Anterior cruciate ligament injury prevention: who is responsible for implementation and what are the challenges?

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The incidence of anterior cruciate ligament (ACL) injuries is increasing in the UK, with a particularly sharp increase among young female athletes participating in sport. ACL injuries result in significant morbidity, with a profound impact on the physical, mental and social health of individuals, alongside lengthy rehabilitation. Therefore, primary prevention of ACL injuries is desirable. The intrinsic and extrinsic risk factors associated with ACL injury, such as deficits in neuromuscular control, impaired movement quality, fatigue, strength imbalances, and subopti mal load management, are shared with a spectrum of other lower-limb musculoskeletal injuries. This overlap supports the concept that ACL injury prevention may not be best considered a condition-specific endeavour, but rather as a component of a comprehensive lower-limb injury prevention strategy. ACL prevention interventions typically include multi-component training methods designed to improve neuromuscular control, functional performance, balance, strength and power. while often framed around ACL injury reduction, their effects extend beyond the knee, conveying protection against other lower-limb injuries and improving overall performance. Despite a growing body of evidence demonstrating the efficacy of neuromuscular injury prevention programmes, their translation into routine practice has been inconsistent. This annotation outlines the current best evidence relating to ACL injury epidemiology and the effectiveness of injury prevention strategies, supporting a transition to integrate ACL injury prevention into wider, sport-specific lower-limb injury prevention programmes. In doing so, it highlights key stakeholders and barriers relevant to large-scale implementation of injury prevention programmes.

Take home message

- The incidence of anterior cruciate ligament (ACL) injuries is rising, particularly among adolescent female athletes in the UK, with significant long-term physical, psychological, and socioeconomic consequences.
- Despite strong evidence for the effectiveness of ACL injury prevention interventions, national-level implementation in the UK remains inadequate and inconsistent.
- Successful ACL injury prevention requires collaborative, multi-stakeholder engagement, including athletes, coaches, governing bodies, schools, healthcare professionals, and government.
- Both top-down policy strategies and bottom-up community engagement are essential to ensure widespread adoption, compliance, and sustainability of prevention initiatives.

Bone & Joint Open

The growing burden of ACL injuries and why prevention works

Anterior cruciate ligament (ACL) injury is one of the most common and feared sporting injuries affecting professional and recreational athletes, with both contact and non-contact mechanisms of injury. While mainstream media frequently highlight injuries that occur in professional athletes, these account for a fraction of those occurring in grassroots participants. In the UK, there are an estimated 20,200 ACL injuries per year,[1] with a four- to six-fold greater risk of ACL injury in females per hours of sport played compared to males.[2] This disparity reflects an interaction between sex-specific biomechanical differences in movement and neuromuscular control, hormonal influences on ligament laxity and muscle function, and gendered environmental factors including differences in coaching, training exposure and access to injury prevention resources.[3,4] A diagnosis of an ACL tear has a considerable physical and psychological impact on the lives of professional and recreational athletes, especially for children and adolescents, and can result in extended time away from sport. Furthermore, ACL injury carries substantial long-term consequences, including high rates of re-rupture, a 40% to 50% risk of developing knee osteoarthritis within ten to 15 years irrespective of treatment strategy,[5,6] and the wider effects of disengagement in sport, typically occurring during a critical period for the development of lifelong physical activity habits.

The management of ACL injury is patient-specific, and focused on achieving a functionally stable knee, with preserved range of motion. For individuals with demanding levels of activity involving changes of direction and pivoting, surgical reconstruction is often indicated.[7] In the UK, the rate of reconstruction has increased 12-fold in the last two decades to 24.2 per 100,000.[8] This increase in incidence has been attributed to both improvements in the diagnosis of ACL injuries, as well as an increase in participation in youth female sport.[9] Concurrently, there has been an increase in ACL reconstructions in this same demographic,[10] emphasizing the need for effective, scalable injury prevention interventions with subsequent implementation and sustainability.

