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A Literature Review on the Intrinsic and Extrinsic Factors Predictive of Hamstring Injuries in Professional, Collegiate, and High School American Football Players, and how Soccer Research can Inform Prevention in American Football

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ABSTRACT

Background: Hamstring injuries are common in American football and can cause significant time loss, reinjury, and reduced athletic performance. Previous papers do not properly address physical, physiological, and environmental factors that affect hamstring injuries in American football. This literature review examined intrinsic and extrinsic factors predictive of hamstring injuries in professional, collegiate, and high school American football players, comparing findings with soccer research to identify potentially transferable prevention strategies. American football is the primary focus, with soccer research serving as a source of prevention evidence rather than an equally weighted assessment of injury predictors.

Methods: Peer-reviewed studies from 2006 to 2026 were reviewed using PubMed, Google Scholar, and SPORTDiscus. Studies were selected if they focused on hamstring injury risk factors, mechanisms, or prevention in American football or soccer athletes.

Results: The strongest intrinsic risk factors included previous hamstring injury, reduced flexibility, hamstring-to-quadriceps strength imbalance, side-to-side asymmetry, and neuromuscular performance deficits. Extrinsic factors included preseason exposure, special teams plays, open-field sprinting, rapid deceleration, workload, and position-specific demands. Soccer studies reported reductions in hamstring injuries through eccentric hamstring strengthening and structured neuromuscular warm-up programs, suggesting that these strategies may inform prevention in American football. Together, these findings suggest a prevention approach that addresses athlete-specific vulnerabilities while preparing players for American football's high-speed movement demands.

Conclusion: Hamstring injuries in American football are multifactorial and result from the interaction between athlete-specific weaknesses and football-specific demands. Prevention should go beyond static stretching and general conditioning by including eccentric hamstring strengthening, neuromuscular warm-ups, progressive sprint exposure, cutting control, and deceleration training. Soccer-based strategies should be adapted to American football's specific contact demands, equipment load, and position-specific movements. Prevention strategies should also be tailored to meet specific athletes' needs, rather than follow a 'one-size-fits-all' approach. Future research should focus more directly on football-specific prevention programs, especially for high school and collegiate athletes.

INTRODUCTION

Hamstring injuries are among the most common soft-tissue injuries in American football, impacting every level of play. In professional football, hamstring strains account for approximately 12–15% of all reported injuries, making them one of the most frequent non-contact injuries in the National Football League (Elliott et al., 2011). At the collegiate level, hamstring strains occur at a rate of about 0.8–1.1 injuries per 1,000 athlete-exposures, with higher rates during games than practices (Boltz et al., 2024). At the high school level, studies report that hamstring injuries account for roughly 10% of all football-related injuries, demonstrating that the risk is present across different levels of play (Garcia et al., 2022).

Furthermore, hamstring injuries in football have high recurrence rates, with research indicating that approximately 20–30% of athletes experience reinjury, often within the same season or shortly after return to play (Orchard & Best, 2002). These injuries also result in a significant loss of playing time, with NFL players missing an average of 2–3 weeks per hamstring strain, depending on severity (Elliott et al., 2011). These statistics highlight both the frequency and impact of hamstring injuries in football populations. Despite training focused on strengthening hamstrings, injury rates remain high.

The hamstring complex is a group of three muscles located in the posterior thigh that connect the pelvis to the lower leg (Hu & Raja, 2026). These muscles act across both the hip and knee joints, playing a critical role in lower-body movement and stability during walking, running, and jumping (Kellis et al., 2021). Functionally, the hamstrings are responsible for hip extension and knee flexion, working in coordination with surrounding muscles such as the gluteus maximus and the quadriceps (Kellis et al., 2021). In addition to producing movement, they are essential for controlling movement (Kellis et al., 2021). During dynamic activities like running, the hamstrings contract eccentrically—lengthening while under tension—to decelerate the lower leg before foot contact (Schache et al., 2012). This eccentric action is especially important during the late swing phase of sprinting, when the muscles experience both maximal stretch and force simultaneously, placing them under significant mechanical stress (Thelen et al., 2005).

