An Evidence-Based Injury Prevention Framework for Youth Soccer: Stretching, Nutrition, and Training Strategies

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Abstract:
This paper proposes a comprehensive guideline for preventing common injuries among adolescent soccer players, utilizing evidence-based strategies. The paper will identify the most common injuries in this population and describe the characteristics of each injury, including factors such as frequency, anatomical location, and mechanism. Based on the injuries highlighted, the project will develop targeted stretching routines and evidence-based guidelines to help minimize injury risk. The paper will then present evidence by referencing existing studies that support the effectiveness of the devised routines and guidelines at preventing injuries. Finally, using all the information gathered, this paper will summarize the key findings into a clear, evidence-based set of recommendations aimed at helping adolescent athletes, parents, and coaches reduce the risk of common soccer injuries.

Introduction:

More than one-third of high school students participate in organized sports; these students gain numerous benefits, including physical fitness, overall health, improved teamwork and discipline, and better mental well-being.[1] However, this rising participation has been linked to a concerning increase in sports-related injuries, especially among adolescent soccer players.[2] To address this issue, research has been conducted in the field of sports medicine to evaluate the effectiveness of various evidence-based prevention strategies and guidelines. While helpful, these studies often focus on breadth rather than depth and provide fragmented guidance. The shortcomings of current studies in addressing the growing adolescent soccer player population sparked a question that this research paper seeks to answer: What are the most common injuries among adolescent soccer players, and how can evidence-based prevention strategies (including training routines) reduce the risk of occurrence? This paper aims to identify the most common injuries in youth soccer and synthesize evidence-based prevention strategies focused on training programs.

Literature Review:

Adolescent soccer players frequently suffer from performance-limiting injuries, most of which affect the lower extremities. This consistent trend can be explained by the sport's physical demands, such as sprinting, cutting, pivoting, and repeated player-to-player contact. These actions primarily involve the lower limbs, contributing to the high incidence of lower-body injuries, including those affecting the thighs, knees, and ankles.[2] Adolescent athletes have unique risk factors compared to adults: rapid growth and open growth plates temporarily increase bone vulnerability, making athletes more prone to strains, sprains, and overuse injuries.[2] Growth spurts can also lead to decreased coordination, muscle growth, and strength imbalances, and increased stress on bones and joints. Additionally, inadequate nutrition, including insufficient caloric intake, protein, calcium, or vitamin D, can limit muscle recovery, bone strength, and overall physical resilience, further increasing the likelihood of injury.[3] Considering these developmental and nutritional factors alongside other risk factors like strength and flexibility is essential for effective and personalized injury prevention.

This section details the four major injury sites affecting adolescent soccer players, highlighting key features such as anatomical location, mechanism, and frequency. For each injury, evidence-based prevention strategies are introduced, and their reported effectiveness is summarized. This information synthesizes the current scientific literature on adolescent soccer injury prevention.

Thigh muscle injuries of the hamstrings and quadriceps are among the most common injuries of adolescent soccer players.[4] These injuries frequently result from specific actions such as sudden accelerations and sprints, and forceful kicking. These movements are heavily utilized during soccer games, and their repetitive nature results in greater strain on the hamstrings and quadriceps.[4] In our specific population of adolescent soccer players, the muscle imbalances characteristic of pubertal growth spurts provide another unique vulnerability to injuries (a trend common among all types of injuries).[2] A lack of flexibility, inadequate muscle activations, and fatigue from overtraining are all major culprits in thigh injuries.[5]