Strong evidence demonstrates that injury prevention is both effective and cost-efficient. Multi-component neuromuscular warm-up programmes have successfully reduced musculoskeletal injury rates across various settings. An evidence-based, multi-disciplinary rugby injury prevention intervention known as 'Activate' instigated a warm-up protocol with neuromuscular training exercises, and demonstrated a reduction in injury rates in the UK.[11,12] This success was possible through collaboration between researchers, charities, athletes, clinicians, national governing bodies, policymakers, teachers and industry partners. Through rule and policy changes (implemented by the Rugby Football Union), research and technology (gumshield sensors and brain health research), education and awareness campaigns, and government-led initiatives (UK Government's Concussion in Sport Guidelines),[13] strategy has been implemented to reduce disease burden. The considerable burden of ACL injuries in the UK represents an important opportunity for these groups to work together to effect meaningful change in the setting of ACL injuries. Despite over fifty years since the initial proposal of ACL injury prevention interventions, ACL injury prevention training is yet to be widely and sustainably adopted at a national or global level.

While the evidence shows that ACL reconstruction resulted in a 65% to 95% return to sport,[14-16] and 55% to 90% return to a competitive or elite level of sport,[16,17] there remains a significant proportion of patients who do not return to their pre-injury level of activity. The increase in incidence of ACL injury has gained attention in both the current literature, and more recently mainstream media outlets in the UK. This has resulted in renewed interest from all stakeholders (including athletes themselves) in injury prevention initiatives to reduce this growing burden.

ACL injury prevention programmes

It is important to appreciate the distinction between an injury prevention 'intervention', shown experimentally to reduce injury rates, and the wider application of this intervention to a target population beyond the controlled setting, an injury prevention 'initiative'. In the setting of ACL injury prevention, the term 'programme' has been used interchangeably to describe both interventions and initiatives, with a number of programmes combining a novel intervention with steps to encourage wider application such as the FIFA 11 .[18] ACL interventions, programmes, and initiatives can be used to prevent a primary ACL injury (primary prevention), to minimize the sequalae of ACL injury, or to prevent re-injury following treatment (secondary prevention). While individual injury prevention programmes differ in structure and delivery, many share common neuromuscular principles and demonstrate similar reductions in injury risk when implemented effectively. Programme selection alone does not determine success; implementation fidelity and contextual suitability are critical.

ACL injury prevention interventions

While interventions encompass environmental, physical, psychological, and social adaptions, in this context, an ACL injury prevention 'intervention' refers to a set of exercises (or non-exercise-based intervention) designed to reduce the risk of injuries. The most widely known ACL injury prevention interventions are multicomponent training methods centred around the development of improved neuromuscular control, lower limb biomechanics, functional performance, balance, strength and power. Examples include the exercises within the FIFA 11+ and the Prevent Injury and Enhance Performance (PEP) (Table I). While a number of interventions have been shown to be effective, there is no widely accepted single optimal injury prevention intervention in the literature. We identified twenty-three clinical studies evaluating the effect of ACL prevention interventions across a variety of sporting activities and levels (Supplementary Material table i). Overall, 13 of these studies (56.5%) are randomized controlled trials, while the remaining ten are cohort studies (43.5%). A total of 17 of the studies (73.9%) reported a lower incidence of ACL injuries in the intervention groups compared with control, with ten of these studies (43.5 %) reaching statistical significance. The reviewed literature shows that there is a disproportionate benefit for females from these interventions compared with males. In studies which showed no effect between prevention programmes and control groups, compliance was either reported as poor, or not recorded in the study.

Notably, incorporation of ACL injury prevention interventions provides benefits beyond reducing ACL injuries, including the prevention of lower limb musculoskeletal injuries, as well as improved sporting performance. This overlap supports the concept that ACL injury prevention may not be best considered a condition-specific endeavour, but rather as a component of a comprehensive lower-limb injury prevention strategy. The FIFA11+ as a regular warm-up significantly reduced the incidence of hamstring injury by 63% in collegiate male soccer players.[21] In addition, there is evidence that regular compliance with interventions focused on neuromuscular training results in increased balance,[22] control, and vertical jump distance.[23]

ACL injury prevention initiatives

ACL injury prevention 'initiatives' encompass both an injury prevention intervention, as well as the strategy for wider implementation. These initiatives play a crucial role and necessitate a practical, multicomponent strategy for successful implementation with cohesion at a larger scale across a variety of sporting settings.

