A Scoping Review for Hamstring Injury Risk Monitoring in Australian Rules Football

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Hamstring strain injuries (HSIs) are the most common time loss injury sustained in male Australian Football League (AFL) athletes, causing significant financial cost, time cost, and impaired team and individual performance. In a squad of 42 players, HSIs accounted for 4.86 new injuries sustained by players per club per AFL season in 2020. This is consistent with injury reporting over the last decade in AFL, despite best efforts to reduce the rate. This scoping review sought to firstly identify the reported hamstring injury prevention risk factors in elite AFL, discern the impact of these factors, and map the gaps in the current literature using a biopsychosocial understanding of injury prevention. The scoping review process was based on the Askey and O'Malley framework. Five relevant online databases (MEDLINE, Proquest, CINAHL, SPORTdiscuss, and EMBASE) were systematically searched using a series of Boolean and operator terms following the PRISMA-ScR protocol using the criteria: (1) assessing male professional/elite athletes in AFL; (2) written in English and peer-reviewed; (3) full text available; and (4) published after 2006. Only manuscripts that fit the search terms and inclusion criteria were retained in the scoping review. Following an initial search, 246 potential studies were identified, with 12 studies meeting the inclusion criteria after full-text screening. The risk factors examined were subclassified into modifiable and non-modifiable categories. Modifiable factors include high-speed running exposure, gluteus medius activation, eccentric hamstring strength, shorter bicep femoris fascicle length, use of interchange, and hamstring stiffness. Non-modifiable factors include previous history of HSI and limb injury, age, and size of injury on MRI. This scoping review highlights the need for continued monitoring of high-speed running volumes as rapid increases in completed distances present as a substantial risk factor. The modifiable mechanistic risk factors of eccentric hamstring strength and hamstring stiffness were identified as important components of player screening to reduce the risk of future HSI. Risk factors identified throughout will help develop comprehensive injury profiling for athletes. Further research is warranted to develop a holistic approach to injury profiling.

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Australian Rules Football is a contact sport involving high-speed running, rapid change of direction, kicking, and ground ball maneuvers [1]. The Australian Football League (AFL) is the pinnacle competition for Australian Rules Football, with 18 teams competing over 23 rounds in-season and up to four games in the final series over seven consecutive months per year to win the grand final. The league also seeks to evolve the rules of the game, with the intent of maximizing commercial revenue through increasing spectator interest and viewership, and balancing these needs with player safety. In 2006 the AFL implemented rule changes aimed at increasing game speed which have the potential to effect historical HSI risk and rates. These changes included a 30-s limit for set shots and a 4.5-m protected area around players taking free kicks or marks. Hamstring strain injuries (HSIs) were the most

common time loss injury sustained in male AFL athletes in 2020 [2]. This statistic for time loss is also consistent with injury reporting over the past decade [3][4][5]. In a squad of 42 players, HSIs accounted for 4.86 new injuries sustained per club per AFL season in 2020, with 74% occurring during matches and the remainder occurring during training [2]. The recurrence rate on the ipsilateral side within the same season was the sixth-highest injury, with a 20% recurrence rate [1]. HSIs result in significant financial loss to the AFL clubs, with the average cost of a single HSI increasing by 56%, from AUD 25,603 to AUD 40,021 [2][4]. Therefore, it is critical to identify risk factors that potentially reduce the rate of injury and financial burden within the AFL [6].

Injury literature classifies the risk factors associated with any particular injury as either non-modifiable or modifiable [7]. A non-modifiable risk factor is defined as a factor that is inherent to the individual injured and cannot be modified by intervention or circumstance [7]. In contrast, a modifiable risk factor responds to change or intervention positively or negatively [7]. The two most discussed non-modifiable risk factors for HSIs are increasing player age and previous history of HSI [6][8][9]. Recent research has centered around identifying modifiable risk factors for HSI's in the AFL that can be targeted through interventions such as eccentric knee flexor strength during the Nordic hamstring exercise or biceps femoris long head fascicle length [6][10][11][12]. This focus aligns with the findings of Bourne et al. [13], who highlighted that hamstring muscle architecture and strength measurements provide valuable insights into HSI risk profiles. They reported that previously injured hamstrings displayed alterations in muscle architecture and reduced eccentric strength, supporting the importance of these modifiable factors in injury prevention strategies. Importantly, if possible, identified modifiable risk factors and the tools for monitoring these factors should reflect the debate on the mechanism of injury i.e., strain vs force [14][15]. The strain-induced model proposes that excessive muscle lengthening during eccentric contractions leads to injury, while the force-induced model suggests that excessive muscle forces, regardless of length changes, are the primary cause. The work of Bourne et al. [13][16] highlights that both architectural factors (related to strain) and strength deficits (related to force capacity) play important roles in reinjury risk, suggesting an integrated approach may be most appropriate. However, a lack of consensus exists around which factors are predictors of injury or how regularly testing should occur, which also reflects the conjecture on the mechanism of injury. Considering the range of modifiable factors in preventing HSI, identifying a comprehensive screening test or tests to monitor HSI risk in AFL players may assist in mitigating the risk of injury.

Anecdotal evidence from allied health professionals recognizes player health as multifactorial, and all elements of the athlete should be considered when identifying risk factors related to HSIs. It has been identified that a stressful family or workplace situation may affect the body's capacity to recover from training loads that were previously well tolerated, leading to an increased risk of an athlete sustaining a HSI [17]. Considering the interplay between biomechanical and psychosocial factors leading to injury (such as variations in factors influencing external load and internal capacity), exploring these factors holistically may assist in a better understanding of potential contributors around the time of injury.

This study aimed to identify potentially useful HSI risk monitoring tools in elite field team sport athletes, specifically for AFL athletes. In doing so, we sought to discern the impact of these monitoring tools and map the gaps in the current literature using a biopsychosocial understanding of injury prevention. A scoping review was conducted over

a systematic review as it is hypothesis-generating in nature, versus a systematic review which is hypothesis-testing. A scoping review allowed us to identify knowledge gaps, scope the literature available, and clarify concepts around HSI risk factors in the AFL. This scoping review may be helpful to a future systematic review to assess the quality of evidence and challenge the hypothesis further [18].

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