41 full-text articles assessed for eligibility, 25 meet all inclusion and exclusion criteria and had data extracted to the present review.

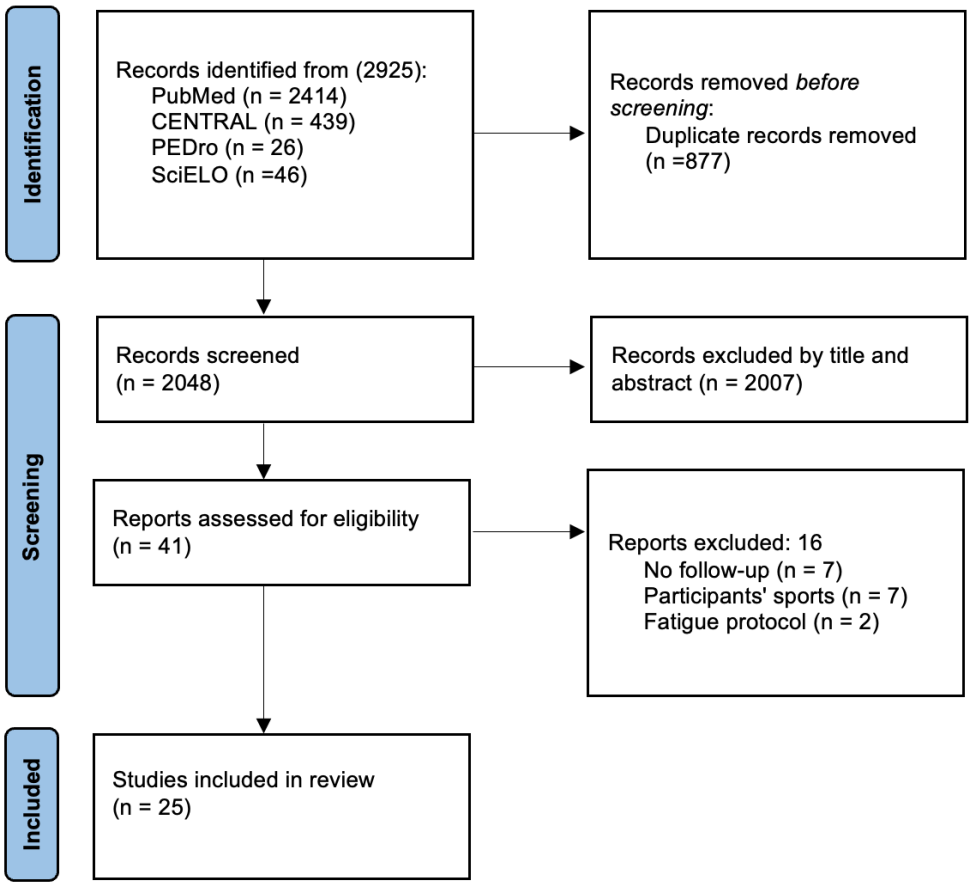

Figure 1. PRISMA flow diagram

Risk of bias

As detailed in Table 2, the PEDro score of the included studies ranged from 3 to 7. Only two studies scored greater than 6 [25; 26], indicating a low risk of bias, while 23 studies had a score equal to or less than 6 [27- 49], indicating a high risk of bias. The average score of all included studies in this systematic review was 4.6 points.

Table 2. Individual PEDro Scale assessment.

Study	1	2	3	4	5	6	7	8	9	10	11	Total
Andersson et al. (2008)	N	Y	N	Y	N	N	N	Y	Y	Y	Y	**6**
Babak et al. (2021)	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	**6**
Bouzid et al. (2018)	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	**6**
Clifford et al. (2018)	N	Y	Y	N	Y	N	N	Y	Y	Y	Y	**7**
De Nardi et al. (2011)	N	Y	N	Y	N	N	N	N	N	Y	Y	**4**
Fullagar et al. (2016)	Y	Y	N	Y	N	N	N	N	N	Y	Y	**4**
Gimenes et al. (2021)	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	**6**
Kawczynski et al. (2014)	Y	N	N	N	N	N	N	Y	Y	N	Y	**3**
Kinugasa & Kilding (2009)	N	Y	N	Y	N	N	N	N	N	Y	Y	**4**
Marin et al. (2012)	N	Y	N	N	N	N	N	N	Y	Y	Y	**4**
Marques-Jimenez et al. (2018a)	Y	Y	N	N	N	N	N	N	N	Y	Y	**3**
Marques-Jimenez et al. (2018b)	Y	Y	N	N	N	N	N	N	N	Y	Y	**3**
Moreira et al. (2021)	Y	Y	N	N	Y	N	N	Y	Y	Y	Y	**6**
Padulo et al. (2014)	Y	Y	N	N	N	N	N	N	N	Y	Y	**3**
Pooley et al. (2020)	N	Y	N	N	N	N	N	Y	Y	Y	Y	**5**
Rey et al. (2012a)	N	Y	N	Y	N	N	N	Y	Y	Y	Y	**6**
Rey et al. (2012b)	N	Y	N	Y	N	N	N	Y	Y	Y	Y	**6**
Rey et al. (2019)	N	Y	N	Y	N	N	N	Y	N	Y	Y	**5**
Rowsell et al. (2009)	N	Y	N	N	N	N	N	Y	N	Y	Y	**4**
Rowsell et al. (2011)	N	N	N	N	N	N	N	Y	Y	Y	Y	**4**
Rupp et al. (2012)	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y	**7**
Russel et al. (2017)	N	Y	N	N	N	N	N	N	N	Y	Y	**3**
Sajadian et al. (2017)	N	N	N	N	N	N	N	N	N	Y	Y	**2**
Trecroci et al. (2020)	Y	Y	N	N	N	N	N	Y	N	Y	Y	**4**
Von Stengel et al. (2018)	Y	Y	N	Y	N	N	N	Y	N	Y	Y	**5**

Y: yes; N: no. Criteria: 1 Eligibility criteria (not used for score); 2 Subjects were randomly allocated; 3 Allocation was concealed; 4 Groups were similar at baseline; 5 There was blinding of all subjects; 6 There was blinding of all therapists who administered the therapy; 7 There was blinding of all assessors who measured at least one key outcome; 8 Measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups; 9 All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analyzed by 'intention-to-treat'; 10 The results of between-group statistical comparisons are reported; 11 The study provides both point measures and measures of variability.

Characteristics of studies

The main characteristics of each study included in this systematic review is listed in Table 2. Twenty-two studies assessed male players (n= 377) [28; 29; 25;

[30-37; 39-49], two studies assessed female players (n= 30) [38; 27], and one study assessed a mixed sample (n=13 male and 9 female players) [26]. Thirteen studies were carried out with professional players (n= 224) [25; 27-29; 32; 33; 35; 38; 41; 42; 43; 47; 49], five studies with amateur/semi-professional players (n= 93) [31; 36; 37; 48], and seven studies with academy players (n= 112) [26; 30; 34; 39; 40; 44; 45; 46]. Physical performance outcomes were analyzed in 19 studies (n= 318) [25-31; 34; 35; 36; 39-42; 44; 46; 48; 49], being jump and sprinting the most often evaluations. Perception-related outcomes were analyzed in 19 studies (n= 317) [25; 26; 27; 29-32; 34-38; 40; 41; 43; 44; 46; 48; 49], being delayed-onset muscle soreness and RPE the most frequently used variables. Biomarkers were analyzed in 16 studies (n= 265) [27-34; 36; 37; 39; 40; 44; 46; 47; 49], being CK the most used biomarker of recovery. The number of studies and participants treated with each physiotherapeutic intervention is illustrated in Figure 2.