Most hamstring injuries occur when the forces placed on the hamstring exceed its structural capacity (Hickey et al., 2022). This most often occurs at the musculotendinous junction, where muscle fibers transition into tendons (Crema et al., 2022). One primary mechanism of injury is excessive stretch, which

occurs when the hip flexes while the knee extends, lengthening the hamstring across both joints (Lempainen et al., 2022). Additionally, eccentric overload during high-speed running can place extreme strain on muscle fibers, making sprinting a high-risk activity for injury (Bourne et al., 2016).

American football and soccer both involve high-speed sprinting, rapid deceleration, and changes of direction. These shared movements require the hamstrings to produce force while also controlling and slowing the lower limb, placing them under substantial eccentric loading. American football involves distinct contact demands, equipment loads, and position-specific movements, including special teams plays, which differ from soccer. Despite these differences, these similarities provide a reason to examine soccer research for useful prevention strategies and consider how they can be adapted for American football. The most relevant comparison is between movement demands rather than identical plays or positions. Open-field running in American football and sprinting during soccer match play both require athletes to run at high speeds and respond to changes in movement. The reviewed studies identify high-speed running as an important injury context in both sports. This provides a basis for considering whether exercises used to prevent hamstring injuries in soccer could help prepare American football players for similar demands.

- Previous papers have yet to sufficiently address the interplay among biomechanical, physiological, and environmental risk factors that contribute to a higher incidence of hamstring injuries across different levels of American football (Freckleton & Pizzari, 2013). People still need to better understand why these factors affect the hamstring so greatly and what an athlete or institution can do to address them. To address these items, this study provides a literature review of the most common intrinsic and extrinsic factors that can lead to hamstring injuries in American football players of all ages, as well as strategies to prevent them by tying in soccer prevention strategies. Soccer research is included to help identify prevention strategies that may address shared movement demands. The reviewed soccer literature provides more prevention-focused evidence, allowing this review to consider how these findings might inform American football prevention while recognizing that their effectiveness cannot be assumed to transfer directly between sports. Specifically, this review considers how soccer-based eccentric strengthening and neuromuscular warm-up programs could inform changes to American football training and preparation. The more detailed examination of American football positions and play situations is intended to identify where these prevention approaches may need sport-specific adaptation.

METHODS

A literature search was conducted using PubMed, Google Scholar, and SPORTDiscus. Additional studies were identified through backward citation searches of the reference lists of relevant articles. All articles were retrieved between March and April 2026. Search queries included combinations of keywords such as “hamstring,” “injury,” “football,” “soccer,” “prevention,” and “American football.” Boolean operators (AND) were used to refine searches (e.g., “hamstring injury AND football AND American”). Filters were

applied to include peer-reviewed articles and restrict publication dates to the period from 2006 to 2026. Sources were selected based on their relevance to the topic, with an initial title screening followed by abstract or full-text analysis as needed. In the initial title screening, sources were kept when hamstrings, American football, or athletes were mentioned. The abstracts or full texts of these articles were then reviewed to determine their inclusion. Articles were selected that provided substantive insight into hamstring injury mechanisms, risk factors, and prevention strategies.

To better understand hamstring injuries in comparable sporting contexts, we included studies if they examined hamstring injuries in American football or in soccer athletes at the professional, collegiate, or high school level. This was to allow for a greater number of articles used to generate a broader understanding of the topic. Both intrinsic factors (e.g., strength imbalances, flexibility, and previous injury history) and extrinsic factors (e.g., training load, playing conditions, and competition level) were considered. Only peer-reviewed studies published between 2006 and 2026 were used to ensure a balance between foundational and recent research. Studies that were less directly relevant to hamstring strain mechanisms or athletic populations were not a primary focus of this review. The included studies were grouped by sport (soccer and football) and analyzed with respect to intrinsic and extrinsic factors to identify broader patterns.

Information was manually selected, reviewed, and organized to highlight key themes, including study design, sample size, participant characteristics, variables examined, and key findings. No automation tools were used. Primary attention was given to data items, including identified predictors of hamstring injury and the effectiveness of prevention or rehabilitation strategies. General trends across studies were prioritized over isolated findings.