The key features of thigh injuries are anatomical location, mechanism, and frequency. Thigh injuries commonly affect two major muscle groups: the hamstrings and the quadriceps.[4] The muscles in the hamstring group–consisting of the biceps femoris, semitendinosus, and semimembranosus–are located at the back of the thigh and connect the pelvis to the back of the knee. These muscles flex the knee and extend the hip. The hamstring muscle group is especially strained when sprinting and decelerating quickly (very common in soccer). During these actions, the hamstring muscles undergo an eccentric contraction, in which the muscle fibers lengthen while generating force to slow down the leg. This places significant stress on the biceps femoris, and if the muscle is not able to withstand it, the muscle fibers can tear. This acute rupture is known as a hamstring strain or tear, depending on severity. Additionally, this injury can occur during both the eccentric (lengthening) phase and during forceful concentric contractions.[7] Hamstring strains, in particular, are among the most common non-contact muscle injuries that adolescent soccer players can face.[6] Older adolescents and males tend to have a higher rate of injury compared to their counterparts.[4] One study found that hamstring strains occur at approximately 0.3 to 1.9 times per 1000 exposure hours in youth soccer, with recurrence rates significantly higher (4-68%).[6]

The muscles in the quadriceps group–consisting of the rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius–are located at the front of the thigh and connect the femur and pelvis to the patella. The quadriceps are used to extend the knee, which makes them essential for activities like running, jumping, and kicking. Contrary to the hamstrings, quadriceps strains occur through concentric contractions–when the muscle shortens while producing force. The rectus femoris is the most frequently injured muscle in the quadriceps group because it is highly active during kicking motions. Since the muscle crosses both the hip and knee joints, extra stress is placed when the two joints are moving dynamically in opposite directions**.** The quadriceps don't "snap" like the hamstrings, but rather pop with a sharp pain in the front of the thigh.[8] This is mainly due to the different mechanisms of the muscle groups. Although not as commonly injured as the hamstrings, they account for approximately 5% of all soccer injuries and 19% of muscle-tendon injuries. They are the third most frequent muscle injury in soccer players.[9] Unlike hamstrings, females are significantly more likely to face quadriceps injuries. Data from NCAA surveillance showed that women's soccer had an incidence rate of 5.61 per

10,000 athlete exposures (AEs) compared with 2.52 per 10,000 AEs in men's soccer. An AE is commonly used in sports injury surveillance and is defined as one athlete participating in one practice or competition where there is a risk of injury.[10]

To prevent thigh injuries, injury prevention programs that focus on addressing muscle imbalances, flexibility, and neuromuscular control have been proven effective.[4] Eccentric strengthening exercises, such as the Nordic hamstring curl, have been shown to reduce hamstring injury incidence. This is because these types of exercises strengthen the hamstrings and increase muscle-tendon resilience.[11] Quadriceps injuries can also be prevented with eccentric and concentric exercises, such as Bulgarian split squats. Additionally, regular stretching of both muscles can allow the corresponding muscle to absorb more stress and therefore prevent muscle fiber tears. Universal prevention methods, such as adequate stretching and muscle activation before games, are essential for preventing injuries.[5]

Knee ligament injuries, although less common than muscle strains, are much more serious and alarming to athletes' doctors. These injuries are characterized by their long recovery times, high recurrence rates, and functionally limiting nature.[13] Most knee injuries involve rapid directional changes, awkward landings, quick pivots, and direct contact–all of which happen frequently on the soccer field.[14] The adolescent period presents unique risks for knee injuries because it weakens neuromuscular control and, in turn, decreases coordination.[2] This weakening simultaneously contributes to muscle imbalances between the hamstrings and quadriceps, leading to instability in the knee joint.[12] In addition to the risk factors for hamstring injuries, knee injuries are also caused by improper landing mechanics and inadequate strength in the stabilizing muscles of the hips and core.[14] Knee injuries consist of a family of various injuries; however, this paper will focus on the most common ones: the ACL and MCL. Although PCL and LCL injuries occur, the mechanisms of injury are so rare on the soccer field that they are not worth mentioning. These injuries typically require high-impact trauma, such as that seen in car accidents, making them uncommon in soccer.