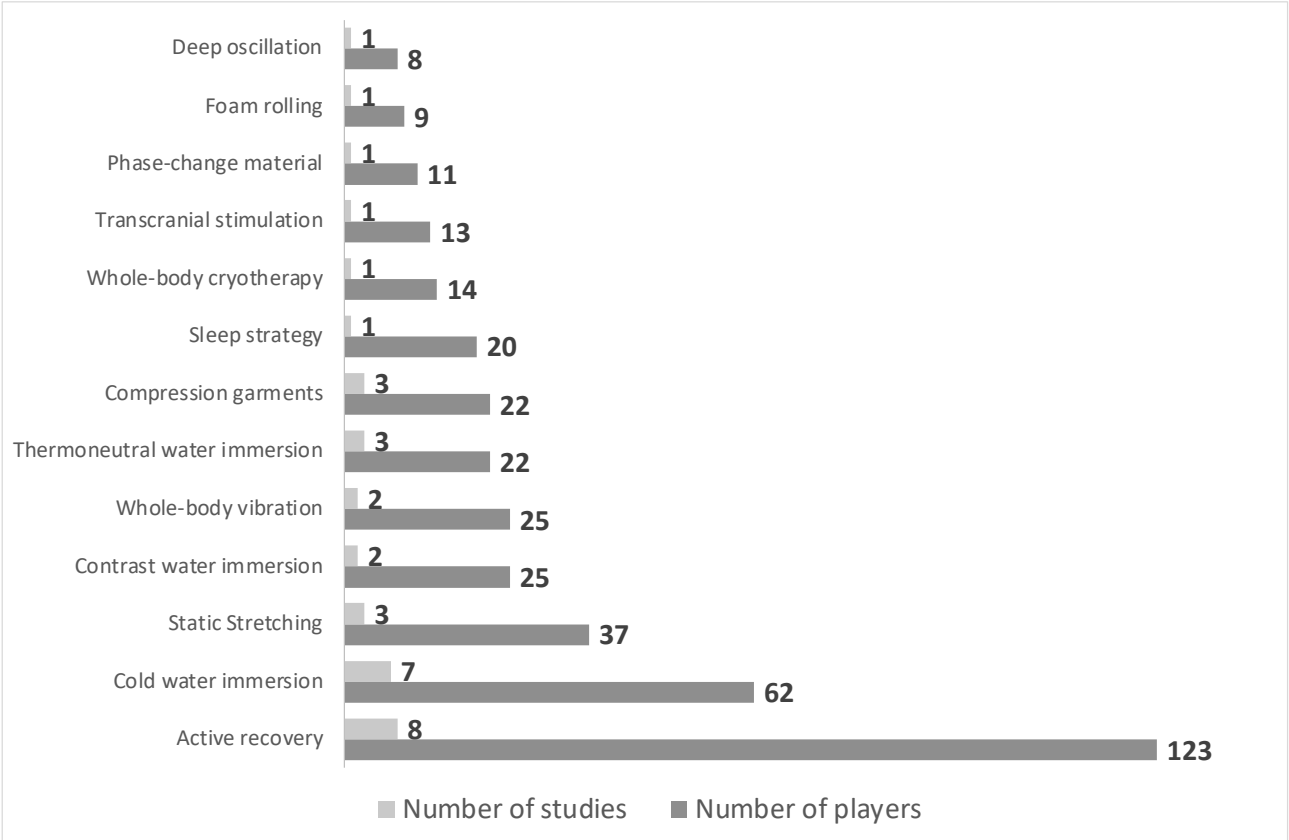

Figure 2. Number of studies and participants for each recovery intervention in this review.

Effects of recovery interventions

A summary of findings from each study included in this systematic review is listed in Table 3, organized according to the intervention effects on outcomes related to performance, perception, and biomarkers.

Table 3. Characteristics and findings of the studies included in the systematic review

Study	Participants	Fatigue protocol	Recovery intervention	Outcomes
Andersson et al. (2008)	17 professional female players (~22 y)	90' friendly match	Active recovery vs. Passive recovery	**Performance:** no between-group difference for CMJ, sprint, or isokinetic torque. **Perception:** no between-group difference for muscle soreness. **Biomarkers:** no between-group difference for CK, urea, or uric acid.
Babak et al. (2021)	22 professional male players (~18 y)	90' simulated match (LIST)	CWI vs. Static stretching	**Performance:** no between-group difference for jump or repeated sprint ability. **Perception:** no assessments. **Biomarkers:** no between-group difference for LDH or AST.
Bouzid et al. (2018)	8 professional male players (~19 y)	45' simulated match (modified LIST)	CWI vs. TWI	**Performance:** CMJ, SJ, 20 m sprint and MVIC improved with CWI. **Perception:** RPE improved with CWI. **Biomarkers:** no between-group difference for CK.
Clifford et al. (2018)	11 professional male players (~19 y)	90' official match	Phase Change Material cold vs. Phase Change Material ambient	**Performance:** MVIC improved with PCMcold. **Perception:** soreness and perceived effectiveness improved with PCMcold. **Biomarkers:** no assessments.
De Nardi et al. (2018)	18 academy male players (~15 y)	175' football training	Passive recovery vs. CWI vs. CTI	**Performance:** no between-group difference for CMJ or shuttle run. **Perception:** no between-group difference for RPE. **Biomarkers:** CK improved with CWI and CTI.
Fullagar et al. (2016)	20 amateur male players (not reported)	90' friendly match	Sleep hygiene vs. Normal sleep	**Performance:** no between-group difference for CMJ or YYIR. **Perception:** sleep parameters improved with sleep hygiene. **Biomarkers:** higher maximal HR in normal sleep.
Gimenes et al. (2021)	20 professional male players (~18 y)	Two 90' friendly matches	Compression stocks vs. Passive recovery	**Performance:** distances covered in higher speeds improved with compression stocks.

				Perception: soreness after match 2 improved with compression stocks. **Biomarkers:** no between-group difference for HR.
Kawczynski et al. (2014)	11 professional male players (~18 y)	90' official match	Standard recovery training (active recovery) vs. Soreness reduction training (active recovery) vs. Passive recovery	**Performance:** no assessments. **Perception:** *no between-group comparisons were done.* **Biomarkers:** *no between-group comparisons were done.*
Kinugasa & Kilding (2009)	28 amateur male players (~14 y)	90' official match	CTI vs. Static stretching vs. Combined recovery (CWI + Active recovery)	**Performance:** no between-group difference for vertical jump. **Perception:** soreness improved with combined recovery. **Biomarkers:** no between-group difference for HR or body temperature.
Marin et al. (2012)	16 professional male players (~17 y)	Repeated-sprint ability test	WBV vs. Passive recovery	**Performance:** CMJ improved with WBV. **Perception:** soreness improved for WBV. **Biomarkers:** no assessments.
Marques-Jimenez et al. (2018a)	18 amateur male players (~25 y)	90' friendly match	FLC vs. STC vs. SHC vs. Passive recovery	**Performance:** 10m and 20m time improved with FLC compared to passive; SHC improved CMJ and 10m compared to STC and 10m and 20m compared to FLC. **Perception:** SHC improved RPE compared to passive; FLC improved TQR compared to passive. **Biomarkers:** SHC improved LDH compared to passive.
Marques-Jimenez et al. (2018b)	18 amateur male players (~24 y)	90' friendly match	FLC vs. STC vs. SHC vs. Passive recovery	**Performance:** no assessments. **Perception:** SHC improved calf and thigh soreness compared to passive. **Biomarkers:** CK and LDH improved with compression interventions; SHC and FLC improved calf swelling compared to passive.
Moreira et al. (2021)	13 professional female players (~26 y)	90' official match	Transcranial direct current stimulation vs. Sham stimulation	**Performance:** no assessments. **Perception:** Well-Being Questionnaire improved with tDCS. **Biomarkers:** no assessments.
Padulo et al. (2014)	17 academy male players (~16 y)	Repeated-sprint ability test	WBV vs. Passive recovery	**Performance:** repeated-sprint ability improved with WBV. **Perception:** no assessments.

				Biomarkers: lactate improved with WBV.
Pooley et al. (2020)	15 academy male players (~16 y)	80’ official match	CWI vs. Active recovery vs. Static stretching	**Performance:** no between-group difference for CMJ **Perception:** soreness improved with active recovery and CWI. **Biomarkers:** CK improved with active recovery and CWI.
Rey et al. (2012a)	31 professional male players (~23,5 y)	45’ football training	Active recovery vs. Passive recovery	**Performance:** CMJ improved with active recovery. **Perception:** no assessments. **Biomarkers:** no assessments.
Rey et al. (2012b)	31 professional male players (~23,5 y)	45’ football training	Active recovery vs. Passive recovery	**Performance:** no assessments. **Perception:** no between-group difference for soreness. **Biomarkers:** no between-group difference for tensiomyography.
Rey et al. (2019)	18 professional male players (~26 y)	60’ football training	Foam rolling vs. Passive recovery	**Performance:** agility improved with foam rolling. **Perception:** soreness and questionnaires improved with foam rolling. **Biomarkers:** no assessments.
Rowsell et al. (2009)	13 academy male players (~15 y)	90’ official match	CWI vs. TWI	**Performance:** no between-group difference for CMJ, shuttle or agility. **Perception:** soreness and fatigue improved with CWI. **Biomarkers:** no between-group difference for CK, LDH and interleukins.
Rowsell et al. (2011)	13 academy male players (~15 y)	90’ official match	CWI vs. TWI	**Performance:** total running distance improved with CWI. **Perception:** soreness and fatigue improved with CWI. **Biomarkers:** no between-group difference for HR.
Rupp et al. (2012)	13 academy male and 9 female players (~19 y)	YYIR	CWI vs. Passive recovery	**Performance:** no between-group difference for CMJ and YYIR time. **Perception:** no between-group difference for perceptual fatigue. **Biomarkers:** no assessments.
Russel et al. (2017)	14 academy male players (~18 y)	15 x 30m sprints	Whole-body cryotherapy vs. Passive recovery	**Performance:** no between-group difference for peak power output.