A qualitative synthesis approach was used to identify patterns, consistencies, and discrepancies across studies. No formal meta-analysis was conducted. The goal of this review is to integrate results across multiple studies to develop a comprehensive understanding of hamstring injury risk factors. No statistical software was used.

RESULTS

Soccer

Across the included soccer-focused studies, hamstring injury risk was associated with both intrinsic and extrinsic factors (Askling et al., 2003). The most common intrinsic factors identified included previous hamstring injury, reduced hamstring strength, lower eccentric strength, hamstring-to-quadriceps strength imbalance, and reduced flexibility (Freckleton & Pizzari, 2013). Several studies identified a history of prior injury as a major risk factor for future hamstring injury (Askling et al., 2003). Other studies examined strength and flexibility measures as predictors of injury risk (van der Horst et al., 2015). Extrinsic factors included match exposure, preseason training, sprinting demands, and workload (Maniar et al., 2023). Soccer studies frequently reported hamstring injuries during high-speed running or

sprint-related actions and showed match play exposes players to greater injury risk than regular training (Maniar et al., 2023). Overall, the soccer literature included more prevention-focused studies than the American football literature, with many studies examining whether structured exercise programs reduced hamstring injury rates (van der Horst et al., 2015).

The clearest prevention findings in the soccer literature came from eccentric strengthening and structured neuromuscular warm-up programs (Askling et al., 2003). The Nordic Hamstring Exercise was one of the most supported interventions (van der Horst et al., 2015). In a 2015 randomized controlled trial of male amateur soccer players, van der Horst et al. found that the Nordic Hamstring Exercise reduced hamstring injury incidence from 0.8 injuries per 1,000 player-hours in the control group to 0.25 injuries per 1,000 player-hours in the intervention group. In a 2003 investigation, Askling et al. also reported fewer hamstring injuries in elite soccer players after preseason strength training with eccentric overload. Multicomponent programs were also effective. In male collegiate soccer players, a 2024 study by Silvers-Granelli et al. found that the 11+ injury prevention program, which consists of running exercises, core and leg strengthening exercises, balance, plyometrics, and agility drills, decreased hamstring injury risk by 63% compared with a traditional warm-up, with higher compliance producing greater reductions in injury risk. Similarly, the Extended Knee Control program, a coach-led warm-up targeting strength and balance with 10 progression levels for each, reduced weekly prevalence of hamstring, knee, and ankle injuries compared with other prevention approaches (Sjökvist et al., 2022). Across these soccer prevention studies, interventions involving eccentric hamstring strengthening or multicomponent neuromuscular exercise programs reported reductions in hamstring injury rates, whereas studies focused solely on stretching or general conditioning showed less consistent preventive effects.

American Football

Across the included football-focused studies, the strongest evidence for hamstring injury risk came from intrinsic factors, particularly prior injury history, flexibility, strength balance, and broader neuromuscular performance, while extrinsic factors were most clearly reflected in exposure context, season timing, and movement demands (Iguchi et al., 2016). Several additional football studies focused on prognosis or return to play rather than on pre-injury risk and were therefore less useful for answering the central research question (Jenkins et al., 2024). Few studies focused on high school football; instead, most highlighted collegiate and NFL-level American football (Elliott et al., 2011).

Among the intrinsic predictors, the clearest prospective evidence came from collegiate cohorts. In a preliminary prospective study of male American college football players, 25 of 78 players (32.1%) sustained a hamstring strain, and lower hamstring flexibility, a lower hamstring-to-quadriceps (H:Q) strength ratio, and a lower general joint laxity score were identified as risk factors (Mizutani et al., 2023). A second prospective collegiate study of Japanese American football players recorded 63 total injuries, including 23 hamstring strains, and found that vertical jump height significantly predicted hamstring strain occurrence ($p = 0.02$), suggesting that neuromuscular performance may be relevant to future injury

risk (Iguchi et al., 2016). Cross-sectional collegiate football data also showed that side-to-side lower-limb asymmetries and H:Q imbalances were present even when ratios were generally within commonly cited normal ranges, supporting the possibility that subtle strength asymmetries may still matter in football populations (Tatlıcıoğlu et al., 2019).