In the early 2000s, Norway introduced ACL injury prevention interventions and initiatives with widespread implementation. utilizing the FIFA11+ intervention, the Norwegian Football Federation mandated its incorporation into training for youth and amateur soccer teams. Both coaches and players were educated and empowered to execute the intervention correctly, with coaches trained in injury prevention as part of their licencing process. The Norwegian School of Sport Sciences conducted studies to ensure its efficacy, in combination with a mandatory national ACL injury registry to continue monitoring. Following this, the initiative "Get Set – Train Smarter" on a mobile application was introduced to provide ACL injury prevention to a broader audience across different sports. A similar approach was applied nationwide for soccer players in Sweden. Between 2005 and 2015, there was a significant reduction in the number of cruciate ligament injuries in both sexes after introduction of an injury prevention initiative.[24] This multidisciplinary approach provides evidence for the efficacy of multidisciplinary input provided all partners are engaged appropriately.

While there have been a number of ACL injury prevention initiatives in the UK, evidence of successfully reducing the national injury burden does not exist. Determining such output is of course very difficult, and will take detailed analysis of injury rates over many years. Power Up to Play is a charitable initiative founded by medical professionals with the intention to enhance teenage athlete health through the prevention of severe knee injuries, including ACL rupture, in grassroot sport in the UK. Via a national network of volunteers, they have been trying to raise awareness of the effectiveness of injury prevention interventions and deliver training events for coaches to support widespread implementation of the Prevent Injury and Enhance Performance (PEP) intervention before training and competition. They provide free, educational materials via a website and offer face-to-face coach training sessions to empower correct implementation of the warm-up on a regular basis.

Who are the key partners in ACL injury prevention in the UK?

In order design a strategy to reduce the growing burden of ACL injuries in the UK, it is important to consider the key partners or stakeholders involved in tackling this problem. In the context of ACL injury prevention in the UK, a partner or stakeholder can be defined as any individual, group or organization who may be involved in the prevention or treatment of ACL injuries. They include, but are not limited to, the athlete (and family if paediatric), coaches, medical professionals (physiotherapists, sports medicine physicians and orthopaedic surgeons, nutritionists, physiologists), sports and conditioning coaches, governing sporting bodies, charities, researchers and academics, medical societies, as well as government and public health organizations. The successful design and implementation of ACL prevention initiatives is a challenge faced by the multidisciplinary team whether through direct involvement, funding, or policy influence. Involvement varies among individuals, but collaboration is necessary and a shared responsibility. Understanding the complexity of each partner and their potential roles at the respective stages of ACL injury prevention is important and the key to success.

Athletes

Athletes at all levels are the key beneficiaries of ACL injury prevention. Their active participation in intervention and initiative design, adherence to protocol and feedback are all vital to a successful implementation. As previously discussed, ACL injury results in a lengthy rehabilitation period and the risk of failure to return to pre-injury level of sport, even without consideration of the current National Health Service waiting lists. The implications of ACL injuries and subsequent rehabilitation are beyond physical injury. As well as time and missed competition, there are financial and psychological consequences that are poorly captured in the current evidence-base. Sport is often a huge part of an individual's life, especially in the child and adolescent population, and absence from activity due to injury can have profound implications on athletic development and psychological wellbeing. Alongside training with appropriate technique, sport-specific interventions can reduce the burden of ACL injuries. It is paramount that the athletes themselves understand the severity of ACL injury and engage with injury prevention throughout their career. Currently, Denmark is the only country which mandates the reporting of ACL injuries into a national database.[25] Formal registration of athletes with sporting federations presents the opportunity to capture more accurate epidemiological data within the UK, as seen in other sports, such as tennis.

Coaches and sports teams

Coaches and sports teams are responsible for the training, performance, safety, and health of their athletes. They are in a unique position with opportunity to directly implement injury prevention initiatives. Through education of athletes and supervision during training sessions and competition warm-ups, they have control over intervention duration, frequency and compliance. Certification courses could be developed to address injury prevention training for coaches, with accreditation for sports teams partaking in this activity. With access to information on current research, and

Table I. Injury prevention interventions.

Injury prevention intervention*	Yr	Sport	Overview
FIFA 11+ [19]	2006	Soccer	15 structured exercises lasting 20 minutes with emphasis on core stabilization, eccentric thigh muscle training, proprioceptive training, dynamic stabilization, and plyometric exercises, all performed with proper postural alignment.
KLIP	2004	Female athletes	A 20-minute plyometric focused training which aims to reduce the peak force and rate of force development during landing.
Sportsmetrics[18]	1986	Female athletes	A 15-minute warm up focusing on neuromuscular exercises designed to build overall leg strength and improve balance, stability and body mechanics during jumping/landing tasks.
PEP[20]	1972	Soccer	A 15- to 20-minute warm-up with emphasis on stretching, strengthening, plyometrics, and sport-specific agility training.