				Perception: no between-group difference for perceptual recovery and soreness. **Biomarkers:** testosterone level improved with WBC.
Sajadian et al. (2017)	18 professional male players (~20 y)	90'simulated match	Active recovery vs. Deep-water running	**Performance:** no assessments. **Perception:** no assessments. **Biomarkers:** no between-group difference for CK, LDH and AST.
Trecroci et al. (2020)	9 amateur male players (~17 y)	90'friendly match	Soccer-specific training vs. Active recovery	**Performance:** no between-group difference for 30m sprint, repeated-sprint ability and extension MVIC; flexion MVIC improved with active recovery. **Perception:** no between-group difference for RPE. **Biomarkers:** no assessments.
Von Stengel et al. (2018)	8 professional male players (~22 y)	90' football training	Deep-oscillation vs. Passive recovery	**Performance:** flexion strength improved with deep-oscillation. **Perception:** RPE improved with deep-oscillation. **Biomarkers:** no between-group difference for CK.

AST: aspartate aminotransferase; CTI: contrast water immersion; CK: creatine kinase; CMJ: counter-movement jump; CWI: cold water immersion; FLC: full-leg compression; HR: heart rate; LDH: lactate dehydrogenase; LIST: Loughborough Intermittent Shuttle test; MVIC: maximal voluntary isometric contraction; RPE: rating of perceived exertion; STC: stockings compression; SHC: shorts compression; SJ: squat jump; TQR: total quality recovery; TWI: thermoneutral water immersion; Y: years; YYIR: Yo-Yo intermittent recovery test; WBC: whole-body cryotherapy; WBV: whole-body vibration

DISCUSSION

The aim of this systematic review was to review the available evidence regarding physiotherapeutic interventions used for football-related fatigue recovery and assess the effect of such interventions on players' physical performance, perception and biomarkers. There is a noteworthy heterogeneity regarding the interventions investigated and the methodological approach behind each recovery modality. Overall, results indicated that each recovery-related outcome may benefit from different recovery strategies.

Active recovery

Eight studies [27; 33; 34; 40; 42; 43; 47; 48] measured the effects of active recovery in football-related fatigue outcomes, and 5 of them [33; 34; 40; 42; 48] demonstrated some kind of benefit of this recovery intervention. Studies overall diverged in methodological aspects regarding exercise type, volume and intensity. Running [33; 42; 43] and cycling [27; 34; 40] were the most frequently exercise types implemented. Sajadian et al. (2017) investigated the effects of a deep-water running protocol and found no differences compared with a conventional running recovery protocol. Trecroci et al (2020) proposed a soccer-specific routine using exercises from the FIFA 11+, small-sided games and tactical drills and set plays, but no additional effects were found in comparison with a conventional running recovery protocol (except a slight improvement on knee flexion MVIC).

Most studies with active recovery demonstrated no benefits of this intervention of performance-related outcomes [27; 33; 34; 40; 43; 47; 48], while Rey et al. (2012a) observed a faster recovery of CMJ performance through a 12-minute running protocol at 65% maximal aerobic capacity (associated with an 8-minute static stretching protocol). While some studies found no improvements for perception-related outcomes [27; 33; 42; 43; 47; 48], Kinugasa & Kilding (2009) and Pooley et al. (2019) found improvements on muscle soreness after recovery protocols encompassing three bouts of two minutes (60-80 RPM, 90-100 W) and a single bout of 10 minutes (80-100 RPM, 80 W) of cycle ergometer exercise, respectively. The recovery protocol used by Pooley et al. (2019) was the only one to promote positive changes on biomarkers.

In conclusion, active recovery is the most investigated physiotherapeutic intervention in football-related fatigue studies, but results are inconsistent. This

might be related to the heterogeneity of exercise protocols. The most adequate exercise type and the optimal dose remain uncertain. However, it is noteworthy that active recovery is an easy implementation strategy in team sports like football, since it does not require expensive equipment and can be performed in the own field of play with all players of the squad simultaneously. In addition, no negative effects of active recovery were reported by studies. Therefore, considering these factors in association with a few evidence supporting potential benefits of active recovery on performance, perception and biomarkers, this intervention might have a role in the recovery protocols designed for football players.

Cold water immersion

CWI is one of the most studied recovery interventions [17] and so it was also featured in football-related studies. Seven studies in this review [26; 28- 40; 44; 45] assessed the effects of CWI in football-related fatigue. All studies diverged in methodological aspects regarding temperature and time of immersion, ranging from 10 to 15°C and from one to 15 minutes. Only two studies [28; 26] fit in the suggested procedures from a recent review [50] of 11 to 15 minutes of immersion with water temperature of 11 to 15°C, even though both studies did not show between-group differences.

Only Bouzid et al. (2018) and Rowsell et al. (2011) demonstrated increments in performance recovery (CMJ, squat jump, 20m sprint and MVIC; total distance respectively), utilizing, correspondingly, 10 minutes in 10°C and five sets of one minute in 10°C CWI protocol intervealed with one minute sitting in ambient temperature. On the other hand, four studies reported benefits of CWI for perception-related outcomes: Bouzid et al. (2018) showed better RPE, while Pooley et al. (2020) and Rowsell et al. (2011; 2009) demonstrated benefits in perceived soreness. Regarding biomarkers, only two studies [30; 40] related increments in CK concentration after CWI. Both studies analyzed male academy athletes with 10 minutes in 14°C [40] and eight minutes in 15°C [30] protocol. Concerning football-related recovery, it seems, however, that CWI may not present increments for performance recovery, while this intervention seems able to promote benefits for perception-related outcomes.

Static stretching

Three studies [28; 34; 40] utilized static stretching as a recovery modality. Two studies [28; 34] used stretching as a control intervention, thereby the protocols were not fully described: Babak et al. (2021) dedicated 10 minutes of stretching for lower limbs and Kinugasa & Kilding (2009) utilized seven minutes of stretching, yet none demonstrated benefits in comparison to active recovery and CWI. Pooley et al. (2020) presented two sets of 15 seconds of static stretching for gastrocnemius, hamstrings, quadriceps, gluteus, hip flexors, adductors and abductors (three minutes and 30 seconds of total load) and, even though was the only study aiming to demonstrate the effects of stretching in recovery, no benefit was displayed. In fact, in the same study, the static stretching group showed worst results for CK and perceived muscle soreness when compared to CWI and active recovery. These findings are supported by a recent review [15], which did not recommend the use of static stretching for recovery purposes. Therefore, regarding football-related fatigue recovery, there is no recommendation that supports the implementation of static stretching as a feasible strategy.

Contrast water immersion

Contrast water immersion was analyzed in two studies [30; 34]. Kinugasa & Kilding (2009) did not show benefits for performance, perception, nor biomarkers from the contrast water immersion with a protocol of three sets of one minute in cold water (12°C) interleaved with two minutes of hot shower (38°C). De Nardi et al. (2011), on the other hand, presented a lower CK increase in the immersion group, utilizing two sets of two minutes immersed in cold water (15°C) interleaved with two minutes in thermoneutral water (28°C). Findings of De Nardi et al. (2011) are ratified by a recent meta-analysis [11], which also presented reduced CK concentration. De Nardi et al. (2009), however, presented the same CK results in the CWI group of the study, and, in addition, did not reported any benefits for performance and perception, so we question the real efficacy of the CTI for football-related fatigue, regarding logistics of implementation of such intervention. Based on the presented literature, there is no satisfactory evidence to support the use of contrast water immersion for football-related fatigue recovery.

Compression garments

Compression garments have already demonstrated significant improves in sports-related fatigue recovery [11]. In this review, three studies [32; 36; 37] assessed effects on football players. Marqués-Jiménez et al. (2018; 2018b) compared different lower-limbs compression garments (full lower limb, stockings and shorts), while Gimenes et al. (2021) compared a ¾ stockings to a control group. All the three studies utilized the garments during matches, however Marqués-Jiménez et al. (2018; 2018b) implemented the use for seven hours for three days after matches. Recent evidence [51] support the use of compression garments with an optimal pressure of 14 to 19 mmHg at the thigh and 19 to 24 mmHg at the calf, which corroborates the findings in this review.