Not all intrinsic variables were consistently predictive (Wille et al., 2022). In a prospective cohort of 129 Division I football athletes, biceps femoris long head fascicle length was not associated with future hamstring injury, suggesting that a commonly proposed structural variable did not predict injury in this sample (Meier et al., 2025). The same study reported that athletes with BMI $\geq$ 30 had a lower risk of hamstring injury (OR 0.27, 95% CI 0.08–0.84, $p = 0.03$). Similarly, another prospective study found that preseason eccentric hamstring strength was not associated with later hamstring strain injury after controlling for known risk factors and sex (Wille et al., 2022). Together, these findings suggest that single physical measurements may be insufficient for predicting injury risk and that screening should instead consider multiple interacting factors.

Professional football studies reinforced the importance of injury history and the multifactorial nature of risk (Jenkins et al., 2024). In a 12-year NFL review, 2,101 hamstring injuries were documented in 1,354 players, with 442 players (33%) sustaining a subsequent reinjury and 27% of those reinjuries occurring during the same season (Jenkins et al., 2024). Mean injured-reserve duration was 2.4 ± 2.1 weeks (Jenkins et al., 2024). The high reinjury rate despite this relatively short recovery period highlights the importance of careful rehabilitation and return-to-play decisions. Defensive skill players accounted for the largest share of injuries (50.4%), followed by offensive skill players (37.7%), suggesting that position-specific demands may influence injury burden (Jenkins et al., 2024). More advanced modeling work also supported a multifactor approach (Sharma et al., 2025). In a cohort of 93 American football players (9 injured, 84 uninjured), the best predictive model combined intramuscular fat radiomics, muscle imbalance variables, and injury-profile data, achieving an AUC of 0.79 (95% CI 0.78–0.79) (Sharma et al., 2025). This further supports using combined risk profiles rather than relying on a single predictor.

The main extrinsic findings came from NFL epidemiology and football-specific mechanism studies (Herzog et al., 2023). In a five-season NFL analysis, 5,780 lower-extremity strains were reported in 2,769 players, representing a 1-year risk of 26.7% (Herzog et al., 2023). Hamstring strains accounted for 54.7% (3,163/5,780) of all lower-extremity strains, and 69% of lower-extremity strains resulted in time loss (Herzog et al., 2023). These findings emphasize the significant effect of hamstring injuries on player availability and the need for effective prevention strategies. The highest game injury rate occurred during the preseason at 2.9 per 10,000 player-plays, suggesting that season timing and exposure load are important contextual factors (Herzog et al., 2023). By play type, punt plays had the highest strain rate at 14.9 per 1,000 plays, followed by kickoffs (7.5), pass plays (4.3), and run plays (2.6), further suggesting that special teams and high-speed open-field scenarios may create greater hamstring strain exposure (Herzog et al., 2023). Therefore, prevention efforts may benefit from preparing athletes for repeated high-speed running and football-specific exposure demands. Narrative football reviews and video analysis

were consistent with these findings, describing hamstring injuries as frequently occurring during high-speed running, sprinting, and explosive movement (Lamplot & Matava, 2016; Myslinski et al., 2025).

A smaller portion of the American football literature addressed prevention or post-injury classification rather than true prediction (Hollabaugh et al., 2025). A systematic review of static stretching in football codes identified 35 studies, of which only 4 were analytic, and none were randomized controlled trials, indicating weak evidence that static stretching alone prevents hamstring injury (Rogan et al., 2013). A retrospective collegiate classification study reported 21 tears in 121 athletes (17.3%), with 89.3% of injuries occurring before the season and all injuries occurring in practice; median return to play was 26 days, and reinjury risk was 19.0% (4/21), although classification grade was not significantly associated with return-to-play time (Hollabaugh et al., 2025). These studies were useful descriptively, but they contributed less directly to identifying predictors of injury.

DISCUSSION

Hamstring injury risk in American football is best understood through the interaction between extrinsic demands and intrinsic vulnerabilities, where the highest-risk movements and exposure conditions act as triggers that expose underlying athlete-specific weaknesses (Mizutani et al., 2023). Rather than being caused by one isolated factor, hamstring injuries appear to occur when sport-specific demands such as sprinting, cutting, rapid deceleration, preseason workload, and high-speed play interact with factors such as previous injury, reduced flexibility, H:Q imbalance, asymmetry, and neuromuscular deficits (Freckleton & Pizzari, 2013). This interaction is the main premise supported by the findings and suggests that prevention should address both the demands placed on the athlete and the athlete's ability to tolerate those demands.