The anterior cruciate ligament (ACL) is one of the knee-stabilizing ligaments that connect the femur to the tibia. It runs diagonally through the center of the knee and, with the help of the PCL, provides rotational stability to the knee during fast directional changes, decelerations, or jumps. The ACL, unlike the PCL, helps prevent the shin from shooting forward when stopping or cutting, making it a more realistic and dangerous injury on the pitch. ACL injuries are commonly non-contact and occur when the knee is suddenly forced into an unnatural position, such as valgus collapse (knee caving in) or hyperextension (during a rapid stop or pivot). An example of this is an athlete planting their foot to cut directions while the upper body continues to move forward, causing excessive strain on the ACL. When the force placed on the ligament–due to the intensive action–exceeds its capacity, the ligament tears.[14] These tears, while being predominantly non-contact, can still occur through contact if a significant enough blow is delivered to the outside of the knee. The overall injury rates for female soccer players are consistently higher than those of their male counterparts. One study states that the female ACL injury incidence ranges from 0.116 to 0.32 per 1000 AEs, while among male athletes it ranges from 0.040 to 0.12 per 1000 AEs.[15] The same "universal" risk factors from thigh injuries affect the chance of injury, but it has been found that females have a significantly higher chance of an ACL injury than males.

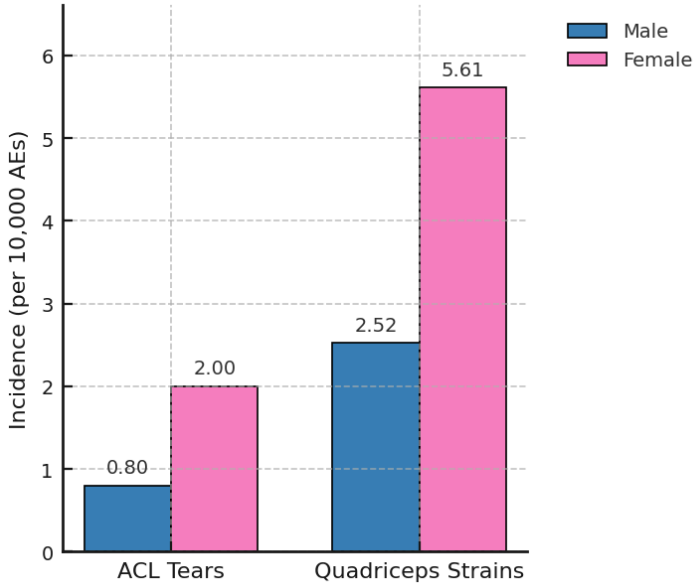

Figure 1 | Sex-specific incidence of ACL tears and quadriceps strains in adolescent soccer players. Bar graph showing injury incidence rates in male (blue) and female (pink) players, expressed as injuries per 10,000 athlete exposures (AEs). Female athletes demonstrated higher rates of both anterior cruciate ligament (ACL) tears (2.0 vs. 0.8 per 10,000 AEs in males) and quadriceps strains (5.61 vs. 2.52 per 10,000 AEs in males). Data derived from systematic reviews and epidemiologic surveillance studies in adolescent and collegiate soccer populations.[10,15]

The medial collateral ligament (MCL) is another key knee-stabilizing ligament that connects the femur to the tibia and runs along the medial side of the joint. This ligament is responsible for resisting inward pushing forces. It also helps the knee stay stable during various actions such as cutting, side-stepping, and direct collisions from the outside of the leg. MCL tears are commonly contact injuries and occur when an outside force pushes the knee inward, putting stress on the MCL. If the force applied to the knee exceeds the threshold of force that the MCL can withstand, the MCL is torn. These tears can also occur without contact through awkward landings or missteps, but are less frequent.[17] MCLs occur more frequently than ACLs, with an injury rate of 0.33 per 1000 player-hours. MCL injuries are nine times more likely to occur during a game, and 70% of the time, they are caused by contact.[16] There is limited data on the incidence of MCL injuries by sex in adolescent soccer players. Even from the ACL data showing females have a higher injury rate and a higher likelihood of ligament injuries than males, it would be speculative to conclude MCL injury incidences for females. Further research is necessary on the different injury rates between sexes for MCL injuries in soccer.