The three studies found positive results regarding performance: Gimenes et al. (2021) showed an increase in the total distance covered in high speed in the compression group compared to control, while Marqués-Jimenéz et al. (2018; 2018b) demonstrated better results in the 10m, 20m and T-test times for the FLC group compared to the control group. Also, the SHC reported better results for CMJ and 10 m time; and 10 m and 20 m time, when compared to STC and FLC, respectively. Concerning perception outcomes, Gimenes et al. (2021) reported better soreness for the compression group compared to control, while Marqués-Jimenéz et al. (2018; 2018b) showed better RPE and TQR for the SHC and FLC groups respectively, compared to control. These effects presented for both performance and perception, however, seems to last, majorly, only in the 24 hours after match. Alternatively, fewer benefits were shown for biomarkers (Marqués-Jimenéz et al., 2018): only a reduction in LDH at the halftime was demonstrated in the SHC group compared to control. Based on the findings of this review, it appears that the use of compression garments may have some benefits for recovering performance and perception regarding football-related fatigue, but not for biomarkers. Future studies, however, should investigate the time of usage of such intervention.

Whole body vibration

WBV, utilizing vibration plataforms, appeared in two studies [39; 35]. Although its factual effects, dose and time of use is still unclear in the literature [52], both studies presented benefits for performance: Padulo et al. (2014) demonstrated

better results in the RSA, while Marin et al. (2012) showed benefits in the CMJ. One study [35] also assessed perception, reporting benefits for the WBV group for soreness, when compared to control. On the other hand, one study evaluated biomarkers [39], indicating a reduction in the lactate concentration. Both studies diverged in methodological aspects since Marin et al. (2012) performed exercises over the platform (~ 10 minutes) and Padulo et al. (2014) utilized short bouts (~ 15 seconds) during the repeated-sprint ability test intervals. Further investigations are still needed concerning WBV application before recommendations are made for football-related fatigue recovery.

Thermoneutral water immersion

Three studies assessed TWI as a recovery method for football-related fatigue [29; 45; 44]. All three studies presented no benefits in the intervention compared to CWI, demonstrating that the effects of water immersion may have a relation with the water temperature. The studies presented different methodological approaches, since Bouzid et al. (2018) applied 10 minutes immersed in 28°C, while Rowsell et al. (2009; 2011) interleaved five set of one minute immersed in 34°C with one minute sitting in ambient (24°C) temperature. Due to the lack of literature, the benefits of TWI are uncertain, however, based on the findings on this review, TWI should not be recommended for football-related fatigue recovery.

Other interventions

Several interventions, such as sleep hygiene [31], whole-body cryotherapy - cryotherapy chamber - [46], transcranial stimulation [38], phase-change material [25], foam rolling [41], deep water running [47] and deep-oscillation [49] were investigated in single studies. Even though some beneficial effects are shown [25; 38; 41; 46; 49], these results should be interpreted with discretion due the lack of evidence, specially related to football. Curiously, excepting Russel et al. (2017), these interventions presented positive effects over perception and three studies [25; 49; 41] reported increments in performance variables. We must emphasize, however, that these recovery strategies – excepting Fullagar et al., (2016) – requires equipment that may difficult its usage in larger groups.

Limitations

Despite popularization of new technologies for recovery in the current context of professional football, this review highlighted the lack of football-related studies on intermittent pneumatic compression [8], massage/myofascial release [10], photobiomodulation [53], magnetic therapy [54], hyperbaric chambers [54] and percussive gun-assisted therapy [54]. It means physical therapists have applied these interventions based solely on the manufacturer's' recommendations and/or their own clinical experience. Therefore, football-related fatigue studies should be carried out in order to verify the effects of these commercially available interventions.

A range of outcomes were analyzed by studies included in this review, which have assessed in different time-points after real football matches, simulated match protocol, or training sessions. This heterogeneity is also found in relation to the recovery interventions time-point, which were applied during the exercise protocol, immediately after, or even several hours afterward. Such characteristics made it impossible for more robust statistical procedures to be used in the present review, such as, for example, a meta-analysis. Conversely, this lack of standardization portrays the real world of football (and other sports as well) in which recovery interventions are employed through considerably varied protocols.

CONCLUSION

This systematic review gathered 25 studies, which assessed effectiveness of 13 physiotherapeutic interventions used for football-related fatigue recovery. Active recovery, cold water immersion and compression garments were the most investigated interventions. Other interventions (such as foam rolling, whole-body vibration and contrast water immersion) were assessed by only one or two studies. Twenty-three of included studies (92%) had PeDRO scores suggestive of a high risk of bias, therefore caution is required regarding the conclusions of this review. In summary, despite some interventions showing promising results on specific outcomes (see discussion sections for details), there is not enough evidence to highlight a physiotherapeutic intervention capable of acting simultaneously on aspects of recovery related to performance, perception and

biomarkers. Therefore, it seems recommended that practitioners choose the recovery strategy based on the target outcomes (performance, perception or biomarkers) for their athletes. Further research is needed to elucidate the optimal parameters and time frame for implementation of physiotherapeutic interventions for football-related fatigue, as well as the effects of holistic approaches using a combination of interventions.

REFERENCES

1. Silva JR, Rumpf MC, Hertzog M, et al. Acute and Residual Soccer Match-Related Fatigue: A Systematic Review and Meta-analysis. *Sports Med*. 2018;48(3):539-583. doi:10.1007/s40279-017-0798-8
2. Bangsbo J, Mohr M, Krustrup P. Physical and metabolic demands of training and match-play in the elite football player. *J Sports Sci*. 2006;24(7):665-674. doi:10.1080/02640410500482529
3. Barnes C, Archer DT, Hogg B, Bush M, Bradley PS. The evolution of physical and technical performance parameters in the English Premier League. *Int J Sports Med*. 2014;35(13):1095-1100. doi:10.1055/s-0034-1375695
4. Nassis GP, Massey A, Jacobsen P, et al. Elite football of 2030 will not be the same as that of 2020: Preparing players, coaches, and support staff for the evolution. *Scand J Med Sci Sports*. 2020;30(6):962-964. doi:10.1111/sms.13681
5. Soligard T, Schwellnus M, Alonso JM, et al. How much is too much? (Part 1) International Olympic Committee consensus statement on load in sport and risk of injury. *Br J Sports Med*. 2016;50(17):1030-1041. doi:10.1136/bjsports-2016-096581
6. Bengtsson H, Ekstrand J, Hägglund M. Muscle injury rates in professional football increase with fixture congestion: an 11-year follow-up of the UEFA

Champions League injury study. *Br J Sports Med*. 2013;47(12):743-747. doi:10.1136/bjsports-2013-092383

7. Eliakim E, Morgulev E, Lidor R, Meckel Y. Estimation of injury costs: financial damage of English Premier League teams' underachievement due to injuries [published correction appears in BMJ Open Sport Exerc Med. 2020 Jun 15;6(1):e000675corr1]. *BMJ Open Sport Exerc Med*. 2020;6(1):e000675. Published 2020 May 20. doi:10.1136/bmjsem-2019-000675
8. Field A, Harper LD, Chrismas BCR, et al. The Use of Recovery Strategies in Professional Soccer: A Worldwide Survey. *Int J Sports Physiol Perform*. 2021;16(12):1804-1815. Published 2021 May 29. doi:10.1123/ijspp.2020-0799
9. Querido SM, Brito J, Figueiredo P, Carnide F, Vaz JR, Freitas SR. Postmatch Recovery Practices Carried Out in Professional Football: A Survey of 56 Portuguese Professional Football Teams [published online ahead of print, 2022 Feb 24]. *Int J Sports Physiol Perform*. 2022;1-7. doi:10.1123/ijspp.2021-0343
10. Altarriba-Bartes A, Peña J, Vicens-Bordas J, Casals M, Peirau X, Calleja-González J. The use of recovery strategies by Spanish first division soccer teams: a cross-sectional survey. *Phys Sportsmed*. 2021;49(3):297-307. doi:10.1080/00913847.2020.1819150
11. Dupuy O, Douzi W, Theurot D, Bosquet L, Dugué B. An Evidence-Based Approach for Choosing Post-exercise Recovery Techniques to Reduce Markers of Muscle Damage, Soreness, Fatigue, and Inflammation: A Systematic Review With Meta-Analysis. *Front Physiol*. 2018;9:403. Published 2018 Apr 26. doi:10.3389/fphys.2018.00403
12. Torres R, Ribeiro F, Alberto Duarte J, Cabri JM. Evidence of the physiotherapeutic interventions used currently after exercise-induced muscle damage: systematic review and meta-analysis. *Phys Ther Sport*. 2012;13(2):101-114. doi:10.1016/j.ptsp.2011.07.005
13. O'Connor R & Hurley D A. The Effectiveness of Physiotherapeutic Interventions in the Management of Delayed Onset Muscle Soreness: a Systematic Review. *Phys Ther Reviews*. 2003;8(4) 177-195, DOI: 10.1179/108331903225003181