In soccer, the strongest evidence for predicting hamstring injury centered on previous injury, strength deficits, eccentric weakness, H:Q imbalance, and flexibility limitations, while extrinsic contributors included match exposure, sprinting demands, preseason training, and workload (Askling et al., 2003; van der Horst et al., 2015). However, literature on soccer differed from that of American football in that it provided clearer prevention-focused evidence (van der Horst et al., 2015). It did this particularly through eccentric strengthening programs, such as the Nordic Hamstring Exercise, and structured neuromuscular warm-ups, such as the 11+ program (Silvers-Granelli et al., 2024; Sjökvist et al., 2022; van der Horst et al., 2015). In American football, the strongest predictors were also related to previous injury, flexibility, H:Q strength ratio, and neuromuscular or performance deficits, while extrinsic contributors were more closely tied to preseason exposure, play context, and high-speed movement demands (Herzog et al., 2023; Mizutani et al., 2023).

At the same time, some commonly proposed screening variables, such as fascicle length and isolated preseason eccentric hamstring strength, were not supported as independent predictors in football cohorts (Meier et al., 2025; Wille et al., 2022). Specific to football, certain findings suggested that isolated single-measure screening tools may have limited predictive value (Wille et al., 2022). Additionally, studies show that future hamstring strain in American football is better explained by integrated structural and functional measures than by any one variable alone (Sharma et al., 2025). While studies about soccer may help answer questions related to prevention strategies that can cross over to football, it is most important to focus on the extrinsic factors that place athletes at risk in American football first, in order to understand how they expose certain intrinsic factors and guide prevention strategies.

High-Speed Movement and Position-Specific Demands

One major pattern in American football literature is that hamstring injury risk appears to be strongly shaped by extrinsic demands (Herzog et al., 2023). Most notably, the extrinsic factors that seem to most strongly affect hamstring injury are player position, preseason exposure, play type, and high-speed movement requirements (Herzog et al., 2023). These factors matter because football does not expose all athletes to hamstring strain in the same way; instead, the risk varies depending on when athletes play, what type of play they are involved in, and how often they are required to sprint, accelerate, or decelerate at high intensity (Myslinski et al., 2025).

For example, Jenkins et al. (2024) found that defensive skill players accounted for the largest share of hamstring injuries at 50.4%, followed by offensive skill players at 37.7%. These skill players include variants of receiver on offense and cornerback on defense. Typically, receivers play the position on the field that requires the most acceleration and deceleration, often planting their foot and cutting hard on the turf at high speeds (Wellman et al., 2016). Cornerbacks, who cover receivers, have to adapt to these changes and react in real time. This can explain why hamstring injuries occur most often in these groups on the field, as these injuries align with the skill positions that are asked to do the most.

Intrinsic factors such as reduced flexibility, a lower hamstring-to-quadriceps strength ratio, and side-to-side asymmetry may help explain why some athletes are more vulnerable during these high-speed, position-specific movements (Tatlıcıoğlu et al., 2019). One of the clearest intrinsic factors was reduced hamstring flexibility (Iguchi et al., 2016). In a study by Mizutani et al. (2023), 25 of 78 male American college football players sustained a hamstring strain, and lower hamstring flexibility was identified as one of the risk factors. This matters in the context of football because many high-risk movements place the hamstrings in a lengthened position while they are also producing force (Myslinski et al., 2025). During sprinting, the hamstrings lengthen rapidly as they slow the lower leg before foot contact. When this occurs repeatedly during open-field plays, special teams plays, or preseason practices, athletes with lower flexibility may have less ability to tolerate that lengthening stress. Therefore, reduced flexibility may not cause injury on its own, but it may become more important when an athlete is repeatedly asked to sprint, stop, cut, and accelerate at high intensity.