Preventing these injuries is crucial to ensure athletes' health and prevent them from missing a significant amount of time from play. For knee injuries, various methods targeting risk factors such as muscle imbalances, neuromuscular control, and correcting incorrect movement mechanics are available. Having strong hamstrings and quadriceps is essential for helping reduce the strain on the knee ligaments. Strengthening these thigh muscles is crucial for improving knee control during high-risk movements and should be incorporated into injury prevention programs.[12] To improve neuromuscular control, programs incorporating plyometrics, balance exercises, agility drills, and proper movement mechanics have been shown to reduce the risk of knee injuries.[18]

Ankle injuries are widespread in adolescent soccer players. The ankle is responsible for absorbing the mechanical loads caused by interactions between the players and the ground,

such as running, jumping, and quick changes of direction. Since these actions occur frequently in soccer, considerable stress is placed on the ankle joint. Applying excessive strain without appropriate precautions can cause injuries. The risk factors for ankle sprains are similar to those seen in other injuries mentioned earlier, including fatigue, poor proprioception, previous injuries, and more. Ankle injuries can range from mild sprains to severe ligament tears. This paper will focus on lateral ankle sprains, medial ankle sprains, and high ankle sprains, which are the most common in adolescent soccer.[2]

The lateral ankle sprain, the most common ankle injury in adolescent soccer, affects the ligaments on the outside of the ankle joint. The key ligaments involved are the anterior talofibular ligament (ATFL), calcaneofibular ligament (CFL), and the posterior talofibular ligament (PTFL). These ligaments stabilize the ankle joint by preventing excessive inversion (rolling inwards); therefore, when the ankle is excessively inverted, these ligaments are stretched beyond their capacity, causing injuries. This injury and the rolling inward motion associated with it commonly occur during plantarflexion (when the foot is pointed downward). This sprain is common among soccer athletes as it involves rapid changes of direction, jumping, and uneven ground contact.[19] Among the three ligaments, the ATFL is the most frequently injured because it is the weakest. Of all ankle injuries, the lateral ankle sprain makes up 62-67% of all ankle-related injuries in soccer players.[2]

Medial ankle sprains, although less common than lateral ones, still pose a significant concern for soccer players. This injury involves excessive strain on the ligaments on the inside of the ankle—primarily the deltoid ligament complex—which is essential for stabilizing the ankle and preventing it from rolling outward during weight-bearing activities. Because of the biomechanics of the ankle and the greater strength of the medial ligaments compared to the lateral ligaments, medial ankle sprains happen less often. These injuries typically occur when the ankle joint excessively everts (rolls outward), stretching the ligaments beyond their capacity. In soccer, this eversion frequently occurs during sudden changes of direction, awkward landings, or contact collisions that cause the foot to roll outward.[20] Unlike lateral ankle sprains, medial sprains usually occur when the ankle is in a neutral or dorsiflexed position (foot toward shin).[21] Although medial ankle sprains account for only about 8–14% of all ankle injuries in soccer players, they can cause significant pain and lead to lost time due to injury.[2]

To reduce the risk of ankle sprains, several methods/treatments have been developed to target key risk factors, including a lack of proprioception, muscle weakness, and overall joint instability. One of the most common treatments involves ankle taping or bracing. These techniques help provide greater stability to the joint through external support. Taping/bracing the ankle was shown to reduce the risk of ankle sprains by 50-70% in individuals with a history of ankle sprains. However, data on taping versus bracing were gathered separately. Taping offers more immediate support, while bracing provides consistent support and can be reused (cost-effective). Deciding between tape vs brace also depends on skin irritation or allergic reactions to the tape, but the brace can also interfere with footwear fit (especially if bulky). Bracing is generally recommended for long-term ankle injury prevention, while taping may be used for a more short-term purpose or during the rehabilitation process.[22]

Methods:
This research paper gathers findings from various sources to produce a comprehensive guideline for injury prevention in adolescent soccer players. Articles were identified using keywords such as “most common injuries in soccer,” “ACL prevention strategies for adolescent soccer players,” and “injury prevention in youth sports,” primarily through public research databases like PubMed and Google Scholar. Studies were chosen based on their applicability to adolescent soccer players.