14. Barnett A. Using recovery modalities between training sessions in elite athletes: does it help?. *Sports Med*. 2006;36(9):781-796. doi:10.2165/00007256-200636090-00005
15. Afonso J, Clemente FM, Nakamura FY, et al. The Effectiveness of Post-exercise Stretching in Short-Term and Delayed Recovery of Strength, Range of Motion and Delayed Onset Muscle Soreness: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Front Physiol*. 2021;12:677581. Published 2021 May 5. doi:10.3389/fphys.2021.677581
16. Davis HL, Alabed S, Chico TJA. Effect of sports massage on performance and recovery: a systematic review and meta-analysis [published correction appears in BMJ Open Sport Exerc Med. 2021 Apr 21;7(2):e000614corr1]. *BMJ Open Sport Exerc Med*. 2020;6(1):e000614. Published 2020 May 7. doi:10.1136/bmjsem-2019-000614
17. Higgins TR, Greene DA, Baker MK. Effects of Cold Water Immersion and Contrast Water Therapy for Recovery From Team Sport: A Systematic Review and Meta-analysis. *J Strength Cond Res*. 2017;31(5):1443-1460. doi:10.1519/JSC.0000000000001559
18. Simjanovic M, Hooper S, Leveritt M, Kellmann M, & Rynne S. The use and perceived effectiveness of recovery modalities and monitoring techniques in elite sport. *J Sci Med in Sport.* 2009;*12*
19. Rey E, Padrón-Cabo A, Barcala-Furelos R, Casamichana D & Romo-Pérez V. Practical active and passive recovery strategies for soccer players. *Str Cond J*. 2018;*40*(3);45-57.
20. Nédélec M, McCall A, Carling C, Legall F, Berthoin S, Dupont G. Recovery in soccer : part ii-recovery strategies. *Sports Med*. 2013;43(1):9-22. doi:10.1007/s40279-012-0002-0
21. Altarriba-Bartes A, Peña J, Vicens-Bordas J, Milà-Villaroel R, Calleja-González J. Post-competition recovery strategies in elite male soccer players. Effects on performance: A systematic review and meta-analysis. *PLoS One*. 2020;15(10):e0240135. Published 2020 Oct 2. doi:10.1371/journal.pone.0240135

22. Kellmann M, Bertollo M, Bosquet L, et al. Recovery and Performance in Sport: Consensus Statement. *Int J Sports Physiol Perform*. 2018;13(2):240-245. doi:10.1123/ijspp.2017-0759
23. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71. Published 2021 Mar 29. doi:10.1136/bmj.n71
24. Armijo-Olivo S, da Costa BR, Cummings GG, et al. PEDro or Cochrane to Assess the Quality of Clinical Trials? A Meta-Epidemiological Study. *PLoS One*. 2015;10(7):e0132634. Published 2015 Jul 10. doi:10.1371/journal.pone.0132634
25. Clifford T, Abbott W, Kwiecien SY, Howatson G, McHugh MP. Cryotherapy Reinvented: Application of Phase Change Material for Recovery in Elite Soccer. *Int J Sports Physiol Perform*. 2018;13(5):584-589. doi:10.1123/ijspp.2017-0334
26. Rupp KA, Selkow NM, Parente WR, Ingersoll CD, Weltman AL, Saliba SA. The effect of cold water immersion on 48-hour performance testing in collegiate soccer players. *J Strength Cond Res*. 2012;26(8):2043-2050. doi:10.1519/JSC.0b013e318239c3a1
27. Andersson H, Raastad T, Nilsson J, Paulsen G, Garthe I, Kadi F. Neuromuscular fatigue and recovery in elite female soccer: effects of active recovery. *Med Sci Sports Exerc*. 2008;40(2):372-380. doi:10.1249/mss.0b013e31815b8497
28. Farkhari Babak M, Mosaferi Ziaaldini M, Hoseini Seyyed Reza A. Experience of cold-water immersion on recovery efficiency after soccer match. *Tunis Med*. 2021;99(2):252-258.
29. Bouzid MA, Ghattassi K, Daab W, et al. Faster physical performance recovery with cold water immersion is not related to lower muscle damage level in professional soccer players. *J Therm Biol*. 2018;78:184-191. doi:10.1016/j.jtherbio.2018.10.001
30. De Nardi M, La Torre A, Barassi A, Ricci C, Banfi G. Effects of cold-water immersion and contrast-water therapy after training in young soccer players. *J Sports Med Phys Fitness*. 2011;51(4):609-615.
31. Fullagar H, Skorski S, Duffield R, Meyer T. The effect of an acute sleep hygiene strategy following a late-night soccer match on recovery of

players. *Chronobiol Int*. 2016;33(5):490-505. doi:10.3109/07420528.2016.1149190

32. Gimenes SV, Marocolo M, Pavin LN, et al. Compression Stockings Used During Two Soccer Matches Improve Perceived Muscle Soreness and High-Intensity Performance. *J Strength Cond Res*. 2021;35(7):2010-2017. doi:10.1519/JSC.0000000000003048
33. Kawczyński A, Mroczek D, Frąckiewicz A, et al. Effects of two recovery procedures after a football game on sensory and biochemical markers. *J Sports Med Phys Fitness*. 2014;54(4):394-402.
34. Kinugasa T, Kilding AE. A comparison of post-match recovery strategies in youth soccer players. *J Strength Cond Res*. 2009;23(5):1402-1407. doi:10.1519/JSC.0b013e3181a0226a
35. Marín PJ, Herrero AJ, García-López D, et al. Acute effects of whole-body vibration on neuromuscular responses in older individuals: implications for prescription of vibratory stimulation. *J Strength Cond Res*. 2012;26(1):232-239. doi:10.1519/JSC.0b013e31821d9789
36. Marqués-Jiménez D, Calleja-González J, Arratibel I, Delextrat A, Uriarte F, Terrados N. Physiological and physical responses to wearing compression garments during soccer matches and recovery. *J Sports Med Phys Fitness*. 2018;58(11):1642-1651. doi:10.23736/S0022-4707.17.07831-8
37. Marqués-Jiménez D, Calleja-González J, Arratibel-Imaz I, Delextrat A, Uriarte F, Terrados N. Influence of different types of compression garments on exercise-induced muscle damage markers after a soccer match. *Res Sports Med*. 2018;26(1):27-42. doi:10.1080/15438627.2017.1393755
38. Moreira A, Machado DGDS, Bikson M, et al. Effect of Transcranial Direct Current Stimulation on Professional Female Soccer Players' Recovery Following Official Matches. *Percept Mot Skills*. 2021;128(4):1504-1529. doi:10.1177/00315125211021239
39. Padulo J, Di Giminiani R, Ibba G, et al. The acute effect of whole body vibration on repeated shuttle-running in young soccer players. *Int J Sports Med*. 2014;35(1):49-54. doi:10.1055/s-0033-1345171

40. Pooley S, Spendiff O, Allen M, Moir HJ. Comparative efficacy of active recovery and cold water immersion as post-match recovery interventions in elite youth soccer. *J Sports Sci*. 2020;38(11-12):1423-1431. doi:10.1080/02640414.2019.1660448
41. Rey E, Padrón-Cabo A, Costa PB, Barcala-Furelos R. Effects of Foam Rolling as a Recovery Tool in Professional Soccer Players. *J Strength Cond Res*. 2019;33(8):2194-2201. doi:10.1519/JSC.0000000000002277
42. Rey E, Lago-Peñas C, Lago-Ballesteros J, Casáis L. The effect of recovery strategies on contractile properties using tensiomyography and perceived muscle soreness in professional soccer players. *J Strength Cond Res*. 2012;26(11):3081-3088. doi:10.1519/JSC.0b013e3182470d33
43. Rey E, Lago-Peñas C, Casáis L, Lago-Ballesteros J. The effect of immediate post-training active and passive recovery interventions on anaerobic performance and lower limb flexibility in professional soccer players. *J Hum Kinet*. 2012;31:121-129. doi:10.2478/v10078-012-0013-9
44. Rowsell GJ, Coutts AJ, Reaburn P, Hill-Haas S. Effects of cold-water immersion on physical performance between successive matches in high-performance junior male soccer players. *J Sports Sci*. 2009;27(6):565-573. doi:10.1080/02640410802603855
45. Rowsell GJ, Coutts AJ, Reaburn P, Hill-Haas S. Effect of post-match cold-water immersion on subsequent match running performance in junior soccer players during tournament play. *J Sports Sci*. 2011;29(1):1-6. doi:10.1080/02640414.2010.512640
46. Russell M, Birch J, Love T, et al. The Effects of a Single Whole-Body Cryotherapy Exposure on Physiological, Performance, and Perceptual Responses of Professional Academy Soccer Players After Repeated Sprint Exercise. *J Strength Cond Res*. 2017;31(2):415-421. doi:10.1519/JSC.0000000000001505
47. Sajadian M, Kordi M, Gaeini A & Rahnama N. Comparison of Effects of Active Recovery and Deep Water Running on Soccer Players Indices of Muscular Damage. *Int J Clin Skills*. 2018;*12*(1).
48. Trecroci A, Porcelli S, Perri E, et al. Effects of Different Training Interventions on the Recovery of Physical and Neuromuscular