Strength balance was another major intrinsic factor related to these same high-speed movement demands (Tatlıcıoğlu et al., 2019). Mizutani et al. (2023) also identified a lower hamstring-to-quadriceps strength ratio as a risk factor, and Tatlıcıoğlu et al. (2019) found that collegiate football players showed side-to-side lower-limb asymmetries and H:Q imbalances. This is important because the hamstrings and quadriceps work together during sprinting, cutting, and deceleration (Tatlıcıoğlu et al., 2019). The quadriceps help produce powerful knee extension, while the hamstrings help control the lower leg and assist with hip extension (Kellis et al., 2021). If the hamstrings are weaker than the quadriceps, the athlete may be able to generate speed and power but may not have sufficient posterior-chain control to safely slow the limb. This is especially relevant for receivers, defensive backs, and special teams players, as these athletes often accelerate, decelerate, and change direction at high speed.

Rapid Cutting, Deceleration, and Asymmetry

Side-to-side asymmetry is closely linked to the movement demands of football (Tatlıcıoğlu et al., 2019). Football movements are rarely balanced or predictable. Players cut off one leg, plant in different directions, absorb contact unevenly, and react to opponents in real time. Because of this, even subtle lower-limb asymmetries may matter. An athlete may appear generally strong, but if one side is weaker or less controlled than the other, that side may be placed under greater stress during sudden cuts or decelerations. This helps explain why broad strength or conditioning alone may not fully capture injury risk in football athletes.

These movement demands are especially relevant for skill players because receivers and defensive backs repeatedly plant, cut, and react at high speed. In these situations, the extrinsic demand is the rapid change in speed or direction, while the intrinsic vulnerability may be poor strength balance or uneven control between the two sides of the body. Therefore, the high-speed deceleration itself may not cause injury in every athlete, but it may expose an underlying weakness when the athlete has insufficient hamstring strength relative to the quadriceps or greater weakness on one side.

Additionally, neuromuscular performance also appeared to be important. In a 2016 investigation, Iguchi et al. found that vertical jump height significantly predicted hamstring strain in Japanese American football players. While this does not mean that jumping itself causes hamstring injuries, it suggests that general lower-body performance may reflect deeper qualities such as power production, coordination, and force control. Since football requires repeated bursts of sprinting, jumping, cutting, and sudden changes of direction, athletes with poorer neuromuscular control may place greater stress on the hamstrings during explosive movements.

Special Teams Plays and High-Speed Sprint Exposure

Specifically, when examining the phases of the game in which hamstring injuries occur most often, we can see that they occur most in fast-paced areas of the game, such as special teams plays like punts and kickoffs (Elliott et al., 2011). Herzog et al. (2023) found that punt plays had the highest strain rate at 14.9 per 1,000 plays, followed by kickoffs at 7.5, pass plays at 4.3, and run plays at 2.6. This offers a different

perspective on hamstring injury risk, showing that these injuries occur during the highest-speed parts of the game.

This can also be explained by recognizing that in all three phases of football, it is the duty of both teams to sprint as fast as they can to one area and slow down quickly to either block an opponent or tackle the runner. In run plays, this distance is shortened and usually restricted to a couple of yards per play. However, punt and kickoff plays typically span over fifty yards of the field, meaning that this slowing occurs at much higher speeds after a prolonged period of running. These findings align with Lamplot and Matava (2016) and Myslinski et al. (2025), who reported that hamstring injuries frequently occur during high-speed running, sprinting, and explosive movement patterns.

The intrinsic factors identified in the football literature help explain why these high-speed special teams plays may be especially dangerous for certain athletes. Lower flexibility may reduce an athlete's ability to tolerate repeated lengthening stress during sprinting, while a lower H:Q ratio may limit the hamstrings' ability to control the lower leg during rapid deceleration (Iguchi et al., 2016). Side-to-side asymmetry may also place one leg under greater stress when the athlete suddenly cuts or slows down (Tatlıcıoğlu et al., 2019). Therefore, the prolonged sprinting and high-speed deceleration required during punts and kickoffs may act as extrinsic triggers that expose these underlying intrinsic vulnerabilities.

It is important to note that the NFL recently changed its kickoff formations to reduce injuries, and further research is needed to assess the effect on hamstring injury rates (National Football League [NFL], 2024).