*A number of injury prevention programmes include both the introduction of an intervention and attempts at wider application.
FIFA, Federation Internationale de Football Association; KLIP, knee ligament injury prevention; PEP, Prevent Injury and Enhance Performance.

key resources for education on ACL injury prevention and subsequent implementation, coaches could be provided with the ability to deliver injury prevention interventions specific to their sport and athlete demographic.

Parents and guardians

Parents and guardians support young athletes through ensuring access to training sessions, as well as encouraging participation in injury prevention interventions. This could be targeted through education to foster a culture, promoting physical literacy where safety, warm-ups, and sport-specific training is promoted on a regular basis with positive reinforcement on health behaviours. There is evidence that the adolescent female athlete is most heavily influenced by her mother regarding sport decision-making;[26] therefore, an individual's parent or guardian could be key in encouraging and implementing injury prevention strategies at home.

Sporting national governing bodies

National governing bodies oversee the governance, rules, and regulations within a sport at the elite and grassroot level, with the ability to mandate the use of, or incentivize, the adoption of injury prevention interventions. They have the authority to create nationwide institutional change across sports clubs and schools through the promotion of public health and safety in sport. They provide the infrastructure, resources, and support required to implement injury prevention initiatives through the creation of policies, allocation of funding and regulation of regular training schedules. They can ensure that a consistent and unified messaged regarding injury prevention is communicated with athletes, coaches and parents. Through funding and promoting research into injury prevention, optimal interventions can be continually developed, alongside a framework to determine the efficacy of implemented interventions through a national sports injury reporting process. This regular monitoring process will support continued implementation and accreditation updating. They can set policy guidelines based on their responsibility to advocate for the safety and wellbeing of athletes to ensure that injury prevention is incorporated into training protocols at all levels.

Schools and educational institutions

In the UK, there is a strong sporting culture throughout the education system with 40% of children active at school for at least 30 minutes per day. Mandated participation in physical activity is seen internationally, regulated to different age cohorts. Schools and universities provide a platform through which individuals are exposed to physical activity, sports training, and competition. Through physical education sessions and increasing awareness in extra-curricular sports, there is ample opportunity for injury prevention implementation. For younger children, teachers may promote awareness of safe and strong movement patterns,[27] with the teachers directly involved in designing strategy for implementation to their target audience. For older children and adolescents, teachers should be empowered through education to deliver both general and sport-specific injury prevention interventions. Injury prevention could be integrated into the curriculum for children throughout their school career, as well as in teaching qualifications. Such physical literacy as it has been termed is vital for programmes to 'stick'. Institutions have a duty of care for their students and can decrease the incidence of injury through integration of injury prevention interventions, promoting health and ongoing participation in the process.

Health professionals (physiotherapists, physicians and surgeons, nutritionists, sports scientists)

Medical professionals are directly responsible for the diagnosis, treatment and rehabilitation of ACL injuries. Experience in managing the injuries provides unique expertise into the design of evidence- based injury prevention programmes, as well as the screening of athletes' physical and mental health. They are in a unique position to identify risk factors for injury. By preventing the incidence of ACL injuries, they reduce the need for the financial implications of surgery and prolonged rehabilitation. Using a multidisciplinary approach, the patient and athlete can benefit from input from each speciality.

Researchers and academics

The researchers are involved in studying ACL injury mechanisms, risk factors and injury prevention methods to develop and refine evidence-based protocols. Through meticulous methodology and rigorous examination in trials across different environments, their work ensures that ACL injury prevention interventions remain supported by scientific research and are continuously improved and tested. This then allows the dissemination of such data through research presentation and publication to affect the subsequent iteration of future interventions. As part of the process, they can improve the accuracy of outcome data through national registries of sporting injuries across clubs and educational institutions.

Professional medical associations and societies

The medical societies play a fundamental role in the education of healthcare professionals on the optimal interventions with their current evidence-base. They enable the cooperation of individuals working in a variety of environments to provide multidisciplinary input on the prevention of this debilitating injury. For example, the British Association of Sport and Exercise Medicine (BASEM), British Association for Surgery of the Knee (BASK), European Society of Sports Traumatology, Knee Surgery and Arthroscopy (ESSKA), Faculty for Sport and Exercise Medicine (FSEM), British Orthopaedic Sports Trauma and Arthroscopy Association (BOSTAA), and the British Orthopaedic Association (BOA) are specialist organizations aiming to provide a forum for research, education, and advice on expert, patient-centred healthcare management. They have important role to advocate for policy change, lead and communicate with partners and promote implementation. Implementing prevention interventions have currently proved very difficult for the medial societies. A consistent and collaborative message from a 'coalition of associations or societies' is more likely to be heard.