Performance After a Soccer Match. *J Strength Cond Res*. 2020;34(8):2189-2196. doi:10.1519/JSC.0000000000003269

49. von Stengel S, Teschler M, Weissenfels A, Willert S, Kemmler W. Effect of deep oscillation as a recovery method after fatiguing soccer training: A randomized cross-over study. *J Exerc Sci Fit*. 2018;16(3):112-117. doi:10.1016/j.jesf.2018.10.004
50. Machado AF, Ferreira PH, Micheletti JK, et al. Can Water Temperature and Immersion Time Influence the Effect of Cold Water Immersion on Muscle Soreness? A Systematic Review and Meta-Analysis. *Sports Med*. 2016;46(4):503-514. doi:10.1007/s40279-015-0431-7
51. Brown FCW, Hill JA, Pedlar CR. Compression Garments for Recovery from Muscle Damage: Evidence and Implications of Dose Responses. *Curr Sports Med Rep*. 2022;21(2):45-52. doi:10.1249/JSR.0000000000000933
52. Alam MM, Khan AA, Farooq M. Effect of whole-body vibration on neuromuscular performance: A literature review. *Work*. 2018;59(4):571-583. doi:10.3233/WOR-182699
53. Leal-Junior ECP, Lopes-Martins RÁB, Bjordal JM. Clinical and scientific recommendations for the use of photobiomodulation therapy in exercise performance enhancement and post-exercise recovery: current evidence and future directions. *Braz J Phys Ther*. 2019;23(1):71-75. doi:10.1016/j.bjpt.2018.12.002
54. Cullen ML, Casazza GA, Davis BA. Passive Recovery Strategies after Exercise: A Narrative Literature Review of the Current Evidence. *Curr Sports Med Rep*. 2021;20(7):351-358. doi:10.1249/JSR.0000000000000859

4 ARTIGO 2

PERCEPTIONS OF PROFESSIONAL MALE FOOTBALL PLAYERS ON POST-EXERCISE RECOVERY STRATEGIES

Formatado conforme normas do periódico Science and Medicine in Football (Fator de Impacto 2.815)

ABSTRACT

Background: Individual beliefs and preferences determines compliance and success of an intervention, especially when outcomes are potentially influenced by the placebo effect. However, the perceptions of professional football (soccer) players on post-exercise recovery strategies are unknown.

Objective: The aim of this study was to describe the professional male football players' perception towards effectiveness of post-exercise recovery strategies.

Methods: One-hundred professional male football players from the 1st to 4th division of Brazilian Championship answered an online questionnaire.

Results: Cold water immersion (88% of approval), nutritional supplements (71%), massage (66%), stretching (64%), and active recovery (60%) were the top-5 ranked strategies. More than half of players also believe that myofascial self-release (55%) and hot water immersion (53%) are effective recovery strategies. Less than ¼ of players believe that cupping therapy (24%), phototherapy (14%) or vibration platforms (4%) helps on recovery process.

Conclusion: Considering the inconsistency in the literature about the effectiveness of recovery strategies in the football context, knowing the players' beliefs and preferences can be crucial to improve adherence and increase the chances of success of the chosen interventions.

Key-words: Athletes; Post-exercise recovery; Soccer; Sport; Sport science; Sports Medicine; Sports Physical Therapy.

INTRODUCTION

The relationship between fatigue and recovery and its impact on performance and injury risk has attracted the interest of football (soccer) medicine community for many years. Professional football players take a few days to fully restore their pre-matches physical performance skills, as well as normalizing physiological markers of stress (Nedelec et al., 2012). During fixture congested periods, players usually have a 3-4 day-interval between matches, which may be insufficient to restore normal homeostasis, increasing their injury risk (Bengtsson et al., 2013). Considering that injuries have a negative impact on the players' career (Niederer et al., 2018) and on the club performance and finances (Eliakim et al., 2020).

Post-exercise recovery organismic allostatic balance is regained by reestablishing the invested resources on a physiological and psychological level (Kellmann et al., 2018). At the physiological level, professional football clubs have invested in a range of strategies to optimize post-exercise recovery, such as food/fluid replacement, nutritional supplements, drugs, low-intensity exercise ("active recovery"), stretching, cold water immersion, compression garments, massage, myofascial self-release ("foam roller"), among others (Altarriba-Bartes et al., 2020; Field et al., 2021). However, scientific evidence supporting the effectiveness of some strategies is lacking (Dupuy et al., 2018). In addition, only a few studies on post-exercise recovery strategies have involved professional athletes, possibly because they are often justifiably reluctant to participate in controlled studies that change their routines (Barnnet, 2006). Consequently, the true effect of most recovery strategies on professional football players is still unclear.

In addition to scientific evidence (which is still deficient regarding recovery in football) and clinical expertise, evidence-based practice is supported by a third equally important pillar: the 'patient values' (i.e., individual beliefs, preferences, concerns and expectations) (Herbert et al., 2011). The players' perceptions are crucial to determine compliance and success of an intervention (Babatunde et al., 2017; Finch & Donaldson, 2010), even more when the players' sense of recovery involves subjective parameters that can be affected by the placebo effect (Tavel, 2014). Interestingly, despite recent investigations on the perceptions of professional football players about injury prevention (Zech &

Wellmann, 2017; Liporaci et al., 2021), their opinions regarding post-exercise recovery strategies remain unexplored. Therefore, the aim of this study was to describe the professional male football players' perception towards effectiveness of post-exercise recovery strategies.

MATERIAL AND METHODS

Participants

This cross-sectional observational study assessed male professional football players from the 1st to 4th division of Brazilian Championship. The project was approved by the institutional ethics board (#2.768.715), and all participants consented to participate voluntarily.

Procedures

The questionnaire was created by two sport science researchers using Google Forms platform (google.com/forms). Two physiotherapists experienced with professional football reviewed the questionnaire to check cultural issues and ensure accessible language for participants. The final questionnaire was available online for participants from March to August 2018.

Physiotherapists from Brazilian football clubs were asked to disseminate the study among the professional football community through WhatsApp Messenger groups. A standard message designed by the researchers inviting players to participate in the survey through an online questionnaire was sent to groups. Upon accessing the web-link provided, the purpose and procedure of the questionnaire were explained. Confidentially and anonymity were detailed before players consented to participate. After providing demographic data, players answered two multiple choice questions:

(1) Listed below are some post-exercise recovery strategies commonly used in football. Tag those you already used.

(2) Listed below are some post-exercise recovery strategies commonly used in football. Tag those you believe actually work to accelerate recovery after football matches or training sessions.

Participants could mark as many options as they wanted. An option "other" was also available if the participant wanted to add a recovery modality not

contemplated in the options, as well as an option “none of the above” if the participant did not believe in the efficacy of any modality.

Data Analysis

Raw data were exported and analyzed on Microsoft Excel software. Distribution of ‘yes’ and ‘no’ answers was assessed for each recovery strategy.

RESULTS

One-hundred male professional football players participated in this study (Table 1). Figure 1 shows the players’ experience and perception regarding effectiveness of post-exercise recovery strategies.

Table 1. Characteristics of participants.

Age (years) *	24.5±4.6 (18-37)
Tactical position (distribution)	
- Goalkeepers	10
- Defenders	25
- Midfielders	43
- Forwards	22
Competitive level (distribution)	
- 1st division	27
- 2nd division	22
- 3rd division	27
- 4th division	24

* mean ± standard deviation (minimum-maximum)