Relevant studies were grouped based on four primary research aims:

- *Aim 1*: Identify the most common injuries among adolescent soccer players and describe them by key features such as frequency, anatomical location, and mechanism (contact vs. non-contact).
- *Aim 2:* Investigate the primary risk factors linked with each identified injury and, based on these findings, develop targeted stretching routines and training guidelines aimed at reducing injury risk.
- *Aim 3*: Evaluate the effectiveness of the formulated training routines in preventing their respective associated injuries.
- *Aim 4*: Develop a comprehensive, efficient training program that addresses the prevention of the most common injuries among adolescent soccer players.

Each article’s findings were summarized with respect to the aim with which it correlated. Additionally, the Notion app was used to help organize and track information with its corresponding sources. This method enabled the effective comparison of studies and helped identify consistent, evidence-supported injury prevention strategies, which informed the development of ideas expressed in this paper.

Results:
Our review found consistent evidence from multiple sources indicating that adolescent soccer players experience a higher rate of lower-body injuries compared to other types of injuries.[2] Based on both prevalence and the duration of time missed from play, the most impactful injuries were classified by their anatomical location: thigh, knee, and ankle. These injuries, listed in order of decreasing prevalence, include hamstring strains, quadriceps strains, lateral ankle sprains, medial ankle sprains, MCL tears, and ACL tears.[6,10,15,16,2] While knee ligament injuries occur less frequently than muscle or ankle injuries, they tend to be more severe and require a longer recovery, making them particularly important to address.[13] These injuries usually happen from sprinting, quick changes of direction, awkward landings, or contact during play.[4] Additionally, risk factors such as gender, age, and growth-related changes can further influence injury likelihood, with female athletes, for example, exhibiting higher rates of ACL tears.[15] By evaluating both frequency and severity, this review emphasizes the injuries that present the greatest overall risk to adolescent soccer players.

Injury Type	Mechanism	Frequency	Prevention
Hamstring Strain	Sprinting, sudden acceleration, and deceleration[7]	0.3-1.9 per 1000 exposure hours; recurrence 4-68%[6]	Eccentric strengthening (nordics), stretching, proper warmups, and muscle activations[5,11]
Quadriceps Strain	Running, jumping, and kicking[8]	5% of all soccer injuries; 19% of muscle-tendon injuries; higher in females (5.61 vs. 2.52 per 10,000 AEs)[10]	Eccentric and concentric strengthening (Bulgarian split squat), stretching, proper warmups, and muscle activations[5,11]
ACL	Rapid directional changes, deceleration, and awkward landings[14]	0.116-0.32 per 1,000 AEs in females, 0.040-0.12 per 1,000 AEs in males[15]	Strengthen hamstrings and quadriceps, plyometrics, balance exercises, agility drills, and proper landing mechanics[12,18]
MCL	Outside contact force pushing the knee inside[17]	0.33 per 1,000 AEs; 9x more likely in games; 70% contact injuries[16]	Strengthen hamstrings and quadriceps, neuromuscular control, and proper movement mechanics[12,18]
Lateral Ankle Sprain	Excessive inversion, rapid changes in direction, and jumping[19]	62-67% of all ankle injuries[2]	Ankle taping or bracing, proprioception exercises, strengthening, and balance training
Medial Ankle Sprain	Excessive eversion, awkward landings, contact collisions[20]	8-14% of all ankle injuries[2]	Ankle taping or bracing, proprioception exercises, strengthening, and balance training[22]

Table 1. Overview of the mechanism, frequency, and prevention of common injury types.