Preseason Exposure and Athlete Readiness

Preseason exposure is also thought to affect hamstring injuries heavily (Herzog et al., 2023). Herzog et al. (2023) also found that the highest game injury rate occurred during the preseason at 2.9 per 10,000 player-plays. In the NFL, the preseason consists of the first few games before the regular season, used to evaluate player talent and help athletes get accustomed to the physicality of the game (NFL, 2019). Although these games occur early in the year, when athletes may be expected to be less worn down from a full season, hamstring injuries are most common during this time (Herzog et al., 2023). This could be explained by the fact that the preseason is a time in the NFL when players must fight for their spot on the team, leading to more aggressive, high-speed movement and game-like conditions very early in the season, straining the hamstrings.

Intrinsic factors help explain why this preseason exposure may affect some athletes more than others. Prior injury history, reduced flexibility, a lower H:Q strength ratio, side-to-side asymmetry, and broader neuromuscular or performance deficits may make athletes less prepared to tolerate repeated high-speed movements when game-like demands increase (Iguchi et al., 2016; Mizutani et al., 2023; Tatlıcıoğlu et al., 2019). When athletes are repeatedly asked to sprint, stop, cut, and accelerate at high intensity, these athlete-specific weaknesses may become more important.

The higher injury rate during preseason and on special teams suggests that hamstring injuries may be caused not only by individual weaknesses but also by the specific environments and movement demands athletes are placed in. While extrinsic factors help explain when and where hamstring injuries occur in American football, intrinsic factors help explain why certain athletes may be more vulnerable when placed in those situations. These findings suggest that hamstring injuries are not caused only by the external demands of football but also by how prepared an athlete's body is to handle those demands.

Multifactorial Injury Risk

At the same time, the football literature showed that not every proposed intrinsic measure was consistently predictive (Wille et al., 2022). Meier et al. (2025) found that biceps femoris long head fascicle length was not associated with future hamstring injury risk, and Wille et al. (2022) found that preseason eccentric hamstring strength was not associated with later hamstring strain after controlling for other factors. These findings suggest that football injury risk cannot be fully explained by one isolated measurement. A single strength test or structural variable may miss the bigger picture of how the athlete moves, their injury history, and the external demands they face during practices and games.

Because of this, the strongest interpretation is that injury risk in football is multifactorial. Sharma et al. (2025) supported this idea by finding that the best predictive model combined intramuscular fat radiomics, muscle imbalance variables, and injury-profile data. Overall, the findings suggest that hamstring injury risk is best understood through the interactions among flexibility, strength balance, asymmetry, neuromuscular performance, and prior injury history during repeated sprinting, cutting, preseason workloads, and high-speed play. In American football, these athlete-specific weaknesses may become most harmful when they are exposed by repeated sprinting, cutting, preseason workloads, special teams plays, and other high-speed movement demands.

Prevention

Because hamstring injury risk in American football appears to result from high-speed extrinsic demands exposing underlying intrinsic vulnerabilities, prevention should directly target an athlete's ability to tolerate eccentric force during sprinting, cutting, and rapid deceleration. The soccer prevention findings are important because soccer and American football share similar hamstring-risk mechanics. In both sports, athletes sprint at high speeds, cover open space, decelerate quickly, and change direction, which places eccentric stress on the hamstrings. Since football injuries were also linked to high-speed running, sprinting, special teams plays, and open-field movement, the prevention strategies that reduced hamstring injuries in soccer may be useful for football as well. This is especially true because the hamstrings are stressed in similar ways during both sports: they must help produce speed while also controlling the leg and slowing the body down during rapid movement. Since football hamstring injuries are closely tied to preseason exposure, skill-position play, special teams, and high-speed movement demands, prevention should focus on increasing the capacity of athletes to tolerate these demands rather than relying solely on general stretching or basic conditioning.