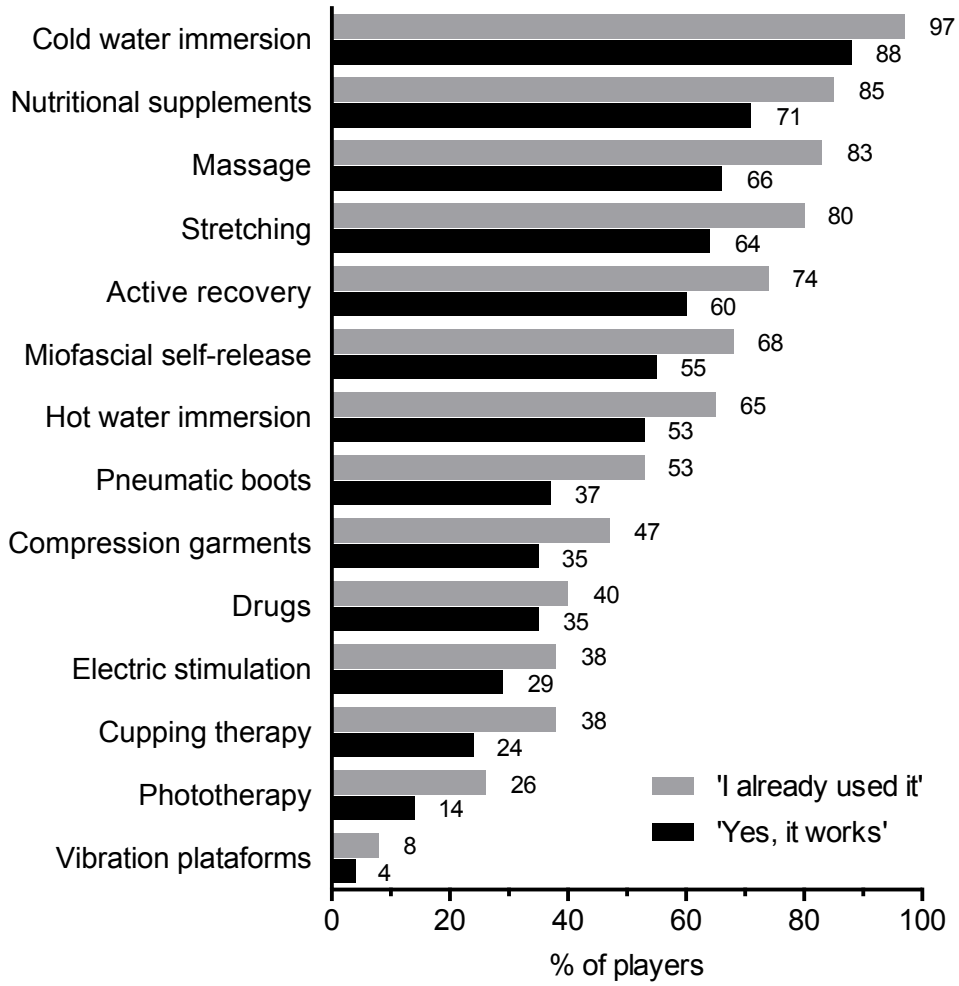

Figure 1. Football players' experience and perception regarding effectiveness of post-exercise recovery strategies.

DISCUSSION

To the best of our knowledge, this is the first study to asked professional football players about their opinion regarding the effectiveness of post-exercise recovery strategies. Cold water immersion, nutritional supplements, massage, stretching, and active recovery were the top-5 ranked strategies. More than half of players also believe that myofascial self-release and hot water immersion are effective recovery strategies. Less than ¼ of players believe that cupping therapy, phototherapy (LASER or LEDs) or vibration platforms helps on recovery process.

Cold water immersion was the preferred post-exercise recovery strategy of football players engaged in the current study. This strategy seems to be ineffective or just slightly better than passive recovery in the management of delayed-onset muscle soreness (Higgins et al., 2017; Machado et al., 2016). Cold

water immersion effects on biochemical and performance markers related to post-exercise recovery seems also to be not greater than the placebo effect (Broatch et al., 2014). But it does not prevent the widely use of cold water immersion in the football environment, and our data support that almost all players already used it and 88% believe this recovery strategy works.

A range of nutritional supplements have been used to accelerate post-exercise recovery, such as fruit-derived supplements, plant-derived supplements, herbal supplements, amino acid and protein supplements, vitamin supplements, and others (Harty et al., 2019). Specific guidelines with evidence-based nutritional recommendations for post-exercise recovery in football are lacking, but experts have already provided some practical strategies to facilitate the recovery of football players from the demands of training and congested fixture schedule (Rawson et al., 2018; Ranchordas et al., 2017). The current study did not assess the preference of football players for specific supplement types, but our findings support their confidence in nutritional interventions for post-exercise recovery.

Low-intensity exercise, usually called ‘active recovery’, may be applied both immediately after a strenuous training session and along the match subsequent days (Nédélec at al., 2013). Running is the most traditionally used exercise, but workouts at the fitness center or the pool (i.e., exercise associated with hot water immersion) may also be employed. The intensity and duration of recovery sessions using low-intensity exercise are highly variable, which contributes to the conflicting results found in the literature. Our results suggest that most football players are receptive to active recovery strategies, which is a crucial point for adherence to this type of intervention that requires the active participation of athletes. Further investigation should be carried out to assess their perception about the different protocols of active recovery.

Differently from recovery strategies acting systemically (e.g., cold/hot water immersion, nutritional supplements, and active recovery), massage, myofascial self-release, and stretching act on the specific muscle groups in which they were applied. The effectiveness of massage (Poppendieck et al., 2016) and myofascial self-release (Wiewelhove et al., 2019) to optimize post-exercise recovery is rather small and partly unclear, while studies have failed to prove the benefits of stretching conducted before exercise, after exercise, or both (Herbert et al., 2011b). The heterogeneity of protocols using these strategies limits solid

conclusions about their effectiveness in post-exercise recovery, but our findings support that most football players beliefs in it efficiency.

In general, there is a high level of uncertainty about the role of post-exercise recovery strategies commonly used in football. The indiscriminate use of strategies with such a low level of evidence by professional clubs is somewhat questionable. However, it is worthwhile to mention that perhaps the outcomes commonly evaluated in post-exercise recovery studies (i.e., delayed onset-muscle soreness, strength/power performance, biochemical markers) leave out more subjective aspects that athletes value in the recovery process (Hendricks et al., 2020). Post-exercise recovery is a complex process involving both physiological and psychological pathways (Kellmann et al., 2018), thus the 'player values' (i.e., individual beliefs, preferences, concerns and expectations) (Herbert et al., 2011a) likely play a role. Agreement with interventions is determinant for compliance and results in the clinical setting (Babatunde et al., 2017) and in the sports field (Finch & Donaldson 2010). Therefore, this study highlights the importance of the medical/coaching staff knowing their players' perception (and change it, when necessary) before implementing a standard recovery protocol. The athletes' beliefs may be influenced by knowledge provided by specialists (e.g., medical/coaching staff), thus education may be a preliminary step to get athlete buy-in.

This study has some limitations. We chose to apply a short questionnaire to increase the participants compliance, thus we were unable to perform a deeper analysis to understand the players' choices. Since our sample size was smaller than expected, sub-analyses by age and competitive level were not possible. Extrapolation of the findings to other populations of footballers requires caution. Consequently, this study was formatted as a short communication and can be considered a first step to elucidate the football players perceptions regarding post-exercise recovery strategies.

In conclusion, cold water immersion, nutritional supplements, massage, stretching, and active recovery were the top-5 ranked strategies by professional football players participating in this study. Considering the inconsistency in the literature about the effectiveness of recovery strategies in the football context, knowing the players' beliefs and preferences can be crucial to improve adherence and increase the chances of success of the chosen interventions.

REFERENCES

Altarriba-Bartes, A., Peña, J., Vicens-Bordas, J., Casals, M., Peirau, X., & Calleja-González, J. (2021). The use of recovery strategies by Spanish first division soccer teams: a cross-sectional survey. The Physician and sportsmedicine, 49(3), 297–307. https://doi.org/10.1080/00913847.2020.1819150

Altarriba-Bartes, A., Peña, J., Vicens-Bordas, J., Milà-Villaroel, R., & Calleja-González, J. (2020). Post-competition recovery strategies in elite male soccer players. Effects on performance: A systematic review and meta-analysis. PloS one, 15(10), e0240135. https://doi.org/10.1371/journal.pone.0240135

Babatunde, F., MacDermid, J., & MacIntyre, N. (2017). Characteristics of therapeutic alliance in musculoskeletal physiotherapy and occupational therapy practice: a scoping review of the literature. BMC health services research, 17(1), 375. https://doi.org/10.1186/s12913-017-2311-3

Barnett A. (2006). Using recovery modalities between training sessions in elite athletes: does it help?. Sports medicine (Auckland, N.Z.), 36(9), 781–796. https://doi.org/10.2165/00007256-200636090-00005

Bengtsson, H., Ekstrand, J., & Hägglund, M. (2013). Muscle injury rates in professional football increase with fixture congestion: an 11-year follow-up of the UEFA Champions League injury study. British journal of sports medicine, 47(12), 743–747. https://doi.org/10.1136/bjsports-2013-092383

Broatch, J. R., Petersen, A., & Bishop, D. J. (2014). Postexercise cold water immersion benefits are not greater than the placebo effect. Medicine and science in sports and exercise, 46(11), 2139–2147. https://doi.org/10.1249/MSS.0000000000000348

Dupuy, O., Douzi, W., Theurot, D., Bosquet, L., & Dugué, B. (2018). An Evidence-Based Approach for Choosing Post-exercise Recovery Techniques to Reduce Markers of Muscle Damage, Soreness, Fatigue, and Inflammation: A Systematic Review With Meta-Analysis. Frontiers in physiology, 9, 403. https://doi.org/10.3389/fphys.2018.00403