Media and influencers

Media and influencers can raise awareness about ACL injuries and their prevention directly to athletes, coaches, and their relevant support networks using digital campaigns, to aid in the promotion of sport-specific prevention interventions and initiatives. Through widespread dissemination of critical information outside of the sports practice setting, such as online via social media, the successful adoption of effective prevention strategies can be increased, along with the promotion of positive health behaviours and physical literacy.

Insurance companies

Insurance companies are financially invested in the health of their policy holders. ACL injuries and their management are expensive. Companies often cover medical treatments and are impacted by the duration and demands of ACL rehabilitation. By supporting interventions to reduce the injury burden, they can reduce the volume of insurance claims in this setting. They may also see lower premiums and a better consumer experience when injury prevention interventions are implemented.

Working together to achieve results

Due to the complex and multidisciplinary nature of sport, as well as the diverse involvement of stakeholders, a collaborative approach is necessitated. Both top-down and bottom-up strategies are important in successful implementation of ACL prevention interventions and initiatives in the UK. A top-down strategy would involve the design of a method for implementation and dissemination from centralized authorities such as Sporting National Governing Bodies, the government, and national sports federations. These authorities could collaborate to create frameworks, mandate protocols and oversee the nationwide implementation of ACL injury prevention interventions. For example, Sporting National Governing Bodies could mandate the inclusion of injury prevention warm-ups in their respective sports, or ensure that education on injury prevention is routinely embedded into coaching certification. This could be replicated in the schools' physical education curriculum with an emphasis or reestablishment of the value of non-sports specific physical education in early years. This approach allows for uniformity across the nation, with standardized funding allocation and integration into public health policy.

To drive behavioural change in sport, a bottom-up approach is also needed to tailor change to local contextual needs. By empowering coaches and athletes, there is an ownership of the interventions improving engagement and optimizing long-term compliance. Social media campaigns could be targeted at athletes and coaches to raise awareness of ACL injury severity and provide information on positive injury prevention behaviours. In addition, sports coaches and volunteers could be empowered with necessary education to confidently reduce injury risk for their athletes through free online resources. A hybrid strategy with integrated communication and knowledge is likely to be the most effective approach, with the combination of top-down support and standard-setting, as well as bottom-up engagement with feedback loops to ensure compliance. This model would permit central oversight and resource allocation, while empowering coaches and athletes to lead the behavioural and cultural change for sustained implementation.

Challenges to implementation of interventions

Awareness and education

Implementing widespread ACL injury prevention in the UK is complex.[28-30] Sufficient awareness at an athlete and coaching level is not currently widespread in the UK. Most individuals understand the significance of ACL injury after its occurrence, rather than through injury prevention education. In a survey of university athletes, only a third of respondents knew about ACL injury prevention programmes.[28] A successful strategy for implementation should aim to increase not only awareness of injury severity, but of the presence of effective interventions to reduce risk. When considering the best age at which to target these interventions, injury prevention and its associated education should ideally be implemented early, ideally in the primary school setting. Information and prevention initiatives should be engaging and age appropriate. A specific intervention should be chosen, with clear oversight and standards set for duration, delivery and evaluation to ensure lasting efficacy.

Adherence and feasibility

A regular concern is compliance among both athletes and coaches, due to the time commitment involved in delivering prevention strategies, as well as the physical and psychological demand of incorporating these exercises alongside routine training. A meta-analysis has demonstrated a dose-response relationship whereby greater adherence correlates with reduced rates of lower limb injuries in general, as well as specifically reducing ACL injury incidence.[29] Compliance with regular injury prevention protocols varied from 29% to 100% in the 23 studies identified by the authors. A cross-sectional study from USA showed that while 52% of coaches were aware of injury prevention interventions, only 21% reported implementing them with their team in practice.[30] Shorter, more manageable interventions to improve athlete engagement have been examined by promising results.[31] Interventions must be time-efficient, easy to understand, simple to deliver and positioned as essential components of athletic development. A debate will emerge whether such programmes should be implemented as a 'warm up' at the start of training or as a separate agility programme, covered in the outcomes of the Inaugural Meeting of the National ACL Injury Coalition in USA.[32] A mobile application, RIIP REPS (An acronym for Reduce Injuries Improve Performance), has been designed to facilitate implementation of injury prevention interventions across high school sports participants.[33] Furthermore, an approach that seeks to cover all musculoskeletal injuries (rather than targeting ACL injuries alone) will help shift negative connotations associated with a single specific injury to improving wider performance, and increasing the acceptability of programmes to coaches and players of a single all-encompassing strategy. Around the world programmes are emerging which aim to tackle the complex issues, such as the 'Prevention for All' neuromuscular training-based programme which is easily accessible to athletes of all levels.[34]