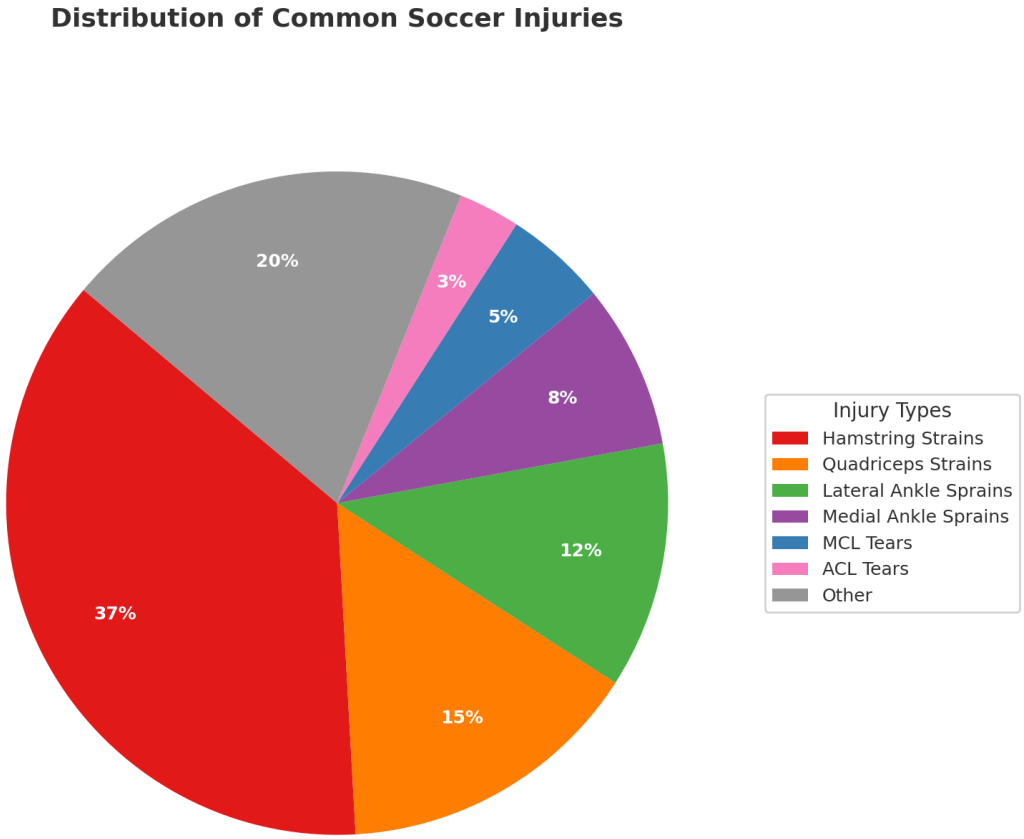

Figure 2 | Distribution of common injuries in adolescent soccer players. Pie chart illustrating the relative proportions of common soccer-related injuries. Hamstring strains were the most frequent (37%), followed by quadriceps strains (15%), lateral ankle sprains (12%), medial ankle sprains (8%), medial collateral ligament (MCL) tears (5%), and anterior cruciate ligament (ACL) tears (3%). Other injuries accounted for 20% of cases.

Discussion/Analysis:
This review of the existing literature on soccer injuries confirms that the lower body is the most common site of injury. Hamstring strains, quadriceps strains, lateral and medial ankle sprains, and knee ligament tears pose the greatest risk. Keeping players safe on the field is a top priority. By identifying these injuries and exploring prevention strategies for each, this review offers valuable insights into how adolescent soccer players can reduce their risk. These findings directly address the research question by highlighting both the major injuries and the evidence-based programs available to help prevent them.

The prevention strategies described in the literature review differ in both their evidence strength and level of detail. Hamstring strains have been closely studied, and eccentric strengthening exercises, such as the Nordic hamstring curl, have demonstrated clear effectiveness in reducing the incidence and recurrence of these injuries. In contrast, quadriceps strengthening through exercises like the Bulgarian split squat is advised, but these guidelines are broader and less injury-specific compared to the highly targeted hamstring programs. A similar trend is observed with knee ligament injuries: ACL prevention strategies, including neuromuscular control, agility drills, proper landing mechanics, and plyometrics, are well-supported by multiple studies. In contrast, MCL-specific interventions are less frequently examined and are often generalized to knee ligament injuries rather than being tailored to the MCL specifically. Ankle sprain prevention is another area of strong agreement, especially regarding taping or bracing, although programs often do not differentiate between lateral and medial ankle sprains. Overall, while several effective prevention strategies exist, evidence is strongest for specific injuries, indicating opportunities for more targeted study.