Eliakim E, Morgulev E, Lidor R, Meckel Y. (2020). Estimation of injury costs:

Financial damage of English Premier League teams' underachievement due to injuries. BMJ Open Sport and Exercise Medicine, 6, 1, 1-6. doi:10.1136/bmjsem-2019-000675

Field, A., Harper, L. D., Chrismas, B., Fowler, P. M., McCall, A., Paul, D. J., Chamari, K., & Taylor, L. (2021). The Use of Recovery Strategies in Professional Soccer: A Worldwide Survey. International journal of sports physiology and performance, 16(12), 1804–1815. https://doi.org/10.1123/ijspp.2020-0799

Finch, C. F., & Donaldson, A. (2010). A sports setting matrix for understanding the implementation context for community sport. British journal of sports medicine, 44(13), 973–978. https://doi.org/10.1136/bjsm.2008.056069

Harty, P. S., Cottet, M. L., Malloy, J. K., & Kerksick, C. M. (2019). Nutritional and Supplementation Strategies to Prevent and Attenuate Exercise-Induced Muscle Damage: a Brief Review. Sports medicine - open, 5(1), 1. https://doi.org/10.1186/s40798-018-0176-6

Hendricks, S., Hill, H., Hollander, S. D., Lombard, W., & Parker, R. (2020). Effects of foam rolling on performance and recovery: A systematic review of the literature to guide practitioners on the use of foam rolling. Journal of bodywork and movement therapies, 24(2), 151–174. https://doi.org/10.1016/j.jbmt.2019.10.019

Herbert, R., Jamtvedt, G., Mead, J., Hagen, K. B. (2011a). Practical evidence-based physiotherapy. Oxford: Elsevier Butterworth-Heinemann.

Herbert, R. D., de Noronha, M., & Kamper, S. J. (2011b). Stretching to prevent or reduce muscle soreness after exercise. Cochrane Database of Systematic Reviews, (7).

Higgins, T. R., Greene, D. A., & Baker, M. K. (2017). Effects of Cold Water Immersion and Contrast Water Therapy for Recovery From Team Sport: A Systematic Review and Meta-analysis. Journal of strength and conditioning research, 31(5), 1443–1460. https://doi.org/10.1519/JSC.0000000000001559

Kellmann, M., Bertollo, M., Bosquet, L., Brink, M., Coutts, A. J., Duffield, R., Erlacher, D., Halson, S. L., Hecksteden, A., Heidari, J., Kallus, K. W., Meeusen, R., Mujika, I., Robazza, C., Skorski, S., Venter, R., & Beckmann, J. (2018). Recovery and Performance in Sport: Consensus

Statement. International journal of sports physiology and performance, 13(2), 240–245. https://doi.org/10.1123/ijspp.2017-0759

Liporaci, R.F., Yoshimura, S., & Baroni, B.M. (2021). Perceptions of Professional Football Players on Injury Risk Factors and Prevention Strategies, Science and Medicine in Football, DOI: 10.1080/24733938.2021.1937689

Machado, A. F., Ferreira, P. H., Micheletti, J. K., de Almeida, A. C., Lemes, Í. R., Vanderlei, F. M., Netto Junior, J., & Pastre, C. M. (2016). Can Water Temperature and Immersion Time Influence the Effect of Cold Water Immersion on Muscle Soreness? A Systematic Review and Meta-Analysis. Sports medicine (Auckland, N.Z.), 46(4), 503–514. https://doi.org/10.1007/s40279-015-0431-7

Nédélec, M., McCall, A., Carling, C., Legall, F., Berthoin, S., & Dupont, G. (2013). Recovery in soccer : part ii-recovery strategies. Sports medicine (Auckland, N.Z.), 43(1), 9–22. https://doi.org/10.1007/s40279-012-0002-0

Niederer, D., Engeroff, T., Wilke, J., Vogt, L., & Banzer, W. (2018). Return to play, performance, and career duration after anterior cruciate ligament rupture: A case-control study in the five biggest football nations in Europe. Scandinavian journal of medicine & science in sports, 28(10), 2226–2233. https://doi.org/10.1111/sms.13245

Poppendieck, W., Wegmann, M., Ferrauti, A., Kellmann, M., Pfeiffer, M., & Meyer, T. (2016). Massage and Performance Recovery: A Meta-Analytical Review. Sports medicine (Auckland, N.Z.), 46(2), 183–204. https://doi.org/10.1007/s40279-015-0420-x

Ranchordas, M. K., Dawson, J. T., & Russell, M. (2017). Practical nutritional recovery strategies for elite soccer players when limited time separates repeated matches. Journal of the International Society of Sports Nutrition, 14(1), 35.

Rawson, E. S., Miles, M. P., & Larson-Meyer, D. E. (2018). Dietary Supplements for Health, Adaptation, and Recovery in Athletes. International journal of sport nutrition and exercise metabolism, 28(2), 188–199. https://doi.org/10.1123/ijsnem.2017-0340

Tavel M. E. (2014). The placebo effect: the good, the bad, and the ugly. The American journal of medicine, 127(6), 484–488. https://doi.org/10.1016/j.amjmed.2014.02.002

Wiewelhove, T., Döweling, A., Schneider, C., Hottenrott, L., Meyer, T., Kellmann, M., Pfeiffer, M., & Ferrauti, A. (2019). A Meta-Analysis of the Effects of Foam Rolling on Performance and Recovery. Frontiers in physiology, 10, 376. https://doi.org/10.3389/fphys.2019.00376

Zech, A., & Wellmann, K. (2017). Perceptions of football players regarding injury risk factors and prevention strategies. PloS one, 12(5), e0176829. https://doi.org/10.1371/journal.pone.0176829

5 CONCLUSÃO GERAL

O artigo 1 da presente dissertação evidencia a carência de estudos de boa qualidade metodológica que forneçam alicerces científicos para a utilização das intervenções fisioterapêuticas comumente utilizadas para fins de *recovery* no futebol. Isso significa que, até o presente momento, a escolha das intervenções para *recovery* tem de ser pautada em evidências provenientes de estudos envolvendo outras modalidades de exercício físico (algumas consideravelmente distintas das demandas do futebol) e/ou pautada na experiência e percepção dos próprios fisioterapeutas. Portanto, instiga-se que estudos de boa qualidade metodológica sejam desenvolvidos para elucidar a potencialidade das diferentes intervenções no âmbito do futebol. Além disso, apesar de algumas intervenções terem se mostrado benéficas sobre alguns desfechos relacionados à recuperação, parece não haver um recurso capaz de otimizar simultaneamente a recuperação da performance, percepção e biomarcadores. Portanto recomenda-se que a tomada de decisão dos fisioterapeutas sempre leve em consideração o desfecho relacionado à recuperação pós-exercício que se objetiva atingir com a intervenção.

O artigo 2 da presente dissertação é pioneiro na descrição das percepções de atletas profissionais de futebol masculino acerca da efetividade de estratégias de *recovery*. Os atletas têm confiança na efetividade de algumas, mas não todas, estratégias de *recovery* comumente aplicadas no contexto do futebol. Considerando as inconsistências da literatura acerca da efetividade das estratégias de recuperação no contexto do futebol, expressas no estudo 1, recomenda-se que os fisioterapeutas conheçam e levem consideração as crenças e preferências dos atletas sob sua responsabilidade na tomada de decisão sobre qual estratégia de *recovery* adotar. Ainda, se necessário, trabalhos educativos podem ser direcionados aos atletas para buscar uma maior aderência e aumentar as chances de sucesso da intervenção escolhida.

6 IMPACTOS DO TRABALHO

O presente trabalho teve como maior intenção conseguir auxiliar o profissional fisioterapeuta na sua tomada de decisão na prática clínica. As recomendações abordadas trarão, apesar das inconsistências da literatura, luz a um tema contemporâneo, no qual a atuação do fisioterapeuta ainda é muito pautada em experiências individuais e guiada por apelos mercadológicos. Saber não apenas as melhores técnicas, mas em que momento e para qual objetivo utilizá-las é a base para a efetividade da nossa atuação e para a consolidação da valorização e do reconhecimento técnico e científico da nossa profissão. A PBE é o caminho mais objetivo para desempenhar com mais segurança e com menor desperdício de recursos. Ao atuarmos junto a atletas com a devida responsabilidade que temos com sua saúde e, em muitos casos, com a sua profissão, não podemos arriscar lançar mão de técnicas sem benefícios comprovados. Em relação ao tema desta dissertação, a adequada recuperação de um atleta pode ser um divisor de águas entre a performance, a lesão e, inclusive, o desempenho da equipe. Os resultados deste trabalho irão, portanto, estimular a produção de conhecimento acerca deste tema e instigar o pensamento crítico do profissional.