Resources, funding, and scalability

A major consideration is the funding required to implement ACL prevention both at professional and amateur levels. While professional sports teams can see a direct financial benefit in implementing interventions, the most appropriate source of funding and leadership in delivering strategies to benefit grass-roots players is less clear. However, cost analysis research from Australia has predicted that nationwide implementation of ACL prevention interventions is estimated to reduce the incidence of ACL injuries by 9%, as well as future knee osteoarthritis and subsequent knee arthroplasty by 8.1%.[35] A cost-effectiveness analysis performed alongside a randomized control trial supports this, particularly when resource-intensive screening procedures are omitted.[36] Simple, coach-friendly tools and interventions could be developed which do not necessitate significant financial investment or resources, especially for amateur implementation. Online resources that are easily accessible would facilitate the dissemination of materials across all settings.

Language, messaging, and engagement

The use of language and specific terminology when discussing injury prevention is vital in successful implementation.[37] Referring to prevention interventions as 'optimal preparation' rather than 'injury prevention' has been shown to increase compliance.[38] Focusing on performance optimization rather than the negative connotations associated with injury could increase athlete engagement, with evidence that regular compliance to injury prevention interventions results in improved overall team performance in men's soccer.[38] It is paramount that there is consistency in the message and terminology used across the UK, even between different initiatives. At a grass-roots level, emotionally resonant messaging can be used to raise awareness on social media to athletes, parents/guardians and coaches. For example, role models could discuss personal experiences, educating their audience on the impact of ACL injury on physical, mental, and social wellbeing. The messaging has to be considered most effective when based on knowledge and understanding of the injury.

Intervention heterogeneity and sport-specific demands

There remains a lack of consensus on the most effective ACL injury prevention intervention. When comparing different interventions, there is significant heterogeneity among study methodology and participant demographics, as well as optimal duration and frequency of intervention. The application of different interventions across a multitude of sporting environments makes the interpretation of current data difficult. A challenge facing the design of ACL prevention interventions is the unique lower limb biomechanical demands across different sports. Changes of direction, pivoting, jumping and landing forces, place individual forces through the ACL, necessitating unique considerations for injury prevention intervention design for different sports. This is an example of where intervention design is a multi-disciplinary effort requiring sport-specific collaboration.

Future directions

While the scientific evidence for ACL injury prevention is strong, translation into widespread practice is not yet established. Efforts to address the physical, social and structural determinants of implementation will be critical in discovering the potential of these interventions on a nationwide level. Future efforts to implement ACL injury prevention interventions must prioritize partner collaboration, policy integration and deliverable strategies that resonate with diverse sporting environments. The next step includes the designation of a nominated steering group, incorporating members from national governing bodies, the government, and healthcare workers to devise a strategy to drive change to reduce the rising incidence of ACL injuries in the UK and its associated impact on affected individuals.

ACL injury represents a substantial burden in young and active populations, but it is preventable. Despite a robust evidence base supporting neuromuscular injury prevention interventions, population-level reductions in ACL injury incidence have not been realised. This reflects the complexity of translating effective interventions into routine practice across diverse sporting environments, particularly at grass-roots level where time, resources, and expertise are limited. The challenges to implementation extend beyond programme efficacy and include issues of awareness, adherence, funding, messaging, stakeholder coordination, and long-term sustainability. Understanding these barriers is essential if

prevention strategies are to achieve meaningful and sustained impact.

Social media

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Supplementary material

A table including all identified studies examining anterior cruciate ligament (ACL) injury prevention programmes with ACL injuries as a reported outcome.

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Data sharing

All data generated or analyzed during this study are included in the published article and/or in the supplementary material.