The clearest soccer-based strategy that could transfer to football is eccentric hamstring strengthening (van der Horst et al., 2015). Van der Horst et al. (2015) found that the Nordic Hamstring Exercise reduced hamstring injury incidence from 0.8 injuries per 1,000 player-hours to 0.25 injuries per 1,000 player-hours in soccer players, and Askling et al. (2003) also reported fewer injuries after preseason eccentric overload training. For context, the Nordic Hamstring Exercise is a bodyweight movement where a person is on their knees with their ankles secured and slowly lowers their upper body toward the floor by extending at the knees and slowly comes up (van der Horst et al., 2015). This exercise targets primarily the biceps femoris, semitendinosus, and semimembranosus muscles, which form the outer and inner hamstrings (Askling et al., 2003). The Nordic Hamstring Exercise is known for building muscle and preventing injury (Askling et al., 2003). These findings suggest that football programs should include consistent eccentric hamstring work, as the hamstrings are often injured when lengthening under force during sprinting, cutting, and rapid deceleration. By improving the hamstrings' ability to tolerate eccentric force, this type of training directly addresses the mechanism that may make athletes vulnerable during high-speed movement. This would be especially important for receivers, defensive backs, and special teams players, since these athletes are repeatedly asked to sprint, plant, decelerate, and react at high speeds. Football programs should also use structured neuromuscular warm-ups, like those used in soccer, rather than relying solely on traditional warm-ups or static stretching. In soccer, the 11+ program reduced the risk of hamstring injury by 63%, and the Extended Knee Control program lowered the weekly prevalence of hamstring, knee, and ankle injuries (Silvers-Granelli et al., 2024; Sjökvist et al., 2022). For football, this supports using warm-ups that include balance, landing control, core stability, sprint mechanics, cutting technique, and progressive acceleration/deceleration drills. These programs would help athletes not only strengthen their hamstrings but also improve their lower-body control during explosive movements.

While soccer-specific injury prevention programs can be a strong foundation, football injury prevention programs should be modified to address the sport-specific extrinsic demands that may trigger underlying intrinsic vulnerabilities. Teams should use these soccer programs to help their athletes strengthen their hamstrings and prevent injuries where they are most likely to occur. However, these soccer programs should not be copied directly into football without adjustment. Football has unique contact demands, position-specific movements, equipment load, and special teams situations that soccer does not fully replicate. Therefore, football hamstring injury prevention should be targeted toward the situations where injury risk is highest. Because injury rates were elevated during the preseason and on special-teams plays, teams should gradually introduce sprinting volume, cutting, and contact-speed drills rather than suddenly increasing intensity. The reason hamstring strain is most common during preseason may be related to the rapid increase in football-specific running and high-speed movement demands after a period of reduced exposure to these activities (Herzog et al., 2023). Skill players and special teams athletes may also need extra hamstring strengthening and deceleration training because their positions expose them to more high-speed running. Overall, soccer prevention research suggests that hamstring injuries in football can be reduced by consistently training the hamstrings to tolerate eccentric force, improving neuromuscular

control, and tailoring prevention programs to football-specific demands such as preseason workload, open-field sprinting, and rapid deceleration (Silvers-Granelli et al., 2024). This approach directly addresses both sides of the injury mechanism by improving intrinsic capacity while preparing athletes for the extrinsic demands most likely to expose weakness.

CONCLUSION

Hamstring injuries in American football are best understood as multifactorial injuries caused by the interaction between athlete-specific weaknesses and the demands of the sport across professional, collegiate, and high school levels. The strongest predictive intrinsic factors include prior injury history, reduced flexibility, hamstring-to-quadriceps strength imbalance, side-to-side asymmetry, and neuromuscular performance deficits, while the clearest extrinsic factors include preseason exposure, special teams plays, open-field sprinting, rapid deceleration, and position-specific movement demands (Herzog et al., 2023; Iguchi et al., 2016). Because of this, prevention should go beyond static stretching or general conditioning and instead focus on eccentric hamstring strengthening, neuromuscular warm-ups, progressive sprint exposure, cutting control, and deceleration mechanics. Soccer research shows that eccentric strengthening and structured warm-up programs can reduce hamstring injuries, but these strategies should be adapted to fit football's unique contact demands, equipment load, and movement patterns (Silvers-Granelli et al., 2024). Overall, reducing hamstring injuries in American football requires a combined approach that addresses both the athlete's physical risk factors and the sport's high-speed demands, while future research should focus more directly on football-specific prevention programs, especially for high school and collegiate athletes. Future reviews could also examine whether rugby-based injury prevention research offers additional insights relevant to American football.

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