While the literature provides useful insights into common soccer injuries and prevention strategies, several limitations impact the confidence in applying these findings to adolescents. A significant limitation is that not all studies focused on adolescents; many included adults or mixed-age groups. Because puberty brings unique risk factors, findings from larger populations may not fully reflect the adolescent experience. Similarly, these studies sometimes focused on athletics as a whole rather than specifically on soccer. This overlooks the distinctive conditions of soccer players and limits the strength of the data collected. Another limitation is how injuries were defined and categorized. In some studies, ankle and knee injuries were combined. In contrast, others emphasized only high-profile injuries such as ACL tears or hamstring strains, underrepresenting conditions like MCL or quadriceps strains. To address this, future studies should standardize injury definitions, which would improve comparability and strengthen the reliability of findings. Furthermore, nearly all studies reviewed were observational. Without randomized assignment, we cannot draw causal conclusions about prevention strategies. Finally, the variability across studies in injury definitions, populations, and designs makes it more challenging to generalize the results.

The findings of this review can be used to develop a proven injury-prevention program aimed at maintaining adolescents' health or serve as a basis for customized programs specifically designed for youth soccer players. Current evidence strongly supports strategies such as Nordic hamstring curls, neuromuscular training, and ankle bracing, which can be combined into a comprehensive prevention program. To further strengthen such programs, more research focusing on adolescent-specific populations is needed to consider growth-related changes and

variables such as training load. Future work should involve experimental studies designed to establish cause-and-effect relationships and assess the effectiveness of these strategies in real-world youth soccer environments. By focusing future efforts on the specific needs of adolescents, more effective and evidence-based prevention guidelines can be created for this expanding group of players.

Conclusion:

This review ultimately identified the lower body as the most common site of injuries in adolescent soccer players, with hamstring strains, quadriceps strains, lateral and medial ankle sprains, and ACL and MCL tears posing the most significant risk and resulting in the most time away from play. While all the prevention strategies discussed in this paper are evidence-based, the strength of that evidence varies. Nordic curls for hamstrings, along with neuromuscular training, plyometrics, and proper landing mechanics for ACL injuries, are the most strongly supported, reflecting the high research focus on these injuries. Other strategies, although supported, are less reliable; for example, MCL interventions are generally effective for knee ligament injuries, but they lack MCL-specific data.

These findings are directly relevant to young athletes, parents, and coaches in the real world. By accounting for growth-related changes, considering nutritional aspects, and identifying the most common injuries, stakeholders can implement structured, evidence-based training programs, warm-ups, and recovery routines tailored to adolescent soccer players. Coaches can develop practices that include neuromuscular training, proper landing mechanics, and sport-specific strength exercises, lowering the risk of high-impact injuries like ACL tears. Parents can support adherence to at-home preventive routines, monitor training loads, and promote recovery. Athletes themselves benefit by developing awareness of which movements and training habits place them at greater risk, as well as how to take ownership of their long-term health. Ultimately, applying these strategies yields substantial benefits, including minimizing time lost to injury, maximizing on-field performance, and promoting sustainable physical health during critical years of adolescent development.

This paper provides a foundation for coaches, youth programs, and sports medicine practitioners to adopt more effective injury prevention strategies in adolescent soccer. By integrating the most evidence-based exercises—such as Nordic hamstring curls, neuromuscular training, and landing mechanics—into regular training, teams can proactively reduce injury risk rather than reacting after injuries occur. Beyond the team level, these findings can guide club and league policies, promoting the use of standardized warm-up protocols and player monitoring systems across youth soccer programs. Over time, this could shift the culture of adolescent sports toward prioritizing long-term athlete health, ensuring that players not only perform at their best during their teenage years but also sustain athletic longevity into adulthood. By further developing adolescent-specific prevention programs, youth soccer can balance performance and player safety, ensuring long-term growth and continued participation in the sport.

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